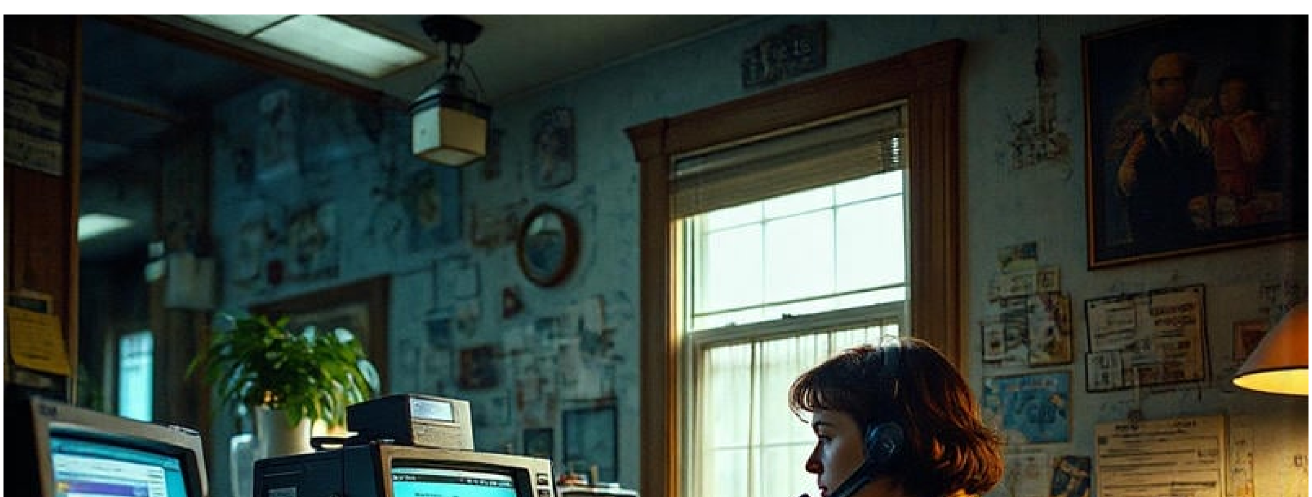
- **Understanding SEER Ratings for Mobile Home Cooling**
  Understanding SEER Ratings for Mobile Home Cooling Tracking Power Usage in Mobile Home Heating Systems Adapting Mobile Homes for High Efficiency HVAC Equipment Comparing SEER Values to Lower Energy Costs in Mobile Homes Evaluating ROI of Efficient 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
- **Exploring Common Certifications Required for Mobile Home HVAC Service**
  Exploring Common Certifications Required for Mobile Home HVAC Service Understanding EPA Regulations for Mobile Home Cooling Systems Evaluating Technician Training Programs for Mobile Home Heating Examining NATE Credentials and What They Mean for Mobile Home Repair Verifying Local Licensing for Mobile Home HVAC Professionals Assessing Safety Knowledge in Mobile Home Technician Work Matching Skill Levels to Complex Mobile Home AC Installations Identifying Gaps in Technical Training for Mobile Home HVAC Work Learning About Continuing Education for Mobile Home Furnace Repair Validating Experience Through Field Tests in Mobile Home HVAC Exploring Online Resources for Mobile Home Technician Readiness Collaborating with Certified Professionals for Mobile Home HVAC Projects
- **About Us**



Adapting Mobile Homes for High Efficiency HVAC Equipment

How SEER Ratings Impact Energy Efficiency in Mobile Homes

As society becomes increasingly aware of the need for sustainable living, many homeowners are exploring ways to reduce their environmental footprint while enhancing comfort and efficiency within their homes. One area that offers significant potential for improvement is the heating, ventilation, and air conditioning (HVAC) system. For mobile home owners in particular, upgrading to high-efficiency HVAC equipment can yield substantial benefits, including energy savings, improved comfort levels, and positive environmental impacts.

Seasonal tune-ups keep mobile home HVAC systems running smoothly **Mobile Home Hvac Service** expert.

Mobile homes present unique challenges when it comes to maintaining a comfortable indoor climate. Due to their construction and design, these homes often face issues with insulation and air leaks, which can lead to higher energy consumption as HVAC systems work harder to maintain desired temperatures. Upgrading to a high-efficiency HVAC system provides a viable solution to these challenges by optimizing energy use and delivering consistent performance even under less-than-ideal conditions.

One of the most compelling reasons to upgrade is the potential for energy savings. High-efficiency HVAC systems are designed with advanced technology that allows them to use significantly less electricity or fuel compared to traditional units. Features such as variable speed motors, smart thermostats, and improved heat exchangers contribute to this enhanced efficiency. For mobile home owners who may already be contending with high utility bills due to poor insulation or older appliances, this reduction in energy usage translates directly into cost savings over time.

Beyond financial considerations, upgrading an HVAC system also enhances overall comfort within a mobile home. High-efficiency units are not only better at maintaining consistent temperatures but also offer improved humidity control and quieter operation. This means that residents can enjoy a more stable indoor environment without the noise disruptions common with older models. Additionally, these systems often come equipped with advanced filtration options that improve indoor air quality-a boon for those concerned about allergens or pollutants.

The environmental impact of adopting high-efficiency HVAC equipment should not be underestimated either. By consuming less energy, these systems contribute fewer greenhouse gas emissions during their operation cycle-a critical factor in combating climate change. As more mobile home owners make the switch to efficient technologies, the cumulative effect on reducing carbon footprints can be significant.

Furthermore, many governments and utilities now offer incentives such as rebates or tax credits for homeowners who choose energy-efficient upgrades. These financial incentives can offset initial costs associated with purchasing new equipment and make transitioning more accessible for those on tight budgets.

In conclusion, adapting mobile homes for high-efficiency HVAC equipment presents numerous advantages that align both personal interests in reduced living costs and broader societal goals of sustainability. While there may be initial investments involved in making such upgrades, the long-term benefits-ranging from lower utility bills and increased indoor comfort levels to contributing towards environmental conservation-make it an endeavor worth considering for any mobile homeowner wishing to enhance their living space responsibly.

The Relationship Between SEER Ratings and Cooling Costs —

As society increasingly focuses on energy efficiency and sustainability, the adaptation of mobile homes to accommodate high-efficiency HVAC systems has become an important topic. Mobile homes, often characterized by their compact size and unique structural characteristics, present both challenges and opportunities when considering upgrades to more efficient heating, ventilation, and air conditioning (HVAC) systems. Assessing current HVAC systems is a critical step in this process, as it lays the foundation for evaluating compatibility with new equipment and identifying any necessary modifications.

Mobile homes typically feature older or less sophisticated HVAC systems that may not meet today's energy efficiency standards. These existing setups are often tailored to the specific needs and constraints of mobile home environments. Before introducing high-efficiency equipment, a comprehensive evaluation of these current systems is essential. This assessment involves examining components such as ductwork integrity, insulation quality, system capacity, and energy consumption patterns.

One primary focus during this evaluation is the compatibility of existing ductwork with new high-efficiency units. Many modern HVAC systems require ductwork that can handle increased airflow without significant loss of pressure or efficiency. In many cases, original ductwork in mobile homes may be undersized or poorly insulated, leading to heat loss or gain that undermines the benefits of high-efficiency equipment. Therefore, inspecting duct size and condition becomes a crucial part of the assessment process.

Additionally, insulation plays a pivotal role in maintaining energy efficiency within mobile homes. Proper insulation ensures that conditioned air remains within the living spaces rather than escaping through walls or ceilings. During an assessment, checking for adequate insulation levels can reveal whether enhancements are required to fully leverage the advantages offered by newer HVAC technologies.

Another consideration is system capacity relative to the size and layout of the mobile home. High-efficiency models are designed to provide optimal performance; however, they must be correctly sized for their environment to function effectively without unnecessary strain or short cycling.

Once compatibility has been established through thorough evaluation, modifications may be necessary to prepare for installation. This could involve upgrading ductwork materials, enhancing insulation layers throughout the home structure-or even repositioning certain elements like vents-to ensure maximum efficacy from newly installed equipment.

Moreover-beyond just technical adjustments-the transition towards more efficient systems also necessitates educating homeowners about maintenance practices essential for keeping these advanced units running smoothly over time; regular filter changes along with routine professional inspections help maintain peak operational status while extending overall lifespan significantly longer than traditional alternatives might allow otherwise if neglected entirely instead unfortunately so too often still happens today sadly enough across many regions worldwide indeed unfortunately still true at least currently speaking anyway hopefully improving soon though ideally progressively ongoing moving forward optimistically certainly one hopes sincerely truly deeply genuinely absolutely always ultimately finally conclusively definitively permanently forevermore eternally perpetually endlessly infinitely timelessly unendingly everlastingly ceaselessly continuously constantly continually perpetuating indefinitely onwards upwards forwards positively resolutely determinedly unwaveringly steadfastly steadfast unwavering unyielding persistent relentless tireless perseverant enduring enduring lasting durable resilient robust vigorous strong powerful mighty forceful influential effective efficacious productive fruitful worthwhile beneficial advantageous valuable precious invaluable priceless treasured cherished beloved adored revered venerated respected admired esteemed appreciated acknowledged recognized salient evident manifest apparent obvious clear plain conspicuous noticeable observable discernible perceptible detectable audible visible tangible palpable sensible understandable comprehensible intelligible coherent rational logical reasonable sound valid legitimate genuine authentic real true factual actual concrete substantial solid firm stable secure safe protected safeguarded defended shielded guarded sheltered harbored concealed hidden veiled covered cloaked shrouded enveloped enfolded embraced encircled surrounded encompassed enclosed enwrapped enveloped

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Choosing the Right SEER Rating for Your Mobile Home HVAC System

Adapting mobile homes for high efficiency HVAC equipment involves a thoughtful consideration of various factors to ensure optimal performance, energy savings, and comfort. Mobile homes present unique challenges and opportunities in the realm of heating, ventilation, and air conditioning due to their distinct construction features and often limited space. Therefore, selecting the right high efficiency HVAC system requires careful assessment of several key factors including size, capacity, and energy ratings.

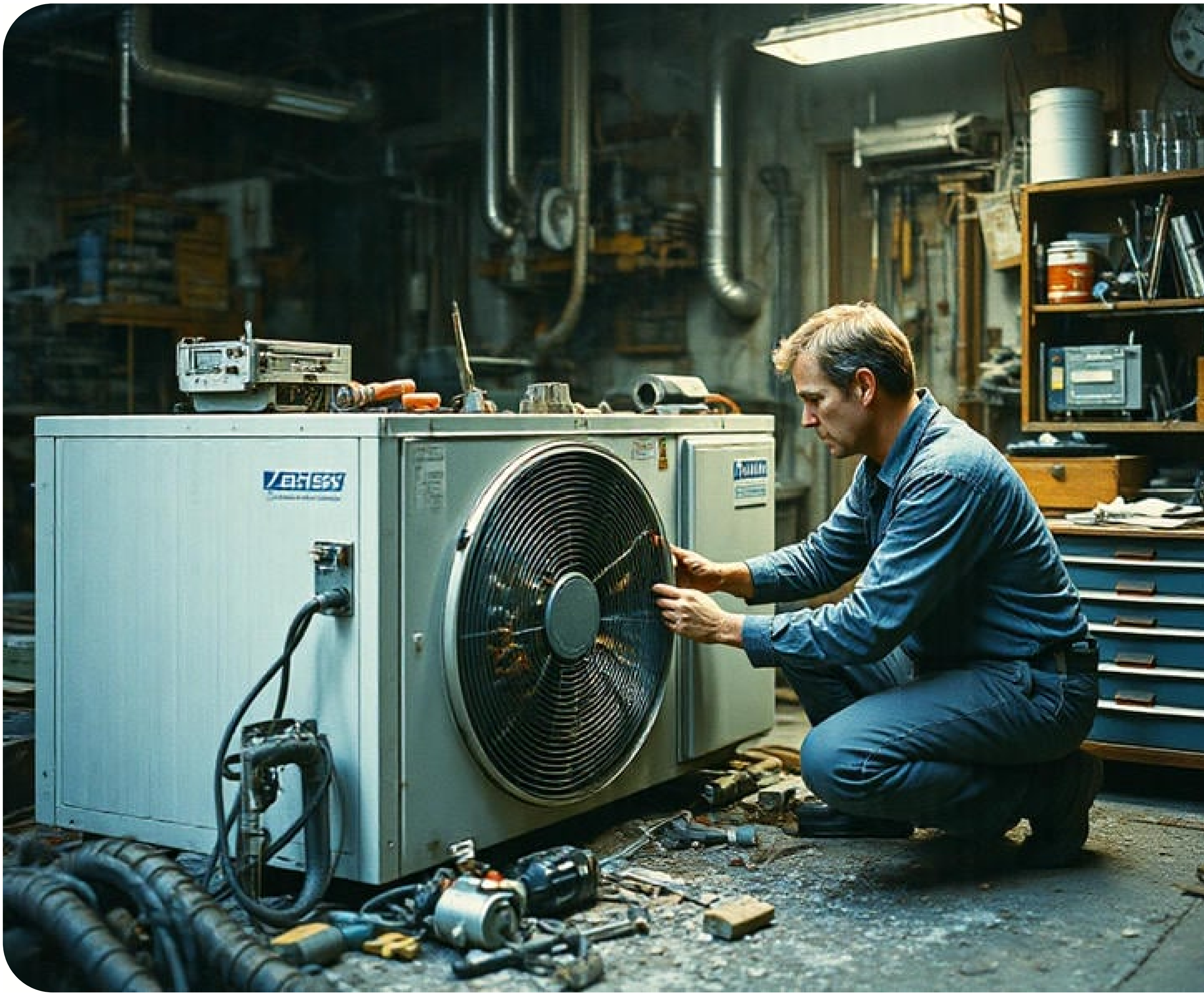
The first factor to consider is the size of the mobile home. Unlike traditional houses, mobile homes have specific spatial constraints that necessitate a tailored approach to HVAC installation. The physical dimensions of the home directly influence the type and size of HVAC system required. An oversized unit may lead to short cycling-where the system turns on and off frequently-resulting in inefficient operation and increased wear and tear. Conversely, an undersized system may struggle to maintain comfortable temperatures during extreme weather conditions. Therefore, conducting an accurate load calculation is essential to determine the appropriate system size that will effectively cater to the home's heating and cooling demands without wasting energy.

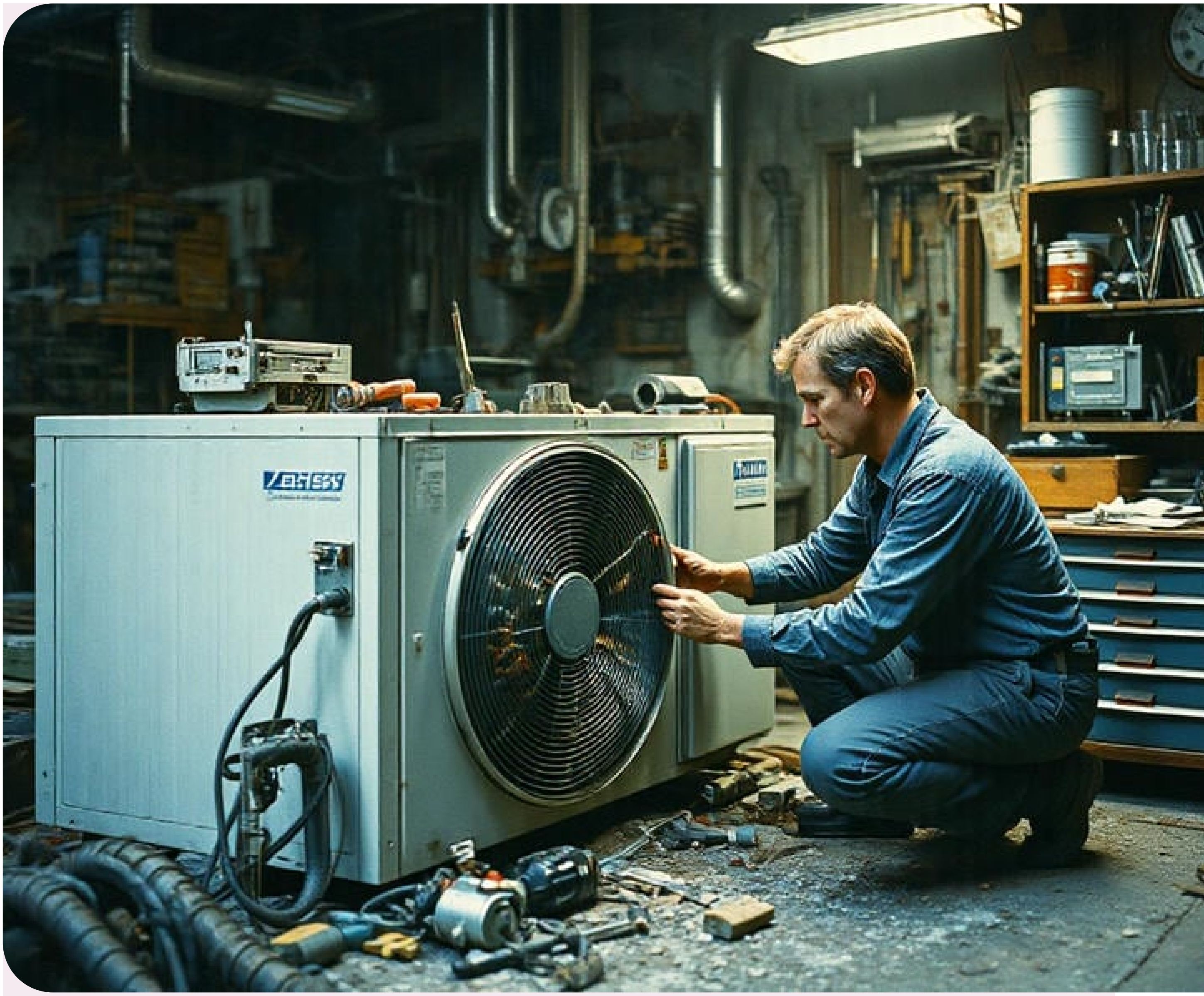
Capacity is another critical element when choosing an HVAC system for a mobile home. Capacity refers to the ability of an HVAC unit to heat or cool a specified area within a given time frame. Measured in British Thermal Units (BTUs), this parameter should align closely with the needs dictated by both the climate zone where the mobile home is located and its insulation properties. A well-insulated mobile home in a moderate climate might require significantly less capacity than one situated in harsher environments or lacking adequate insulation.

Energy ratings are equally vital in selecting a high efficiency HVAC system for mobile homes. Energy efficiency not only reduces utility bills but also contributes positively towards environmental sustainability by lowering overall energy consumption. Systems with higher Seasonal Energy Efficiency Ratio (SEER) ratings typically offer better performance at reduced operational costs compared to those with lower ratings. Additionally, considering units with ENERGY STAR certification can further ensure compliance with rigorous standards for energy efficiency set by regulatory bodies.

Beyond these fundamental considerations, it's also beneficial to look into newer technologies such as smart thermostats that enhance control over temperature settings leading to more efficient usage patterns tailored specifically for occupants' lifestyles. Moreover, regular maintenance practices cannot be overlooked as they play a crucial role in preserving system efficiency over time.

In conclusion, adapting mobile homes for high efficiency HVAC systems requires deliberate attention towards specific factors including size determination through precise load calculations, appropriate capacity selection based on environmental conditions and structural aspects of the home itself along with prioritizing superior energy ratings like SEER values complemented by advanced technological integrations if possible-all aimed at achieving sustainable comfort levels tailored uniquely for each dwelling's requirements while fostering long-term cost-effectiveness alongside ecological responsibility.





Factors Influencing SEER Rating Effectiveness in Mobile Homes

Adapting Mobile Homes for High Efficiency HVAC Equipment: Installation Considerations

In recent years, the push towards energy efficiency has permeated various aspects of residential living, including mobile homes. These dwellings, which provide affordable and flexible housing solutions for many, are not exempt from the growing demand for sustainable living practices. A significant upgrade that can transform the energy profile of a mobile home is the installation of high-efficiency HVAC systems. However, this undertaking requires careful consideration of unique installation needs and potential challenges inherent to mobile homes.

Mobile homes differ from traditional houses in several ways, most notably in their structural design. Typically constructed on a chassis with lighter materials to facilitate mobility, these homes present particular constraints when it comes to installing advanced HVAC systems. One primary concern is space limitation. High-efficiency units often require more room than conventional systems due to additional components designed for improved performance. Therefore, installers must creatively utilize existing space or modify certain areas without compromising the structural integrity of the home.

Another important consideration is load-bearing capability. Mobile homes have specific weight limits that cannot be overlooked when adding new equipment. High-efficiency HVAC systems may weigh more than older models due to enhanced features such as heat exchangers and larger compressors. Installers need to assess whether the current support structure can handle the increased weight or if reinforcements are necessary.

Moreover, ductwork presents its own set of challenges in mobile homes. Many older models lack sufficient ducting infrastructure suitable for modern HVAC requirements. Retrofitting new ducts can be complicated by spatial constraints and accessibility issues within walls and under floors. In some cases, alternative solutions such as mini-split systems might be more feasible due to their minimal ductwork requirement and flexibility in placement.

Energy efficiency upgrades also necessitate an evaluation of existing insulation quality and sealing effectiveness within the mobile home. Poor insulation can negate even the most efficient HVAC system's benefits through thermal losses during heating or cooling cycles. As part of the preparation process, addressing any gaps or weak points in insulation should be prioritized to ensure optimal system performance post-installation.

Additionally, power supply considerations cannot be ignored when integrating high-efficiency HVAC units into a mobile home setup. These systems may require different voltage levels or dedicated circuits that older electrical panels might not support readily without upgrades or modifications.

Finally, regulatory compliance plays a crucial role throughout this adaptation process since building codes governing HVAC installations can vary significantly between regions-especially where manufactured housing regulations intersect with local ordinances regarding energy efficiency standards.

Despite these challenges associated with installing high-efficiency HVAC equipment in mobile homes effectively addressing them leads directly towards substantial long-term benefits: reduced utility costs; improved indoor air quality; enhanced comfort levels year-round; decreased environmental impact-all contributing positively toward sustainable living goals while maintaining affordability inherent within mobile housing options.

Ultimately adapting mobile homes for high-efficiency heating ventilation air conditioning involves navigating technical logistical hurdles while balancing practicality sustainability aspirations-a task requiring thoughtful planning expert guidance committed execution but ultimately rewarding both environmentally financially those who undertake endeavor successfully transforming humble abodes into exemplars modern eco-conscious habitation epitomizing perfect harmony between innovation tradition comfort conservation alike!

Comparing SEER Ratings Across Different Mobile Home Cooling Systems

Adapting mobile homes to accommodate new high-efficiency HVAC equipment is a significant step toward enhancing energy efficiency and reducing utility costs. However, it involves a detailed cost analysis and budget planning to ensure the process is both feasible and financially prudent. This essay explores the key considerations in estimating expenses associated with this adaptation and highlights potential financing options or incentives available to homeowners.

The first step in cost analysis for installing high-efficiency HVAC systems in mobile homes is understanding the specific requirements of these dwellings. Mobile homes often present unique challenges due to their construction, limited space, and existing infrastructure. As such, it's essential to assess whether structural modifications are required to support the new system. This might include reinforcing walls or floors, upgrading electrical systems, or improving ductwork design. These structural adaptations can significantly influence the overall cost.

Beyond structural changes, one must consider the price of the HVAC equipment itself. High-efficiency units tend to be more expensive upfront than standard models but often offer substantial savings on energy bills over time. It's crucial for homeowners to factor in these long-term savings when evaluating initial expenditures.

Another vital aspect of budget planning involves labor costs associated with installation. Engaging skilled professionals ensures that the system is installed correctly and operates efficiently, thereby maximizing its lifespan and performance. Labor costs can vary widely depending on geographic location and the complexity of the installation process.

Once expenses are estimated, exploring financing options becomes a priority for many homeowners who may not have immediate access to sufficient funds. Traditional bank loans or lines of credit can provide necessary financial support; however, they often come with interest rates that increase overall project costs.

Fortunately, there are various incentives and financing programs designed specifically for energy-efficient home improvements that can ease financial burdens. Federal tax credits may be available for certain types of high-efficiency HVAC systems, allowing homeowners to recoup a portion of their investment during tax season. Additionally, some states offer rebates or grants as part of their commitment to promoting sustainable living practices.

Utility companies also frequently run incentive programs aimed at encouraging customers to install energy-efficient appliances by offering rebates or reduced rates on service plans post-installation. Homeowners should inquire about such opportunities directly with their local providers as these programs vary widely based on location.

Moreover, some manufacturers offer special financing deals or extended payment plans on their products which could alleviate immediate cash flow pressures while enabling access to top-tier technology solutions without delay.

In conclusion, adapting mobile homes for high efficiency HVAC equipment requires careful consideration across several dimensions: understanding potential expenses related both directly (equipment) and indirectly (structural modifications) involved; identifying suitable financing pathways; leveraging available incentives designed specifically around promoting eco-friendly upgrades where possible-all contributing towards making informed decisions capable not only improving individual household comfort but also fostering broader environmental stewardship benefits over time through reduced carbon footprints achieved via enhanced energy efficiencies realized therein thereby ultimately aiding long-term fiscal prudence amidst evolving climate imperatives today's society increasingly demands we all collectively embrace sooner rather than later if meaningful progress desired indeed true sense word earnest!

Tips for Maintaining Optimal Performance of High-SEER Rated Systems

In the quest for energy efficiency and environmental sustainability, mobile homes are increasingly being adapted with high-efficiency HVAC (Heating, Ventilation, and Air Conditioning) systems. These advanced systems not only enhance comfort but also reduce energy consumption and costs. However, to ensure these benefits are fully realized and the systems have a long lifespan, regular maintenance and upkeep are essential.

High-efficiency HVAC systems in mobile homes present unique challenges due to the limited space and specific structural considerations of such dwellings. The first step in maintaining these systems is understanding their design and functionality. Unlike traditional units, high-efficiency models often incorporate complex technologies like variable-speed compressors or smart thermostats that require specialized knowledge for proper service.

A critical aspect of maintenance is regular inspection. Homeowners should routinely check for any visible signs of wear or damage in the system components. This includes examining ductwork for leaks, ensuring air filters are clean and replaced as required, and verifying that vents are unobstructed to allow optimal airflow. In mobile homes, where space can be tight, it's crucial to ensure that nothing blocks airflow around the HVAC unit.

Professional servicing should be scheduled at least annually. A certified technician can perform detailed checks that go beyond what an average homeowner might do. This includes assessing refrigerant levels, testing electrical connections for safety hazards, calibrating thermostats for accuracy, and cleaning internal components that may accumulate dust or debris over time. Such professional assessments help identify small issues before they escalate into costly repairs.

Additionally, upgrading insulation in a mobile home can work synergistically with a high-efficiency HVAC system by reducing thermal loss. Properly insulated walls, roofs, and floors diminish the workload on an HVAC system by maintaining indoor temperatures more effectively.

Investing in technology can further aid maintenance efforts. Smart home devices now offer remote monitoring capabilities that alert homeowners to potential issues before they become significant problems. For instance, sensors connected to smartphone apps can provide real-time data on system performance or notify owners when it's time for routine tasks like changing filters.

Moreover, understanding the importance of seasonal adjustments is vital for efficient operation throughout the year. During warmer months when cooling demands increase, ensure ventilation fans operate correctly to assist in air circulation without overburdening the system. Conversely, sealing drafts during colder months prevents heat escape and reduces unnecessary strain on heating functionalities.

Finally, educating all occupants about best practices-such as setting thermostats to moderate temperatures when away from home-can significantly contribute to both energy savings and equipment longevity.

In conclusion, while adapting mobile homes for high-efficiency HVAC equipment offers substantial advantages in terms of comfort and cost savings, it requires diligent maintenance practices tailored specifically to these modern systems' needs. By combining routine inspections with professional servicing and leveraging technological aids where possible, homeowners can ensure their upgraded systems perform optimally well into the future while enjoying enhanced living environments within their mobile homes.

Future Trends in SEER Ratings and Mobile Home Cooling Technology

Adapting mobile homes for high-efficiency HVAC equipment is a topic that has gained significant traction in recent years, as more homeowners seek to enhance comfort and energy efficiency. Case studies and success stories provide invaluable insights into how real-life mobile home owners have navigated this transformation. These narratives not only illustrate the practical steps involved but also highlight the benefits that come with modernizing these living spaces.

Consider the story of the Johnson family from Florida, who were struggling with an outdated cooling system in their mobile home. With sweltering summers making indoor conditions unbearable, they decided it was time for a change. After researching various options, they chose to install a mini-split heat pump system designed specifically for compact living spaces. The installation process was smooth, taking just a couple of days, and the immediate improvement in air quality and temperature control was remarkable. Not only did their new system drastically reduce their energy bills by nearly 30%, but it also provided them with the ability to zone heat or cool specific areas of their home as needed.

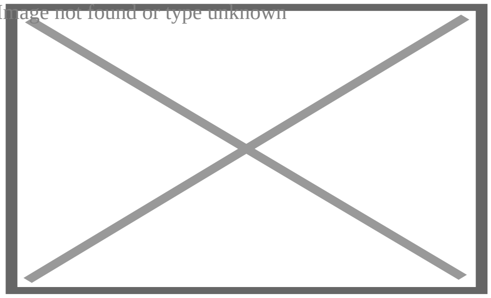
Another inspiring example comes from a retired couple in Arizona, who transformed their aging mobile home into an energy-efficient haven. Aware of rising utility costs, they replaced their old furnace with a state-of-the-art geothermal heat pump. Although initially apprehensive about the upfront cost, they found numerous incentives and rebates available for eco-friendly upgrades which significantly offset their investment. Within months, they noticed not only reduced monthly expenses but also increased overall comfort during both winter's chill and summer's blaze.

In Oregon, a single mother named Lisa embarked on her journey to improve her mobile home's efficiency after receiving multiple high electricity bills that strained her budget. With limited funds but plenty of determination, she took advantage of community programs offering free consultations on energy-saving improvements. Guided by experts, Lisa opted for an energy-efficient ductless HVAC unit that minimized installation challenges typically associated with traditional systems in smaller dwellings like hers. The result was transformative: better climate control throughout her home year-round and substantial savings that allowed her to redirect funds towards other essential needs.

These case studies underscore several key themes vital for those considering similar upgrades: research and education are paramount; there are often financial aids available; and most importantly-improvements lead not just to enhanced living environments but tangible economic benefits over time.

Ultimately, adapting mobile homes for high-efficiency HVAC systems is more than just a technical upgrade-it represents empowerment through innovation. It allows homeowners to take charge of their environmental footprint while reaping rewards in terms of comfort and cost-effectiveness. As more people share their successes, they pave the way for others to follow suit, creating communities where sustainable living becomes accessible and desirable for all who call these unique homes theirs.

About Ventilation (architecture)



An ab anbar (water reservoir) with double domes and windcatchers (openings near the top of the towers) in the central desert city of Naeen, Iran. Windcatchers are a form of natural ventilation.[1]

Ventilation is the intentional introduction of outdoor air into a space. Ventilation is mainly used to control indoor air quality by diluting and displacing indoor pollutants; it can also be used to control indoor temperature, humidity, and air motion to benefit thermal comfort, satisfaction with other aspects of the indoor environment, or other objectives.

The intentional introduction of outdoor air is usually categorized as either mechanical ventilation, natural ventilation, or mixed-mode ventilation.[2]

- Mechanical ventilation is the intentional fan-driven flow of outdoor air into and/or out from a building. Mechanical ventilation systems may include supply fans (which push outdoor air into a building), exhaust[3] fans (which draw air out of a building and thereby cause equal ventilation flow into a building), or a combination of both (called balanced ventilation if it neither pressurizes nor depressurizes the inside air,[3] or only slightly depressurizes it). Mechanical ventilation is often provided by equipment that is also used to heat and cool a space.
- Natural ventilation is the intentional passive flow of outdoor air into a building through planned openings (such as louvers, doors, and windows). Natural ventilation does not require mechanical systems to move outdoor air. Instead, it relies entirely on passive physical phenomena, such as wind pressure, or the stack effect. Natural ventilation openings may be fixed, or adjustable. Adjustable openings may be controlled automatically (automated), owned by occupants (operable), or a combination of both. Cross ventilation is a phenomenon of natural ventilation.
- Mixed-mode ventilation systems use both mechanical and natural processes. The mechanical and natural components may be used at the same time, at different times of day, or in different seasons of the year.[4] Since natural ventilation flow depends on environmental conditions, it may not always provide an appropriate amount of ventilation. In this case, mechanical systems may be used to supplement

or regulate the naturally driven flow.

Ventilation is typically described as separate from infiltration.

- Infiltration is the circumstantial flow of air from outdoors to indoors through leaks (unplanned openings) in a building envelope. When a building design relies on infiltration to maintain indoor air quality, this flow has been referred to as adventitious ventilation.[5]

The design of buildings that promote occupant health and well-being requires a clear understanding of the ways that ventilation airflow interacts with, dilutes, displaces, or introduces pollutants within the occupied space. Although ventilation is an integral component of maintaining good indoor air quality, it may not be satisfactory alone.[6] A clear understanding of both indoor and outdoor air quality parameters is needed to improve the performance of ventilation in terms of occupant health and energy.[7] In scenarios where outdoor pollution would deteriorate indoor air quality, other treatment devices such as filtration may also be necessary.[8] In kitchen ventilation systems, or for laboratory fume hoods, the design of effective effluent capture can be more important than the bulk amount of ventilation in a space. More generally, the way that an air distribution system causes ventilation to flow into and out of a space impacts the ability of a particular ventilation rate to remove internally generated pollutants. The ability of a system to reduce pollution in space is described as its "ventilation effectiveness". However, the overall impacts of ventilation on indoor air quality can depend on more complex factors such as the sources of pollution, and the ways that activities and airflow interact to affect occupant exposure.

An array of factors related to the design and operation of ventilation systems are regulated by various codes and standards. Standards dealing with the design and operation of ventilation systems to achieve acceptable indoor air quality include the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standards 62.1 and 62.2, the International Residential Code, the International Mechanical Code, and the United Kingdom Building Regulations Part F. Other standards that focus on energy conservation also impact the design and operation of ventilation systems, including ASHRAE Standard 90.1, and the International Energy Conservation Code.

When indoor and outdoor conditions are favorable, increasing ventilation beyond the minimum required for indoor air quality can significantly improve both indoor air quality and thermal comfort through ventilative cooling, which also helps reduce the energy demand of buildings.[9][10] During these times, higher ventilation rates, achieved through passive or mechanical means (air-side economizer, ventilative pre-cooling), can be particularly beneficial for enhancing people's physical health.[11] Conversely, when conditions are less favorable, maintaining or improving indoor air quality through ventilation may require increased use of mechanical heating or cooling, leading to higher energy consumption.

Ventilation should be considered for its relationship to "venting" for appliances and combustion equipment such as water heaters, furnaces, boilers, and wood stoves. Most importantly, building ventilation design must be careful to avoid the backdraft of combustion products from "naturally vented" appliances into the occupied space. This issue is of greater importance for buildings with more air-tight envelopes. To avoid the hazard, many modern combustion appliances utilize "direct venting" which draws combustion air directly from outdoors, instead of from the indoor environment.

Design of air flow in rooms

[edit]

The air in a room can be supplied and removed in several ways, for example via ceiling ventilation, cross ventilation, floor ventilation or displacement ventilation.[*citation needed*]

Ceiling ventilation

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  Ceiling ventilation
  Cross ventilation

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  Cross ventilation
  Floor ventilation

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  Floor ventilation

Displacement ventilation

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  Displacement ventilation

Furthermore, the air can be circulated in the room using vortexes which can be initiated in various ways:

Tangential flow vortices, initiated horizontally

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  Tangential flow vortices, initiated horizontally

Tangential flow vortices, initiated vertically

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  Tangential flow vortices, initiated vertically

Diffused flow vortices from air nozzles

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  Diffused flow vortices from air nozzles

Diffused flow vortices due to roof vortices

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Diffused flow vortices due to roof vortices

Ventilation rates for indoor air quality

[edit]

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The examples and perspective in this article **deal primarily with the United States and do not represent a worldwide view of the subject**. You may improve this article, discuss the issue on the talk page, or create a new article, as appropriate. *(April 2024) (Learn how and when to remove this message)*

The ventilation rate, for commercial, industrial, and institutional (CII) buildings, is normally expressed by the volumetric flow rate of outdoor air, introduced to the building. The typical units used are cubic feet per minute (CFM) in the imperial system, or liters per second (L/s) in the metric system (even though cubic meter per second is the preferred unit for volumetric flow rate in the SI system of units). The ventilation rate can also be expressed on a per person or per unit floor area basis, such as CFM/p or CFM/ft^2, or as air changes per hour (ACH).

Standards for residential buildings

[edit]

For residential buildings, which mostly rely on infiltration for meeting their ventilation needs, a common ventilation rate measure is the air change rate (or air changes per hour): the hourly ventilation rate divided by the volume of the space (*I* or *ACH*; units of 1/h). During the winter, ACH may range from 0.50 to 0.41 in a tightly air-sealed house to 1.11 to 1.47 in a loosely air-sealed house.[12]

ASHRAE now recommends ventilation rates dependent upon floor area, as a revision to the 62-2001 standard, in which the minimum ACH was 0.35, but no less than 15 CFM/person (7.1 L/s/person). As of 2003, the standard has been changed to 3 CFM/100 sq. ft. (15 L/s/100 sq. m.) plus 7.5 CFM/person (3.5 L/s/person).[13]

Standards for commercial buildings

[edit]

Ventilation rate procedure

[edit]

Ventilation Rate Procedure is rate based on standard and prescribes the rate at which ventilation air must be delivered to space and various means to the condition that air.[14] Air quality is assessed (through CO_2 measurement) and ventilation rates are mathematically derived using constants. Indoor Air Quality Procedure uses one or more guidelines for the specification of acceptable concentrations of certain contaminants in indoor air but does not prescribe ventilation rates or air treatment methods.[14] This addresses both quantitative and subjective evaluations and is based on the Ventilation Rate Procedure. It also accounts for potential contaminants that may have no measured limits, or for which no limits are not set (such as formaldehyde off-gassing from carpet and furniture).

Natural ventilation

[edit]
Main article: Natural ventilation

Natural ventilation harnesses naturally available forces to supply and remove air in an enclosed space. Poor ventilation in rooms is identified to significantly increase the localized moldy smell in specific places of the room including room corners.[11] There are three types of natural ventilation occurring in buildings: wind-driven ventilation, pressure-driven flows, and stack ventilation.[15] The pressures generated by 'the stack effect' rely upon the buoyancy of heated or rising air. Wind-driven ventilation relies upon the force of the prevailing wind to pull and push air through the enclosed space as well as through breaches in the building's envelope.

Almost all historic buildings were ventilated naturally.[16] The technique was generally abandoned in larger US buildings during the late 20th century as the use of air conditioning became more widespread. However, with the advent of advanced Building Performance Simulation (BPS) software, improved Building Automation Systems (BAS), Leadership in Energy and Environmental Design (LEED) design requirements, and improved window manufacturing techniques; natural ventilation has made a resurgence in commercial buildings both globally and throughout the US.[17]

The benefits of natural ventilation include:

- Improved indoor air quality (IAQ)
- Energy savings
- Reduction of greenhouse gas emissions
- Occupant control
- Reduction in occupant illness associated with sick building syndrome
- Increased worker productivity

Techniques and architectural features used to ventilate buildings and structures naturally include, but are not limited to:

- Operable windows
- Clerestory windows and vented skylights
- Lev/convection doors
- Night purge ventilation
- Building orientation
- Wind capture façades

Airborne diseases

[edit]

Natural ventilation is a key factor in reducing the spread of airborne illnesses such as tuberculosis, the common cold, influenza, meningitis or COVID-19.[18] Opening doors and windows are good ways to maximize natural ventilation, which would make the risk of airborne contagion much lower than with costly and maintenance-requiring mechanical systems. Old-fashioned clinical areas with high ceilings and large windows provide the greatest protection. Natural ventilation costs little and is maintenance-free, and is particularly suited to limited-resource settings and tropical climates, where the burden of TB and institutional TB transmission is highest. In settings where respiratory isolation is difficult and climate permits, windows and doors should be opened to reduce the risk of airborne contagion. Natural ventilation requires little maintenance and is inexpensive.[19]

Natural ventilation is not practical in much of the infrastructure because of climate. This means that the facilities need to have effective mechanical ventilation systems and or use Ceiling Level UV or FAR UV ventilation systems.

Ventilation is measured in terms of air changes per hour (ACH). As of 2023, the CDC recommends that all spaces have a minimum of 5 ACH.[20] For hospital rooms with airborne contagions the CDC recommends a minimum of 12 ACH.[21] Challenges in facility ventilation are public unawareness,[22][23] ineffective government oversight, poor building codes that are based on comfort levels, poor system operations, poor maintenance, and lack of transparency.[24]

Pressure, both political and economic, to improve energy conservation has led to decreased ventilation rates. Heating, ventilation, and air conditioning rates have dropped since the energy crisis in the 1970s and the banning of cigarette smoke in the 1980s and 1990s.[25][26][*better source needed*]

Mechanical ventilation

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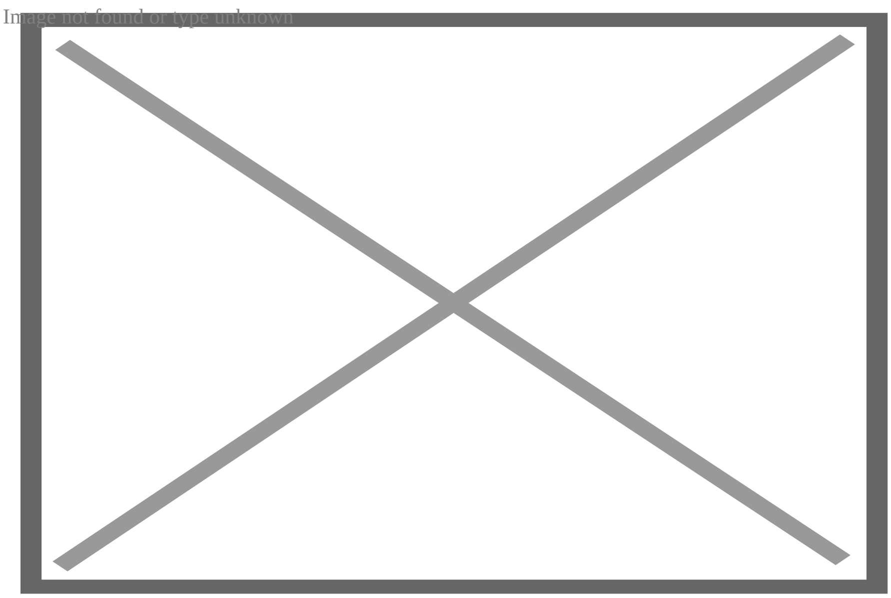
Main article: HVAC



An axial belt-drive exhaust fan serving an underground car park. This exhaust fan's operation is interlocked with the concentration of contaminants emitted by internal combustion engines.

Mechanical ventilation of buildings and structures can be achieved by the use of the following techniques:

- Whole-house ventilation
- Mixing ventilation
- Displacement ventilation
- Dedicated subaerial air supply

Demand-controlled ventilation (DCV)

[edit]

Demand-controlled ventilation (**DCV**, also known as Demand Control Ventilation) makes it possible to maintain air quality while conserving energy.[27][28] ASHRAE has determined that "It is consistent with the ventilation rate procedure that demand control be permitted for use to reduce the total outdoor air supply during periods of less occupancy."[29] In a DCV system, CO_2 sensors control the amount of ventilation.[30][31] During peak occupancy, CO_2 levels rise, and the system adjusts to deliver the same amount of outdoor air as would be used by the ventilation-rate procedure.[32] However, when spaces are less occupied, CO_2 levels reduce, and the system reduces ventilation to conserves energy. DCV is a well-established practice,[33] and is required in high occupancy spaces by building energy standards such as ASHRAE 90.1.[34]

Personalized ventilation

[edit]

This section needs to be **updated**. Please help update this article to reflect recent events or newly available information. *(September 2024)*

Personalized ventilation is an air distribution strategy that allows individuals to control the amount of ventilation received. The approach delivers fresh air more directly to the breathing zone and aims to improve the air quality of inhaled air. Personalized ventilation provides much higher ventilation effectiveness than conventional mixing ventilation systems by displacing pollution from the breathing zone with far less air volume. Beyond improved air quality benefits, the strategy can also improve occupants' thermal comfort, perceived air quality, and overall satisfaction with the indoor environment. Individuals' preferences for temperature and air movement are not equal, and so traditional approaches to homogeneous environmental control have failed to achieve high occupant satisfaction. Techniques such as personalized ventilation facilitate control of a more diverse thermal environment that can improve thermal satisfaction for most occupants.

Local exhaust ventilation

[edit]
See also: Power tool

Local exhaust ventilation addresses the issue of avoiding the contamination of indoor air by specific high-emission sources by capturing airborne contaminants before they are spread into the environment. This can include water vapor control, lavatory effluent control, solvent vapors from industrial processes, and dust from wood- and metal-working machinery. Air can be exhausted through pressurized hoods or the use of fans and pressurizing a specific area.[35]
A local exhaust system is composed of five basic parts:

1. A hood that captures the contaminant at its source
2. Ducts for transporting the air
3. An air-cleaning device that removes/minimizes the contaminant
4. A fan that moves the air through the system
5. An exhaust stack through which the contaminated air is discharged[35]

In the UK, the use of LEV systems has regulations set out by the Health and Safety Executive (HSE) which are referred to as the Control of Substances Hazardous to Health (CoSHH). Under CoSHH, legislation is set to protect users of LEV systems by ensuring that all equipment is tested at least every fourteen months to ensure the LEV systems are performing adequately. All parts of the system must be visually inspected and thoroughly tested and where any parts are found to be defective, the inspector must issue a red label to identify the defective part and the issue.

The owner of the LEV system must then have the defective parts repaired or replaced before the system can be used.

Smart ventilation

[edit]

Smart ventilation is a process of continually adjusting the ventilation system in time, and optionally by location, to provide the desired IAQ benefits while minimizing energy consumption, utility bills, and other non-IAQ costs (such as thermal discomfort or noise). A smart ventilation system adjusts ventilation rates in time or by location in a building to be responsive to one or more of the following: occupancy, outdoor thermal and air quality conditions, electricity grid needs, direct sensing of contaminants, operation of other air moving and air cleaning systems. In addition, smart ventilation systems can provide information to building owners, occupants, and managers on operational energy consumption and indoor air quality as well as a signal when systems need maintenance or repair. Being responsive to occupancy means that a smart ventilation system can adjust ventilation depending on demand such as reducing ventilation if the building is unoccupied. Smart ventilation can time-shift ventilation to periods when a) indoor-outdoor temperature differences are smaller (and away from peak outdoor temperatures and humidity), b) when indoor-outdoor temperatures are appropriate for ventilative cooling, or c) when outdoor air quality is acceptable. Being responsive to electricity grid needs means providing flexibility to electricity demand (including direct signals from utilities) and integration with electric grid control strategies. Smart ventilation systems can have sensors to detect airflow, systems pressures, or fan energy use in such a way that systems failures can be detected and repaired, as well as when system components need maintenance, such as filter replacement.[36]

Ventilation and combustion

[edit]

Combustion (in a fireplace, gas heater, candle, oil lamp, etc.) consumes oxygen while producing carbon dioxide and other unhealthy gases and smoke, requiring ventilation air. An open chimney promotes infiltration (i.e. natural ventilation) because of the negative pressure change induced by the buoyant, warmer air leaving through the chimney. The warm air is typically replaced by heavier, cold air.

Ventilation in a structure is also needed for removing water vapor produced by respiration, burning, and cooking, and for removing odors. If water vapor is permitted to accumulate, it may damage the structure, insulation, or finishes. [*citation needed*] When operating, an air conditioner usually removes excess moisture from the air. A dehumidifier may also be appropriate for removing airborne moisture.

Calculation for acceptable ventilation rate

[edit]

Ventilation guidelines are based on the minimum ventilation rate required to maintain acceptable levels of effluents. Carbon dioxide is used as a reference point, as it is the gas of highest emission at a relatively constant value of 0.005 L/s. The mass balance equation is:

$Q = G/(C_i ? C_a)$

- Q = ventilation rate (L/s)
- G = CO_2 generation rate
- C_i = acceptable indoor CO_2 concentration
- C_a = ambient CO_2 concentration[37]

Smoking and ventilation

[edit]

ASHRAE standard 62 states that air removed from an area with environmental tobacco smoke shall not be recirculated into ETS-free air. A space with ETS requires more ventilation to achieve similar perceived air quality to that of a non-smoking environment.

The amount of ventilation in an ETS area is equal to the amount of an ETS-free area plus the amount V, where:

$V = DSD \times VA \times A/60E$

- V = recommended extra flow rate in CFM (L/s)
- DSD = design smoking density (estimated number of cigarettes smoked per hour per unit area)
- VA = volume of ventilation air per cigarette for the room being designed (ft^3/cig)

- ○ E = contaminant removal effectiveness[38]

History

[edit]

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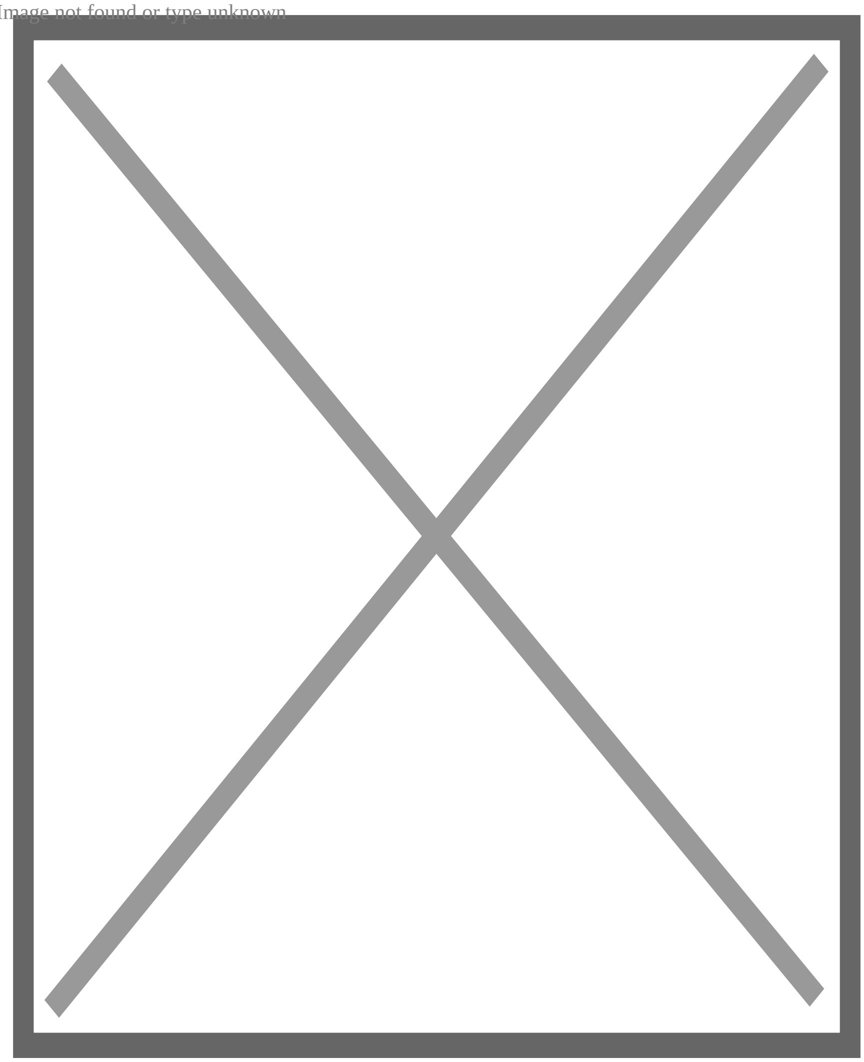

This ancient Roman house uses a variety of passive cooling and passive ventilation techniques. Heavy masonry walls, small exterior windows, and a narrow walled garden oriented N-S shade the house, preventing heat gain. The house opens onto a central atrium with an impluvium (open to the sky); the evaporative cooling of the water causes a cross-draft from atrium to garden.

Primitive ventilation systems were found at the PloÃƒÆ'Ã†â€™Ãƒâ€ Ã¢â‚¬â„¢ÃƒÆ'Ã¢â‚¬Â ÃƒÂ¢Ã¢â€šÂ¬Ã¢â€žÂ¢ÃƒÆ'Ã†â€™ÃƒÂ¢Ã¢â€šÂ¬Ã archeological site (belonging to the VinÃƒÆ'Ã†â€™Ãƒâ€ Ã¢â‚¬â„¢ÃƒÆ'Ã¢â‚¬Â ÃƒÂ¢Ã¢â€šÂ¬Ã¢â€žÂ¢ÃƒÆ'Ã†â€™ÃƒÂ¢Ã¢â€šÂ¬Ã culture) in Serbia and were built into early copper smelting furnaces. The furnace, built on the outside of the workshop, featured earthen pipe-like air vents with hundreds of tiny holes in them and a prototype chimney to ensure air goes into the furnace to feed the fire and smoke comes out safely.[39]

Passive ventilation and passive cooling systems were widely written about around the Mediterranean by Classical times. Both sources of heat and sources of cooling (such as fountains and subterranean heat reservoirs) were used to drive air circulation, and buildings were designed to encourage or exclude drafts, according to climate and function. Public bathhouses were often particularly sophisticated in their heating and cooling. Icehouses are some millennia old, and were part of a well-developed ice industry by classical times.

The development of forced ventilation was spurred by the common belief in the late 18th and early 19th century in the miasma theory of disease, where stagnant 'airs' were thought to spread illness. An early method of ventilation was the use of a ventilating fire near an air vent which would forcibly cause the air in the building to circulate. English engineer John Theophilus Desaguliers provided an early example of this when he installed ventilating fires in the air tubes on the roof of the House of Commons. Starting with the Covent Garden Theatre, gas burning chandeliers on the ceiling were often specially designed to perform a ventilating role.

Mechanical systems

[edit]
Further information: Heating, ventilation, and air conditioning § Mechanical or forced ventilation

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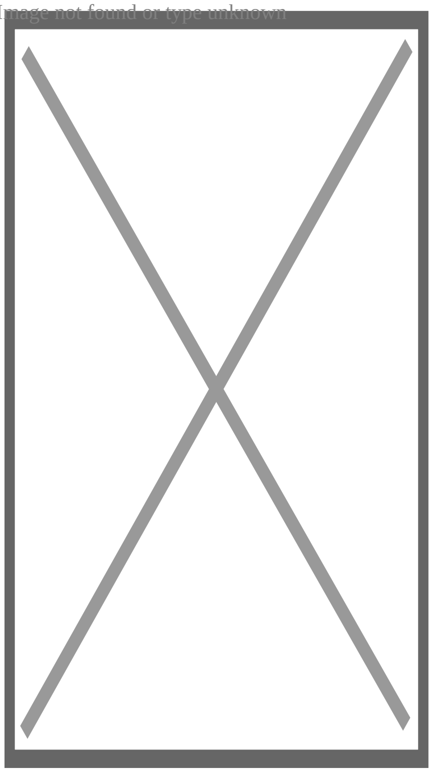

The Central Tower of the Palace of Westminster. This octagonal spire was for ventilation purposes, in the more complex system imposed by Reid on Barry, in which it was to draw air out of the Palace. The design was for the aesthetic disguise of its function.[40][41]

A more sophisticated system involving the use of mechanical equipment to circulate the air was developed in the mid-19th century. A basic system of bellows was put in place to ventilate Newgate Prison and outlying buildings, by the engineer Stephen Hales in the mid-1700s. The problem with these early devices was that they required constant human labor to operate. David Boswell Reid was called to testify before a Parliamentary committee on proposed architectural designs for the new House of Commons, after the old one burned down in a fire in 1834.[40] In January 1840 Reid was appointed by the committee for the House of Lords dealing with the construction of the replacement for the Houses of Parliament. The post was in the capacity of ventilation engineer, in effect; and with its creation there began a long series of quarrels between Reid and Charles Barry, the architect.[42]

Reid advocated the installation of a very advanced ventilation system in the new House. His design had air being drawn into an underground chamber, where it would undergo either heating or cooling. It would then ascend into the chamber through thousands of small holes drilled into the floor, and would be extracted through the ceiling by a special ventilation fire within a great stack.[43]

Reid's reputation was made by his work in Westminster. He was commissioned for an air quality survey in 1837 by the Leeds and Selby Railway in their tunnel.[44] The steam vessels built for the Niger expedition of 1841 were fitted with ventilation systems based on Reid's Westminster model.[45] Air was dried, filtered and passed over charcoal.[46][47] Reid's ventilation method was also applied more fully to St. George's Hall, Liverpool, where the architect, Harvey Lonsdale Elmes, requested that Reid should be involved in ventilation design.[48] Reid considered this the only building in which his system was completely carried out.[49]

Fans

[edit]

With the advent of practical steam power, ceiling fans could finally be used for ventilation. Reid installed four steam-powered fans in the ceiling of St George's Hospital in Liverpool, so that the pressure produced by the fans would force the incoming air upward and through vents in the ceiling. Reid's pioneering work provides the basis for ventilation systems to this day.[43] He was remembered as "Dr. Reid the ventilator" in the twenty-first century in discussions of energy efficiency, by Lord Wade of Chorlton.[50]

History and development of ventilation rate standards

[edit]

Ventilating a space with fresh air aims to avoid "bad air". The study of what constitutes bad air dates back to the 1600s when the scientist Mayow studied asphyxia of animals in confined bottles.[51] The poisonous component of air was later identified as carbon dioxide (CO_2), by Lavoisier in the very late 1700s, starting a debate as to the nature of "bad air" which humans perceive to be stuffy or unpleasant. Early hypotheses included excess concentrations of CO_2 and oxygen depletion. However, by the late 1800s, scientists thought biological contamination, not oxygen or CO_2, was the primary component of unacceptable indoor air. However, it was noted as early as 1872 that CO_2 concentration closely correlates to perceived air quality.

The first estimate of minimum ventilation rates was developed by Tredgold in 1836.[52] This was followed by subsequent studies on the topic by Billings [53] in 1886 and Flugge in 1905. The recommendations of Billings and Flugge were incorporated into numerous building codes from 1900–the 1920s and published as an industry standard by ASHVE (the predecessor to ASHRAE) in 1914.[51]

The study continued into the varied effects of thermal comfort, oxygen, carbon dioxide, and biological contaminants. The research was conducted with human subjects in controlled test chambers. Two studies, published between 1909 and 1911, showed that carbon dioxide was not the offending component. Subjects remained satisfied in chambers with high levels of CO_2, so long as the chamber remained cool.[51] (Subsequently, it has been determined that CO_2 is, in fact, harmful at concentrations over 50,000ppm[54])

ASHVE began a robust research effort in 1919. By 1935, ASHVE-funded research conducted by Lemberg, Brandt, and Morse – again using human subjects in test chambers – suggested the primary component of "bad air" was an odor, perceived by the human olfactory nerves.[55] Human response to odor was found to be logarithmic to contaminant concentrations, and related to temperature. At lower, more comfortable temperatures, lower ventilation rates were satisfactory. A 1936 human test chamber study by Yaglou, Riley, and Coggins culminated much of this effort, considering odor, room volume, occupant age, cooling equipment effects, and recirculated air implications, which guided ventilation rates.[56] The Yaglou research has been validated, and adopted into industry standards, beginning with the ASA code in 1946. From this research base, ASHRAE (having replaced ASHVE) developed space-by-space recommendations, and published them as ASHRAE Standard 62-1975: Ventilation for acceptable indoor air quality.

As more architecture incorporated mechanical ventilation, the cost of outdoor air ventilation came under some scrutiny. In 1973, in response to the 1973 oil crisis and conservation concerns, ASHRAE Standards 62-73 and 62–81) reduced required ventilation from 10 CFM (4.76 L/s) per person to 5 CFM (2.37 L/s) per person. In cold, warm, humid, or dusty climates, it is preferable to minimize ventilation with outdoor air to conserve energy, cost, or filtration. This critique (e.g. Tiller[57]) led ASHRAE to reduce outdoor ventilation rates in 1981, particularly in non-smoking areas. However subsequent research by Fanger,[58] W. Cain, and Janssen validated the Yaglou model. The reduced ventilation rates were found to be a contributing factor to sick building syndrome.[59]

The 1989 ASHRAE standard (Standard 62–89) states that appropriate ventilation guidelines are 20 CFM (9.2 L/s) per person in an office building, and 15 CFM (7.1 L/s) per person for schools, while 2004 Standard 62.1-2004 has lower recommendations again (see tables below). ANSI/ASHRAE (Standard 62–89) speculated that "comfort (odor) criteria are likely to be satisfied if the ventilation rate is set so that 1,000 ppm CO_2 is not exceeded"[60] while OSHA has set a limit of 5000 ppm over 8 hours.[61]

Historical ventilation rates

Author or source	Year	Ventilation rate (IP)	Ventilation rate (SI)	Basis or rationale

Tredgold	1836	4 CFM per person	2 L/s per person	Basic metabolic needs, breathing rate, and candle burning
Billings	1895	30 CFM per person	15 L/s per person	Indoor air hygiene, preventing spread of disease
Flugge	1905	30 CFM per person	15 L/s per person	Excessive temperature or unpleasant odor
ASHVE	1914	30 CFM per person	15 L/s per person	Based on Billings, Flugge and contemporaries
Early US Codes	1925	30 CFM per person	15 L/s per person	Same as above
Yaglou	1936	15 CFM per person	7.5 L/s per person	Odor control, outdoor air as a fraction of total air
ASA	1946	15 CFM per person	7.5 L/s per person	Based on Yahlou and contemporaries
ASHRAE	1975	15 CFM per person	7.5 L/s per person	Same as above
ASHRAE	1981	10 CFM per person	5 L/s per person	For non-smoking areas, reduced.
ASHRAE	1989	15 CFM per person	7.5 L/s per person	Based on Fanger, W. Cain, and Janssen

ASHRAE continues to publish space-by-space ventilation rate recommendations, which are decided by a consensus committee of industry experts. The modern descendants of ASHRAE standard 62-1975 are ASHRAE Standard 62.1, for non-residential spaces, and ASHRAE 62.2 for residences.

In 2004, the calculation method was revised to include both an occupant-based contamination component and an area–based contamination component.[62] These two components are additive, to arrive at an overall ventilation rate. The change was made to recognize that densely populated areas were sometimes overventilated (leading to higher energy and cost) using a per-person methodology.

Occupant Based Ventilation Rates,[62] ANSI/ASHRAE Standard 62.1-2004

IP Units	SI Units	Category	Examples
0 cfm/person	0 L/s/person	Spaces where ventilation requirements are primarily associated with building elements, not occupants.	Storage Rooms, Warehouses
5 cfm/person	2.5 L/s/person	Spaces occupied by adults, engaged in low levels of activity	Office space

7.5 cfm/person	3.5 L/s/person	Spaces where occupants are engaged in higher levels of activity, but not strenuous, or activities generating more contaminants	Retail spaces, lobbies
10 cfm/person	5 L/s/person	Spaces where occupants are engaged in more strenuous activity, but not exercise, or activities generating more contaminants	Classrooms, school settings
20 cfm/person	10 L/s/person	Spaces where occupants are engaged in exercise, or activities generating many contaminants	dance floors, exercise rooms

Area-based ventilation rates,[62] ANSI/ASHRAE Standard 62.1-2004

IP Units	SI Units	Category	Examples
0.06 cfm/ft^2	0.30 L/s/m^2	Spaces where space contamination is normal, or similar to an office environment	Conference rooms, lobbies
0.12 cfm/ft^2	0.60 L/s/m^2	Spaces where space contamination is significantly higher than an office environment	Classrooms, museums
0.18 cfm/ft^2	0.90 L/s/m^2	Spaces where space contamination is even higher than the previous category	Laboratories, art classrooms
0.30 cfm/ft^2	1.5 L/s/m^2	Specific spaces in sports or entertainment where contaminants are released	Sports, entertainment
0.48 cfm/ft^2	2.4 L/s/m^2	Reserved for indoor swimming areas, where chemical concentrations are high	Indoor swimming areas

The addition of occupant- and area-based ventilation rates found in the tables above often results in significantly reduced rates compared to the former standard. This is compensated in other sections of the standard which require that this minimum amount of air is delivered to the breathing zone of the individual occupant at all times. The total outdoor air intake of the ventilation system (in multiple-zone variable air volume (VAV) systems) might therefore be similar to the airflow required by the 1989 standard.
From 1999 to 2010, there was considerable development of the application protocol for ventilation rates. These advancements address occupant- and process-based ventilation rates, room ventilation effectiveness, and system ventilation effectiveness[63]

Problems

[edit]

- In hot, humid climates, unconditioned ventilation air can daily deliver approximately 260 milliliters of water for each cubic meters per hour (m^3/h) of outdoor air (or one pound of water each day for each cubic feet per minute of outdoor air per day), annual average.[*citation needed*] This is a great deal of moisture and can create serious indoor moisture and mold problems. For example, given a 150 m^2 building with an airflow of 180 m^3/h this could result in about 47 liters of water accumulated per day.

- Ventilation efficiency is determined by design and layout, and is dependent upon the placement and proximity of diffusers and return air outlets. If they are located closely together, supply air may mix with stale air, decreasing the efficiency of the HVAC system, and creating air quality problems.
- System imbalances occur when components of the HVAC system are improperly adjusted or installed and can create pressure differences (too much-circulating air creating a draft or too little circulating air creating stagnancy).
- Cross-contamination occurs when pressure differences arise, forcing potentially contaminated air from one zone to an uncontaminated zone. This often involves undesired odors or VOCs.
- Re-entry of exhaust air occurs when exhaust outlets and fresh air intakes are either too close, prevailing winds change exhaust patterns or infiltration between intake and exhaust air flows.
- Entrainment of contaminated outdoor air through intake flows will result in indoor air contamination. There are a variety of contaminated air sources, ranging from industrial effluent to VOCs put off by nearby construction work.[64] A recent study revealed that in urban European buildings equipped with ventilation systems lacking outdoor air filtration, the exposure to outdoor-originating pollutants indoors resulted in more Disability-Adjusted Life Years (DALYs) than exposure to indoor-emitted pollutants.[65]

See also

[edit]

- Architectural engineering
- Biological safety
- Cleanroom
- Environmental tobacco smoke
- Fume hood
- Head-end power
- Heating, ventilation, and air conditioning
- Heat recovery ventilation
- Mechanical engineering
- Room air distribution
- Sick building syndrome
- Siheyuan
- Solar chimney
- Tulou
- Windcatcher

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Air Infiltration & Ventilation Centre (AIVC)

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- Publications from the Air Infiltration & Ventilation Centre (AIVC)

International Energy Agency (IEA) Energy in Buildings and Communities Programme (EBC)

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- Publications from the International Energy Agency (IEA) Energy in Buildings and Communities Programme (EBC) ventilation-related research projects-annexes:
  - EBC Annex 9 Minimum Ventilation Rates
  - EBC Annex 18 Demand Controlled Ventilation Systems
  - EBC Annex 26 Energy Efficient Ventilation of Large Enclosures
  - EBC Annex 27 Evaluation and Demonstration of Domestic Ventilation Systems
  - EBC Annex 35 Control Strategies for Hybrid Ventilation in New and Retrofitted Office Buildings (HYBVENT)
  - EBC Annex 62 Ventilative Cooling

International Society of Indoor Air Quality and Climate

[edit]

- Indoor Air Journal
- Indoor Air Conference Proceedings

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

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- ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality

- ASHRAE Standard 62.2 – Ventilation for Acceptable Indoor Air Quality in Residential Buildings
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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
- Solar heating

Components

- 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
- Grille

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 Manufactured housing

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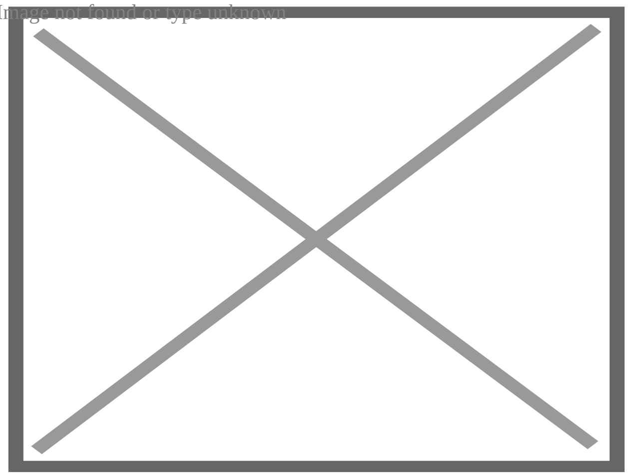


A modern "triple wide" home

Manufactured housing (commonly known as mobile homes in the United States) is a type of prefabricated housing that is largely assembled in factories and then transported to sites of use. The definition of the term in the United States is regulated by federal law (Code of Federal Regulations, 24 CFR 3280): "Manufactured homes are built as dwelling units of at least 320 square feet (30 m^2) in size with a permanent chassis to assure the initial and continued transportability of the home."[1] The requirement to have a wheeled chassis permanently attached differentiates "manufactured housing" from other types of prefabricated homes, such as modular homes.

United States

[edit]

Definition

[edit]

According to the Manufactured Housing Institute's National Communities Council (MHINCC), *manufactured homes*[2]

> are homes built entirely in the factory under a federal building code administered by the U.S. Department of Housing and Urban Development (HUD). The Federal Manufactured Home Construction and Safety Standards (commonly known as the HUD Code) went into effect June 15, 1976. Manufactured homes may be single- or multi-section and are transported to the site and installed.

The MHINCC distinguishes among several types of *factory-built housing*: manufactured homes, modular homes, panelized homes, pre-cut homes, and mobile homes.

From the same source, *mobile home* "is the term used for manufactured homes produced prior to June 15, 1976, when the HUD Code went into effect."[2] Despite the formal definition, *mobile home* and *trailer* are still common terms in the United States for this type of housing.

History

[edit]

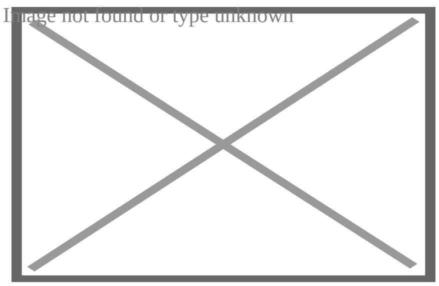
The original focus of this form of housing was its ability to relocate easily. Units were initially marketed primarily to people whose lifestyle required mobility. However, beginning in the 1950s, these homes began to be marketed primarily as an inexpensive form of housing designed to be set up and left in a location for long periods of time, or even permanently installed with a masonry foundation. Previously, units had been eight feet or less in width, but in 1956, the 10-foot (3.0 m) wide home was introduced. This helped solidify the line between mobile and house/travel trailers, since the smaller units could be moved simply with an automobile, but the larger, wider units required the services of a professional trucking company. In the 1960s and '70s, the homes became even longer and wider, making the mobility of the units more difficult. Today, when a factory-built home is moved to a location, it is usually kept there permanently. The mobility of the units has decreased considerably.

The factory-built homes of the past developed a negative stereotype because of their lower cost and the tendency for their value to depreciate more quickly than site-built homes. The tendency of these homes to rapidly depreciate in resale value made using them as collateral for loans far riskier than traditional home loans. Loan terms were usually limited to less than the 30-year term typical of the general home-loan market, and interest rates were considerably higher. In other words, these home loans resembled motor vehicle loans far more than traditional home mortgages. They have been consistently linked to lower-income families, which has led to prejudice and zoning restrictions, which include limitations on the number and density of homes permitted on any given site, minimum size requirements, limitations on exterior colors and finishes, and foundation mandates.

Many jurisdictions do not allow the placement of any additional factory-built homes, while others have strongly limited or forbidden all single-wide models, which tend to depreciate more rapidly than modern double-wide models. The derogatory concept of a "trailer park" is typically older single-wide homes occupying small, rented lots and remaining on wheels, even if the home stays in place for decades.

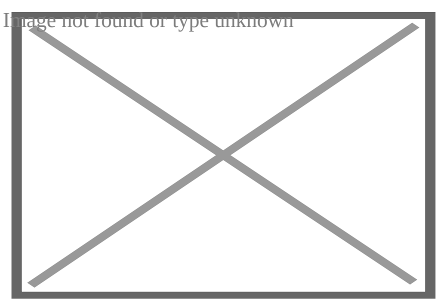
Modern manufactured homes

[edit]

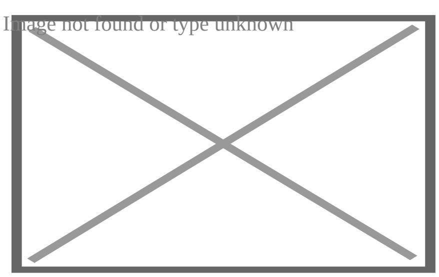


A manufactured house ready to be assembled in Grass Valley, California

Modern homes, especially modular homes, belie this image and can be identical in appearance to site-built homes. Newer homes, particularly double-wides, tend to be built to much higher standards than their predecessors. This has led to a reduction in the rate of value depreciation of many used units.



A manufactured house just before construction of its garage



Stick built garage being added to a new manufactured house

Although great strides have been made in terms of quality, manufactured homes do still struggle with construction problems. Author Wes Johnson has pointed out that the HUD code which governs manufactured homes desperately needs to be updated, quality control at manufacturing facilities are often lax, and set-up issues often compromise even a well-made manufactured home. Johnson states buyers need to be exceptionally cautious if they are entertaining the idea of purchasing any manufactured home by carefully checking it for defects before signing the contract and supervising the set-up process closely. These homes in the modern age are built to be beautiful and last longer than the typical old trailers.[*citation needed*]

When FEMA studied the destruction wrought by Hurricane Andrew in Dade County Florida, they concluded that modular and masonry homes fared best compared to other construction.[3]

High-performance manufactured housing

[edit]

While manufactured homes are considered to be affordable housing, older models can be some of the most expensive in the nation to heat due to energy inefficiency.[4] *High-performance manufactured housing* uses less energy and therefore increases life-cycle affordability by decreasing operating costs. High-performance housing is not only energy efficient, but also attractive, functional, water-efficient, resilient to wind, seismic forces, and moisture penetration, and has healthy indoor environmental quality. Achieving high-performance involves integrated, whole building design, involving many components, not one single technology. High–performance manufactured housing should also include energy efficient appliances, such as Energy Star qualified appliances.[4] Energy Star requires ample insulation: 2x6 walls: R21, roof: R40, floor: R33.

Difference from modular homes

[edit]

Both types of homes - manufactured and modular - are commonly referred to as factory-built housing, but they are not identical. Modular homes are built to International Residential Code (IRC) code. Modular homes can be transported on flatbed trucks rather than being towed, and can lack axles and an automotive-type frame. However, some modular houses are towed behind a semi-truck or toter on a frame similar to that of a trailer. The house is usually in two pieces and is hauled by two separate trucks. Each frame has five or more axles, depending on the size of the house. Once the house has reached its location, the axles and the tongue of the frame are then removed, and the house is set on a concrete foundation by a large crane. Some modern modular homes, once fully assembled, are indistinguishable from site-built homes. In addition, modular homes:

- must conform to the same local, state and regional building codes as homes built on-site;

- are treated the same by banks as homes built on-site. They are easily refinanced, for example;
- must be structurally approved by inspectors;
- can be of any size, although the block sections from which they are assembled are uniformly sized;[5][6]

Difference from IRC codes homes (site built)

[edit]

Manufactured homes have several standard requirements that are more stringent than International Residential Code homes.

Fire Protection

A National Fire Protection Association (NFPA) study from July 2011 shows that occurrence of fires is lower in manufactured housing and the injury rate is lower in manufactured housing. The justification behind the superior fire safety is due to the following higher standard requirements:

- The HUD standard requires a flame spread of 25 or less in water heater and furnace compartments.
- The HUD standard requires a flame spread of 50 or less on the wall behind the range.
- The HUD standard requires a flame spread of 75 or less on the ceilings.
- The HUD standard requires a flame spread of 25 or less to protect the bottoms and side of kitchen cabinets around the range.
- The HUD standard requires additional protection of cabinets above the range.
- The HUD standard requires trim larger than 6" to meet flame spread requirements.
- The HUD standard requires smoke detectors in the general living area.
- The HUD standard requires 2 exterior doors.
- The HUD standard requires bedroom doors to be within 35 feet of an exterior door.

Bay Area

[edit]

The San Francisco Bay Area, located in Northern California, is known for its high real estate prices, making manufactured housing an increasingly popular alternative to traditional real estate.[7] It is mainly the value of the land that makes real estate in this area so expensive. As of May 2011, the median price of a home in Santa Clara was $498,000,[8] while the most expensive manufactured home with all the premium features was only $249,000.[9] This drastic price difference is due to the fact that manufactured homes are typically placed in communities where individuals do not own the land, but instead pay a monthly site fee. This enables a consumer, who could otherwise not afford to live in the Bay Area, the opportunity to own a new home in this location. There are various communities of manufactured homes in the Bay Area, the largest being Casa de Amigos, located in Sunnyvale, California.

Bulk material storage

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  Bulk material storage
  Construction starts with the frame

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  Construction starts with
  the frame
  Interior wall assemblies are attached

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  Interior wall assemblies
  are attached
  Exterior wall assemblies are set in place

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  Exterior wall assemblies
  are set in place
  Roof assembly is set atop the house

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  Roof assembly is set
  atop the house

Drywall completed

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  House is ready for delivery to site

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  House is ready for delivery to site

Australia

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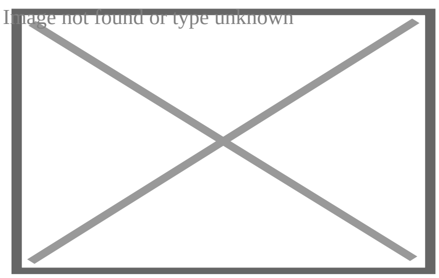

An Australian modern prefabricated house

In Australia these homes are commonly known as **transportable homes**, **relocatable homes** or **prefabricated homes** (not to be confused with the American meaning of the term). They are not as common as in the US, but the industry is expected to grow as this method of construction becomes more accepted.

Manufactured home parks refer to housing estates where the house owner rents the land instead of owning it. This is quite common in Queensland in both the form of tourist parks and over fifty estates. The term transportable homes tends to be used to refer to houses that are built on land that is owned by the house owner.[*citation needed*]

Typically the homes are built in regional areas where the cost of organizing tradespeople and materials is higher than in the cities. In particular prefabricated homes have been popular in mining towns or other towns experiencing demand for new housing in excess of what can be handled by local builders. This method of construction is governed by state construction legislation and is subject to local council approval and homeowners' warranty or home warranty insurance.

Construction process

[edit]

A manufactured home is built entirely inside a huge, climate-controlled factory by a team of craftsmen. The first step in the process is the flooring, which is built in sections, each attached to a permanent chassis with its own wheels and secured for transport upon the home's completion. Depending on the size of the house and the floorplan's layout, there may be two, three or even four sections. The flooring sections have heating, electrical and plumbing connections pre-installed before they are finished with laminate, tile or hardwood. Next, the walls are constructed on a flat level surface with insulation and interior Sheetrock before being lifted by crane into position and secured to the floor sections. The interior ceilings and roof struts are next, vapor sealed and secured to each section's wall frame before being shingled. Then, the exterior siding is added, along with the installation of doors and windows. Finally, interior finishing, such as sealing the drywall, is completed, along with fixture installation and finishing the electrical and plumbing connections. The exposed portions of each section, where they will eventually be joined together, are wrapped in plastic to protect them for transport.

With all the building site prep work completed, the building will be delivered by trucks towing the individual sections on their permanent chassis. The sections will be joined together securely, and all final plumbing and electrical connections are made before a decorative skirt or facade is applied to the bottom exterior of the house, hiding the chassis and finishing off the look of the home.

See also

[edit]

- Image not found or type unknown Housing portal
- Modular home
- Prefabrication
- Prefabricated home
- Reefer container housing units
- British post-war temporary prefab houses
- HUD USER
- Regulatory Barriers Clearinghouse
- Lustron house
- Cardinal Industries, Inc.
- Dymaxion house
- Excel Homes
- All American Homes
- All Parks Alliance for Change

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6. **^** Kit Homes Guide
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Things To Do in Oklahoma County

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USS Oklahoma Anchor Memorial

5 (15)

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Bricktown Water Taxi

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Photo

Crystal Bridge Tropical Conservatory

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National Cowboy & Western Heritage Museum

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Oklahoma City's Adventure District

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Driving Directions From Museum of Osteology to Durham Supply Inc

Driving Directions From Science Museum Oklahoma to Durham Supply Inc

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Driving Directions From Sanctuary Asia to Durham Supply Inc

https://www.google.com/maps/dir/Oklahoma+City+Museum+of+Art/Durham+Supply+In
97.5205029,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-97.5205029!2d35.4695638!1m5!1m1!1sChIJCUnZ1UoUsocRpJXqm8cX514!2m2!1d-97.4774449!2d35.3963954!3e0

https://www.google.com/maps/dir/Stockyards+City+Main+Street/Durham+Supply+Inc/
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https://www.google.com/maps/dir/Museum+of+Osteology/Durham+Supply+Inc/@35.36
97.4418414,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-97.4418414!2d35.3648349!1m5!1m1!1sChIJCUnZ1UoUsocRpJXqm8cX514!2m2!1d-97.4774449!2d35.3963954!3e1

Reviews for Durham Supply Inc

Durham Supply Inc

Image not found or type unknown

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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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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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 ?

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

Image not found or type unknown

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.

Adapting Mobile Homes for High Efficiency HVAC Equipment**View GBP**

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- **Monitoring Seasonal Impacts on Mobile Home AC Efficiency**
- **Choosing Thermostat Controls for Better Mobile Home Efficiency**
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- **Adapting Mobile Homes for High Efficiency HVAC Equipment**

Frequently Asked Questions

What are the key considerations when selecting high-efficiency HVAC equipment for a mobile home?

Key considerations include the size and layout of the mobile home, insulation levels, climate conditions, and energy efficiency ratings of the HVAC system (such as SEER for air conditioners and AFUE for furnaces). Its also important to ensure compatibility with existing ductwork or consider ductless systems if necessary.

How can I improve insulation in my mobile home to support a high-efficiency HVAC system?

Improving insulation involves adding or upgrading insulation in walls, ceilings, and floors. Sealing gaps around windows, doors, and any other openings can also prevent energy loss. Installing energy-efficient windows and adding skirting around the base of the mobile home can further enhance thermal efficiency.

What types of high-efficiency HVAC systems are suitable for mobile homes?

Suitable options include mini-split heat pumps for both heating and cooling without ducts, packaged units that combine heating and cooling components in one unit for ease of installation, or small capacity central systems with appropriately sized ductwork. Electric resistance heaters may be used as supplementary heat sources.

Are there any specific challenges to installing high-efficiency HVAC systems in older mobile homes?

Challenges include limited space for equipment placement, outdated electrical systems that may not support newer models power requirements, inadequate existing ductwork which might need replacement or modification, and potential structural limitations that could affect installation processes.

How does maintaining a high-efficiency HVAC system differ from traditional systems in a mobile home setting?

Maintenance includes regular filter changes to ensure airflow is unrestricted. High-efficiency units may require more frequent professional inspections due to complex technology like variable-speed motors or advanced thermostats. Keeping outdoor components clear of debris is crucial for optimal performance.

Royal Supply Inc

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Google Business Profile

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

Sitemap