- **Understanding SEER Ratings for Mobile Home Cooling**
  Understanding SEER Ratings for Mobile Home Cooling Tracking Power Usage in Mobile Home Heating Systems Adapting Mobile Homes for High Efficiency HVAC Equipment Comparing SEER Values to Lower Energy Costs in Mobile Homes Evaluating ROI of Efficient Upgrades in Mobile Home Air Conditioning Minimizing Heat Loss with Insulation for Mobile Home HVAC Achieving Energy Savings with Variable Speed Motors in Mobile Homes Choosing Thermostat Controls for Better Mobile Home Efficiency Calculating Long Term Benefits of Efficient Mobile Home Furnaces Checking Duct Seal Quality for Improved Mobile Home SEER Performance Pinpointing Energy Loss in Mobile Home HVAC Installations Monitoring Seasonal Impacts on Mobile Home AC Efficiency
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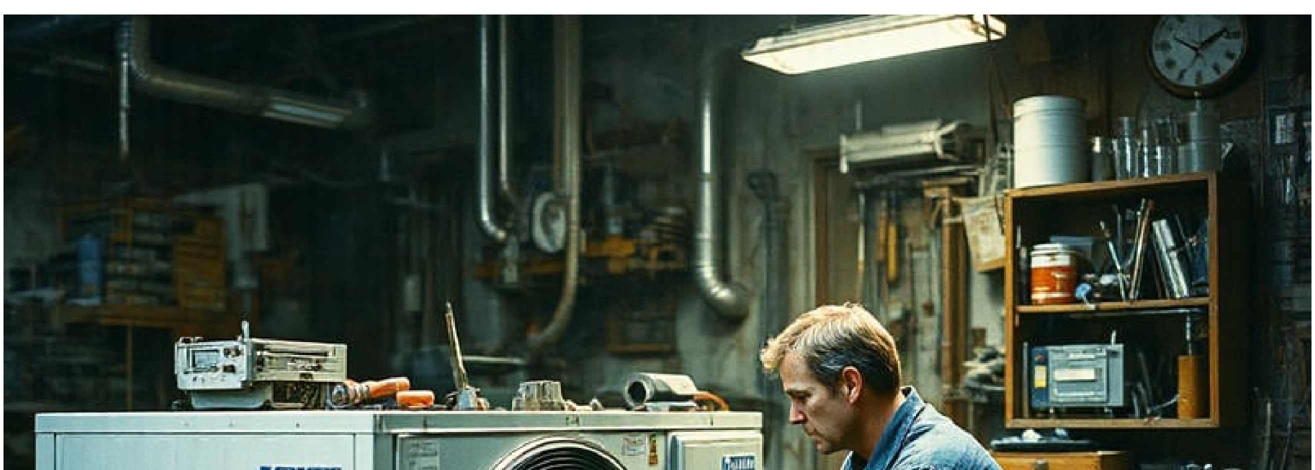
- **About Us**



Evaluating Technician Training Programs for Mobile Home Heating

How SEER Ratings Impact Energy Efficiency in Mobile Homes

Heating mobile homes presents a unique set of challenges and needs that differ significantly from those associated with traditional residential heating systems. This distinctiveness stems from the structural and material characteristics of mobile homes, which require specialized knowledge and skills from technicians tasked with their maintenance and repair. Evaluating technician training programs for mobile home heating, therefore, necessitates an understanding of these challenges to ensure that technicians are well-prepared to address them effectively.

Mobile homes are typically constructed using lighter materials than conventional houses, which impacts their thermal efficiency. Proper drainage prevents moisture buildup near HVAC units in mobile homes **mobile home hvac units** pollutant. The walls, floors, and ceilings often have less insulation, making these homes more susceptible to heat loss in colder months. Consequently, the heating systems used must be both efficient and effective in maintaining comfortable indoor temperatures without excessive energy consumption. Technicians need to be trained not only in the installation and repair of standard heating units but also in optimizing these systems for the specific conditions present in mobile homes.

Another challenge is space constraints. Mobile homes generally offer limited space for installing and servicing HVAC equipment. Technicians must be adept at working within confined areas, requiring training that emphasizes spatial awareness and adaptability. They also need to understand how to balance airflow within these smaller environments to prevent issues such as uneven heating or excessive humidity.

Moreover, many mobile homes utilize different types of heating systems compared to site-built houses, including electric furnaces or space heaters rather than central HVAC systems.

This diversity requires technicians to have a broader skill set covering various heating technologies. Training programs should incorporate modules on different system types commonly found in mobile homes to prepare technicians for any scenario they might encounter.

Safety is another crucial aspect when dealing with mobile home heating systems. Due to their construction materials and design features, improper installation or maintenance can pose significant safety risks such as fire hazards or carbon monoxide leaks. Therefore, technician training programs must prioritize safety protocols and procedures specific to mobile home environments.

Lastly, there is a growing emphasis on energy efficiency and sustainability in all housing sectors, including mobile homes. Technicians should be educated about modern energy-efficient technologies and practices that can help reduce utility costs while minimizing environmental impact-a benefit particularly important for low-income households often residing in mobile housing.

In conclusion, the unique challenges associated with heating mobile homes demand specialized training for technicians responsible for their upkeep. Effective technician training programs should address the structural peculiarities of mobile homes-such as insulation deficiencies and limited spaces-and cover a variety of heating system types while emphasizing safety standards and energy efficiency practices. By doing so, these programs will ensure that technicians are fully equipped to meet the distinctive needs of this segment of the housing market efficiently and safely.

In recent years, the demand for skilled technicians in the mobile home heating industry has surged, driven by advancements in technology and an increased focus on energy efficiency. In this context, specialized technician training programs have emerged as a critical component for ensuring that professionals are well-equipped to meet the unique challenges associated with mobile home heating systems. Evaluating these training programs is essential to ascertain their effectiveness and to highlight their importance in fostering a competent workforce.

Specialized technician training programs play a vital role in bridging the gap between theoretical knowledge and practical application. Unlike traditional HVAC systems found in conventional homes, mobile home heating systems often present distinct challenges due to their compact design and specific technical requirements. Technicians trained through specialized programs gain insights into these nuances, enabling them to deliver efficient and effective solutions tailored to the needs of mobile home residents.

One of the primary benefits of specialized training is its focus on up-to-date technological advancements. The field of mobile home heating is continuously evolving, with new technologies being integrated into existing systems to improve efficiency and reduce environmental impact. Training programs that emphasize current trends ensure that technicians remain at the forefront of innovation, equipped with the latest tools and techniques necessary for modern-day problem-solving.

Moreover, these training programs contribute significantly to safety standards within the industry. Mobile homes pose unique safety challenges due to space constraints and potential exposure risks associated with faulty heating installations. Specialized training ensures that technicians are proficient not only in installation but also in maintenance practices that adhere to stringent safety protocols. This reduces the likelihood of accidents or malfunctions, thereby safeguarding both homeowners and technicians.

The evaluation of technician training programs is crucial for several reasons. First, it provides insights into the curriculum's relevance and adaptability to real-world scenarios. Evaluations help identify areas where improvements can be made, ensuring that courses remain aligned with industry demands. Second, they offer feedback mechanisms for instructors and program developers to refine their pedagogical approaches based on participant experiences and outcomes.

Furthermore, evaluating these programs helps in establishing standardized benchmarks across different institutions offering similar courses. Standardization ensures consistency in skill levels among graduates entering the workforce, which is indispensable for employers seeking qualified candidates who can seamlessly integrate into their operations without extensive additional training.

In conclusion, specialized technician training programs are indispensable assets within the mobile home heating sector. They equip professionals with tailored skills necessary for addressing specific industry challenges while keeping pace with technological advancements. Through rigorous evaluation processes, these programs can continually enhance their offerings, contributing positively towards building a proficient workforce capable of delivering high-quality services within this niche market segment. As such initiatives continue to evolve alongside industry needs, they will undoubtedly play an instrumental role in shaping future developments within mobile home heating technology.

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Choosing the Right SEER Rating for Your Mobile Home HVAC System

Mobile home heating systems are crucial for ensuring comfort and livability in mobile homes, especially during colder months. Understanding the key components of these systems is essential for technicians tasked with installing, maintaining, and repairing them. Evaluating technician training programs for mobile home heating must focus on equipping participants with comprehensive knowledge of these components to ensure efficiency and reliability in service.

At the heart of any mobile home heating system lies the furnace, which is typically smaller than those found in traditional homes due to space constraints. Technicians must be trained to handle various types of furnaces-whether gas, electric, or oil-fired-and understand how each operates within the limited space of a mobile home. A well-structured training program should cover the installation processes specific to these compact systems, highlighting potential challenges like restricted airflow and limited venting options.

Another critical component is the ductwork system that distributes heat throughout the home. Mobile homes often feature unique duct configurations compared to stationary houses, necessitating careful attention during inspections and repairs. Training programs should educate technicians on identifying common issues such as leaks or blockages that can significantly impact energy efficiency and occupant comfort. Hands-on experience with real-world scenarios will better prepare technicians for tackling such challenges effectively.

Thermostats also play a vital role in controlling the heating system's operation. Modern mobile homes may incorporate programmable or smart thermostats that require specialized knowledge for installation and troubleshooting. Training programs must include modules on integrating these advanced technologies into existing systems, thereby reducing energy consumption while enhancing user convenience.

In addition to hardware components, understanding fuel sources is crucial. Technicians need a thorough grasp of safety protocols when working with natural gas or propane systems due to their prevalence in mobile homes. Training should emphasize rigorous safety standards to prevent accidents and ensure proper handling during servicing tasks.

Evaluating technician training programs involves assessing whether they provide adequate coverage of these key components through both theoretical instruction and practical application. Programs should be designed to build confidence in diagnosing issues quickly and implementing effective solutions without compromising safety or quality standards.

Ultimately, robust technician training is indispensable for maintaining reliable mobile home heating systems that meet occupants' needs efficiently while adhering to industry regulations and environmental considerations. By focusing on comprehensive education around core system components-furnaces, ductwork, thermostats, and fuel handling-training programs can produce skilled professionals who are well-equipped to manage any challenge posed by today's increasingly sophisticated heating technologies in mobile homes.

Factors Influencing SEER Rating Effectiveness in Mobile

Homes

Evaluating technician training programs for mobile home heating requires a comprehensive understanding of the typical HVAC systems used in these unique residential environments. Mobile homes, often characterized by their compact size and specific design constraints, necessitate specialized heating solutions that differ significantly from those found in traditional houses. Understanding these systems is crucial for assessing the effectiveness of any training program aimed at equipping technicians with the necessary skills to service them.

Mobile homes generally utilize one of several types of HVAC systems, each with its own set of characteristics and maintenance requirements. The most common system found in mobile homes is the forced air furnace. This system operates by heating air through a central unit which then distributes it throughout the home via ductwork. Forced air furnaces are valued for their efficiency and relative simplicity, making them a popular choice among mobile home manufacturers and residents alike.

Another prevalent heating solution in mobile homes is electric baseboard heating. This system consists of individual units installed along the baseboards in different rooms, providing localized heat without requiring extensive ductwork. While electric baseboard heaters offer straightforward installation and low maintenance, they can be less energy-efficient compared to other options, leading to higher operational costs over time.

Heat pumps have also gained traction as an efficient alternative for mobile home heating. These systems work by transferring heat between the inside and outside environment, offering both heating and cooling capabilities within a single unit. Split-system heat pumps are particularly advantageous due to their ability to modulate temperature effectively while maintaining energy efficiency across seasons.

Additionally, some older or more budget-conscious mobile homes may still rely on direct vent wall furnaces or even wood-burning stoves as supplemental or primary sources of heat. Direct vent wall furnaces draw air directly from outside for combustion, minimizing indoor air quality concerns while providing consistent warmth. Wood-burning stoves, although less common today due to stricter environmental regulations and safety considerations, offer a rustic charm and independence from electrical power sources.

Given this variety of HVAC systems employed in mobile homes, technician training programs must be designed with versatility in mind. Training should encompass not only technical skills related to installation, maintenance, and repair but also an understanding of energy efficiency principles tailored specifically for small spaces like mobile homes. Furthermore, technicians should be well-versed in troubleshooting common issues associated with each type of system-such as airflow problems in ductless setups or thermostat malfunctions in electric-based models-to ensure they can deliver effective service under diverse circumstances.

Moreover, since many mobile home residents are particularly sensitive to cost considerations due to fixed incomes or economic constraints inherent in manufactured housing communities, technicians must be trained to provide solutions that balance performance with affordability. This includes recommending appropriate upgrades or modifications that enhance energy conservation without imposing undue financial strain on homeowners.

In conclusion, evaluating technician training programs for mobile home heating necessitates a thorough grasp of the various HVAC systems typically utilized within these dwellings-from forced air furnaces and electric baseboards to innovative heat pumps and traditional wood stoves. A successful program will equip technicians not only with technical proficiency but also with an acute awareness of economic factors affecting this sector so they may serve their clients effectively while promoting sustainable living practices within compact residential settings like mobile homes.

Comparing SEER Ratings Across Different Mobile Home Cooling Systems

When evaluating technician training programs for mobile home heating systems, one must consider the significant differences from traditional home HVAC systems. These distinctions are crucial not only for understanding the unique needs of mobile homes but also for ensuring that technicians are adequately prepared to address these specific challenges.

Firstly, mobile homes often have space constraints that traditional homes do not. The compact nature of mobile homes requires heating systems that are smaller and more efficient in terms of energy usage. Technicians need to be trained in installing and maintaining these compact systems, which can differ significantly from those found in conventional houses. This includes familiarity with units like packaged terminal air conditioners (PTACs) or smaller heat pumps designed specifically for tight spaces.

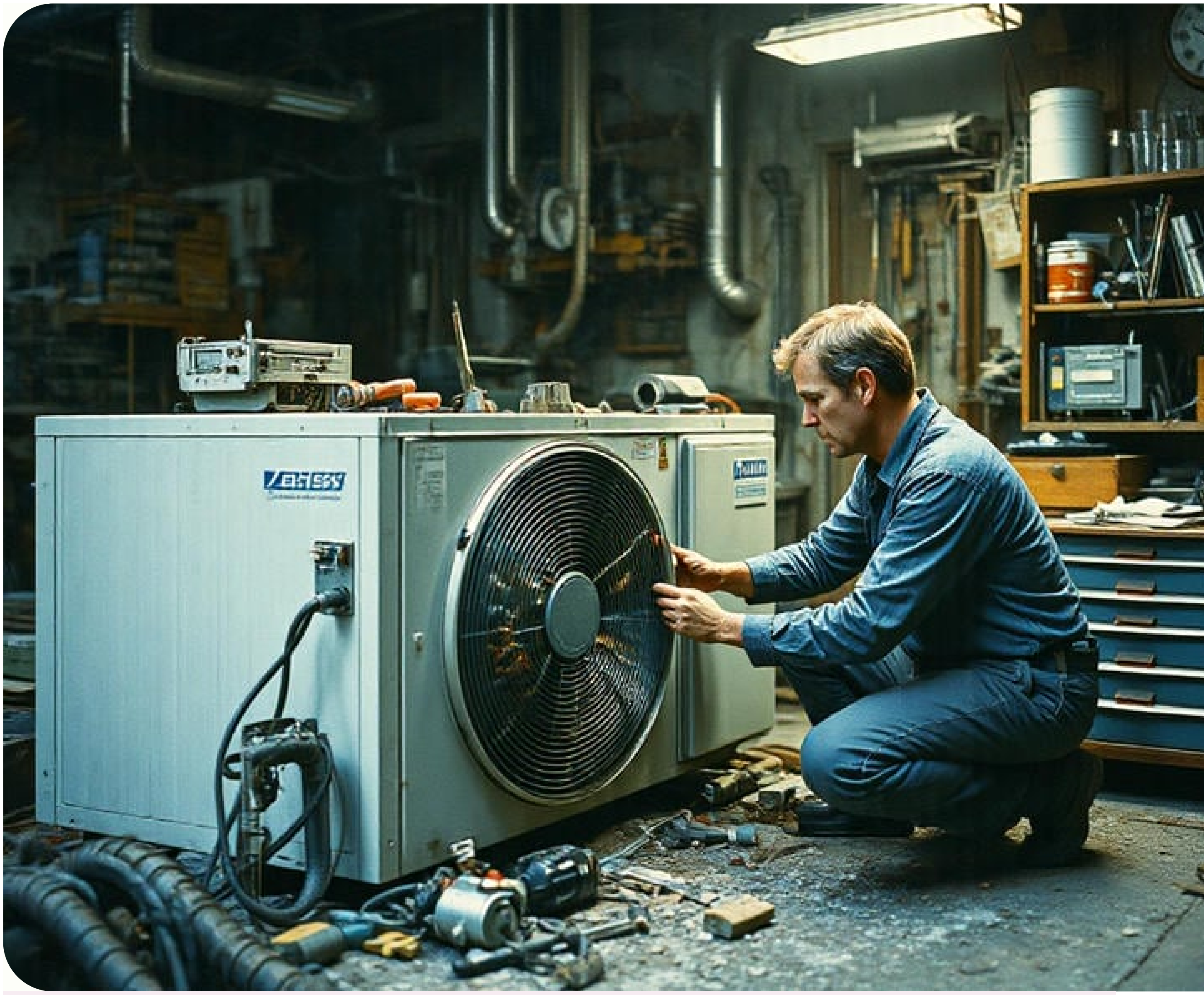
Moreover, the construction materials used in mobile homes can affect the efficiency and functionality of heating systems. Mobile homes typically have less insulation compared to traditional houses, which means they may lose heat more quickly during colder months. As a result, technicians must understand how to optimize these systems for energy efficiency and enhance their performance through measures such as improved insulation or sealing techniques.

Another critical difference is the ventilation requirements in mobile homes. Due to their construction, these homes might face issues with airflow and moisture control more frequently than traditional buildings. Proper training programs should equip technicians with knowledge about advanced ventilation solutions tailored for mobile environments to prevent issues like mold growth or excessive humidity.

Furthermore, mobility itself introduces additional considerations; mobile homes may require heating units that can withstand transportation stresses or varying weather conditions encountered while relocating. Technicians should be skilled in servicing equipment that maintains its integrity and reliability amidst such challenges.

Lastly, regulatory standards for HVAC installations can differ between traditional and mobile home settings. Training programs must cover these regulations comprehensively so that technicians remain compliant with codes specific to manufactured housing.

In conclusion, evaluating technician training programs necessitates an appreciation for the nuanced demands of mobile home heating systems compared to their traditional counterparts. By focusing on space constraints, material impacts on system efficiency, specialized ventilation needs, mobility concerns, and regulatory compliance, these programs will ensure technicians are well-prepared to meet the unique challenges presented by this sector of housing.



Tips for Maintaining Optimal Performance of High-SEER Rated Systems

Evaluating technician training programs, especially those focused on mobile home heating systems, is an essential task that ensures the delivery of high-quality service and safety for residents. The criteria for evaluating such programs need to be comprehensive, addressing both the technical proficiency and the adaptability of technicians to diverse working environments. This essay explores several key areas that should be considered when assessing these training programs.

Firstly, the program's curriculum must be scrutinized for its depth and relevance. A robust curriculum should cover fundamental principles of heating systems, including installation, maintenance, troubleshooting, and repair. It should also encompass new technologies and innovations in energy efficiency and sustainability practices. Given that mobile homes often have unique structural characteristics compared to traditional homes, specialized knowledge about these distinctions is vital.

Secondly, hands-on experience is crucial in technician training. Programs should incorporate practical components where trainees can work directly with mobile home heating units under guided supervision. This experiential learning solidifies theoretical knowledge and enhances problem-solving skills in real-world scenarios. Evaluators must assess whether the training facilities are equipped with up-to-date models and tools reflective of current industry standards.

Another critical criterion is the qualification and expertise of instructors. Trainers should possess significant industry experience and a proven track record of teaching effectiveness. Their ability to convey complex information in an understandable manner greatly influences the success of the program. Furthermore, ongoing professional development opportunities for instructors ensure they remain knowledgeable about evolving technologies and methodologies.

Assessment methods within the program also require evaluation. Effective programs employ a variety of assessment tools to measure trainee competency comprehensively-ranging from written exams testing theoretical understanding to practical evaluations demonstrating technical skills. Continuous feedback mechanisms help trainees identify strengths and areas needing improvement throughout their learning journey.

Moreover, accreditation by recognized industry bodies provides a benchmark for quality assurance in training programs. Accreditation indicates adherence to established standards and often requires periodic reviews ensuring sustained excellence in education delivery.

Finally, post-training support services such as job placement assistance or apprenticeships enhance program value by facilitating transitions from education to employment. Partnerships with local businesses can provide graduates with entry-level positions or internships that allow them to further hone their skills while contributing positively to workforce demands.

In conclusion, evaluating technician training programs for mobile home heating involves assessing curriculum relevance, practical learning opportunities, instructor qualifications, assessment methods, accreditation status, and post-training support services. These criteria collectively ensure that technicians are well-prepared not only technically but also equipped with critical thinking skills necessary for adapting to future challenges within this specialized field.

Future Trends in SEER Ratings and Mobile Home Cooling Technology

Accreditation and certification are crucial components in evaluating technician training programs, particularly in specialized fields such as mobile home heating. Ensuring that technicians are well-prepared to handle the unique challenges associated with mobile home heating systems requires robust training programs that adhere to high standards. Accreditation and certification serve as benchmarks of quality and competence, making them indispensable tools for both educators and trainees.

Accreditation refers to the formal recognition that a training program meets certain predetermined standards set by an authoritative body. For technician training programs focusing on mobile home heating, this often means aligning curricula with industry needs, ensuring that practical skills are taught alongside theoretical knowledge, and meeting safety regulations. Accreditation is not merely a stamp of approval; it is a rigorous process involving peer reviews, audits, and continuous assessments. This ensures that the program remains relevant and up-to-date with technological advancements and regulatory changes within the industry.

Certification, on the other hand, pertains to individuals graduating from these accredited programs. It acts as a testament to their skills and knowledge in mobile home heating systems. Certification typically involves passing standardized exams which test one's understanding of key concepts such as system installation, troubleshooting common issues, maintenance procedures, and compliance with safety codes specific to mobile homes. For technicians entering the workforce, possessing a certification can significantly enhance employability by demonstrating their capability to potential employers.

The integration of accreditation and certification into technician training programs yields numerous benefits. Firstly, it helps maintain consistency across different educational institutions offering similar courses. Students can be assured of receiving high-quality education regardless of where they choose to study. Secondly, it fosters trust between consumers and service providers; homeowners feel more confident hiring certified technicians knowing they have been trained according to stringent standards.

Moreover, these processes encourage continuous professional development among technicians. The dynamic nature of technology in heating systems necessitates ongoing learning; accredited programs often require renewal or periodic updates in curriculum content based on emerging trends or innovations within the field.

In conclusion, accreditation and certification requirements play an essential role in evaluating technician training programs for mobile home heating. They ensure that educational offerings meet industry demands while fostering trust among all stakeholders involved-from trainees seeking to build successful careers to consumers expecting reliable service delivery in maintaining their homes' comfort levels efficiently and safely. As technologies continue evolving rapidly within this niche sector-and indeed across broader HVAC industries-the importance of adhering strictly to these quality assurance measures cannot be overstated for sustained excellence now into future generations alike!

Evaluating technician training programs for mobile home heating requires a keen focus on curriculum development and comprehensiveness. As mobile homes present unique challenges in terms of heating due to their construction and spatial constraints, it is paramount that training programs are meticulously designed to address these specific needs.

A well-rounded curriculum should encompass both theoretical knowledge and hands-on experience. Technicians must be equipped with an understanding of the principles of thermodynamics, heat transfer, and energy efficiency, as these are critical in optimizing heating solutions for mobile homes. Moreover, they should be familiar with the various types of heating systems commonly used in mobile homes, such as forced air furnaces, electric heaters, and heat pumps. This theoretical foundation acts as a backdrop against which practical skills can be developed.

Practical training is where the comprehensive nature of the curriculum truly shines. A robust program will offer simulations and real-world scenarios through internships or partnerships with mobile home manufacturers or service companies. This exposure ensures that technicians can apply their classroom knowledge to diagnose issues effectively, perform maintenance, and execute installations under varying conditions.

Furthermore, safety protocols cannot be overstated in these training programs. Due to the confined spaces and potential for rapid heat loss or gain in mobile homes, technicians must be adept at identifying risks associated with carbon monoxide leaks or electrical faults. Comprehensive safety training helps prevent accidents and ensures compliance with industry standards.

In addition to technical skills, soft skills should also feature prominently within the curriculum. Communication is crucial as technicians often interact directly with homeowners who may not understand complex heating issues. Courses that enhance customer service skills can prepare technicians to explain problems clearly and suggest appropriate solutions confidently.

Finally, any effective evaluation of such programs must consider their adaptability to technological advancements. The field of HVAC (heating, ventilation, and air conditioning) is continually evolving with new technologies aimed at improving efficiency and reducing environmental impact. Training curriculums must therefore incorporate modules on emerging technologies like smart thermostats or solar-assisted heating systems to remain relevant.

In conclusion, when evaluating technician training programs for mobile home heating systems, it is essential to concentrate on both the depth and breadth of the curriculum offered. The balance between comprehensive theoretical instruction and practical skill-building ensures that technicians are not only knowledgeable but also capable problem-solvers equipped to meet current demands while adapting to future innovations in the field. This holistic approach guarantees that trained professionals can provide safe, efficient solutions tailored specifically for the unique environment of mobile homes.

Evaluating Technician Training Programs for Mobile Home Heating: Essential Skills and Knowledge Areas

In the ever-evolving world of mobile home heating systems, the role of a technician is both critical and challenging. As these systems become more sophisticated, the demand for highly skilled technicians who can install, maintain, and repair them efficiently has grown exponentially. Therefore, evaluating training programs designed to prepare technicians for this task becomes essential. Such evaluations ensure that these programs impart the necessary skills and knowledge areas required for excellence in this field.

First and foremost, a comprehensive training program must focus on technical proficiency. This includes an in-depth understanding of various mobile home heating systems, from traditional forced-air units to modern high-efficiency models. Trainees should be well-versed in diagnosing common issues like airflow problems or thermostat malfunctions and equipped with the skills to address more complex challenges such as electrical wiring faults or gas leaks. Hands-on experience is crucial here; it's not enough to understand theory alone-practical application solidifies learning and builds confidence.

Communication skills also play a vital role in a technician's skill set. Technicians often serve as the bridge between complex technical systems and homeowners who may have little to no understanding of how their heating system operates. A successful program will train technicians to explain issues clearly and concisely, offer solutions that are understandable to non-experts, and provide excellent customer service even under stressful circumstances.

Safety is another critical area that cannot be overlooked when evaluating technician training programs. Working with mobile home heating systems often involves dealing with hazardous materials such as gas or electricity. Therefore, it's imperative that training programs prioritize safety protocols thoroughly-from teaching proper handling techniques to ensuring technicians are familiar with current industry standards and regulations.

Moreover, staying updated with technological advancements is essential for any aspiring technician. The rapid pace at which technology evolves means new features and systems are continually being introduced into the market. Effective training programs will incorporate modules that cover emerging technologies such as smart thermostats or eco-friendly energy solutions, preparing technicians not just for today's challenges but also tomorrow's innovations.

Finally, problem-solving abilities are indispensable for any technician working in this field. Mobile home environments can present unique challenges due to space constraints or older infrastructure that might not easily accommodate newer heating technologies. Training programs should encourage analytical thinking and creativity in finding effective solutions tailored to each situation.

In conclusion, evaluating technician training programs for mobile home heating requires a multifaceted approach focused on technical skill development, communication prowess, safety adherence, continuous learning about technological advancements, and fostering problem-solving capabilities. By ensuring these essential skills and knowledge areas are addressed comprehensively within training curricula, we can produce highly competent technicians ready to meet the demands of an increasingly complex industry while ensuring comfort and safety in mobile homes across communities worldwide.

Evaluating technician training programs for mobile home heating systems is crucial in ensuring effective troubleshooting and maintenance. Mobile homes, with their unique design and structure, often face distinct challenges when it comes to heating systems. These issues can range from simple thermostat malfunctions to more complex problems like ductwork leaks or inefficient furnace operations. The ability of technicians to address these common issues effectively hinges on the quality and comprehensiveness of their training programs.

A well-structured training program should begin by covering the fundamentals of mobile home heating systems. This foundational knowledge includes understanding the different types of heating units commonly found in mobile homes and how they differ from those used in traditional houses. Technicians must be familiar with both electric and gas furnaces, as each requires specific troubleshooting techniques. Additionally, special attention should be paid to the space constraints typical in mobile homes, which can complicate repairs and maintenance.

Beyond technical knowledge, a successful training program should emphasize practical problem-solving skills. Troubleshooting is often about identifying not just the symptom but also the root cause of an issue. For example, if a resident reports uneven heating throughout their home, a skilled technician will not only check for obstructions in vents but also assess potential insulation problems or issues with the home's layout that could affect airflow. Developing such diagnostic acumen requires hands-on practice under varied conditions.

Moreover, communication skills are an essential component of any technician's training regimen. Technicians must be able to explain problems and solutions clearly to homeowners who may have limited technical knowledge themselves. Training programs should therefore include modules on customer interaction and service excellence, ensuring that technicians can provide reassurance and clarity during potentially stressful situations.

Furthermore, staying updated with the latest technologies is indispensable for modern technicians. As mobile home heating systems evolve with advancements like smart thermostats or energy-efficient models, ongoing education becomes imperative. Training programs must incorporate continual learning opportunities that allow technicians to keep pace with industry innovations.

In conclusion, evaluating technician training programs for mobile home heating systems involves assessing their ability to impart comprehensive technical knowledge alongside practical troubleshooting skills and effective communication strategies. A robust program prepares technicians not only to fix existing problems but also to foresee potential future issues-ultimately enhancing customer satisfaction and contributing to safer living environments within mobile homes. By focusing on these elements, we ensure that technicians are fully equipped to handle the unique challenges presented by mobile home heating systems today and tomorrow.

Evaluating technician training programs for mobile home heating systems requires a nuanced understanding of both the unique characteristics of mobile homes and the specific skills needed to maintain their heating systems. Mobile homes, unlike traditional houses, often use compact and specialized heating units due to space limitations and mobility considerations. Therefore, technicians must be trained in techniques that address the distinct challenges posed by these types of dwellings.

Firstly, installation techniques for mobile home heating systems demand precision and adaptability. Unlike traditional installations, where space is seldom a constraint, mobile home installations require technicians to work within tight confines. This necessitates not only a firm grasp of general HVAC principles but also an ability to customize solutions on the fly. Training programs must incorporate hands-on modules that simulate these environments, allowing technicians to gain confidence and competence in handling real-world scenarios.

Moreover, maintenance techniques for these systems are equally critical. Mobile homes often face unique environmental conditions due to their locations-whether in parks or rural settings-which can impact the longevity and efficiency of heating systems. Regular maintenance is vital to ensure optimal performance and prevent breakdowns during extreme weather conditions. Technicians should be adept at diagnosing problems quickly and efficiently; thus, training programs should emphasize troubleshooting skills specific to mobile home units.

Another key aspect of effective training programs is staying up-to-date with technological advancements in mobile home heating. As energy efficiency becomes increasingly important, new technologies are continuously being developed to meet these demands. Training programs should incorporate continuous education opportunities that allow technicians to stay abreast of new developments such as smart thermostats or advanced insulation materials tailored for mobile homes.

Furthermore, safety is paramount when dealing with any form of HVAC system; however, it takes on added importance in the context of mobile homes where space constraints could potentially amplify risks associated with improper installations or maintenance errors. Training should therefore emphasize strict adherence to safety protocols specific to confined spaces and educate technicians about potential hazards unique to mobile home environments.

In evaluating technician training programs for mobile home heating systems, it's crucial not only to assess the technical content but also the effectiveness of teaching methods employed. Programs that blend theoretical knowledge with practical application tend to produce more competent technicians who can adapt swiftly to varied working conditions.

Ultimately, successful evaluation hinges on feedback from both trainees and employers regarding program efficacy in preparing technicians for fieldwork challenges they will encounter specifically within mobile home contexts. By fostering a cycle of continuous improvement through this feedback loop-ensuring courses remain relevant as industry standards evolve-we can better equip our workforce with necessary skills while safeguarding comfort and safety for those residing within these uniquely American domiciles: the humble yet resilient mobile home.

In the contemporary landscape of technician training programs for mobile home heating, technology plays an indispensable role. As the demand for efficient and environmentally friendly heating solutions grows, so does the need for skilled technicians who can install, maintain, and repair these systems. Technology not only enhances the learning experience but also ensures that training programs are aligned with industry standards and innovations.

One of the primary ways technology impacts technician training is through the use of simulation software and virtual reality (VR). These tools provide trainees with hands-on experience in a controlled environment, allowing them to practice diagnosing and repairing heating systems without the risk of causing real-world damage. This immersive approach helps build confidence and competence by enabling learners to visualize complex systems and understand their inner workings comprehensively.

Moreover, online learning platforms have revolutionized access to education. These platforms offer a range of resources, from interactive modules to video tutorials, which can be accessed anytime and anywhere. This flexibility is particularly beneficial for technicians who may already be working full-time or those living in remote areas where traditional classroom settings are inaccessible. Online forums and collaborative tools further enhance this learning model by facilitating peer-to-peer interaction and knowledge sharing.

Data analytics is another technological advancement that has found its way into training programs. By analyzing data from assessments and practical exercises, educators can tailor their teaching methods to meet individual learner needs. This personalized approach ensures that trainees receive targeted support in areas where they may struggle while reinforcing their strengths.

Additionally, mobile applications have made it easier for technicians to stay updated on industry developments. Apps providing instant access to manuals, troubleshooting guides, and instructional videos mean that learning continues beyond formal training sessions. Technicians can quickly reference materials on-site, improving efficiency and reducing downtime during repairs.

Technology also plays a crucial role in evaluating the effectiveness of training programs themselves. Digital feedback mechanisms allow instructors to gather insights from participants about what aspects of the program are most beneficial or require improvement. This continuous feedback loop aids in refining curriculum design, ensuring it remains relevant to current industry needs.

However, while technology offers numerous benefits, it also poses challenges that must be addressed. The rapid pace of technological change means that both trainers and trainees need ongoing education to keep up with new tools and techniques. Additionally, there is a risk that over-reliance on digital solutions might undermine the development of critical thinking skills essential for problem-solving in real-world scenarios.

In conclusion, technology serves as both an enabler and enhancer within technician training programs for mobile home heating. By leveraging innovative tools such as simulations, online platforms, data analytics, mobile apps, and digital evaluation methods, these programs can produce highly skilled professionals ready to meet modern demands. Nevertheless, balancing technological integration with traditional skill-building approaches remains key to cultivating well-rounded technicians capable of thriving in an ever-evolving industry landscape.

In today's rapidly evolving technological landscape, the training and development of technicians for mobile home heating systems have become increasingly vital. As these systems grow more sophisticated, the need for effective training programs that equip technicians with practical skills becomes paramount. One of the most promising approaches to this challenge is the use of simulations and online modules for practical learning.

Simulations offer a dynamic way to recreate real-world scenarios in a controlled environment. For technician training in mobile home heating, simulations can replicate complex heating system malfunctions or installation procedures without the risks associated with real-life mistakes. This hands-on experience allows trainees to engage deeply with the material, experimenting with different solutions and observing outcomes without fear of causing damage or incurring costs.

The value of simulations lies in their ability to provide immediate feedback. Trainees can see the consequences of their actions almost instantly, allowing them to learn from errors and adjust their techniques accordingly. This iterative process enhances problem-solving skills and ensures that technicians are better prepared for actual fieldwork. Furthermore, simulations can be tailored to specific models or brands of heating systems, providing targeted training that aligns closely with what technicians will encounter in their professional roles.

Complementing simulations are online modules, which serve as flexible platforms for theoretical learning and conceptual understanding. These modules often include interactive content such as videos, quizzes, and discussion forums that cater to different learning styles. For technicians who may be balancing work commitments with education, online modules offer the convenience of self-paced study accessible from anywhere at any time.

Online modules also play a crucial role in standardizing training across diverse geographic regions. By providing consistent educational resources, they ensure that all trainees receive the same foundational knowledge regardless of location. This consistency is particularly important for maintaining quality standards across widespread services like mobile home heating repairs and installations.

Moreover, integrating simulations with online modules fosters a comprehensive learning experience where theory meets practice seamlessly. Trainees can first acquire knowledge through an online module before applying it within a simulation context. This blended approach not only reinforces learning but also bridges gaps between abstract concepts and tangible skills.

While there are clear benefits to using simulations and online modules in technician training programs for mobile home heating systems, challenges do exist. The initial investment in technology infrastructure can be significant, posing financial hurdles for some institutions or companies. Additionally, ensuring access to these digital tools requires reliable internet connectivity-a resource not universally available.

Despite these challenges, as technology continues to advance and become more affordable, incorporating simulations and online modules into technician training programs represents an exciting opportunity for growth within this field. By embracing these innovative methods now, we prepare future generations of technicians who are adept at navigating both traditional mechanical issues as well as new technological frontiers in mobile home heating systems.

In conclusion, leveraging simulations alongside online educational resources offers significant advantages when evaluating technician training programs in mobile home heating sectors by enhancing both skill acquisition efficiency and overall job readiness among trainees-ultimately leading towards higher service quality standards throughout industry practices globally today!

In an era characterized by rapid technological advancements, the integration of emerging technologies such as smart thermostats is reshaping various industries, including mobile home heating systems. As we evaluate technician training programs designed for this domain, it becomes increasingly essential to consider how these innovations are incorporated into educational curricula. Understanding this integration not only enhances the skill set of technicians but also ensures they are equipped to meet modern consumer demands and energy efficiency standards.

Smart thermostats represent a significant leap forward in the way individuals manage and control their home heating systems. These devices offer enhanced functionality, allowing users to remotely adjust temperature settings via smartphones or other connected devices. They also incorporate algorithms that learn user preferences over time and optimize energy use, contributing to reduced utility bills and a smaller carbon footprint. For mobile homes, where space and resources may be limited, such efficiencies can be particularly impactful.

The integration of smart thermostat technology into technician training programs requires a multi-faceted approach. Firstly, there must be a foundational understanding of traditional HVAC systems-how they operate within the unique constraints of mobile homes-and how smart technology interfaces with these systems. Technicians need to grasp both hardware installation skills and software literacy to effectively manage updates and troubleshoot issues. This dual expertise ensures that they are capable not only of installing these advanced devices but also maintaining them over time.

Moreover, training programs must emphasize hands-on experience with smart thermostats. Simulations or practical workshops can provide invaluable insights into real-world scenarios technicians might encounter. By working directly with the technology in a controlled environment, trainees can develop problem-solving skills crucial for diagnosing issues quickly and efficiently-a key competency as these devices become more widespread.

Another critical element is staying updated on industry trends and technological improvements. As manufacturers continue to innovate, offering new features or integrating artificial intelligence capabilities into their products, training programs must evolve accordingly. This continuous learning process enables technicians to deliver up-to-date service advice and installations that align with current best practices.

Furthermore, effective communication skills should be emphasized within training modules. As technicians often serve as intermediaries between complex technological systems and end-users who may have varying degrees of technical knowledge, they must articulate instructions clearly and offer guidance on how customers can maximize their device's potential.

In conclusion, as we evaluate technician training programs for mobile home heating solutions in light of emerging technologies like smart thermostats, it becomes evident that comprehensive education tailored towards both technical proficiency and customer interaction is imperative. Through robust curricula that encompass theoretical knowledge coupled with practical application-supported by ongoing professional development-technicians will be well-prepared to navigate the challenges posed by this evolving field while delivering superior service outcomes for consumers seeking energy-efficient living solutions in their mobile homes.

Assessing program outcomes and effectiveness is a critical component in evaluating technician training programs for mobile home heating. As the demand for efficient heating solutions continues to grow, especially in residential contexts such as mobile homes, the need for skilled technicians becomes paramount. The ability to assess how well these training programs prepare technicians not only ensures quality service but also enhances customer satisfaction and safety.

At the heart of assessing program outcomes is determining whether the training objectives align with industry standards and expectations. This involves a careful analysis of the curriculum offered by the training program. Does it cover essential skills such as system diagnostics, maintenance procedures, and installation techniques? Are emerging technologies and energy-efficient practices part of the coursework? These questions guide evaluators in understanding the depth and breadth of knowledge imparted to students.

Effectiveness evaluation goes beyond just content; it examines how well students can apply what they've learned in real-world settings. Practical assessments, simulations, and on-the-job training are crucial tools in this respect. For instance, technicians should be able to troubleshoot common issues found in mobile home heating systems efficiently. By directly observing student performance during practical exercises or internships, evaluators gain insights into their readiness for fieldwork.

Furthermore, feedback from graduates who have completed these programs can provide valuable perspectives on effectiveness. Their experiences highlight areas where the program excels or needs improvement. Additionally, input from employers who hire these trained technicians offers another layer of assessment regarding workforce readiness and capability.

Another important aspect of assessing program effectiveness is measuring long-term outcomes such as job placement rates and career advancement opportunities for graduates. A successful program typically boasts high employment rates within relevant industries shortly after completion. Moreover, tracking career progression over time can indicate whether foundational skills provided by the program remain useful and adaptable as technology evolves.

Lastly, continuous improvement mechanisms are vital for maintaining relevance in technician training programs for mobile home heating. Regular updates informed by technological advancements and regulatory changes ensure that curricula remain current and effective.

In conclusion, assessing program outcomes and effectiveness in technician training programs involves a multifaceted approach that considers curriculum quality, practical application skills, feedback from stakeholders, employment metrics, and adaptability to change. By rigorously evaluating these elements, educators can enhance their offerings to produce competent technicians ready to meet modern heating challenges effectively within mobile homes-a sector that calls for both precision engineering skills and innovative problem-solving capabilities.

Evaluating technician competency post-training is a critical component in the realm of mobile home heating, where precision and skill are paramount to ensure safety and efficiency. As mobile homes present unique challenges due to their structural and spatial constraints, technicians must be adept at navigating these intricacies with both expertise and confidence. To properly assess whether training programs for technicians are effective, we must employ a range of metrics that holistically measure competency.

Firstly, technical knowledge assessment is fundamental. This involves both theoretical evaluations through written tests and practical examinations on equipment specific to mobile home heating systems. These assessments are designed to gauge the technician's understanding of complex systems, such as HVAC units tailored for mobile environments. A high score indicates that the individual has absorbed the necessary information during training and can apply it in real-world scenarios.

Another significant metric is hands-on performance evaluation. This examines how well technicians can execute tasks such as installation, maintenance, and troubleshooting of heating systems in confined spaces typical of mobile homes. Performance evaluations should be conducted under supervised conditions, with experienced evaluators observing not only the outcome but also the process employed by each technician. This ensures that techniques align with industry standards and best practices.

Customer satisfaction surveys provide an indirect yet insightful metric for evaluating technician competency post-training. By soliciting feedback from clients who have received service from recently trained technicians, organizations can gather data on perceived professionalism, problem-solving abilities, and overall service quality. Positive customer feedback often correlates with a competent technician who effectively applies their training in client interactions.

Furthermore, time-to-competency is an essential metric that reflects the efficiency of a training program. It measures how quickly a technician becomes proficient after completing their initial training regimen. A shorter time-to-competency suggests that the program efficiently imparts necessary skills and knowledge, enabling technicians to transition smoothly into full productivity within their roles.

Lastly, continued education tracking should not be overlooked as a metric for long-term competency evaluation. The field of heating technology is ever-evolving; thus, technicians must engage in ongoing learning to stay current with new technologies and methods. Monitoring participation in advanced courses or workshops helps ensure sustained proficiency beyond initial training.

In conclusion, evaluating technician competency post-training through these multidimensional metrics provides a comprehensive overview of their readiness to tackle challenges inherent in mobile home heating systems. By systematically applying these measures-ranging from technical assessments to customer feedback-organizations can refine their training programs continuously while ensuring high standards of service delivery by their technicians.

Evaluating technician training programs for mobile home heating systems is a multifaceted process that requires comprehensive approaches to ensure the programs' effectiveness. One of the most invaluable aspects of this evaluation is deriving feedback from both employers and customers, who serve as the ultimate beneficiaries of these training endeavors. By understanding their perspectives, training organizations can tailor their programs to better meet industry standards and customer expectations.

Employers play a crucial role in assessing the competencies that technicians gain from training programs. They are positioned to evaluate whether technicians possess the necessary skills and knowledge to perform efficiently in real-world scenarios. Employers can provide insights into how well-trained technicians adapt to new technologies, troubleshoot issues, and maintain or install heating systems efficiently. Their feedback helps identify gaps between what is taught and what is needed on-site, offering a roadmap for curriculum enhancement.

Similarly, customers offer an equally important vantage point by providing feedback based on their experiences with technicians' services. Since customers interact directly with technicians during maintenance or installation of mobile home heating systems, they can comment on technicians' professionalism, problem-solving abilities, and overall service quality. Understanding customer satisfaction levels helps gauge whether the training program adequately prepares technicians to not only solve technical issues but also deliver excellent customer service.

Moreover, integrating feedback from both employers and customers fosters a holistic improvement cycle within technician training programs. Training institutions can use this feedback to adjust teaching methodologies, update course content, and incorporate soft skills training that emphasizes communication and client interaction. This ensures that graduates not only meet technical requirements but also excel in interpersonal aspects integral to customer satisfaction.

Additionally, regular engagement with employers and customers encourages ongoing relationships that benefit all parties involved. Employers gain access to highly qualified personnel who align well with their operational needs; customers experience improved service quality; and educational providers enhance their reputation through producing proficient graduates who fulfill market demands effectively.

In conclusion, leveraging feedback mechanisms from employers and customers is indispensable when evaluating technician training programs for mobile home heating systems. These perspectives provide critical insights into practical skill application and client service excellence-two pillars essential for success in today's competitive job market. Ultimately, incorporating such feedback leads to more robust educational offerings that prepare future technicians comprehensively while ensuring high standards of performance in the field.

In recent years, the mobile home heating industry has witnessed a series of transformative trends that are reshaping technician training requirements. As we delve into evaluating technician training programs for mobile home heating, it is crucial to consider how these industry trends impact the necessary skills and knowledge that technicians must possess to thrive in this evolving landscape.

One of the most significant trends influencing technician training is the growing emphasis on energy efficiency and sustainable practices. With climate change at the forefront of global concerns, there is an increasing demand for mobile home heating systems that minimize environmental impact. This shift necessitates advanced training for technicians in understanding and implementing energy-efficient technologies. Programs must now prioritize teaching about energy-saving components, such as high-efficiency furnaces and smart thermostats, which require specialized knowledge for installation and maintenance.

Moreover, technological advancements are rapidly transforming mobile home heating systems. The integration of smart technology into these systems means that technicians need to be well-versed in digital diagnostics and remote monitoring tools. Training programs must adapt by incorporating modules on IoT (Internet of Things) applications within heating systems, enabling technicians to troubleshoot issues efficiently through digital interfaces. This not only improves service delivery but also enhances customer satisfaction by ensuring timely responses to system malfunctions.

Another critical trend impacting technician training is the increasing complexity of regulatory standards governing mobile home heating installations. Technicians must stay abreast of ever-evolving codes and regulations to ensure compliance with safety and environmental guidelines. Training programs should include comprehensive updates on local and national regulations, equipping technicians with the knowledge needed to navigate these complexities confidently. Understanding these legal frameworks not only helps in maintaining safety but also protects businesses from potential liabilities.

Furthermore, as demographic shifts continue to shape consumer preferences, there is a rising expectation for personalized service in mobile home heating solutions. Today's consumers seek customized solutions tailored specifically to their needs and preferences. Consequently, technician training programs must emphasize soft skills such as effective communication and customer service alongside technical expertise. Technicians who can engage with customers effectively will be better equipped to understand their unique requirements and provide tailored solutions that enhance overall customer satisfaction.

In conclusion, evaluating technician training programs for mobile home heating requires a keen understanding of current industry trends impacting skill requirements. Energy efficiency demands an emphasis on sustainable practices; technological advancements call for expertise in smart technologies; regulatory changes necessitate a thorough understanding of codes; while demographic shifts highlight the importance of personalized service delivery. By aligning training programs with these trends, we can prepare technicians not only to meet today's challenges but also excel in tomorrow's dynamic environment-ensuring they remain indispensable assets within the industry long into the future.

Environmental regulations have increasingly become a focal point in various industries, and the heating, ventilation, and air conditioning (HVAC) systems in mobile homes are no exception. As the world continues to grapple with climate change and environmental degradation, the need for stringent regulations on energy consumption and emissions has never been more pressing. In this context, evaluating technician training programs for mobile home heating becomes not only necessary but also urgent.

Mobile homes present unique challenges when it comes to HVAC systems. These structures often prioritize affordability and portability over insulation and energy efficiency. Consequently, they can be significant contributors to energy wastage if not properly managed. Environmental regulations aim to mitigate these issues by enforcing standards that require HVAC systems to be both efficient and environmentally friendly.

Technicians who work with mobile home HVAC systems must be adequately trained to comply with these regulations. A robust training program should cover several key areas: understanding new technologies that enhance energy efficiency, learning about refrigerants that have a lower environmental impact, and mastering installation techniques that minimize heat loss or gain. Programs should also focus on teaching technicians how to conduct energy audits effectively. These audits help identify areas where improvements can be made in existing systems-whether through better insulation or more efficient appliances-thus complying with regulatory standards while also benefiting homeowners financially.

One critical component of technician training is staying updated on evolving environmental laws. Regulations are continually changing as governments respond to new scientific data about climate change's impact. For instance, the phase-out of certain hydrofluorocarbons (HFCs), which contribute significantly to global warming, requires technicians to adapt quickly by learning about alternative refrigerants like R-32 or R-454B. Training programs must therefore include modules that keep technicians informed about such changes so they can implement solutions effectively.

Moreover, incorporating soft skills into training programs cannot be overlooked. Technicians should be trained in effective communication so they can educate homeowners about the benefits of adhering to environmental standards-not just from an ecological perspective but also in terms of cost savings over time.

Additionally, hands-on experience is invaluable in technician training programs for mobile home heating systems affected by environmental regulations. Simulated environments or apprenticeships allow trainees to apply what they've learned in real-world scenarios under expert supervision. This experiential learning ensures that once they are certified professionals, they can seamlessly integrate their knowledge into their day-to-day tasks.

In conclusion, as environmental regulations continue tightening around HVAC systems in mobile homes, there is an urgent need for comprehensive technician training programs tailored specifically for this niche market. Such programs must blend technical expertise with up-to-date regulatory knowledge while also fostering communication skills needed for homeowner education. Only through thorough preparation and continuous learning will technicians be able to meet these challenges head-on-making meaningful contributions toward both economic efficiency and environmental stewardship within the realm of mobile home heating solutions.

As we journey through the 21st century, innovations in heating technology have become a cornerstone of modern living, particularly for mobile homes. This evolution necessitates not only advancements in the technology itself but also a reevaluation and updating of training methods for technicians who install and maintain these systems. The need for effective evaluation of technician training programs thus emerges as a crucial aspect of ensuring these technological innovations are implemented safely, efficiently, and sustainably.

The landscape of heating technology has dramatically transformed with the introduction of smart thermostats, energy-efficient heat pumps, and integrated solar heating systems. These advancements promise enhanced comfort and reduced energy costs for mobile home residents. However, they also present new challenges that demand up-to-date technical skills. Traditional training methods may no longer be sufficient to equip technicians with the necessary competencies to handle such sophisticated systems.

To address this gap, training programs must incorporate comprehensive modules that cover both theoretical knowledge and practical application of these innovations. Technicians should be adept at understanding the intricacies of modern heating technologies and troubleshooting potential issues that may arise during installation or maintenance. This requires a shift from conventional rote learning techniques to more interactive and hands-on approaches.

Simulation-based training can play a pivotal role in this transformation. By using virtual reality environments or augmented reality tools, trainees can gain exposure to real-world scenarios without the risk associated with actual system failures. Such immersive experiences enhance learning outcomes by allowing technicians to experiment with different solutions in a controlled setting.

Moreover, continuous assessment is vital in evaluating the effectiveness of updated training programs. Regular testing through both written examinations and practical assessments ensures that technicians remain proficient as technologies evolve. Feedback mechanisms should be integrated into these evaluations to identify areas where additional instruction might be needed.

Incorporating feedback loops from fieldwork into training curricula is another essential strategy. Technicians often encounter unique challenges on-site that are not covered in standard courses. By creating channels for experienced professionals to share their insights with trainers and trainees alike, programs can remain relevant and responsive to real-world demands.

Additionally, collaboration between manufacturers of heating technologies and educational institutions can foster innovation in teaching methodologies. By providing access to cutting-edge equipment and expert knowledge, such partnerships enhance the quality of technician education while keeping pace with industry developments.

In conclusion, as innovations in mobile home heating technology continue to advance at an unprecedented rate, so too must our approach to technician training evolve. By embracing modern educational tools like simulation-based learning, incorporating continuous assessment strategies, leveraging field experience feedback, and fostering industry-education collaborations, we can ensure that our workforce is well-equipped to meet future challenges head-on. As a result, we empower technicians not only as skilled workers but also as invaluable contributors to sustainable living practices within mobile home communities worldwide.

About Heat pump

This article is about devices used to heat and potentially also cool a building (or water) using the refrigeration cycle. For more about the theory, see Heat pump and refrigeration cycle. For details of the most common type, see air source heat pump. For a similar device for cooling only, see air conditioner. For heat pumps used to keep food cool, see refrigerator. For other uses, see Heat pump (disambiguation).

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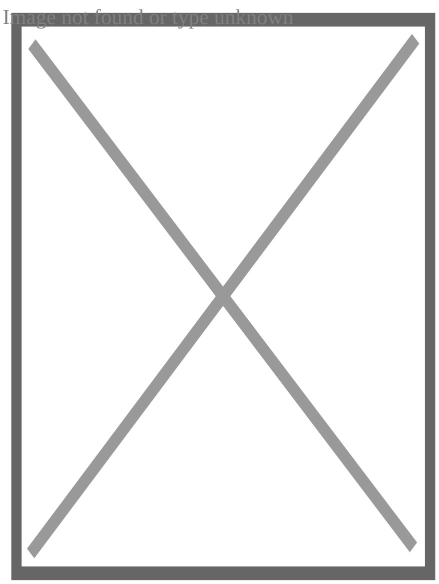

External heat exchanger of an air-source heat pump for both heating and cooling

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Mitsubishi heat pump interior air handler wall unit

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Part of a series on

Sustainable energy

A car drives past 4 wind turbines in a field, with more on the horizon

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Energy conservation

- Arcology
- Building insulation
- Cogeneration
- Compact fluorescent lamp
- Eco hotel
- Eco-cities
- Ecohouse
- Ecolabel
- Efficient energy use
- Energy audit
- Energy efficiency implementation
- Energy recovery
- Energy recycling
- Energy saving lamp
- Energy Star
- Energy storage
- Environmental planning
- Environmental technology
- Fossil fuel phase-out
- Glass in green buildings
- Green building and wood
- Green building
- Heat pump
- List of low-energy building techniques
- Low-energy house
- Microgeneration
- Passive house
- Passive solar building design
- Sustainable architecture
- Sustainable city
- Sustainable habitat
- Sustainable refurbishment
- Thermal energy storage
- Tropical green building
- Waste-to-energy
- Zero heating building
- Zero-energy building

Renewable energy

- Biofuel
  - Sustainable
- Biogas
- Biomass
- Carbon-neutral fuel
- Geothermal energy
- Geothermal power
- Geothermal heating
- Hydropower
  - Hydroelectricity
  - Micro hydro
  - Pico hydro
  - Run-of-the-river
  - Small hydro
- Marine current power
- Marine energy
- Tidal power
  - Tidal barrage
  - Tidal farm
  - Tidal stream generator
- Ocean thermal energy conversion
- Renewable energy transition
- Renewable heat
- Solar
- Wave
- Wind
  - Community
  - Farm
  - Floating wind turbine
  - Forecasting
  - Industry
  - Lens
  - Outline
  - Rights
  - Turbine
  - Windbelt
  - Windpump

Sustainable transport

- Green vehicle
  - Electric vehicle
    - Bicycle
  - Solar vehicle
  - Wind-powered vehicle
- Hybrid vehicle
  - Human-electric
    - Twike
  - Plug-in
- Human-powered transport
  - Helicopter
  - Hydrofoil
  - Land vehicle
    - Bicycle
    - Cycle rickshaw
    - Kick scooter
    - Quadracycle
    - Tricycle
    - Velomobile
  - Roller skating
  - Skateboarding
  - Walking
  - Watercraft
- Personal transporter
- Rail transport
  - Tram
- Rapid transit
  - Personal rapid transit
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- icon Image not found or type unknown Renewable energy portal

A **heat pump** is a device that consumes energy (usually electricity) to transfer heat from a cold heat sink to a hot heat sink. Specifically, the heat pump transfers thermal energy using a refrigeration cycle, cooling the cool space and warming the warm space.[1] In cold weather, a heat pump can move heat from the cool outdoors to warm a house (e.g. winter); the pump may also be designed to move heat from the house to the warmer outdoors in warm weather (e.g. summer). As they transfer heat rather than generating heat, they are more energy-efficient than other ways of heating or cooling a home.[2]

A gaseous refrigerant is compressed so its pressure and temperature rise. When operating as a heater in cold weather, the warmed gas flows to a heat exchanger in the indoor space where some of its thermal energy is transferred to that indoor space, causing the gas to condense to its liquid state. The liquified refrigerant flows to a heat exchanger in the outdoor space where the pressure falls, the liquid evaporates and the temperature of the gas falls. It is now colder than the temperature of the outdoor space being used as a heat source. It can again take up energy from the heat source, be compressed and repeat the cycle.

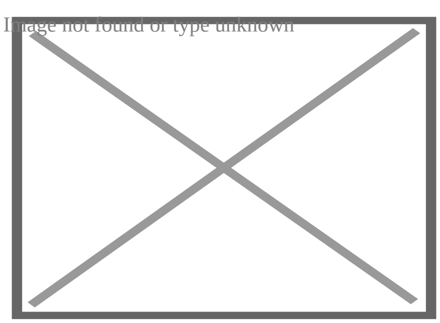
Air source heat pumps are the most common models, while other types include ground source heat pumps, water source heat pumps and exhaust air heat pumps.[3] Large-scale heat pumps are also used in district heating systems.[4]

The efficiency of a heat pump is expressed as a coefficient of performance (COP), or seasonal coefficient of performance (SCOP). The higher the number, the more efficient a heat pump is. For example, an air-to-water heat pump that produces 6kW at a SCOP of 4.62 will give over 4kW of energy into a heating system for every kilowatt of energy that the heat pump uses itself to operate. When used for space heating, heat pumps are typically more energy-efficient than electric resistance and other heaters.

Because of their high efficiency and the increasing share of fossil-free sources in electrical grids, heat pumps are playing a role in climate change mitigation.[5][6] Consuming 1 kWh of electricity, they can transfer 1[7] to 4.5 kWh of thermal energy into a building. The carbon footprint of heat pumps depends on how electricity is generated, but they usually reduce emissions.[8] Heat pumps could satisfy over 80% of global space and water heating needs with a lower carbon footprint than gas-fired condensing boilers: however, in 2021 they only met 10%.[4]

Principle of operation

[edit]



A: indoor compartment, B: outdoor compartment, I: insulation, 1: condenser, 2: expansion valve, 3: evaporator, 4: compressor

Main articles: Heat pump and refrigeration cycle and Vapor-compression refrigeration

Heat flows spontaneously from a region of higher temperature to a region of lower temperature. Heat does not flow spontaneously from lower temperature to higher, but it can be made to flow in this direction if work is performed. The work required to transfer a given amount of heat is usually much less than the amount of heat; this is the motivation for using heat pumps in applications such as the heating of water and the interior of buildings.[9]

The amount of work required to drive an amount of heat Q from a lower-temperature reservoir such as ambient air to a higher-temperature reservoir such as the interior of a building is: $\displaystyle W=\frac{Q}{\mathrm{COP}}$ where

- $\displaystyle W$ is the work performed on the working fluid by the heat pump's compressor.
- $\displaystyle Q$ is the heat transferred from the lower-temperature reservoir to the higher-temperature reservoir.
- $\displaystyle \mathrm{COP}$ is the instantaneous coefficient of performance for the heat pump at the temperatures prevailing in the reservoirs at one instant.

The coefficient of performance of a heat pump is greater than one so the work required is less than the heat transferred, making a heat pump a more efficient form of heating than electrical resistance heating. As the temperature of the higher-temperature reservoir increases in response to the heat flowing into it, the coefficient of performance decreases, causing an increasing amount of work to be required for each unit of heat being transferred.[9]

The coefficient of performance, and the work required by a heat pump can be calculated easily by considering an ideal heat pump operating on the reversed Carnot cycle:

- If the low-temperature reservoir is at a temperature of 270 K (?3 °C) and the interior of the building is at 280 K (7 °C) the relevant coefficient of performance is 27. This means only 1 joule of work is required to transfer 27 joules of heat from a reservoir at 270 K to another at 280 K. The one joule of work ultimately ends up as thermal energy in the interior of the building so for each 27 joules of heat that are removed from the low-temperature reservoir, 28 joules of heat are added to the building interior, making the heat pump even more attractive from an efficiency perspective.[note 1]
- As the temperature of the interior of the building rises progressively to 300 K (27 °C) the coefficient of performance falls progressively to 9. This means each joule of work is responsible for transferring 9 joules of heat out of the low-temperature reservoir and into the building. Again, the 1 joule of work ultimately ends up as thermal energy in the interior of the building so 10 joules of heat are added to the building interior.[note 2]

This is the theoretical amount of heat pumped but in practice it will be less for various reasons, for example if the outside unit has been installed where there is not enough airflow. More data sharing with owners and academics—perhaps from heat meters—could improve efficiency in the long run.[11]

History

[edit]

Milestones:

1748
: William Cullen demonstrates artificial refrigeration.[12]

1834
: Jacob Perkins patents a design for a practical refrigerator using dimethyl ether.[13]

1852
: Lord Kelvin describes the theory underlying heat pumps.[14]

1855–1857
: Peter von Rittinger develops and builds the first heat pump.[15]

1877
: In the period before 1875, heat pumps were for the time being pursued for vapour compression evaporation (open heat pump process) in salt works with their obvious advantages for saving wood and coal. In 1857, Peter von Rittinger was the first to try to implement the idea of vapor compression in a small pilot plant. Presumably inspired by Rittinger's experiments in Ebensee, Antoine-Paul Piccard from the University of Lausanne and the engineer J. H. Weibel from the Weibel–Briquet company in Geneva built the world's first really functioning vapor compression system with a two-stage piston compressor. In 1877 this first heat pump in Switzerland was installed in the Bex salt works.[14][16]

1928
: Aurel Stodola constructs a closed-loop heat pump (water source from Lake Geneva) which provides heating for the Geneva city hall to this day.[17]

1937–1945
: During the First World War, fuel prices were very high in Switzerland but it had plenty of hydropower.[14]
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In the period before and especially during the Second World War, when neutral Switzerland was completely surrounded by fascist-ruled countries, the coal shortage became alarming again. Thanks to their leading position in energy technology, the Swiss companies Sulzer, Escher Wyss and Brown Boveri built and put in operation around 35 heat pumps between 1937 and 1945. The main heat sources were lake water, river water, groundwater, and waste heat. Particularly noteworthy are the six historic heat pumps from the city of Zurich with heat outputs from 100 kW to 6 MW. An international milestone is the heat pump built by Escher

Wyss in 1937/38 to replace the wood stoves in the City Hall of Zurich. To avoid noise and vibrations, a recently developed rotary piston compressor was used. This historic heat pump heated the town hall for 63 years until 2001. Only then was it replaced by a new, more efficient heat pump.[14]

1945

John Sumner, City Electrical Engineer for Norwich, installs an experimental water-source heat pump fed central heating system, using a nearby river to heat new Council administrative buildings. It had a seasonal efficiency ratio of 3.42, average thermal delivery of 147 kW, and peak output of 234 kW.[18]

1948

Robert C. Webber is credited as developing and building the first ground-source heat pump.[19]

1951

First large scale installation—the Royal Festival Hall in London is opened with a town gas-powered reversible water-source heat pump, fed by the Thames, for both winter heating and summer cooling needs.[18]

2019

The Kigali Amendment to phase out harmful refrigerants takes effect.

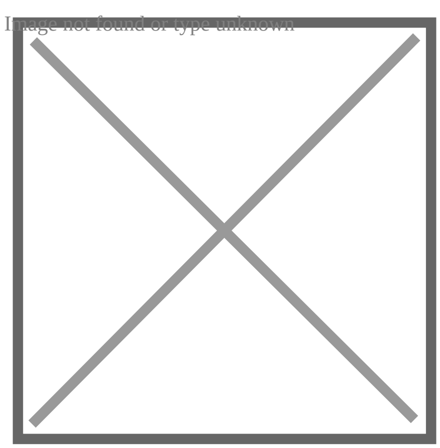
Types

[edit]

Air-source

[edit]

This section is an excerpt from Air source heat pump.[edit]



Heat pump on balcony of apartment

An air source heat pump (ASHP) is a heat pump that can absorb heat from air outside a building and release it inside; it uses the same vapor-compression refrigeration process and much the same equipment as an air conditioner, but in the opposite direction. ASHPs are the most common type of heat pump and, usually being smaller, tend to be used to heat individual houses or flats rather than blocks, districts or industrial processes.[20][21]

Air-to-air heat pumps provide hot or cold air directly to rooms, but do not usually provide hot water. *Air-to-water* heat pumps use radiators or underfloor heating to heat a whole house and are often also used to provide domestic hot water.

An ASHP can typically gain 4 kWh thermal energy from 1 kWh electric energy. They are optimized for flow temperatures between 30 and 40 °C (86 and 104 °F), suitable for buildings with heat emitters sized for low flow temperatures. With losses in efficiency, an ASHP can even provide full central heating with a flow temperature up to 80 °C (176 °F).[22]

As of 2023 about 10% of building heating worldwide is from ASHPs. They are the main way to phase out gas boilers (also known as "furnaces") from houses, to avoid their greenhouse gas emissions.[23]

Air-source heat pumps are used to move heat between two heat exchangers, one outside the building which is fitted with fins through which air is forced using a fan and the other which either directly heats the air inside the building or heats water which is then circulated around the building through radiators or underfloor heating which releases the heat to the building. These devices can also operate in a cooling mode where they extract heat via the internal heat exchanger and eject it into the ambient air using the external heat exchanger. Some can be used to heat water for washing which is stored in a domestic hot water tank.[24]

Air-source heat pumps are relatively easy and inexpensive to install, so are the most widely used type. In mild weather, coefficient of performance (COP) may be between 2 and 5, while at temperatures below around ?8 °C (18 °F) an air-source heat pump may still achieve a COP of 1 to 4.[25]

While older air-source heat pumps performed relatively poorly at low temperatures and were better suited for warm climates, newer models with variable-speed compressors remain highly efficient in freezing conditions allowing for wide adoption and cost savings in places like Minnesota and Maine in the United States.[26]

Ground source

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This section is an excerpt from Ground source heat pump.[edit]

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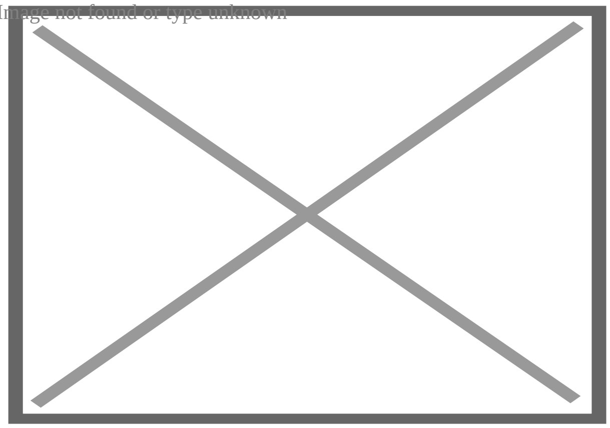


A heat pump in combination with heat and cold storage

A ground source heat pump (also geothermal heat pump) is a heating/cooling system for buildings that use a type of heat pump to transfer heat to or from the ground, taking advantage of the relative constancy of temperatures of the earth through the seasons. Ground-source heat pumps (GSHPs) – or geothermal heat pumps (GHP), as they are commonly termed in North America – are among the most energy-efficient technologies for providing HVAC and water heating, using far less energy than can be achieved by burning a fuel in a boiler/furnace or by use of resistive electric heaters.

Efficiency is given as a coefficient of performance (CoP) which is typically in the range 3 – 6, meaning that the devices provide 3 – 6 units of heat for each unit of electricity used. Setup costs are higher than for other heating systems, due to the requirement to install ground loops over large areas or to drill bore holes, and for this reason, ground source is often suitable when new blocks of flats are built.[27] Otherwise air-source heat pumps are often used instead.

Heat recovery ventilation

[edit]
Main article: Heat recovery ventilation

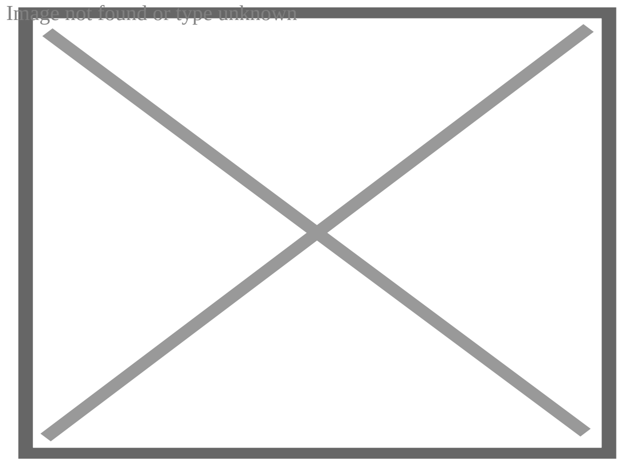
Exhaust air heat pumps extract heat from the exhaust air of a building and require mechanical ventilation. Two classes exist:

- Exhaust air-air heat pumps transfer heat to intake air.
- Exhaust air-water heat pumps transfer heat to a heating circuit that includes a tank of domestic hot water.

Solar-assisted

[edit]

This section is an excerpt from Solar-assisted heat pump.[edit]

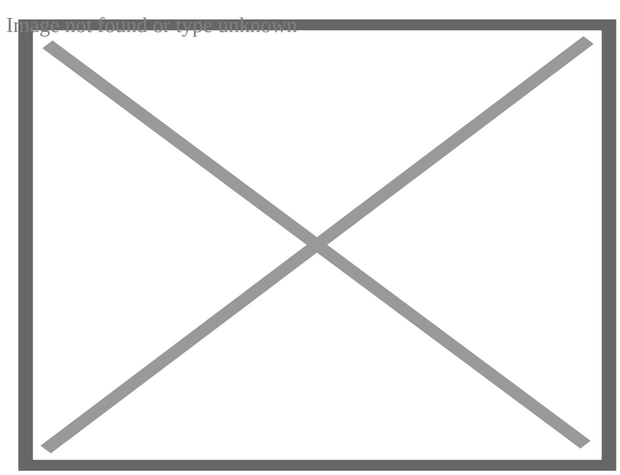


Hybrid photovoltaic-thermal solar panels of a SAHP in an experimental installation at Department of Energy at Polytechnic of Milan

A solar-assisted heat pump (SAHP) is a machine that combines a heat pump and thermal solar panels and/or PV solar panels in a single integrated system.[28] Typically these two technologies are used separately (or only placing them in parallel) to produce hot water.[29] In this system the solar thermal panel performs the function of the low temperature heat source and the heat produced is used to feed the heat pump's evaporator.[30] The goal of this system is to get high coefficient of performance (COP) and then produce energy in a more efficient and less expensive way.
It is possible to use any type of solar thermal panel (sheet and tubes, roll-bond, heat pipe, thermal plates) or hybrid (mono/polycrystalline, thin film) in combination with the heat pump. The use of a hybrid panel is preferable because it allows covering a part of the electricity demand of the heat pump and reduce the power consumption and consequently the variable costs of the system.

Water-source

[edit]



Water-source heat exchanger being installed

A water-source heat pump works in a similar manner to a ground-source heat pump, except that it takes heat from a body of water rather than the ground. The body of water does, however, need to be large enough to be able to withstand the cooling effect of the unit without freezing or creating an adverse effect for wildlife.[31] The largest water-source heat pump was installed in the Danish town of Esbjerg in 2023.[32][33]

Others

[edit]

A thermoacoustic heat pump operates as a thermoacoustic heat engine without refrigerant but instead uses a standing wave in a sealed chamber driven by a loudspeaker to achieve a temperature difference across the chamber.[34]

Electrocaloric heat pumps are solid state.[35]

Applications

[edit]

The International Energy Agency estimated that, as of 2021, heat pumps installed in buildings have a combined capacity of more than 1000 GW.[4] They are used for heating, ventilation, and air conditioning (HVAC) and may also provide domestic hot water and tumble clothes drying.[36] The purchase costs are supported in various countries by consumer rebates.[37]

Space heating and sometimes also cooling

[edit]

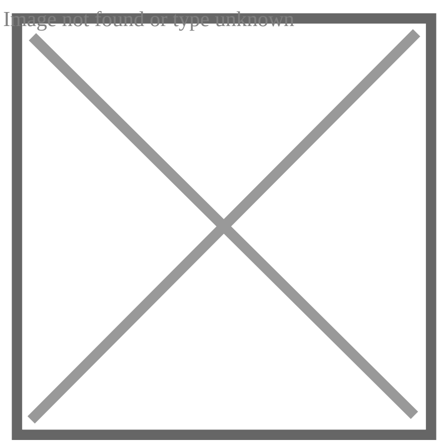
In HVAC applications, a heat pump is typically a vapor-compression refrigeration device that includes a reversing valve and optimized heat exchangers so that the direction of *heat flow* (thermal energy movement) may be reversed. The reversing valve switches the direction of refrigerant through the cycle and therefore the heat pump may deliver either heating or cooling to a building.

Because the two heat exchangers, the condenser and evaporator, must swap functions, they are optimized to perform adequately in both modes. Therefore, the Seasonal Energy Efficiency Rating (SEER in the US) or European seasonal energy efficiency ratio of a reversible heat pump is typically slightly less than those of two separately optimized machines. For equipment to receive the US Energy Star rating, it must have a rating of at least 14 SEER. Pumps with ratings of 18 SEER or above are considered highly efficient. The highest efficiency heat pumps manufactured are up to 24 SEER.[38]

Heating seasonal performance factor (in the US) or Seasonal Performance Factor (in Europe) are ratings of heating performance. The SPF is Total heat output per annum / Total electricity consumed per annum in other words the average heating COP over the year.[39]

Window mounted heat pump

[edit]



Saddle-style window mounted heat pump 3D sketch

Window mounted heat pumps run on standard 120v AC outlets and provide heating, cooling, and humidity control. They are more efficient with lower noise levels, condensation management, and a smaller footprint than window mounted air conditioners that just do cooling.[40]

Water heating

[edit]

In water heating applications, heat pumps may be used to heat or preheat water for swimming pools, homes or industry. Usually heat is extracted from outdoor air and transferred to an indoor water tank.[41][42]

District heating

[edit]

Large (megawatt-scale) heat pumps are used for district heating.[43] However as of 2022 about 90% of district heat is from fossil fuels.[44] In Europe, heat pumps account for a mere 1% of heat supply in district heating networks but several countries have targets to decarbonise their networks between 2030 and 2040.[4] Possible sources of heat for such applications are sewage water, ambient water (e.g. sea, lake and river water), industrial waste heat, geothermal energy, flue gas, waste heat from district cooling and heat from solar seasonal thermal energy storage.[45] Large-scale heat pumps for district heating combined with thermal energy storage offer high flexibility for the integration of variable renewable energy. Therefore, they are regarded as a key technology for limiting climate change by phasing out fossil fuels.[45][46] They are also a crucial element of systems which can both heat and cool districts.[47]

Industrial heating

[edit]

There is great potential to reduce the energy consumption and related greenhouse gas emissions in industry by application of industrial heat pumps, for example for process heat.[48][49] Short payback periods of less than 2 years are possible, while achieving a high reduction of CO_2 emissions (in some cases more than 50%).[50][51] Industrial heat pumps can heat up to 200 °C, and can meet the heating demands of many light industries.[52][53] In Europe alone, 15 GW of heat pumps could be installed in 3,000 facilities in the paper, food and chemicals industries.[4]

Performance

[edit]
Main article: Coefficient of performance

The performance of a heat pump is determined by the ability of the pump to extract heat from a low temperature environment (the *source*) and deliver it to a higher temperature environment (the *sink*).[54] Performance varies, depending on installation details, temperature differences, site elevation, location on site, pipe runs, flow rates, and maintenance.

In general, heat pumps work most efficiently (that is, the heat output produced for a given energy input) when the difference between the heat source and the heat sink is small. When using a heat pump for space or water heating, therefore, the heat pump will be most efficient in mild conditions, and decline in efficiency on very cold days. Performance metrics supplied to consumers attempt to take this variation into account.

Common performance metrics are the SEER (in cooling mode) and seasonal coefficient of performance (SCOP) (commonly used just for heating), although SCOP can be used for both modes of operation.[54] Larger values of either metric indicate better performance.[54] When comparing the performance of heat pumps, the term *performance* is preferred to *efficiency*, with coefficient of performance (COP) being used to describe the ratio of useful heat movement per work input.[54] An electrical resistance heater has a COP of 1.0, which is considerably lower than a well-designed heat pump which will typically have a COP of 3 to 5 with an external temperature of 10 °C and an internal temperature of 20 °C. Because the ground is a constant temperature source, a ground-source heat pump is not subjected to large temperature fluctuations, and therefore is the most energy-efficient type of heat pump.[54]

The "seasonal coefficient of performance" (SCOP) is a measure of the aggregate energy efficiency measure over a period of one year which is dependent on regional climate.[54] One framework for this calculation is given by the Commission Regulation (EU) No. 813/2013.[55]

A heat pump's operating performance in cooling mode is characterized in the US by either its energy efficiency ratio (EER) or seasonal energy efficiency ratio (SEER), both of which have units of BTU/(h·W) (note that 1 BTU/(h·W) = 0.293 W/W) and larger values indicate better performance.

COP variation with output temperature

Pump type and source	**Typical use**	**35 °C (e.g. heated screed floor)**
High-efficiency air-source heat pump (ASHP), air at ?20 °C[56]		2.2
Two-stage ASHP, air at ?20 °C[57]	Low source temperature	*2.4*
High-efficiency ASHP, air at 0 °C[56]	Low output temperature	*3.8*

Prototype transcritical CO_2 (R744) heat pump with tripartite gas cooler, source at 0 °C[58]	High output temperature	3.3	ÃƒÆ’Ã†â€™Ãƒâ€ Ã¢â‚¬â„¢ÃƒÆ’Ã¢â‚¬Â ÃƒÂ¢Ã¢â€šÂ¬Ã¢â€ž
Ground-source heat pump (GSHP), water at 0 °C[56]		5.0	
GSHP, ground at 10 °C[56]	Low output temperature	*7.2*	
Theoretical Carnot cycle limit, source ?20 °C		5.6	
Theoretical Carnot cycle limit, source 0 °C		8.8	
Theoretical Lorentzen cycle limit (CO_2 pump), return fluid 25 °C, source 0 °C[58]		10.1	

Theoretical Carnot cycle limit, source 10 °C	12.3

Carbon footprint

[edit]

The carbon footprint of heat pumps depends on their individual efficiency and how electricity is produced. An increasing share of low-carbon energy sources such as wind and solar will lower the impact on the climate.

heating system	emissions of energy source	efficiency	resulting emissions for thermal energy
heat pump with onshore wind power	11 gCO_2/kWh[59]	400% (COP=4)	3 gCO_2/kWh
heat pump with global electricity mix	436 gCO_2/kWh[60] (2022)	400% (COP=4)	109 gCO_2/kWh
natural-gas thermal (high efficiency)	201 gCO_2/kWh[61]	90%[*citation needed*]	223 gCO_2/kWh
heat pump electricity by lignite (old power plant) and low performance	1221 gCO_2/kWh[61]	300% (COP=3)	407 gCO_2/kWh

In most settings, heat pumps will reduce CO_2 emissions compared to heating systems powered by fossil fuels.[62] In regions accounting for 70% of world energy consumption, the emissions savings of heat pumps compared with a high-efficiency gas boiler are on average above 45% and reach 80% in countries with cleaner electricity mixes.[4] These values can be improved by 10 percentage points, respectively, with alternative refrigerants. In the United States, 70% of houses could reduce emissions by installing a heat pump.[63][4] The rising share of renewable electricity generation in many countries is set to increase the emissions savings from heat pumps over time.[4]

Heating systems powered by green hydrogen are also low-carbon and may become competitors, but are much less efficient due to the energy loss associated with hydrogen conversion, transport and use. In addition, not enough green hydrogen is expected to be available before the 2030s or 2040s.[64][65]

Operation

[edit]
See also: Vapor-compression refrigeration

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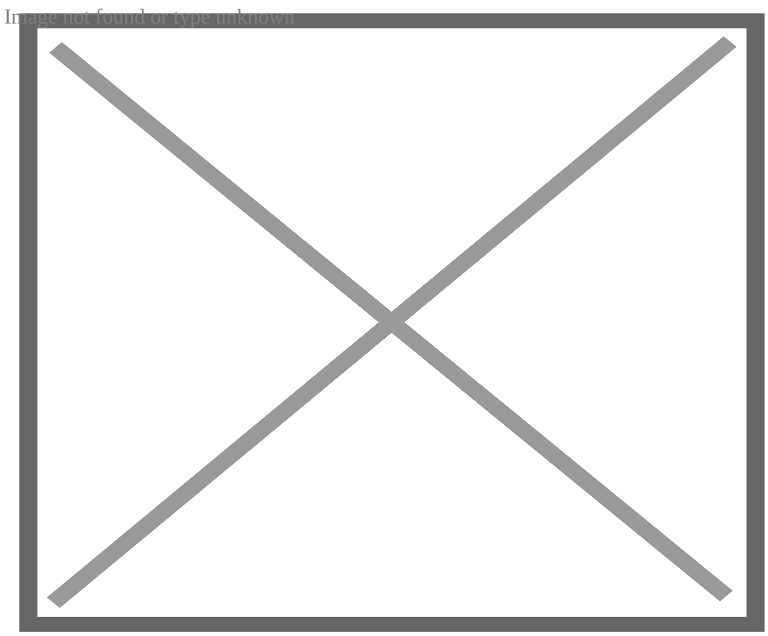
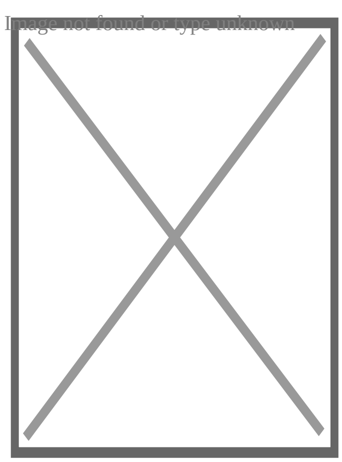
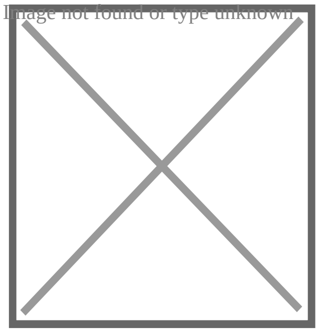


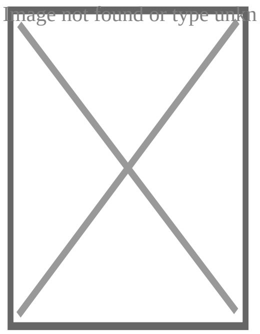
Figure 2: Temperature–entropy diagram of the vapor-compression cycle



An internal view of the outdoor unit of an Ecodan air source heat pump



Large heat pump setup for a commercial building



Wiring and connections to a central air unit inside

Vapor-compression uses a circulating refrigerant as the medium which absorbs heat from one space, compresses it thereby increasing its temperature before releasing it in another space. The system normally has eight main components: a compressor, a reservoir, a reversing valve which selects between heating and cooling mode, two thermal expansion valves (one used when in heating mode and the other when used in cooling mode) and two heat exchangers, one associated with the external heat source/sink and the other with the interior. In heating mode the external heat exchanger is the evaporator and the internal one being the condenser; in cooling mode the roles are reversed.

Circulating refrigerant enters the compressor in the thermodynamic state known as a saturated vapor[66] and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed vapor is then in the thermodynamic state known as a superheated vapor and it is at a temperature and pressure at which it can be condensed with either cooling water or cooling air flowing across the coil or tubes. In heating mode this heat is used to heat the building using the internal heat exchanger, and in cooling mode this heat is rejected via the external heat exchanger.

The condensed, liquid refrigerant, in the thermodynamic state known as a saturated liquid, is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in the adiabatic flash evaporation of a part of the liquid refrigerant. The auto-refrigeration effect of the adiabatic flash evaporation lowers the temperature of the liquid and-vapor refrigerant mixture to where it is colder than the temperature of the enclosed space to be refrigerated.

The cold mixture is then routed through the coil or tubes in the evaporator. A fan circulates the warm air in the enclosed space across the coil or tubes carrying the cold refrigerant liquid and vapor mixture. That warm air evaporates the liquid part of the cold refrigerant mixture. At the same time, the circulating air is cooled and thus lowers the temperature of the enclosed space to the desired temperature. The evaporator is where the circulating refrigerant absorbs and removes heat which is subsequently rejected in the condenser and transferred elsewhere by the water or air used in the condenser.

To complete the refrigeration cycle, the refrigerant vapor from the evaporator is again a saturated vapor and is routed back into the compressor.

Over time, the evaporator may collect ice or water from ambient humidity. The ice is melted through defrosting cycle. An internal heat exchanger is either used to heat/cool the interior air directly or to heat water that is then circulated through radiators or underfloor heating circuit to either heat or cool the buildings.

Improvement of coefficient of performance by subcooling

[edit]
Main article: Subcooling

Heat input can be improved if the refrigerant enters the evaporator with a lower vapor content. This can be achieved by cooling the liquid refrigerant after condensation. The gaseous refrigerant condenses on the heat exchange surface of the condenser. To achieve a heat flow from the gaseous flow center to the wall of the condenser, the temperature of the liquid refrigerant must be lower than the condensation temperature.

Additional subcooling can be achieved by heat exchange between relatively warm liquid refrigerant leaving the condenser and the cooler refrigerant vapor emerging from the evaporator. The enthalpy difference required for the subcooling leads to the superheating of the vapor drawn into the compressor. When the increase in cooling achieved by subcooling is greater that the compressor drive input required to overcome the additional pressure losses, such a heat exchange improves the coefficient of performance.[67]

One disadvantage of the subcooling of liquids is that the difference between the condensing temperature and the heat-sink temperature must be larger. This leads to a moderately high pressure difference between condensing and evaporating pressure, whereby the compressor energy increases.

Refrigerant choice

[edit]
Main article: Refrigerant

Pure refrigerants can be divided into organic substances (hydrocarbons (HCs), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), hydrofluoroolefins (HFOs), and HCFOs), and inorganic substances (ammonia (NH_3), carbon dioxide (CO_2), and water (H_2O)[68])).[69] Their boiling points are usually below ?25 °C.[70]

In the past 200 years, the standards and requirements for new refrigerants have changed. Nowadays low global warming potential (GWP) is required, in addition to all the previous requirements for safety, practicality, material compatibility, appropriate atmospheric life,[*clarification needed*] and compatibility with high-efficiency products. By 2022, devices using refrigerants with a very low GWP still have a small market share but are expected to play an increasing role due to enforced regulations,[71] as most countries have now ratified the Kigali Amendment to ban HFCs.[72] Isobutane (R600A) and propane (R290) are far less harmful to the environment than conventional hydrofluorocarbons (HFC) and are already being used in air-source heat pumps.[73] Propane may be the most suitable for high temperature heat pumps.[74] Ammonia (R717) and carbon dioxide (R-744) also have a low GWP. As of 2023 smaller CO_2 heat pumps are not widely available and research and development of them continues.[75] A 2024 report said that refrigerants with GWP are vulnerable to further international restrictions.[76]

Until the 1990s, heat pumps, along with fridges and other related products used chlorofluorocarbons (CFCs) as refrigerants, which caused major damage to the ozone layer when released into the atmosphere. Use of these chemicals was banned or severely restricted by the Montreal Protocol of August 1987.[77]

Replacements, including R-134a and R-410A, are hydrofluorocarbons (HFC) with similar thermodynamic properties with insignificant ozone depletion potential (ODP) but had problematic GWP.[78] HFCs are powerful greenhouse gases which contribute to climate change.[79][80] Dimethyl ether (DME) also gained in popularity as a refrigerant in combination with R404a.[81] More recent refrigerants include difluoromethane (R32) with a lower GWP, but still over 600.

refrigerant	20-year GWP	100-year GWP
R-290 propane[82]	0.072	0.02
R-600a isobutane		3[83]
R-32[82]	491	136
R-410a[84]	4705	2285
R-134a[84]	4060	1470
R-404a[84]	7258	4808

Devices with R-290 refrigerant (propane) are expected to play a key role in the future.[74][85] The 100-year GWP of propane, at 0.02, is extremely low and is approximately 7000 times less than R-32. However, the flammability of propane requires additional safety measures: the maximum safe charges have been set significantly lower than for lower flammability refrigerants (only allowing approximately 13.5 times less refrigerant in the system than R-32).[86][87][88] This means that R-290 is not suitable for all situations or locations. Nonetheless, by 2022, an increasing number of devices with R-290 were offered for domestic use, especially in Europe.[*citation needed*]

At the same time,[*when?*] HFC refrigerants still dominate the market. Recent government mandates have seen the phase-out of R-22 refrigerant. Replacements such as R-32 and R-410A are being promoted as environmentally friendly but still have a high GWP.[89] A heat pump typically uses 3 kg of refrigerant. With R-32 this amount still has a 20-year impact equivalent to 7 tons of CO_2, which corresponds to two years of natural gas heating in an average household. Refrigerants with a high ODP have already been phased out.[*citation needed*]

Government incentives

[edit]

Financial incentives aim to protect consumers from high fossil gas costs and to reduce greenhouse gas emissions,[90] and are currently available in more than 30 countries around the world, covering more than 70% of global heating demand in 2021.[4]

Australia

[edit]

Food processors, brewers, petfood producers and other industrial energy users are exploring whether it is feasible to use renewable energy to produce industrial-grade heat. Process heating accounts for the largest share of onsite energy use in Australian manufacturing, with lower-temperature operations like food production particularly well-suited to transition to renewables.

To help producers understand how they could benefit from making the switch, the Australian Renewable Energy Agency (ARENA) provided funding to the Australian Alliance for Energy Productivity (A2EP) to undertake pre-feasibility studies at a range of sites around Australia, with the most promising locations advancing to full feasibility studies.[91]

In an effort to incentivize energy efficiency and reduce environmental impact, the Australian states of Victoria, New South Wales, and Queensland have implemented rebate programs targeting the upgrade of existing hot water systems. These programs specifically encourage the transition from traditional gas or electric systems to heat pump based systems.[92][93][94][95][96]

Canada

[edit]

In 2022, the Canada Greener Homes Grant[97] provides up to $5000 for upgrades (including certain heat pumps), and $600 for energy efficiency evaluations.

China

[edit]

Purchase subsidies in rural areas in the 2010s reduced burning coal for heating, which had been causing ill health.[98]

In the 2024 report by the International Energy Agency (IEA) titled "The Future of Heat Pumps in China," it is highlighted that China, as the world's largest market for heat pumps in buildings, plays a critical role in the global industry. The country accounts for over one-quarter of global sales, with a 12% increase in 2023 alone, despite a global sales dip of 3% the same year.[99]

Heat pumps are now used in approximately 8% of all heating equipment sales for buildings in China as of 2022, and they are increasingly becoming the norm in central and southern regions for both heating and cooling. Despite their higher upfront costs and relatively low awareness, heat pumps are favored for their energy efficiency, consuming three to five times less energy than electric heaters or fossil fuel-based solutions. Currently, decentralized heat pumps installed in Chinese buildings represent a quarter of the global installed capacity, with a total capacity exceeding 250 GW, which covers around 4% of the heating needs in buildings.[99]

Under the Announced Pledges Scenario (APS), which aligns with China's carbon neutrality goals, the capacity is expected to reach 1,400 GW by 2050, meeting 25% of heating needs. This scenario would require an installation of about 100 GW of heat pumps annually until 2050. Furthermore, the heat pump sector in China employs over 300,000 people, with employment numbers expected to double by 2050, underscoring the importance of vocational training for industry growth. This robust development in the heat pump market is set to play a significant role in reducing direct emissions in buildings by 30% and cutting PM2.5 emissions from residential heating by nearly 80% by 2030.[99][100]

European Union

[edit]

To speed up the deployment rate of heat pumps, the European Commission launched the Heat Pump Accelerator Platform in November 2024.[101] It will encourage industry experts, policymakers, and stakeholders to collaborate, share best practices and ideas, and jointly discuss measures that promote sustainable heating solutions.[102]

United Kingdom

[edit]

As of 2022: heat pumps have no Value Added Tax (VAT) although in Northern Ireland they are taxed at the reduced rate of 5% instead of the usual level of VAT of 20% for most other products.[103] As of 2022 the installation cost of a heat pump is more than a gas boiler, but with the "Boiler Upgrade Scheme"[104] government grant and assuming electricity/gas costs remain similar their lifetime costs would be similar on average.[105] However lifetime cost relative to a gas boiler varies considerably depending on several factors, such as the quality of the heat pump installation and the tariff used.[106] In 2024 England was criticised for still allowing new homes to be built with gas boilers, unlike some other counties where this is banned.[107]

United States

[edit]
Further information: Environmental policy of the Joe Biden administration and Climate change in the United States

The High-efficiency Electric Home Rebate Program was created in 2022 to award grants to State energy offices and Indian Tribes in order to establish state-wide high-efficiency electric-home rebates. Effective immediately, American households are eligible for a tax credit to cover the costs of buying and installing a heat pump, up to $2,000. Starting in 2023, low- and moderate-level income households will be eligible for a heat-pump rebate of up to $8,000.[108]

In 2022, more heat pumps were sold in the United States than natural gas furnaces.[109]

In November 2023 Biden's administration allocated 169 million dollars from the Inflation Reduction Act to speed up production of heat pumps. It used the Defense Production Act to do so, because according to the administration, energy that is better for the climate is also better for national security.[110]

Notes

[edit]

1. **^** As explained in Coefficient of performance TheoreticalMaxCOP = (desiredIndoorTempC + 273) ÷ (desiredIndoorTempC - outsideTempC) = (7+273) ÷ (7 - (-3)) = 280÷10 = 28 [10]
2. **^** As explained in Coefficient of performance TheoreticalMaxCOP = (desiredIndoorTempC + 273) ÷ (desiredIndoorTempC - outsideTempC) = (27+273) ÷ (27 - (-3)) = 300÷30 = 10[10]

References

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1. **^** *"Heat Pump Systems". Energy.gov. Retrieved 26 March 2024.*
2. **^** *"Heat Pump Systems". US Department of Energy. Archived from the original on 27 April 2023. Retrieved 27 April 2023.*
3. **^** *"Exhaust air heat pumps". Energy Saving Trust. Retrieved 22 February 2024.*
4. ^ ***a b c d e f g h i*** *Technology Report: The Future of Heat Pumps. International Energy Agency (Report). November 2022. Archived from the original on 6 January 2023. Retrieved 6 January 2023.* License: CC BY 4.0.
5. **^** IPCC AR6 WG3 Ch11 2022, Sec. 11.3.4.1.
6. **^** IPCC SR15 Ch2 2018, p. 142.
7. **^** *Everitt, Neil (11 September 2023). "Study proves heat pump efficiency at low temperatures". Cooling Post. Retrieved 22 January 2024.*
8. **^** *Deetjen, Thomas A.; Walsh, Liam; Vaishnav, Parth (28 July 2021). "US residential heat pumps: the private economic potential and its emissions, health, and grid impacts". Environmental Research Letters.* ***16*** *(8): 084024. Bibcode:2021ERL....16h4024D. doi:10.1088/1748-9326/ac10dc. ISSN 1748-9326. S2CID 236486619.*
9. ^ ***a b*** G. F. C. Rogers and Y. R. Mayhew (1957), *Engineering Thermodynamics, Work and Heat Transfer*, Section 13.1, Longmans, Green & Company Limited.

10. ^ ***a b*** *"Is there some theoretical maximum coefficient of performance (COP) for heat pumps and chillers?". Physics Stack Exchange. Retrieved 22 February 2024.*
11. **^** *Williamson, Chris (13 October 2022). "Heat pumps are great. Let's make them even better". All you can heat. Retrieved 22 February 2024.*
12. **^** *"The often forgotten Scottish inventor whose innovation changed the world". The National. 10 April 2022. Retrieved 21 February 2024.*
13. **^** *Bathe, Greville; Bathe, Dorothy (1943). Jacob Perkins, his inventions, his times, & his contemporaries. The Historical Society of Pennsylvania. p. 149.*
14. ^ ***a b c d*** *"History of Heat Pumping Technologies in Switzerland – Texts". www.aramis.admin.ch. Archived from the original on 23 November 2021. Retrieved 14 September 2023.*
15. **^** *Banks, David L. (6 May 2008). An Introduction to Thermogeology: Ground Source Heating and Cooling (PDF). Wiley-Blackwell. ISBN 978-1-4051-7061-1. Archived (PDF) from the original on 20 December 2016. Retrieved 5 March 2014.*
16. **^** *Wirth, E. (1955), Aus der Entwicklungsgeschichte der Wärmepumpe, Schweizerische Bauzeitung (in German), vol. 73, pp. 647–650, archived from the original on 20 November 2021, retrieved 20 November 2021*
17. **^** *Randall, Ian (31 July 2022). "Heat pumps: The centuries-old system now at the heart of the Government's energy strategy". Daily Express. Retrieved 16 March 2024.*
18. ^ ***a b*** *Electricity supply in the United Kingdom : a chronology – from the beginnings of the industry to 31 December 1985. The Electricity Council. 1987. ISBN 978-0851881058. OCLC 17343802.*
19. **^** *Banks, David (August 2012). An Introduction to Thermogeology: Ground Source Heating and Cooling. John Wiley & Sons. p. 123.*
20. **^** *"Why Britain's homes will need different types of heat pump". The Economist. ISSN 0013-0613. Retrieved 19 February 2024.*
21. **^** *"What is an Air-Source Heat Pump? A Complete Guide In 2024". NEWNTIDE. 24 October 2024. Retrieved 30 September 2024.*
22. **^** *Le, Khoa; Huang, M.J.; Hewitt, Neil (2018). "Domestic High Temperature Air Source Heat Pump: Performance Analysis Using TRNSYS Simulations". International High Performance Buildings Conference. West Lafayette, IN, USA: 5th International High Performance Buildings Conference at Purdue University: 1. Retrieved 20 February 2022.*
23. **^** *"Heat pumps show how hard decarbonisation will be". The Economist. ISSN 0013-0613. Retrieved 14 September 2023.*
24. **^** *Lawrence, Karen. "Air source heat pumps explained". Which?. Archived from the original on 4 October 2022. Retrieved 4 October 2022.*
25. **^** *Canada, Natural Resources (22 April 2009). "Heating and Cooling With a Heat Pump". natural-resources.canada.ca. Retrieved 22 February 2024.*
26. **^** *"Heat pumps do work in the cold – Americans just don't know it yet". Grist. 9 May 2022. Archived from the original on 9 May 2022. Retrieved 9 May 2022.*
27. **^** *"Heat pumps are hot items. But for people living in condos, getting one presents some challenges".*

28. **^** *Sezen, Kutbay; Gungor, Afsin (1 January 2023). "Comparison of solar assisted heat pump systems for heating residences: A review". Solar Energy.* ***249****: 424–445. doi:10.1016/j.solener.2022.11.051. ISSN 0038-092X. "Photovoltaic-thermal direct expansion solar assisted heat pump (PV/T-DX-SAHP) system enables to benefit the waste heat for evaporation of refrigerant in PV/T collector-evaporator, while providing better cooling for PV cells (Yao et al., 2020)."*
29. **^** *"Solar-assisted heat pumps". Archived from the original on 28 February 2020. Retrieved 21 June 2016.*
30. **^** *"Pompe di calore elio-assistite" (in Italian). Archived from the original on 7 January 2012. Retrieved 21 June 2016.*
31. **^** *Energy Saving Trust (13 February 2019). "Could a water source heat pump work for you?". Energy Saving Trust. Archived from the original on 4 October 2022. Retrieved 4 October 2022.*
32. **^** *Baraniuk, Chris (29 May 2023). "The 'exploding' demand for giant heat pumps". BBC News. Archived from the original on 7 September 2023. Retrieved 19 September 2023.*
33. **^** *Ristau, Oliver (24 July 2022). "Energy transition, the Danish way". DW. Archived from the original on 9 August 2023. Retrieved 19 September 2023.*
34. **^** *Padavic-Callaghan, Karmela (6 December 2022). "Heat pump uses a loudspeaker and wet strips of paper to cool air". New Scientist. Archived from the original on 4 January 2023. Retrieved 4 January 2023.*
35. **^** *Everitt, Neil (14 August 2023). "Scientists claim solid-state heat pump breakthrough". Cooling Post. Archived from the original on 24 September 2023. Retrieved 17 September 2023.*
36. **^** *"Heat Pump Systems". U.S. Department of Energy. Archived from the original on 4 July 2017. Retrieved 5 February 2016.*
37. **^** *"Renewable Heat Incentive – Domestic RHI – paid over 7 years". Ground Source Heat Pump Association. Archived from the original on 8 March 2018. Retrieved 12 March 2017.*
38. **^** *"Heat Pump Efficiency | Heat Pump SEER Ratings". Carrier. Archived from the original on 14 January 2023. Retrieved 14 January 2023.*
39. **^** *"COP and SPF for Heat Pumps Explained". Green Business Watch UK. 7 November 2019. Retrieved 22 February 2024.*
40. **^** *"Why This Window Heat Pump is Genius – Undecided with Matt Ferrell". 11 June 2024.*
41. **^** *"How it Works — Heat Pump Water Heaters (HPWHs)". www.energystar.gov. Retrieved 22 January 2024.*
42. **^** *"Heat-pump hot water systems". Sustainability Victoria. Retrieved 22 January 2024.*
43. **^** *Baraniuk, Chris (29 May 2023). "The 'exploding' demand for giant heat pumps". BBC News. Archived from the original on 7 September 2023. Retrieved 17 September 2023.*
44. **^** *"District Heating – Energy System". IEA. Retrieved 22 January 2024.*

45. ^ ***a*** ***b*** *David, Andrei; et al. (2017). "Heat Roadmap Europe: Large-Scale Electric Heat Pumps in District Heating Systems". Energies.* ***10*** *(4): 578. doi: 10.3390/en10040578.*
46. **^** *Sayegh, M. A.; et al. (2018). "Heat pump placement, connection and operational modes in European district heating". Energy and Buildings.* ***166****: 122–144. Bibcode:2018EneBu.166..122S. doi:10.1016/j.enbuild.2018.02.006. Archived from the original on 14 December 2019. Retrieved 10 July 2019.*
47. **^** *Buffa, Simone; et al. (2019), "5th generation district heating and cooling systems: A review of existing cases in Europe", Renewable and Sustainable Energy Reviews (in German), vol. 104, pp. 504–522, doi: 10.1016/j.rser.2018.12.059*
48. **^** *"Home". Annex 35. Retrieved 22 February 2024.*
49. **^** *"Industrial Heat Pumps: it's time to go electric". World Business Council for Sustainable Development (WBCSD). Retrieved 22 February 2024.*
50. **^** IEA HPT TCP Annex 35 Publications Archived 2018-09-21 at the Wayback Machine
51. **^** *"Application of Industrial Heat Pumps. Annex 35 two-page summary". HPT – Heat Pumping Technologies. Retrieved 28 December 2023.*
52. **^** *"Norwegian Researchers Develop World's Hottest Heat Pump". Ammonia21. 5 August 2021. Archived from the original on 23 May 2022. Retrieved 7 June 2022.*
53. **^** *"Heat pumps are key to helping industry turn electric". World Business Council for Sustainable Development (WBCSD). Archived from the original on 24 September 2023. Retrieved 4 October 2022.*
54. ^ ***a*** ***b*** ***c*** ***d*** ***e*** ***f*** *"Heating and cooling with a heat pump: Efficiency terminology". Natural Resources Canada. 8 September 2022. Archived from the original on 3 April 2023. Retrieved 3 April 2023.*
55. **^** Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters
56. ^ ***a*** ***b*** ***c*** ***d*** The Canadian Renewable Energy Network 'Commercial Earth Energy Systems', Figure 29 Archived 2011-05-11 at the Wayback Machine. . Retrieved December 8, 2009.
57. **^** Technical Institute of Physics and Chemistry, Chinese Academy of Sciences 'State of the Art of Air-source Heat Pump for Cold Region', Figure 5 Archived 2016-04-14 at the Wayback Machine. . Retrieved April 19, 2008.
58. ^ ***a*** ***b*** SINTEF Energy Research 'Integrated CO_2 Heat Pump Systems for Space Heating and DHW in low-energy and passive houses', J. Steen, Table 3.1, Table 3.3 Archived 2009-03-18 at the Wayback Machine. . Retrieved April 19, 2008.
59. **^** *"How Wind Can Help Us Breathe Easier". Energy.gov. Archived from the original on 28 August 2023. Retrieved 13 September 2023.*
60. **^** *"Global Electricity Review 2023". Ember. 11 April 2023. Archived from the original on 11 April 2023. Retrieved 13 September 2023.*
61. ^ ***a*** ***b*** Quaschning 2022

62. **^** *"The UK is sabotaging its own plan to decarbonize heating". Engadget. 27 May 2021. Archived from the original on 6 June 2021. Retrieved 6 June 2021.*
63. **^** *Deetjen, Thomas A; Walsh, Liam; Vaishnav, Parth (28 July 2021). "US residential heat pumps: the private economic potential and its emissions, health, and grid impacts". Environmental Research Letters.* ***16*** *(8): 084024. Bibcode:2021ERL....16h4024D. doi:10.1088/1748-9326/ac10dc. S2CID 236486619.*
64. **^** *"Can the UK rely on hydrogen to save its gas boilers?". inews.co.uk. 21 May 2021. Archived from the original on 6 June 2021. Retrieved 6 June 2021.*
65. **^** IEA (2022), Global Hydrogen Review 2022, IEA, Paris https://www.iea.org/reports/global-hydrogen-review-2022 Archived 2023-01-10 at the Wayback Machine , License: CC BY 4.0
66. **^** Saturated vapors and saturated liquids are vapors and liquids at their saturation temperature and saturation pressure. A superheated vapor is at a temperature higher than the saturation temperature corresponding to its pressure.
67. **^** *Ludwig von Cube, Hans (1981). Heat Pump Technology. Butterworths. pp. 22–23. ISBN 0-408-00497-5. Archived from the original on 3 April 2023. Retrieved 2 January 2023.*
68. **^** *Chamoun, Marwan; Rulliere, Romuald; Haberschill, Philippe; Berail, Jean Francois (1 June 2012). "Dynamic model of an industrial heat pump using water as refrigerant". International Journal of Refrigeration.* ***35*** *(4): 1080–1091. doi:10.1016/j.ijrefrig.2011.12.007. ISSN 0140-7007.*
69. **^** *Wu, Di (2021). "Vapor compression heat pumps with pure Low-GWP refrigerants". Renewable and Sustainable Energy Reviews.* ***138****: 110571. doi:10.1016/j.rser.2020.110571. ISSN 1364-0321. S2CID 229455137. Archived from the original on 24 September 2023. Retrieved 17 November 2022.*
70. **^** *"Everything you need to know about the wild world of heat pumps". MIT Technology Review. Archived from the original on 1 August 2023. Retrieved 19 September 2023.*
71. **^** *Miara, Marek (22 October 2019). "Heat Pumps with Climate-Friendly Refrigerant Developed for Indoor Installation". Fraunhofer ISE. Archived from the original on 20 February 2022. Retrieved 21 February 2022.*
72. **^** *Rabe, Barry G. (23 September 2022). "Pivoting from global climate laggard to leader: Kigali and American HFC policy". Brookings. Archived from the original on 4 October 2022. Retrieved 4 October 2022.*
73. **^** *Itteilag, Richard L. (9 August 2012). Green Electricity and Global Warming. AuthorHouse. p. 77. ISBN 9781477217405. Archived from the original on 23 November 2021. Retrieved 1 November 2020.*
74. ^ ***a b*** *"Propane-powered heat pumps are greener". The Economist. 6 September 2023. ISSN 0013-0613. Archived from the original on 17 September 2023. Retrieved 17 September 2023.*
75. **^** *"Smart CO2 Heat Pump". www.dti.dk. Archived from the original on 30 January 2023. Retrieved 17 September 2023.*

76. **^** *"Annex 53 Advanced Cooling/Refrigeration Technologies 2 page summary". HPT – Heat Pumping Technologies. Retrieved 19 February 2024.*
77. **^** *"Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer – 7th Edition". United Nations Environment Programme – Ozone Secretariat. 2007. Archived from the original on 30 May 2016. Retrieved 18 December 2016.*
78. **^** *"Refrigerants – Environmental Properties". The Engineering ToolBox. Archived from the original on 14 March 2013. Retrieved 12 September 2016.*
79. **^** R-410A#Environmental effects.
80. **^** *Ecometrica.com (27 June 2012). "Calculation of green house gas potential of R-410A". Archived from the original on 13 July 2015. Retrieved 13 July 2015.*
81. **^** *"R404 and DME Refrigerant blend as a new solution to limit global warming potential" (PDF). 14 March 2012. Archived from the original (PDF) on 14 March 2012.*
82. ^ ***a b*** IPCC_AR6_WG1_Ch7 2021, 7SM-26
83. **^** *LearnMetrics (12 May 2023). "List of Low GWP Refrigerants: 69 Refrigerants Below 500 GWP". LearnMetrics. Archived from the original on 10 June 2023. Retrieved 13 September 2023.*
84. ^ ***a b c*** *"Global warming potential (GWP) of HFC refrigerants". iifiir.org. Archived from the original on 24 September 2023. Retrieved 13 September 2023.*
85. **^** *Everitt, Neil (15 September 2023). "Qvantum plant has 1 million heat pump capacity". Cooling Post. Archived from the original on 24 September 2023. Retrieved 17 September 2023.*
86. **^** *Miara, Marek (22 October 2019). "Heat Pumps with Climate-Friendly Refrigerant Developed for Indoor Installation". Fraunhofer ISE. Archived from the original on 20 February 2022. Retrieved 21 February 2022.*
87. **^** *"Refrigerant Safety – About Refrigerant Safety, Toxicity and Flammability". Checkmark. Retrieved 17 April 2024.*
88. **^** *"A2L – Mildly Flammable Refrigerants". ACR Journal. 1 September 2015. Retrieved 17 April 2024.*
89. **^** *US Environmental Protection Agency, OAR (14 November 2014). "Phaseout of Ozone-Depleting Substances (ODS)". US EPA. Archived from the original on 24 September 2015. Retrieved 16 February 2020.*
90. **^** *"Heat Pumps". IEA. Archived from the original on 17 September 2023. Retrieved 17 September 2023.*
91. **^** *"Electrifying industrial processes with heat pumps". 22 March 2022. Archived from the original on 8 August 2022. Retrieved 9 August 2022.*
92. **^** *Department of Energy, Environment and Climate Action, Victoria Government (Australia) (11 October 2023). "Hot water systems for businesses". Victoria Government.*
93. **^** *Department of Energy, Environment and Climate Action (Australia), Victoria Government (23 September 2023). "Hot water systems for households". Victoria Government.*

94. **^** *New South Wales Climate and Energy Action, New South Wales Government (Australia) (8 December 2023). "Upgrade your hot water system". NSW Government.*
95. **^** *Australian Government, Queensland (5 October 2023). "Queensland Business Energy Saving and Transformation Rebates". Queensland Government.*
96. **^** *Time To Save (21 November 2023). "Hot Water Rebates in Australia: A Detailed Guide For Businesses". Timetosave.*
97. **^** *"Canada Greener Homes Grant". 17 March 2021. Archived from the original on 17 January 2022. Retrieved 17 January 2022.*
98. **^** *"Coal fired boiler replacement in Beijing rural area". Archived from the original on 24 March 2023. Retrieved 14 September 2023.*
99. ^ ***a b c*** *"Executive summary – The Future of Heat Pumps in China – Analysis". IEA . Retrieved 12 April 2024.*
100. **^** IEA (2024), The Future of Heat Pumps in China, IEA, Paris https://www.iea.org/reports/the-future-of-heat-pumps-in-china, Licence: CC BY 4.0
101. **^** *"The Heat Pump Accelerator Platform". European Commission. 2024. Retrieved 27 November 2024.*
102. **^** *"Heat pumps". European Commission. 2024. Retrieved 27 November 2024.*
103. **^** *"HMCR rates for goods and services". 11 July 2022. Archived from the original on 22 July 2022. Retrieved 24 August 2022.*
104. **^** *"Apply for the Boiler Upgrade Scheme". Archived from the original on 19 September 2023. Retrieved 14 September 2023.*
105. **^** *"BBC Radio 4 – Sliced Bread, Air Source Heat Pumps". BBC. Archived from the original on 30 April 2022. Retrieved 30 April 2022.*
106. **^** *Lawrence, Karen (3 May 2024). "Air source heat pump costs and savings". Which?. Retrieved 7 June 2024.*
107. **^** *"Clean Heat without the Hot Air: British and Dutch lessons and challenges". UKERC. Retrieved 7 June 2024.*
108. **^** *Shao, Elena. "H. R. 5376 – Inflation Reduction Act of 2022". Congress.gov. U.S. Congress. Archived from the original on 17 November 2022. Retrieved 17 November 2022.*
109. **^** *"As Heat Pumps Go Mainstream, a Big Question: Can They Handle Real Cold?". The New York Times. 22 February 2023. Archived from the original on 11 April 2023. Retrieved 11 April 2023.*
110. **^** *Frazin, Rachel (17 November 2023). "Biden administration uses wartime authority to bolster energy efficient manufacturing". The Hill. Retrieved 29 November 2023.*

Sources

[edit]

IPCC reports

[edit]

- *IPCC (2021). Masson-Delmotte, V.; Zhai, P.; Pirani, A.; Connors, S. L.; et al. (eds.). Climate Change 2021: The Physical Science Basis (PDF). Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press (In Press).*
  - *Forster, P.; Storelvmo, T.; Armour, K.; Collins, W. (2021). "Chapter 7: The Earth's energy budget, climate feedbacks, and climate sensitivity Supplementary Material" (PDF). IPCC AR6 WG1 2021.*
- *IPCC (2018). Masson-Delmotte, V.; Zhai, P.; Pörtner, H.-O.; Roberts, D.; et al. (eds.). Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (PDF). Intergovernmental Panel on Climate Change.* https://www.ipcc.ch/sr15/.
  - *Rogelj, J.; Shindell, D.; Jiang, K.; Fifta, S.; et al. (2018). "Chapter 2: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development" (PDF). IPCC SR15 2018. pp. 93–174.*
- *IPCC (2022). Shula, P. R.; Skea, J.; Slade, R.; Al Khourdajie, A.; et al. (eds.). Climate Change 2022: Mitigation of Climate Change (PDF). Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, New York, USA: Cambridge University Press (In Press). Archived from the original (PDF) on 4 April 2022. Retrieved 10 May 2022.*
  - *IPCC (2022). "Industry" (PDF). IPCC AR6 WG3 2022.*

Other

[edit]

- *Quaschning, Volker. "Specific Carbon Dioxide Emissions of Various Fuels". Retrieved 22 February 2022.*

External links

[edit]

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Heating, ventilation, and air conditioning

Fundamental concepts	○ Air changes per hour ○ Bake-out ○ Building envelope ○ Convection ○ Dilution ○ Domestic energy consumption ○ Enthalpy ○ Fluid dynamics ○ Gas compressor ○ Heat pump and refrigeration cycle ○ Heat transfer ○ Humidity ○ Infiltration ○ Latent heat ○ Noise control ○ Outgassing ○ Particulates ○ Psychrometrics ○ Sensible heat ○ Stack effect ○ Thermal comfort ○ Thermal destratification ○ Thermal mass ○ Thermodynamics ○ Vapour pressure of water

Technology	○ Absorption-compression heat pump ○ Absorption refrigerator ○ Air barrier ○ Air conditioning ○ Antifreeze ○ Automobile air conditioning ○ Autonomous building ○ Building insulation materials ○ Central heating ○ Central solar heating ○ Chilled beam ○ Chilled water ○ Constant air volume (CAV) ○ Coolant ○ Cross ventilation ○ Dedicated outdoor air system (DOAS) ○ Deep water source cooling ○ Demand controlled ventilation (DCV) ○ Displacement ventilation ○ District cooling ○ District heating ○ Electric heating ○ Energy recovery ventilation (ERV) ○ Firestop ○ Forced-air ○ Forced-air gas ○ Free cooling ○ Heat recovery ventilation (HRV) ○ Hybrid heat ○ Hydronics ○ Ice storage air conditioning ○ Kitchen ventilation ○ Mixed-mode ventilation ○ Microgeneration ○ Passive cooling ○ Passive daytime radiative cooling ○ Passive house ○ Passive ventilation ○ Radiant heating and cooling ○ Radiant cooling ○ Radiant heating ○ Radon mitigation ○ Refrigeration ○ Renewable heat ○ Room air distribution ○ Solar air heat ○ Solar combisystem ○ Solar cooling

- Air conditioner inverter
- Air door
- Air filter
- Air handler
- Air ionizer
- Air-mixing plenum
- Air purifier
- Air source heat pump
- Attic fan
- Automatic balancing valve
- Back boiler
- Barrier pipe
- Blast damper
- Boiler
- Centrifugal fan
- Ceramic heater
- Chiller
- Condensate pump
- Condenser
- Condensing boiler
- Convection heater
- Compressor
- Cooling tower
- Damper
- Dehumidifier
- Duct
- Economizer
- Electrostatic precipitator
- Evaporative cooler
- Evaporator
- Exhaust hood
- Expansion tank
- Fan
- Fan coil unit
- Fan filter unit
- Fan heater
- Fire damper
- Fireplace
- Fireplace insert
- Freeze stat
- Flue
- Freon
- Fume hood
- Furnace
- Gas compressor
- Gas heater
- Gasoline heater
- Grease duct

Measurement and control

- Air flow meter
- Aquastat
- BACnet
- Blower door
- Building automation
- Carbon dioxide sensor
- Clean air delivery rate (CADR)
- Control valve
- Gas detector
- Home energy monitor
- Humidistat
- HVAC control system
- Infrared thermometer
- Intelligent buildings
- LonWorks
- Minimum efficiency reporting value (MERV)
- Normal temperature and pressure (NTP)
- OpenTherm
- Programmable communicating thermostat
- Programmable thermostat
- Psychrometrics
- Room temperature
- Smart thermostat
- Standard temperature and pressure (STP)
- Thermographic camera
- Thermostat
- Thermostatic radiator valve

Professions, trades, and services

- Architectural acoustics
- Architectural engineering
- Architectural technologist
- Building services engineering
- Building information modeling (BIM)
- Deep energy retrofit
- Duct cleaning
- Duct leakage testing
- Environmental engineering
- Hydronic balancing
- Kitchen exhaust cleaning
- Mechanical engineering
- Mechanical, electrical, and plumbing
- Mold growth, assessment, and remediation
- Refrigerant reclamation
- Testing, adjusting, balancing

Industry organizations

- AHRI
- AMCA
- ASHRAE
- ASTM International
- BRE
- BSRIA
- CIBSE
- Institute of Refrigeration
- IIR
- LEED
- SMACNA
- UMC

Health and safety

- Indoor air quality (IAQ)
- Passive smoking
- Sick building syndrome (SBS)
- Volatile organic compound (VOC)

See also

- ASHRAE Handbook
- Building science
- Fireproofing
- Glossary of HVAC terms
- Warm Spaces
- World Refrigeration Day
- Template:Home automation
- Template:Solar energy

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About Sick building syndrome

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Sick building syndrome	
Specialty	Environmental medicine, immunology Image not found or type unknown Edit this on Wikidata

Sick building syndrome (**SBS**) is a condition in which people develop symptoms of illness or become infected with chronic disease from the building in which they work or reside.[1] In scientific literature, SBS is also known as **building-related illness (BRI)**, **building-related symptoms (BRS)**, or **idiopathic environmental intolerance (IEI)**.

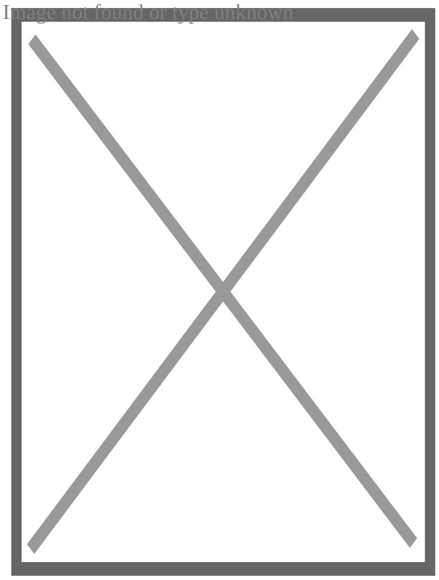
The main identifying observation is an increased incidence of complaints of such symptoms as headache, eye, nose, and throat irritation, fatigue, dizziness, and nausea. The 1989 Oxford English Dictionary defines SBS in that way.[2] The World Health Organization created a 484-page tome on indoor air quality 1984, when SBS was attributed only to non-organic causes, and suggested that the book might form a basis for legislation or litigation.[3]

The outbreaks may or may not be a direct result of inadequate or inappropriate cleaning.[2] SBS has also been used to describe staff concerns in post-war buildings with faulty building aerodynamics, construction materials, construction process, and maintenance.[2] Some symptoms tend to increase in severity with the time people spend in the building, often improving or even disappearing when people are away from the building.[2][4] The term *SBS* is also used interchangeably with "**building-related symptoms**", which orients the name of the condition around patients' symptoms rather than a "sick" building.[5]

Attempts have been made to connect sick building syndrome to various causes, such as contaminants produced by outgassing of some building materials, volatile organic compounds (VOC), improper exhaust ventilation of ozone (produced by the operation of some office machines), light industrial chemicals used within, and insufficient fresh-air intake or air filtration (*see* "Minimum efficiency reporting value").[2] Sick building syndrome has also been attributed to heating, ventilation, and air conditioning (HVAC) systems, an attribution about which there are inconsistent findings.[6]

Signs and symptoms

[edit]



An air quality monitor

Human exposure to aerosols has a variety of adverse health effects.[7] Building occupants complain of symptoms such as sensory irritation of the eyes, nose, or throat; neurotoxic or general health problems; skin irritation; nonspecific hypersensitivity reactions; infectious diseases;[8] and odor and taste sensations.[9] Poor lighting has caused general malaise.[10]

Extrinsic allergic alveolitis has been associated with the presence of fungi and bacteria in the moist air of residential houses and commercial offices.[11] A study in 2017 correlated several inflammatory diseases of the respiratory tract with objective evidence of damp-caused damage in homes.[12]

The WHO has classified the reported symptoms into broad categories, including mucous-membrane irritation (eye, nose, and throat irritation), neurotoxic effects (headaches, fatigue, and irritability), asthma and asthma-like symptoms (chest tightness and wheezing), skin dryness and irritation, and gastrointestinal complaints.[13]

Several sick occupants may report individual symptoms that do not seem connected. The key to discovery is the increased incidence of illnesses in general with onset or exacerbation in a short period, usually weeks. In most cases, SBS symptoms are relieved soon after the occupants leave the particular room or zone.[14] However, there can be lingering effects of various neurotoxins, which may not clear up when the occupant leaves the building. In some cases, including those of sensitive people, there are long-term health effects.[15]

Cause

[edit]

ASHRAE has recognized that polluted urban air, designated within the United States Environmental Protection Agency (EPA)'s air quality ratings as unacceptable, requires the installation of treatment such as filtration for which the HVAC practitioners generally apply carbon-impregnated filters and their likes. Different toxins will aggravate the human body in different ways. Some people are more allergic to mold, while others are highly sensitive to dust. Inadequate ventilation will exaggerate small problems (such as deteriorating fiberglass insulation or cooking fumes) into a much more serious indoor air quality problem.[10]

Common products such as paint, insulation, rigid foam, particle board, plywood, duct liners, exhaust fumes and other chemical contaminants from indoor or outdoor sources, and biological contaminants can be trapped inside by the HVAC AC system. As this air is recycled using fan coils the overall oxygenation ratio drops and becomes harmful. When combined with other stress factors such as traffic noise and poor lighting, inhabitants of buildings located in a polluted urban area can quickly become ill as their immune system is overwhelmed.[10]

Certain VOCs, considered toxic chemical contaminants to humans, are used as adhesives in many common building construction products. These aromatic carbon rings / VOCs can cause acute and chronic health effects in the occupants of a building, including cancer, paralysis, lung failure, and others. Bacterial spores, fungal spores, mold spores, pollen, and viruses are types of biological contaminants and can all cause allergic reactions or illness described as SBS. In addition, pollution from outdoors, such as motor vehicle exhaust, can enter buildings, worsen indoor air quality, and increase the indoor concentration of carbon monoxide and carbon dioxide.[16] Adult SBS symptoms were associated with a history of allergic rhinitis, eczema and asthma.[17]

A 2015 study concerning the association of SBS and indoor air pollutants in office buildings in Iran found that, as carbon dioxide increased in a building, nausea, headaches, nasal irritation, dyspnea, and throat dryness also rose.[10] Some work conditions have been correlated with specific symptoms: brighter light, for example was significantly related to skin dryness, eye pain, and malaise.[10] Higher temperature is correlated with sneezing, skin redness, itchy eyes, and headache; lower relative humidity has been associated with sneezing, skin redness, and eye pain.[10]

In 1973, in response to the oil crisis and conservation concerns, ASHRAE Standards 62-73 and 62-81 reduced required ventilation from 10 cubic feet per minute (4.7 L/s) per person to 5 cubic feet per minute (2.4 L/s) per person, but this was found to be a contributing factor to sick building syndrome.[18] As of the 2016 revision, ASHRAE ventilation standards call for 5 to 10 cubic feet per minute of ventilation per occupant (depending on the occupancy type) in addition to ventilation based on the zone floor area delivered to the breathing zone.[19]

Workplace

[edit]

Excessive work stress or dissatisfaction, poor interpersonal relationships and poor communication are often seen to be associated with SBS, recent[*when?*] studies show that a combination of environmental sensitivity and stress can greatly contribute to sick building syndrome.[15][*citation needed*]

Greater effects were found with features of the psycho-social work environment including high job demands and low support. The report concluded that the physical environment of office buildings appears to be less important than features of the psycho-social work environment in explaining differences in the prevalence of symptoms. However, there is still a relationship between sick building syndrome and symptoms of workers regardless of workplace stress.[20]

Specific work-related stressors are related with specific SBS symptoms. Workload and work conflict are significantly associated with general symptoms (headache, abnormal tiredness, sensation of cold or nausea). While crowded workspaces and low work satisfaction are associated with upper respiratory symptoms.[21] Work productivity has been associated with ventilation rates, a contributing factor to SBS, and there's a significant increase in production as ventilation rates increase, by 1.7% for every two-fold increase of ventilation rate.[22] Printer effluent, released into the office air as ultra-fine particles (UFPs) as toner is burned during the printing process, may lead to certain SBS symptoms.[23][24] Printer effluent may contain a variety of toxins to which a subset of office workers are sensitive, triggering SBS symptoms.[25]

Specific careers are also associated with specific SBS symptoms. Transport, communication, healthcare, and social workers have highest prevalence of general symptoms. Skin symptoms such as eczema, itching, and rashes on hands and face are associated with technical work. Forestry, agriculture, and sales workers have the lowest rates of sick building syndrome symptoms.[26]

From the assessment done by Fisk and Mudarri, 21% of asthma cases in the United States were caused by wet environments with mold that exist in all indoor environments, such as schools, office buildings, houses and apartments. Fisk and Berkeley Laboratory colleagues also found that the exposure to the mold increases the chances of respiratory issues by 30 to 50 percent.[27] Additionally, studies showing that health effects with dampness and mold in indoor environments found that increased risk of adverse health effects occurs with dampness or visible mold environments.[28]

Milton et al. determined the cost of sick leave specific for one business was an estimated $480 per employee, and about five days of sick leave per year could be attributed to low ventilation rates. When comparing low ventilation rate areas of the building to higher ventilation rate areas, the relative risk of short-term sick leave was 1.53 times greater in the low ventilation areas.[29]

Home

[edit]

Sick building syndrome can be caused by one's home. Laminate flooring may release more SBS-causing chemicals than do stone, tile, and concrete floors.[17] Recent redecorating and new furnishings within the last year are associated with increased symptoms; so are dampness and related factors, having pets, and cockroaches.[17] Mosquitoes are related to more symptoms, but it is unclear whether the immediate cause of the symptoms is the mosquitoes or the repellents used against them.[17]

Mold

[edit]
Main article: Mold health issues

Sick building syndrome may be associated with indoor mold or mycotoxin contamination. However, the attribution of sick building syndrome to mold is controversial and supported by little evidence.[30][31][32]

Indoor temperature

[edit]
Main article: Room temperature § Health effects

Indoor temperature under 18 °C (64 °F) has been shown to be associated with increased respiratory and cardiovascular diseases, increased blood levels, and increased hospitalization.[33]

Diagnosis

[edit]

While sick building syndrome (SBS) encompasses a multitude of non-specific symptoms, building-related illness (BRI) comprises specific, diagnosable symptoms caused by certain agents (chemicals, bacteria, fungi, etc.). These can typically be identified, measured, and quantified.[34] There are usually four causal agents in BRi: immunologic, infectious, toxic, and irritant.[34] For instance, Legionnaire's disease, usually caused by *Legionella pneumophila*, involves a specific organism which could be ascertained through clinical findings as the source of contamination within a building.[34]

Prevention

[edit]

- Reduction of time spent in the building
- If living in the building, moving to a new place
- Fixing any deteriorated paint or concrete deterioration
- Regular inspections to indicate for presence of mold or other toxins
- Adequate maintenance of all building mechanical systems
- Toxin-absorbing plants, such as sansevieria[35][36][37][38][39][40][41][*excessive citations*
- Roof shingle non-pressure cleaning for removal of algae, mold, and *Gloeocapsa magma*
- Using ozone to eliminate the many sources, such as VOCs, molds, mildews, bacteria, viruses, and even odors. However, numerous studies identify high-ozone shock treatment as ineffective despite commercial popularity and popular belief.
- Replacement of water-stained ceiling tiles and carpeting
- Only using paints, adhesives, solvents, and pesticides in well-ventilated areas or only using these pollutant sources during periods of non-occupancy
- Increasing the number of air exchanges; the American Society of Heating, Refrigeration and Air-Conditioning Engineers recommend a minimum of 8.4 air exchanges per 24-hour period
- Increased ventilation rates that are above the minimum guidelines[22]
- Proper and frequent maintenance of HVAC systems
- UV-C light in the HVAC plenum
- Installation of HVAC air cleaning systems or devices to remove VOCs and bioeffluents (people odors)
- Central vacuums that completely remove all particles from the house including the ultrafine particles (UFPs) which are less than 0.1 ?m
- Regular vacuuming with a HEPA filter vacuum cleaner to collect and retain 99.97% of particles down to and including 0.3 micrometers
- Placing bedding in sunshine, which is related to a study done in a high-humidity area where damp bedding was common and associated with SBS[17]
- Lighting in the workplace should be designed to give individuals control, and be natural when possible[42]

- Relocating office printers outside the air conditioning boundary, perhaps to another building
- Replacing current office printers with lower emission rate printers[43]
- Identification and removal of products containing harmful ingredients

Management

[edit]

SBS, as a non-specific blanket term, does not have any specific cause or cure. Any known cure would be associated with the specific eventual disease that was cause by exposure to known contaminants. In all cases, alleviation consists of removing the affected person from the building associated. BRI, on the other hand, utilizes treatment appropriate for the contaminant identified within the building (e.g., antibiotics for Legionnaire's disease).[*citation needed*]

Improving the indoor air quality (IAQ) of a particular building can attenuate, or even eliminate, the continued exposure to toxins. However, a Cochrane review of 12 mold and dampness remediation studies in private homes, workplaces and schools by two independent authors were deemed to be very low to moderate quality of evidence in reducing adult asthma symptoms and results were inconsistent among children.[44] For the individual, the recovery may be a process involved with targeting the acute symptoms of a specific illness, as in the case of mold toxins.[45] Treating various building-related illnesses is vital to the overall understanding of SBS. Careful analysis by certified building professionals and physicians can help to identify the exact cause of the BRI, and help to illustrate a causal path to infection. With this knowledge one can, theoretically, remediate a building of contaminants and rebuild the structure with new materials. Office BRI may more likely than not be explained by three events: "Wide range in the threshold of response in any population (susceptibility), a spectrum of response to any given agent, or variability in exposure within large office buildings."[46]

Isolating any one of the three aspects of office BRI can be a great challenge, which is why those who find themselves with BRI should take three steps, history, examinations, and interventions. History describes the action of continually monitoring and recording the health of workers experiencing BRI, as well as obtaining records of previous building alterations or related activity. Examinations go hand in hand with monitoring employee health. This step is done by physically examining the entire workspace and evaluating possible threats to health status among employees. Interventions follow accordingly based on the results of the Examination and History report.[46]

Epidemiology

[edit]

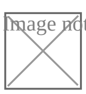
Some studies have found that women have higher reports of SBS symptoms than men.[17][10] It is not entirely clear, however, if this is due to biological, social, or occupational factors.

A 2001 study published in the Journal Indoor Air, gathered 1464 office-working participants to increase the scientific understanding of gender differences under the Sick Building Syndrome phenomenon.[47] Using questionnaires, ergonomic investigations, building evaluations, as well as physical, biological, and chemical variables, the investigators obtained results that compare with past studies of SBS and gender. The study team found that across most test variables, prevalence rates were different in most areas, but there was also a deep stratification of working conditions between genders as well. For example, men's workplaces tend to be significantly larger and have all-around better job characteristics. Secondly, there was a noticeable difference in reporting rates, specifically that women have higher rates of reporting roughly 20% higher than men. This information was similar to that found in previous studies, thus indicating a potential difference in willingness to report.[47]

There might be a gender difference in reporting rates of sick building syndrome, because women tend to report more symptoms than men do. Along with this, some studies have found that women have a more responsive immune system and are more prone to mucosal dryness and facial erythema. Also, women are alleged by some to be more exposed to indoor environmental factors because they have a greater tendency to have clerical jobs, wherein they are exposed to unique office equipment and materials (example: blueprint machines, toner-based printers), whereas men often have jobs based outside of offices.[48]

History

[edit]



This section **possibly contains original research**. Please improve it by verifying the claims made and adding inline citations. Statements consisting only of original research should be removed. *(August 2017) (Learn how and when to remove this message)*

In the late 1970s, it was noted that nonspecific symptoms were reported by tenants in newly constructed homes, offices, and nurseries. In media it was called "office illness". The term "sick building syndrome" was coined by the WHO in 1986, when they also estimated that 10–30% of newly built office buildings in the West had indoor air problems. Early Danish and British studies reported symptoms.

Poor indoor environments attracted attention. The Swedish allergy study (SOU 1989:76) designated "sick building" as a cause of the allergy epidemic as was feared. In the 1990s, therefore, extensive research into "sick building" was carried out. Various physical and chemical factors in the buildings were examined on a broad front.

The problem was highlighted increasingly in media and was described as a "ticking time bomb". Many studies were performed in individual buildings.

In the 1990s "sick buildings" were contrasted against "healthy buildings". The chemical contents of building materials were highlighted. Many building material manufacturers were actively working to gain control of the chemical content and to replace criticized additives. The ventilation industry advocated above all more well-functioning ventilation. Others perceived ecological construction, natural materials, and simple techniques as a solution.

At the end of the 1990s came an increased distrust of the concept of "sick building". A dissertation at the Karolinska Institute in Stockholm 1999 questioned the methodology of previous research, and a Danish study from 2005 showed these flaws experimentally. It was suggested that sick building syndrome was not really a coherent syndrome and was not a disease to be individually diagnosed, but a collection of as many as a dozen semi-related diseases. In 2006 the Swedish National Board of Health and Welfare recommended in the medical journal *Läkartidningen* that "sick building syndrome" should not be used as a clinical diagnosis. Thereafter, it has become increasingly less common to use terms such as *sick buildings* and *sick building syndrome* in research. However, the concept remains alive in popular culture and is used to designate the set of symptoms related to poor home or work environment engineering. *Sick building* is therefore an expression used especially in the context of workplace health.

Sick building syndrome made a rapid journey from media to courtroom where professional engineers and architects became named defendants and were represented by their respective professional practice insurers. Proceedings invariably relied on expert witnesses, medical and technical experts along with building managers, contractors and manufacturers of finishes and furnishings, testifying as to cause and effect. Most of these actions resulted in sealed settlement agreements, none of these being dramatic. The insurers needed a defense based upon Standards of Professional Practice to meet a court decision that declared that in a modern, essentially sealed building, the HVAC systems must produce breathing air for suitable human consumption. ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers, currently with over 50,000 international members) undertook the task of codifying its indoor air quality (IAQ) standard.

ASHRAE empirical research determined that "acceptability" was a function of outdoor (fresh air) ventilation rate and used carbon dioxide as an accurate measurement of occupant presence and activity. Building odors and contaminants would be suitably controlled by this dilution methodology. ASHRAE codified a level of 1,000 ppm of carbon dioxide and specified the use of widely available sense-and-control equipment to assure compliance. The 1989 issue of ASHRAE 62.1-1989 published the whys and wherefores and overrode the 1981 requirements that were aimed at a ventilation level of 5,000 ppm of carbon dioxide (the OSHA workplace limit), federally set to minimize HVAC system energy consumption. This apparently ended the SBS epidemic.

Over time, building materials changed with respect to emissions potential. Smoking vanished and dramatic improvements in ambient air quality, coupled with code compliant ventilation and maintenance, per ASHRAE standards have all contributed to the acceptability of the indoor air environment.[49][50]

See also

[edit]

- Aerotoxic syndrome
- Air purifier
- Asthmagen
- Cleanroom
- Electromagnetic hypersensitivity
- Havana syndrome
- Healthy building
- Indoor air quality
- Lead paint
- Multiple chemical sensitivity
- NASA Clean Air Study
- Nosocomial infection
- Particulates
- Power tools
- Renovation
- Somatization disorder
- Fan death

References

[edit]

1. **^** *"Sick Building Syndrome" (PDF). World Health Organization. n.d.*
2. ^ ***a b c d e*** *Passarelli, Guiseppe Ryan (2009). "Sick building syndrome: An overview to raise awareness". Journal of Building Appraisal.* ***5****: 55–66. doi:10.1057/jba.2009.20.*
3. **^** *European Centre for Environment and Health, WHO (1983). WHO guidelines for indoor air quality: selected pollutants (PDF). EURO Reports and Studies, no 78. Bonn Germany Office: WHO Regional Office for Europe (Copenhagen).*
4. **^** *Stolwijk, J A (1991-11-01). "Sick-building syndrome". Environmental Health Perspectives.* ***95****: 99–100. doi:10.1289/ehp.919599. ISSN 0091-6765. PMC 1568418. PMID 1821387.*

5. **^** *Indoor Air Pollution: An Introduction for Health Professionals (PDF). Indoor Air Division (6609J): U.S. Environmental Protection Agency. c. 2015.*cite book: CS1 maint: location (link)
6. **^** *Shahzad, Sally S.; Brennan, John; Theodossopoulos, Dimitris; Hughes, Ben; Calautit, John Kaiser (2016-04-06). "Building-Related Symptoms, Energy, and Thermal Control in the Workplace: Personal and Open Plan Offices". Sustainability. **8** (4): 331. doi:10.3390/su8040331. hdl:20.500.11820/03eb7043-814e-437d-b920-4a38bb88742c.*
7. **^** *Sundell, J; Lindval, T; Berndt, S (1994). "Association between type of ventilation and airflow rates in office buildings and the risk of SBS-symptoms among occupants". Environ. Int. **20** (2): 239–251. Bibcode:1994EnInt..20..239S. doi:10.1016/0160-4120(94)90141-4.*
8. **^** *Rylander, R (1997). "Investigation of the relationship between disease and airborne (1P3)-b-D-glucan in buildings". Med. Of Inflamm. **6** (4): 275–277. doi:10.1080/09629359791613. PMC 2365865. PMID 18472858.*
9. **^** Godish, Thad (2001). *Indoor Environmental Quality.* New York: CRC Press. pp. 196–197. ISBN 1-56670-402-2
10. ^ ***a b c d e f g*** *Jafari, Mohammad Javad; Khajevandi, Ali Asghar; Mousavi Najarkola, Seyed Ali; Yekaninejad, Mir Saeed; Pourhoseingholi, Mohammad Amin; Omidi, Leila; Kalantary, Saba (2015-01-01). "Association of Sick Building Syndrome with Indoor Air Parameters". Tanaffos. **14** (1): 55–62. ISSN 1735-0344. PMC 4515331. PMID 26221153.*
11. **^** *Teculescu, D. B. (1998). "Sick Building Symptoms in office workers in northern France: a pilot study". Int. Arch. Occup. Environ. Health. **71** (5): 353–356. doi:10.1007/s004200050292. PMID 9749975. S2CID 25095874.*
12. **^** *Pind C. Ahlroth (2017). "Patient-reported signs of dampness at home may be a risk factor for chronic rhinosinusitis: A cross-sectional study". Clinical & Experimental Allergy. **47** (11): 1383–1389. doi:10.1111/cea.12976. PMID 28695715. S2CID 40807627.*
13. **^** *Apter, A (1994). "Epidemiology of the sick building syndrome". J. Allergy Clin. Immunol. **94** (2): 277–288. doi:10.1053/ai.1994.v94.a56006. PMID 8077580.*
14. **^** *"Sick Building Syndrome". NSC.org. National Safety Council. 2009. Retrieved April 27, 2009.*
15. ^ ***a b*** *Joshi, Sumedha M. (August 2008). "The sick building syndrome". Indian Journal of Occupational and Environmental Medicine. **12** (2): 61–64. doi:10.4103/0019-5278.43262. ISSN 0973-2284. PMC 2796751. PMID 20040980.*
16. **^** *"Indoor Air Facts No.4: Sick Building Syndrome" (PDF). United States Environmental Protection Agency (EPA). 1991. Retrieved 2009-02-19.*
17. ^ ***a b c d e f*** *Wang, Juan; Li, BaiZhan; Yang, Qin; Wang, Han; Norback, Dan; Sundell, Jan (2013-12-01). "Sick building syndrome among parents of preschool children in relation to home environment in Chongqing, China". Chinese Science Bulletin. **58** (34): 4267–4276. Bibcode:2013ChSBu..58.4267W. doi:10.1007/s11434-013-5814-2. ISSN 1001-6538.*

18. **^** *Joshi S. M. (2008). "The sick building syndrome". Indian J. Occup. Environ. Med. **12** (2): 61–4. doi:10.4103/0019-5278.43262. PMC 2796751. PMID 20040980.* in section 3 "Inadequate ventilation".
19. **^** ANSI/ASHRAE Standard 62.1-2016.
20. **^** *Bauer R. M., Greve K. W., Besch E. L., Schramke C. J., Crouch J., Hicks A., Lyles W. B. (1992). "The role of psychological factors in the report of building-related symptoms in sick building syndrome". Journal of Consulting and Clinical Psychology. **60** (2): 213–219. doi:10.1037/0022-006x.60.2.213. PMID 1592950.* cite journal: CS1 maint: multiple names: authors list (link)
21. **^** *Azuma K., Ikeda K., Kagi N., Yanagi U., Osawa H. (2014). "Prevalence and risk factors associated with nonspecific building-related symptoms in office employees in Japan: Relationships between work environment, Indoor Air Quality, and occupational stress". Indoor Air. **25** (5): 499–511. doi:10.1111/ina.12158. PMID 25244340.*cite journal: CS1 maint: multiple names: authors list (link)
22. ^ ***a b*** *Wargocki P., Wyon D. P., Sundell J., Clausen G., Fanger P. O. (2000). "The Effects of Outdoor Air Supply Rate in an Office on Perceived Air Quality, Sick Building Syndrome (SBS) Symptoms and Productivity". Indoor Air. **10** (4): 222–236. Bibcode:2000InAir..10..222W. doi:10.1034/j.1600-0668.2000.010004222.x. PMID 11089327.*cite journal: CS1 maint: multiple names: authors list (link)
23. **^** *Morimoto, Yasuo; Ogami, Akira; Kochi, Isamu; Uchiyama, Tetsuro; Ide, Reiko; Myojo, Toshihiko; Higashi, Toshiaki (2010). "[Continuing investigation of effect of toner and its by-product on human health and occupational health management of toner]". Sangyo Eiseigaku Zasshi = Journal of Occupational Health. **52** (5): 201–208. doi:10.1539/sangyoeisei.a10002. ISSN 1349-533X. PMID 20595787.*
24. **^** *Pirela, Sandra Vanessa; Martin, John; Bello, Dhimiter; Demokritou, Philip (September 2017). "Nanoparticle exposures from nano-enabled toner-based printing equipment and human health: state of science and future research needs". Critical Reviews in Toxicology. **47** (8): 678–704. doi:10.1080/10408444.2017.1318354. ISSN 1547-6898. PMC 5857386. PMID 28524743.*
25. **^** McKone, Thomas, et al. "Indoor Pollutant Emissions from Electronic Office Equipment, California Air Resources Board Air Pollution Seminar Series". Presented January 7, 2009. https://www.arb.ca.gov/research/seminars/mckone/mckone.pdf Archived 2017-02-07 at the Wayback Machine
26. **^** *Norback D., Edling C. (1991). "Environmental, occupational, and personal factors related to the prevalence of sick building syndrome in the general population". Occupational and Environmental Medicine. **48** (7): 451–462. doi:10.1136/oem.48.7.451. PMC 1035398. PMID 1854648.*
27. **^** *Weinhold, Bob (2007-06-01). "A Spreading Concern: Inhalational Health Effects of Mold". Environmental Health Perspectives. **115** (6): A300–A305. doi:10.1289/ehp.115-a300. PMC 1892134. PMID 17589582.*

28. **^** *Mudarri, D.; Fisk, W. J. (June 2007). "Public health and economic impact of dampness and mold". Indoor Air.* ***17*** *(3): 226–235. Bibcode:2007InAir..17..226M. doi:10.1111/j.1600-0668.2007.00474.x. ISSN 0905-6947. PMID 17542835. S2CID 21709547.*
29. **^** *Milton D. K., Glencross P. M., Walters M. D. (2000). "Risk of Sick Leave Associated with Outdoor Air Supply Rate, Humidification, and Occupant Complaints". Indoor Air.* ***10*** *(4): 212–221. Bibcode:2000InAir..10..212M. doi: 10.1034/j.1600-0668.2000.010004212.x. PMID 11089326.*cite journal: CS1 maint: multiple names: authors list (link)
30. **^** *Straus, David C. (2009). "Molds, mycotoxins, and sick building syndrome". Toxicology and Industrial Health.* ***25*** *(9–10): 617–635. Bibcode:2009ToxIH..25..617S. doi:10.1177/0748233709348287. PMID 19854820. S2CID 30720328.*
31. **^** *Terr, Abba I. (2009). "Sick Building Syndrome: Is mould the cause?". Medical Mycology.* ***47****: S217–S222. doi:10.1080/13693780802510216. PMID 19255924.*
32. **^** *Norbäck, Dan; Zock, Jan-Paul; Plana, Estel; Heinrich, Joachim; Svanes, Cecilie; Sunyer, Jordi; Künzli, Nino; Villani, Simona; Olivieri, Mario; Soon, Argo; Jarvis, Deborah (2011-05-01). "Lung function decline in relation to mould and dampness in the home: the longitudinal European Community Respiratory Health Survey ECRHS II". Thorax.* ***66*** *(5): 396–401. doi:10.1136/thx.2010.146613. ISSN 0040-6376. PMID 21325663. S2CID 318027.*
33. **^** *WHO Housing and health guidelines. World Health Organization. 2018. pp. 34, 47–48. ISBN 978-92-4-155037-6.*
34. ^ ***a b c*** *Seltzer, J. M. (1994-08-01). "Building-related illnesses". The Journal of Allergy and Clinical Immunology.* ***94*** *(2 Pt 2): 351–361. doi:10.1016/0091-6749(94)90096-5. ISSN 0091-6749. PMID 8077589.*
35. **^** nasa techdoc 19930072988
36. **^** *"Sick Building Syndrome: How indoor plants can help clear the air | University of Technology Sydney".*
37. **^** *Wolverton, B. C.; Johnson, Anne; Bounds, Keith (15 September 1989). Interior Landscape Plants for Indoor Air Pollution Abatement (PDF) (Report).*
38. **^** *Joshi, S. M (2008). "The sick building syndrome". Indian Journal of Occupational and Environmental Medicine.* ***12*** *(2): 61–64. doi:10.4103/0019-5278.43262. PMC 2796751. PMID 20040980.*
39. **^** *"Benefits of Office Plants – Tove Fjeld (Agri. Uni. Of Norway)". 2018-05-13.*
40. **^** *"NASA: 18 Plants Purify Air, Sick Building Syndrome". 2016-09-20. Archived from the original on 2020-10-26.*
41. **^** *"Sick Building Syndrome – How Plants Can Help".*
42. **^** How to deal with sick building syndrome: Guidance for employers, building owners and building managers. (1995). Sudbury: The Executive.
43. **^** *Scungio, Mauro; Vitanza, Tania; Stabile, Luca; Buonanno, Giorgio; Morawska, Lidia (2017-05-15). "Characterization of particle emission from laser printers" (PDF). Science of the Total Environment.* ***586****: 623–630. Bibcode:2017ScTEn.586..623S. doi:10.1016/j.scitotenv.2017.02.030. ISSN 0048-*

9697. PMID 28196755.
44. **^** *Sauni, Riitta; Verbeek, Jos H; Uitti, Jukka; Jauhiainen, Merja; Kreiss, Kathleen; Sigsgaard, Torben (2015-02-25). Cochrane Acute Respiratory Infections Group (ed.). "Remediating buildings damaged by dampness and mould for preventing or reducing respiratory tract symptoms, infections and asthma". Cochrane Database of Systematic Reviews. **2015** (2): CD007897. doi:10.1002/14651858.CD007897.pub3. PMC 6769180. PMID 25715323.*
45. **^** Indoor Air Facts No. 4 (revised) Sick building syndrome. Available from: [1].
46. ^ ***a b*** *Menzies, Dick; Bourbeau, Jean (1997-11-20). "Building-Related Illnesses". New England Journal of Medicine. **337** (21): 1524–1531. doi:10.1056/NEJM199711203372107. ISSN 0028-4793. PMID 9366585.*
47. ^ ***a b*** *Brasche, S.; Bullinger, M.; Morfeld, M.; Gebhardt, H. J.; Bischof, W. (2001-12-01). "Why do women suffer from sick building syndrome more often than men?--subjective higher sensitivity versus objective causes". Indoor Air. **11** (4): 217–222. Bibcode:2001InAir..11..217B. doi:10.1034/j.1600-0668.2001.110402.x. ISSN 0905-6947. PMID 11761596. S2CID 21579339.*
48. **^** Godish, Thad (2001). *Indoor Environmental quality.* New York: CRC Press. pp. 196–197. ISBN 1-56670-402-2
49. **^** *"Sick Building Syndrome – Fact Sheet" (PDF). United States Environmental Protection Agency. Retrieved 2013-06-06.*
50. **^** *"Sick Building Syndrome". National Health Service, England. Retrieved 2013-06-06.*

Further reading

[edit]

- Martín-Gil J., Yanguas M. C., San José J. F., Rey-Martínez and Martín-Gil F. J. "Outcomes of research into a sick hospital". *Hospital Management International*, 1997, pp. 80–82. Sterling Publications Limited.
- Åke Thörn, *The Emergence and preservation of sick building syndrome*, KI 1999.
- Charlotte Brauer, *The sick building syndrome revisited*, Copenhagen 2005.
- Michelle Murphy, *Sick Building Syndrome and the Problem of Uncertainty*, 2006.
- Johan Carlson, "*Gemensam förklaringsmodell för sjukdomar kopplade till inomhusmiljön finns inte*" [Unified explanation for diseases related to indoor environment not found]. *Läkartidningen* 2006/12.
- Bulletin of the Transilvania University of BraÃƒÆ’Ã†â€™Ãƒâ€ Ã¢â‚¬â„¢ÃƒÆ’Ã¢â‚¬Â ÃƒÂ¢Ã¢â€šÂ¬Ã¢â€žÂ¢ÃƒÆ’Ã†â€™ÃƒÂ¢Ã Series I: *Engineering Sciences* • Vol. 5 (54) No. 1 2012 "Impact of Indoor Environment Quality on Sick Building Syndrome in Indian Leed Certified Buildings". by Jagannathan Mohan

External links

[edit]

- Best Practices for Indoor Air Quality when Remodeling Your Home, US EPA

- Renovation and Repair, Part of Indoor Air Quality Design Tools for Schools, US EPA
- Addressing Indoor Environmental Concerns During Remodeling, US EPA
- Dust FAQs, UK HSE Archived 2023-03-20 at the Wayback Machine
- CCOHS: Welding - Fumes And Gases | Health Effect of Welding Fumes

Classification	**MeSH**: D018877 D
External resources	**Patient UK**: Sick building syndrome

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Heating, ventilation, and air conditioning

Fundamental concepts

- Air changes per hour
- Bake-out
- Building envelope
- Convection
- Dilution
- Domestic energy consumption
- Enthalpy
- Fluid dynamics
- Gas compressor
- Heat pump and refrigeration cycle
- Heat transfer
- Humidity
- Infiltration
- Latent heat
- Noise control
- Outgassing
- Particulates
- Psychrometrics
- Sensible heat
- Stack effect
- Thermal comfort
- Thermal destratification
- Thermal mass
- Thermodynamics
- Vapour pressure of water

Technology	◦ Absorption-compression heat pump ◦ Absorption refrigerator ◦ Air barrier ◦ Air conditioning ◦ Antifreeze ◦ Automobile air conditioning ◦ Autonomous building ◦ Building insulation materials ◦ Central heating ◦ Central solar heating ◦ Chilled beam ◦ Chilled water ◦ Constant air volume (CAV) ◦ Coolant ◦ Cross ventilation ◦ Dedicated outdoor air system (DOAS) ◦ Deep water source cooling ◦ Demand controlled ventilation (DCV) ◦ Displacement ventilation ◦ District cooling ◦ District heating ◦ Electric heating ◦ Energy recovery ventilation (ERV) ◦ Firestop ◦ Forced-air ◦ Forced-air gas ◦ Free cooling ◦ Heat recovery ventilation (HRV) ◦ Hybrid heat ◦ Hydronics ◦ Ice storage air conditioning ◦ Kitchen ventilation ◦ Mixed-mode ventilation ◦ Microgeneration ◦ Passive cooling ◦ Passive daytime radiative cooling ◦ Passive house ◦ Passive ventilation ◦ Radiant heating and cooling ◦ Radiant cooling ◦ Radiant heating ◦ Radon mitigation ◦ Refrigeration ◦ Renewable heat ◦ Room air distribution ◦ Solar air heat ◦ Solar combisystem ◦ Solar cooling

- Air conditioner inverter
- Air door
- Air filter
- Air handler
- Air ionizer
- Air-mixing plenum
- Air purifier
- Air source heat pump
- Attic fan
- Automatic balancing valve
- Back boiler
- Barrier pipe
- Blast damper
- Boiler
- Centrifugal fan
- Ceramic heater
- Chiller
- Condensate pump
- Condenser
- Condensing boiler
- Convection heater
- Compressor
- Cooling tower
- Damper
- Dehumidifier
- Duct
- Economizer
- Electrostatic precipitator
- Evaporative cooler
- Evaporator
- Exhaust hood
- Expansion tank
- Fan
- Fan coil unit
- Fan filter unit
- Fan heater
- Fire damper
- Fireplace
- Fireplace insert
- Freeze stat
- Flue
- Freon
- Fume hood
- Furnace
- Gas compressor
- Gas heater
- Gasoline heater
- Grease duct

Measurement and control	○ Air flow meter ○ Aquastat ○ BACnet ○ Blower door ○ Building automation ○ Carbon dioxide sensor ○ Clean air delivery rate (CADR) ○ Control valve ○ Gas detector ○ Home energy monitor ○ Humidistat ○ HVAC control system ○ Infrared thermometer ○ Intelligent buildings ○ LonWorks ○ Minimum efficiency reporting value (MERV) ○ Normal temperature and pressure (NTP) ○ OpenTherm ○ Programmable communicating thermostat ○ Programmable thermostat ○ Psychrometrics ○ Room temperature ○ Smart thermostat ○ Standard temperature and pressure (STP) ○ Thermographic camera ○ Thermostat ○ Thermostatic radiator valve
Professions, trades, and services	○ Architectural acoustics ○ Architectural engineering ○ Architectural technologist ○ Building services engineering ○ Building information modeling (BIM) ○ Deep energy retrofit ○ Duct cleaning ○ Duct leakage testing ○ Environmental engineering ○ Hydronic balancing ○ Kitchen exhaust cleaning ○ Mechanical engineering ○ Mechanical, electrical, and plumbing ○ Mold growth, assessment, and remediation ○ Refrigerant reclamation ○ Testing, adjusting, balancing

Industry organizations	○ AHRI ○ AMCA ○ ASHRAE ○ ASTM International ○ BRE ○ BSRIA ○ CIBSE ○ Institute of Refrigeration ○ IIR ○ LEED ○ SMACNA ○ UMC
Health and safety	○ Indoor air quality (IAQ) ○ Passive smoking ○ Sick building syndrome (SBS) ○ Volatile organic compound (VOC)
See also	○ ASHRAE Handbook ○ Building science ○ Fireproofing ○ Glossary of HVAC terms ○ Warm Spaces ○ World Refrigeration Day ○ Template:Home automation ○ Template:Solar energy

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Employment

Classifications

- Academic tenure
- Casual
- Contingent work
- Full-time job
- Gig worker
- Job sharing
- Part-time job
- Self-employment
- Side job
- Skilled worker
  - Journeyman
  - Technician
  - Tradesperson
- Independent contractor
- Labour hire
- Temporary work
- Laborer
- Wage labour

Hiring	◦ Application ◦ Background check ◦ Business networking ◦ Cover letter ◦ Curriculum vitae ◦ Drug testing ◦ Employment contract ◦ Employment counsellor ◦ Executive search ◦ list ◦ Induction programme ◦ Job fair ◦ Job fraud ◦ Job hunting ◦ Job interview ◦ Letter of recommendation ◦ Onboarding ◦ Overqualification ◦ Person–environment fit ◦ Personality–job fit theory ◦ Personality hire ◦ Probation ◦ Realistic job preview ◦ Recruitment ◦ Résumé ◦ Simultaneous recruiting of new graduates ◦ Underemployment ◦ Work-at-home scheme
Roles	◦ Cooperative ◦ Employee ◦ Employer ◦ Internship ◦ Job ◦ Labour hire ◦ Permanent employment ◦ Supervisor ◦ Volunteering

Working class	◦ Blue-collar ◦ Green-collar ◦ Grey-collar ◦ Pink-collar ◦ Precariat ◦ White-collar ◦ Red-collar ◦ New-collar ◦ No-collar ◦ Orange-collar ◦ Scarlet-collar ◦ Black-collar ◦ Gold-collar

Career and training

- Apprenticeship
- Artisan
  - Master craftsman
- Avocation
- Career assessment
- Career counseling
- Career development
- Coaching
- Creative class
- Education
  - Continuing education
  - E-learning
  - Employability
  - Further education
  - Graduate school
  - Induction training
  - Knowledge worker
  - Licensure
  - Lifelong learning
  - Overspecialization
  - Practice-based professional learning
  - Professional association
  - Professional certification
  - Professional development
  - Professional school
  - Reflective practice
  - Retraining
  - Vocational education
  - Vocational school
  - Vocational university
- Mentorship
- Occupational Outlook Handbook
- Practice firm
- Profession
  - Operator
  - Professional
- Tradesman
- Vocation

Attendance	◦ Break ◦ Break room ◦ Career break ◦ Furlough ◦ Gap year ◦ Leave of absence ◦ Long service leave ◦ No call, no show ◦ Sabbatical ◦ Sick leave ◦ Time clock
Schedules	◦ 35-hour workweek ◦ Four-day week ◦ Eight-hour day ◦ 996 working hour system ◦ Flextime ◦ On-call ◦ Overtime ◦ Remote work ◦ Six-hour day ◦ Shift work ◦ Working time ◦ Workweek and weekend

Wages and salaries	◦ Income bracket
	◦ Income tax
	◦ Living wage
	◦ Maximum wage
	◦ National average salary
	    ◦ World
	    ◦ Europe
	◦ Minimum wage
	    ◦ Canada
	    ◦ Hong Kong
	    ◦ Europe
	    ◦ United States
	◦ Progressive wage
	    ◦ Singapore
	◦ Overtime rate
	◦ Paid time off
	◦ Performance-related pay
	◦ Salary cap
	◦ Wage compression
	◦ Working poor

Benefits	◦ Annual leave ◦ Casual Friday ◦ Child care ◦ Disability insurance ◦ Health insurance ◦ Life insurance ◦ Marriage leave ◦ Parental leave ◦ Pension ◦ Sick leave ◦ United States ◦ Take-home vehicle

Safety and health	◦ Crunch
	◦ Epilepsy and employment
	◦ Human factors and ergonomics
	◦ Karoshi
	◦ List of countries by rate of fatal workplace accidents
	◦ Occupational burnout
	◦ Occupational disease
	◦ Occupational exposure limit
	◦ Occupational health psychology
	◦ Occupational injury
	◦ Occupational noise
	◦ Occupational stress
	◦ Personal protective equipment
	◦ Repetitive strain injury
	◦ Right to sit
	    ◦ United States
	◦ Sick building syndrome
	◦ Work accident
	    ◦ Occupational fatality
	◦ Workers' compensation
	◦ Workers' right to access the toilet
	◦ Workplace health promotion
	◦ Workplace phobia
	◦ Workplace wellness

Equal opportunity	◦ Affirmative action ◦ Equal pay for equal work ◦ Gender pay gap ◦ Glass ceiling

Infractions

- Corporate collapses and scandals
  - Accounting scandals
  - Control fraud
  - Corporate behaviour
  - Corporate crime
- Discrimination
- Exploitation of labour
- Dress code
- Employee handbook
- Employee monitoring
- Evaluation
- Labour law
- Sexual harassment
- Sleeping while on duty
- Wage theft
- Whistleblower
- Workplace bullying
- Workplace harassment
- Workplace incivility

Willingness

- Boreout
- Careerism
- Civil conscription
- Conscription
- Critique of work
- Dead-end job
- Job satisfaction
- McJob
- Organizational commitment
- Refusal of work
- Slavery
  - Bonded labour
  - Human trafficking
  - Labour camp
  - Penal labour
  - Peonage
  - Truck wages
  - Unfree labour
  - Wage slavery
- Work ethic
- Work–life interface
  - Downshifting
  - Slow living
- Workaholic

Termination	- At-will employment
	- Dismissal
	    - Banishment room
	    - Constructive dismissal
	    - Wrongful dismissal
	- Employee offboarding
	- Exit interview
	- Layoff
	- Notice period
	- Pink slip
	- Resignation
	    - Letter of resignation
	- Restructuring
	- Retirement
	    - Mandatory retirement
	    - Retirement age
	    - Retirement planning
	- Severance package
	    - Golden handshake
	    - Golden parachute
	- Turnover

Unemployment	◦ Barriers to entry
	◦ Discouraged worker
	◦ Economic depression
	    ◦ Great Depression
	    ◦ Long Depression
	◦ Frictional unemployment
	◦ Full employment
	◦ Graduate unemployment
	◦ Involuntary unemployment
	◦ Jobless recovery
	◦ Phillips curve
	◦ Recession
	    ◦ Great Recession
	    ◦ Job losses caused by the Great Recession
	    ◦ Lists of recessions
	    ◦ Recession-proof job
	◦ Reserve army of labour
	◦ Structural unemployment
	◦ Technological unemployment
	◦ Types of unemployment
	◦ Unemployment benefits
	◦ Unemployment Convention, 1919
	◦ Unemployment extension
	◦ List of countries by unemployment rate
	◦ Employment-to-population ratio
	    ◦ List
	◦ Wage curve
	◦ Youth unemployment

Public programs	◦ Workfare ◦ Unemployment insurance ◦ Make-work job ◦ Job creation program ◦ Job creation index ◦ Job guarantee ◦ Employer of last resort ◦ Guaranteed minimum income ◦ Right to work ◦ *Historical:* ◦ *U.S.A.:* ◦ Civil Works Administration ◦ Works Progress Administration

Comprehensive Employment and Training Act

See also

- Bullshit job
- Busy work
- Credentialism and educational inflation
- Emotional labor
- Evil corporation
- Going postal
- Kiss up kick down
- Labor rights
- Make-work job
- Narcissism in the workplace
- Post-work society
- Presenteeism
- Psychopathy in the workplace
- Sunday scaries
- Slow movement (culture)
- Toxic leader
- Toxic workplace
- Workhouse

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- Aspects of corporations
- Aspects of jobs
- Aspects of occupations
- Aspects of organizations
- Aspects of workplaces
- Corporate titles
- Critique of work
- Organized labor

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About Durham Supply Inc

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Things To Do in Oklahoma County

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Model T Graveyard

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Photo

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Oklahoma City Zoo

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Photo

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Sanctuary Asia

5 (1)

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Martin Park Nature Center

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Photo

Oklahoma National Guard Museum

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Oklahoma Railway Museum

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Driving Directions in Oklahoma County

Driving Directions From Love's Travel Stop to Durham Supply Inc

Driving Directions From Residence Inn Oklahoma City South to Durham Supply Inc

Driving Directions From Deja Vu Showgirls OKC - Oklahoma Strip Club to Durham Supply Inc

Driving Directions From (DTW) Drew's Tobacco World to Durham Supply Inc

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Driving Directions From Bricktown Water Taxi to Durham Supply Inc

Driving Directions From Museum of Osteology to Durham Supply Inc

Driving Directions From Oklahoma City Zoo to Durham Supply Inc

Driving Directions From Stockyards City Main Street to Durham Supply Inc

Driving Directions From Oklahoma Railway Museum to Durham Supply Inc

Driving Directions From Science Museum Oklahoma to Durham Supply Inc

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Reviews for Durham Supply Inc

Durham Supply Inc

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Noel Vandy

(5)

Thanks to the hard work of Randy our AC finally got the service it needed. These 100 degree days definitely feel long when your house isn't getting cool anymore. We were so glad when Randy came to work on the unit, he had all the tools and products he needed with him and it was all good and running well when he left. With a long drive to get here and only few opportunities to do so, we are glad he got it done in 1 visit. Now let us hope it will keep running well for a good while.

Durham Supply Inc

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Crystal Dawn

(1)

I would give 0 stars. This isnTHE WORST company for heating and air. I purchased a home less than one year ago and my ac has gone out twice and these people refuse to repair it although I AM UNDER WARRANTY!!!! They say it’s an environmental issue and they can’t fix it or even try to or replace my warrantied air conditioning system.

Durham Supply Inc

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K Moore

(1)

No service after the sale. I purchased a sliding patio door and was given the wrong size sliding screen door. After speaking with the salesman and manager several times the issue is still not resolved and, I was charged full price for an incomplete door. They blamed the supplier for all the issues…and have offered me nothing to resolve this.

Durham Supply Inc

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Jennifer Williamson

(5)

First we would like to thank you for installing our air conditioning unit! I’d like to really brag about our technician, Mack, that came to our home to install our unit in our new home. Mack was here for most of the day and throughly explained everything we had a question about. By the late afternoon, we had cold air pumping through our vents and we couldn’t have been more thankful. I can tell you, I would be very lucky to have a technician like Mack if this were my company. He was very very professional, kind, and courteous. Please give Mack a pat on the back and stay rest assured that Mack is doing a great job and upholding your company name! Mack, if you see this, great job!! Thanks for everything you did!! We now have a new HVAC company in the event we need one. We will also spread the word to others!!

Durham Supply Inc

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Salest

(5)

Had to make a quick run for 2 sets of ?? door locks for front and back door.. In/ out in a quick minute! They helped me right away. ?? Made sure the 2 sets had the same ? keys. The ? bathroom was clean and had everything I needed. ? ?. Made a quick inquiry about a random item... they quickly looked it up and gave me pricing. Great ? job ?

Royal Supply Inc

Phone : +16362969959

City : Oklahoma City

State : OK

Zip : 73149

Address : Unknown Address

Google Business Profile

Company Website : **https://royal-durhamsupply.com/locations/oklahoma-city-oklahoma/**

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