Mobile Homes

- **Considering Weight Distribution on Mobile Home Roofs**
  Considering Weight Distribution on Mobile Home Roofs Analyzing Space Limitations for Duct Installation Minimizing Vibrations through Effective Mounting Checking for Clearances near Windows and Doors Verifying Electrical Capacity for New Units Inspecting Crawl Spaces before Major Installations Protecting Exterior Components from Windy Conditions Resolving Access Issues in Narrow Hallways Planning Around Existing Plumbing or Gas Lines Prioritizing Safety in Confined Work Areas Ensuring Adequate Ventilation for Heat Pumps Mitigating Moisture Risks in Humid Climates
- **Comparing Basic and Extended Coverage Options**
  Comparing Basic and Extended Coverage Options Reviewing Part Replacement Clauses in Detail Understanding Labor Inclusions in Contracts Assessing Multi year Agreements for Homeowners Outlining Limitations of Warranty Claims Inspecting Renewal Terms for Ongoing Coverage Checking Deductible Requirements for Repairs Estimating Future Costs through Contract Analysis Tracking Service Visits Outlined in Agreements Selecting Clauses that Cover Seasonal Tuneups Transferring Warranty Benefits to New Owners Planning Budget Strategies for Contract Renewals
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In the realm of HVAC maintenance contracts, part replacement clauses stand as critical components that warrant careful scrutiny. These clauses are not mere formalities; they are pivotal in ensuring both the longevity and efficiency of heating, ventilation, and air conditioning systems. When reviewing these clauses in detail, one must consider their implications on cost, system performance, and overall customer satisfaction.

To begin with, the financial aspect is a primary consideration in evaluating part replacement clauses. HVAC systems are complex assemblies of various mechanical and electronic parts, each with its own lifecycle and potential for failure. A well-defined part replacement clause clearly stipulates which components are covered under the contract and under what conditions they will be replaced. This transparency is crucial for property owners or facility managers as it directly affects budgeting for unexpected repairs or replacements. Professional inspection is necessary before installing a new HVAC unit **mobile home hvac repair** knowledge. Without clear guidelines on part replacement, clients may find themselves facing unforeseen expenses that could have been mitigated through a more comprehensive contract.

Furthermore, the impact of part replacement clauses on system performance cannot be overstated. HVAC systems require regular maintenance to operate at peak efficiency. When parts degrade or malfunction without timely replacement, it can lead to reduced performance or even complete system breakdowns. Detailed part replacement clauses ensure that critical components are monitored and replaced when necessary to maintain optimal functionality. This proactive approach not only enhances system reliability but also contributes to energy savings by preventing inefficient operation caused by worn-out parts.

Finally, from a customer satisfaction perspective, part replacement clauses play a significant role in shaping client trust and loyalty. Contracts that offer clear terms regarding replacements demonstrate a commitment to quality service and customer care. Clients who understand exactly what their contract covers-and see those terms fulfilled-are more likely to remain satisfied with their service provider. This satisfaction translates into long-term relationships that benefit both parties: customers enjoy peace of mind knowing their systems are well-maintained while service providers secure ongoing business.

In conclusion, the importance of part replacement clauses in HVAC maintenance contracts cannot be underestimated. These clauses serve as safeguards against unexpected costs, ensure consistent system performance, and foster strong customer relationships through transparent communication and reliable service delivery. Therefore, when drafting or reviewing an HVAC maintenance contract, stakeholders should pay close attention to these provisions to maximize value and protection for all involved parties.

Impact of HVAC system installation on roof weight distribution —

Mobile homes, with their unique design and structure, present distinct challenges when it comes to heating, ventilation, and air conditioning (HVAC) systems. These systems are crucial for maintaining a comfortable living environment but, like all mechanical setups, they are subject to wear and tear over time. Understanding the key components of a mobile home HVAC system that are prone to replacement can be invaluable for homeowners looking to maintain efficiency and prolong the lifespan of their units.

One of the most frequently replaced components in mobile home HVAC systems is the thermostat. Given its role as the control center for temperature regulation, any malfunction can lead to inefficiencies or even complete system failure. Over time, thermostats can become less responsive or inaccurate due to dust accumulation or outdated technology. Upgrading to a modern programmable thermostat can not only solve these issues but also offer enhanced energy-saving capabilities.

Another critical component susceptible to replacement is the blower motor. Essential for circulating air throughout the home, a failing blower motor can drastically reduce HVAC efficiency. Symptoms of impending failure might include strange noises during operation or inadequate airflow. Regular maintenance checks can help identify problems early on;

however, eventual replacement is often necessary due to motor burnout or mechanical fatigue.

Filters within the HVAC system also demand regular attention and eventual replacement. They play a vital role in ensuring clean air circulates within the home by trapping dust, pollen, and other airborne particles. Clogged or old filters force the system to work harder than necessary, leading to increased energy consumption and reduced air quality. Regularly replacing filters as part of routine maintenance not only enhances system performance but also promotes healthier indoor environments.

Ductwork in mobile homes is another element that might require attention over time. The unique layout of mobile homes often results in ducting that experiences more stress compared to traditional homes. Leaks or blockages within ducts can severely impede airflow efficiency and increase utility costs as the system struggles to maintain desired temperatures. Periodic inspections and repairs or replacements ensure optimal performance from this often-overlooked component.

The condenser unit located outside of mobile homes is exposed to various environmental factors such as weather fluctuations and debris accumulation which contribute significantly towards its wear-and-tear process leading eventually into possible replacements needed overtime especially if preventive measures aren't taken seriously enough like regular cleaning schedules etcetera thus ensuring longevity overall condition-wise speaking here obviously matters greatly!

Finally yet importantly worth mentioning would be refrigerant lines themselves running through these setups since they transport essential cooling agents throughout each entire setup itself thereby facilitating proper climate control mechanisms therein henceforth; however leaks occurring anywhere along their lengths could spell trouble down line requiring immediate attention lest further complications arise potentially necessitating costly interventions later stages unfortunately sometimes unavoidable too depending upon severity extent damages already inflicted upon them prior detection stage perhaps even so vigilance always recommended whenever dealing such critical areas concern particularly given how intricately interwoven everything else seems linked together forming cohesive whole ultimately responsible delivering desired outcomes expected every single day use basis without fail ideally speaking course under normal circumstances assumed naturally enough right?

In conclusion reviewing part-replacement clauses thoroughly becomes imperative understanding better what needs addressed sooner rather than later safeguarding continued functionality effectiveness respective systems involved thereby avoiding unnecessary expenses undue hardships future scenarios possibly arising otherwise unexpectedly catching unawares unprepared individuals caught off guard entirely unaware beforehand ideally taking proactive measures instead wise approach indeed ensuring peace mind satisfaction long run guaranteed practically assuredly!

Posted by on

Considerations for maintaining structural integrity during HVAC installation

In the intricate world of contracts, particularly those related to part replacement, the devil is often in the details. These clauses are not mere boilerplate text; they delineate the rights and obligations of each party, ensuring clarity in transactions that involve replacing parts-be it for machinery, electronics, or other commodities. Understanding these clauses is crucial for both suppliers and consumers as they navigate the often-complex landscape of contractual agreements.

At their core, part replacement clauses aim to address scenarios where components need to be substituted due to defects, wear and tear, or obsolescence. A comprehensive analysis of these clauses reveals a few common elements that are essential for effective contract management.

Firstly, the scope of part replacement is a fundamental aspect. Contracts typically specify what constitutes a "part" eligible for replacement. This includes detailed descriptions and specifications that leave little room for ambiguity. For instance, in an automotive contract, specifying whether only engine parts or all vehicle components fall under this clause can save significant disputes down the line.

Secondly, the conditions under which parts can be replaced are crucial. Clauses might stipulate that replacements occur only if defects arise from normal use as opposed to misuse or accidental damage. This distinction ensures that manufacturers are not unduly burdened with costs arising from user negligence while also safeguarding consumer rights where manufacturer defects are concerned.

Another critical component is the timeline associated with part replacement. Clear timelines help manage expectations between parties regarding how quickly a replacement should occur once a defect is identified and reported. Some contracts may offer immediate replacements within 24 hours while others may extend up to several weeks depending on logistical considerations.

Furthermore, cost implications are inherent in these discussions. Who bears the cost of shipping defective parts back? Is there any charge involved in procuring new ones? Well-drafted clauses will elucidate these financial responsibilities clearly-in some cases placing them solely on one party or allowing for shared expenses depending on circumstances such as warranty coverage or fault attribution.

Additionally, quality assurance post-replacement plays an indispensable role in these agreements. Ensuring that replaced parts meet specific standards and do not compromise the overall product integrity is vital-a task often achieved by including stipulations about original equipment manufacturer (OEM) standards or equivalent quality benchmarks within contract terms.

Finally, dispute resolution mechanisms form another pillar supporting effective part replacement clauses. Given potential disagreements over what constitutes eligibility for replacement or dissatisfaction with new parts' performance levels after installation-having predefined pathways via arbitration or mediation helps maintain cordial business relationships without resorting immediately to litigation.

In conclusion, while reviewing part replacement clauses might seem like an exercise reserved solely for legal experts-it holds tangible importance across various industries impacting stakeholders at multiple levels-from engineers ensuring technical compliance through procurement teams negotiating favorable terms up until end-users seeking assurance about

product longevity and reliability when making purchasing decisions.
Understanding these nuances equips all parties involved with tools necessary not just for compliance but also enhancing mutual trust thereby paving way towards smoother operations devoid of unnecessary conflicts stemming from contractual misunderstandings related specifically around replacing parts effectively when needed most efficiently possible!

Strategies for evenly distributing weight across the

roof when adding or upgrading HVAC systems

When it comes to maintaining the longevity and functionality of machinery, equipment, or even consumer electronics, the importance of a solid part replacement policy cannot be overstated. Comparing different part replacement policies from various manufacturers reveals a landscape as varied as it is complex. These policies are crucial because they directly impact the cost-effectiveness and reliability of owning and using products over time. Reviewing part replacement clauses in detail allows consumers to make informed choices and ensures that they are not caught off guard by unexpected expenses or inadequate coverage.

Manufacturers approach part replacement policies with varying degrees of generosity and restriction. At one end of the spectrum, some companies offer comprehensive warranties that cover parts for an extended period, often with minimal exclusions. These manufacturers understand that providing robust support can enhance customer satisfaction and bolster brand loyalty. Their policies might include free replacements for defective parts within a certain timeframe, easy-to-navigate claim processes, and sometimes even on-site repair services.

Conversely, other manufacturers may limit their liability through stringent conditions embedded in their part replacement clauses. Such policies might restrict coverage to only specific components deemed critical or subject the consumer to numerous conditions before a claim is approved. For example, some warranties might require proof that parts were installed by certified technicians or necessitate regular maintenance checks documented at authorized centers to remain valid. While these stipulations protect manufacturers from misuse or negligence claims, they can also create hurdles for customers needing swift resolutions.

The differences in these approaches often reflect broader company philosophies regarding customer relations and product quality assurance. Manufacturers confident in their product's durability may offer more generous terms as a statement of quality assurance, while those less certain might hedge against potential defects by imposing stricter limits on replacements.

For consumers navigating this landscape, understanding the nuances of part replacement clauses is essential. It requires carefully reading warranty details before purchasing and considering factors such as the length of coverage, ease of claiming replacements, and any additional costs involved-such as shipping fees or labor charges for installing new parts.

Ultimately, the best policy depends on individual needs and priorities. Some users may prioritize low upfront costs and accept more restrictive terms if their usage patterns suggest minimal risk of part failure. Others might prefer paying a premium for peace of mind through comprehensive coverage that promises quick resolution should an issue arise.

In conclusion, comparing different part replacement policies across manufacturers highlights both commonalities and distinctions driven by corporate strategy and market positioning. By reviewing these clauses closely, consumers empower themselves with knowledge that not only protects them financially but also enhances their overall ownership experience-ensuring they choose products backed by supportive frameworks aligned with their expectations for service excellence.

Potential risks of improper weight distribution on mobile home roofs and HVAC efficiency

When it comes to homeownership, the fine print in insurance policies can often be overlooked, yet these details hold significant legal and financial implications. Among these details, part replacement clauses stand out as particularly crucial. These clauses dictate how damaged or outdated components of a home will be addressed by an insurance policy, ultimately shaping the homeowner's financial responsibilities and legal rights.

First and foremost, understanding part replacement clauses is essential for homeowners because they determine what costs will be covered by their insurance provider when repairs are necessary. These clauses typically specify whether parts will be replaced with new items of like kind and quality or if other methods such as repair or cash settlements are alternatives. This distinction can drastically impact the financial burden on the homeowner. For instance, if a policy only covers repair costs but not full replacements for major components like a roof or HVAC system, homeowners might find themselves facing unexpected expenses that insurance doesn't fully cover.

Legally speaking, part replacement clauses can also influence disputes between homeowners and insurers. The language within these clauses must be clear and precise to avoid ambiguity that could lead to litigation. Homeowners should carefully review their policies to ensure they understand the extent of coverage provided. If unclear terms exist within a clause, it may result in disagreements about whether an insurer must replace a part entirely or merely provide patchwork repairs. Courts generally interpret ambiguous terms in favor of the insured; however, relying on judicial intervention can be costly and time-consuming.

Moreover, these clauses have broader implications for property value and safety standards. When inferior parts are used as replacements due to restrictive clauses in an insurance policy, this could potentially reduce the overall value of a home or even compromise its safety standards. Homeowners need to weigh these potential outcomes against any savings they might achieve through lower premiums associated with more restrictive policies.

In essence, reviewing part replacement clauses with attention to detail is not just a bureaucratic exercise-it is a crucial aspect of protecting oneself financially and legally as a homeowner. Consulting with an insurance advisor or legal professional may offer additional insights into how specific clauses could affect individual circumstances.

In conclusion, while part replacement clauses might seem like minor details buried within an extensive insurance policy document, their implications are far-reaching. By ensuring clarity and comprehensiveness in these provisions, homeowners can safeguard against unforeseen financial burdens and ensure their homes remain safe havens rather than sources of stress and uncertainty.

Guidelines for professional assessment and installation to ensure balanced weight

distribution

Negotiating favorable part replacement terms is a critical aspect of contract management, particularly in industries where equipment reliability and maintenance play pivotal roles. Reviewing part replacement clauses in detail is not merely a matter of ticking off a checklist; it requires strategic insight and a keen understanding of both the business needs and the potential supplier constraints. This essay explores best practices for ensuring that these negotiations are successful and yield mutually beneficial agreements.

Firstly, thorough preparation is essential. Before entering any negotiation, it's vital to understand your own organization's requirements fully. This includes not only the technical specifications of parts that might need replacing but also the financial implications of downtime should replacements be delayed. A clear grasp of these factors will provide leverage during negotiations, enabling you to articulate why certain terms are non-negotiable or require more favorable conditions.

One must also closely examine the existing clauses related to part replacement within contracts. Often, these clauses can be dense with legal jargon that obscures crucial details about timelines, costs, or responsibilities. By dissecting each element of the clause, you can identify potential areas for improvement or clarification. For instance, vague language around reasonable timeframes for delivery can lead to significant disputes later on; specifying exact time frames helps mitigate such risks.

Building strong relationships with suppliers is another cornerstone of effective negotiation. It's important to approach discussions with an attitude that favors collaboration over confrontation. Establishing trust can often lead to more flexible arrangements as suppliers may be more willing to accommodate specific requests if they perceive a long-term partnership rather than a transactional relationship.

Furthermore, it's beneficial to benchmark against industry standards when negotiating terms. Understanding what competitors or similar businesses are agreeing upon in their contracts provides context and ensures your expectations are realistic yet competitive. This knowledge serves as a valuable tool in advocating for fair terms without pushing suppliers beyond reasonable limits.

Flexibility should also be factored into negotiations; rigid stances can hinder progress or result in unfavorable outcomes if compromises aren't reached. Being open to alternative solutions-such as staggered deliveries or stockpiling critical parts-can often address concerns while balancing both parties' operational capacities.

Finally, engaging legal expertise cannot be overstated when reviewing complex part replacement clauses. Legal professionals specializing in contract law bring an essential perspective that ensures all stipulations comply with current regulations and protect your organization from unforeseen liabilities.

In conclusion, successfully negotiating favorable part replacement terms hinges on meticulous preparation, detailed review of existing clauses, fostering collaborative supplier relationships, benchmarking against industry norms, maintaining flexibility in discussions, and leveraging legal expertise. By employing these best practices thoughtfully and strategically, organizations can secure agreements that safeguard their interests while promoting efficient operations and sustained partnerships with suppliers.

About Heat pump

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

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

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Mitsubishi heat pump interior air handler wall unit

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Part of a series on

Sustainable energy

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

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Energy conservation

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

Renewable energy

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

Sustainable transport

- Green vehicle
  - Electric vehicle
    - Bicycle
  - Solar vehicle
  - Wind-powered vehicle
- Hybrid vehicle
  - Human-electric
    - Twike
  - Plug-in
- Human-powered transport
  - Helicopter
  - Hydrofoil
  - Land vehicle
    - Bicycle
    - Cycle rickshaw
    - Kick scooter
    - Quadracycle
    - Tricycle
    - Velomobile
  - Roller skating
  - Skateboarding
  - Walking
  - Watercraft
- Personal transporter
- Rail transport
  - Tram
- Rapid transit
  - Personal rapid transit
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A **heat pump** is a device that consumes energy (usually electricity) to transfer heat from a cold heat sink to a hot heat sink. Specifically, the heat pump transfers thermal energy using a refrigeration cycle, cooling the cool space and warming the warm space.[1] In cold weather, a heat pump can move heat from the cool outdoors to warm a house (e.g. winter); the pump may also be designed to move heat from the house to the warmer outdoors in warm weather (e.g. summer). As they transfer heat rather than generating heat, they are more energy-efficient than other ways of heating or cooling a home.[2]

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

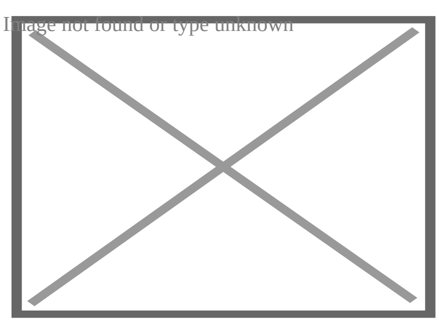
Air source heat pumps are the most common models, while other types include ground source heat pumps, water source heat pumps and exhaust air heat pumps.[3] Large-scale heat pumps are also used in district heating systems.[4]

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

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

Principle of operation

[edit]



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

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

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

The amount of work required to drive an amount of heat Q from a lower-temperature reservoir such as ambient air to a higher-temperature reservoir such as the interior of a building is:

$$W=\frac{Q}{\mathrm{COP}}$$

where

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

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

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

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

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

History

[edit]

Milestones:

1748
: William Cullen demonstrates artificial refrigeration.[12]

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

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

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

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

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

1937–1945
: During the First World War, fuel prices were very high in Switzerland but it had plenty of hydropower.[14]
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In the period before and especially during the Second World War, when neutral Switzerland was completely surrounded by fascist-ruled countries, the coal shortage became alarming again. Thanks to their leading position in energy technology, the Swiss companies Sulzer, Escher Wyss and Brown Boveri built and put in operation around 35 heat pumps between 1937 and 1945. The main heat sources were lake water, river water, groundwater, and waste heat. Particularly noteworthy are the six historic heat pumps from the city of Zurich with heat outputs from 100 kW to 6 MW. An international milestone is the heat pump built by Escher Wyss in 1937/38 to replace the wood stoves in the City Hall of Zurich. To avoid noise and vibrations, a recently developed rotary piston compressor was used. This historic heat pump heated the town hall for 63 years until 2001. Only then was it replaced by a new, more efficient heat pump.[14]

1945

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

1948

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

1951

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

2019

The Kigali Amendment to phase out harmful refrigerants takes effect.

Types

[edit]

Air-source

[edit]

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

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Heat pump on balcony of apartment

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

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

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

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

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

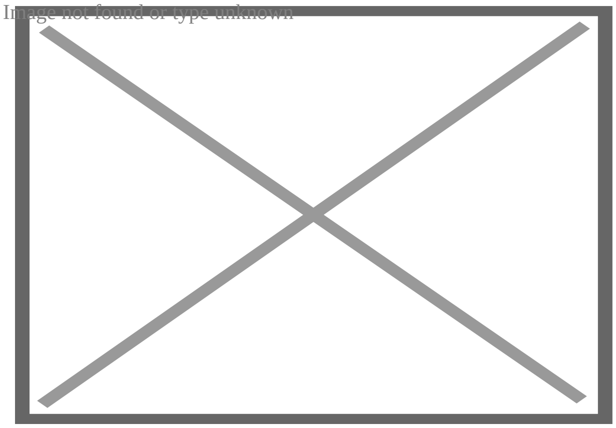
Air-source heat pumps are relatively easy and inexpensive to install, so are the most widely used type. In mild weather, coefficient of performance (COP) may be between 2 and 5, while at temperatures below around ?8 °C (18 °F) an air-source heat pump may still achieve a COP of 1 to 4.[25]

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

Ground source

[edit]

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



A heat pump in combination with heat and cold storage

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

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

Heat recovery ventilation

[edit]
Main article: Heat recovery ventilation

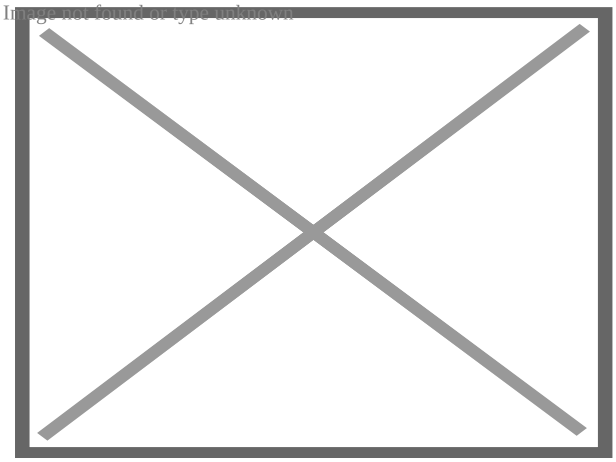
Exhaust air heat pumps extract heat from the exhaust air of a building and require mechanical ventilation. Two classes exist:

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

Solar-assisted

[edit]

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



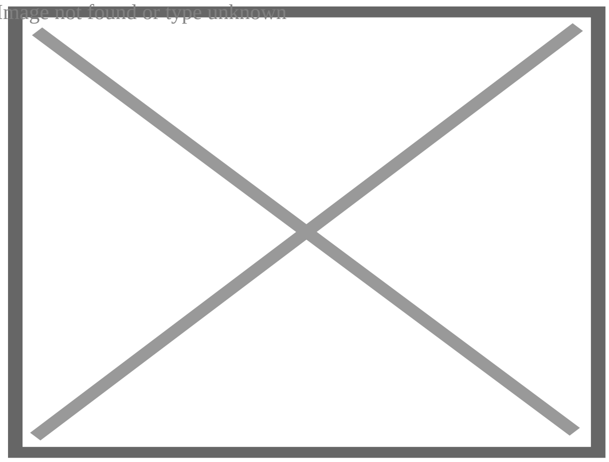
Hybrid photovoltaic-thermal solar panels of a SAHP in an experimental installation at Department of Energy at Polytechnic of Milan

A solar-assisted heat pump (SAHP) is a machine that combines a heat pump and thermal solar panels and/or PV solar panels in a single integrated system.[28] Typically these two technologies are used separately (or only placing them in parallel) to produce hot water.[29] In this system the solar thermal panel performs the function of the low temperature heat source and the heat produced is used to feed the heat pump's evaporator.[30] The goal of this system is to get high coefficient of performance (COP) and then produce energy in a more efficient and less expensive way.

It is possible to use any type of solar thermal panel (sheet and tubes, roll-bond, heat pipe, thermal plates) or hybrid (mono/polycrystalline, thin film) in combination with the heat pump. The use of a hybrid panel is preferable because it allows covering a part of the electricity demand of the heat pump and reduce the power consumption and consequently the variable costs of the system.

Water-source

[edit]



Water-source heat exchanger being installed

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

Others

[edit]

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

Electrocaloric heat pumps are solid state.[35]

Applications

[edit]

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

Space heating and sometimes also cooling

[edit]

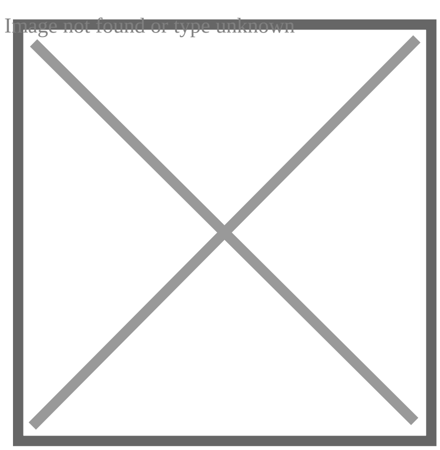
In HVAC applications, a heat pump is typically a vapor-compression refrigeration device that includes a reversing valve and optimized heat exchangers so that the direction of *heat flow* (thermal energy movement) may be reversed. The reversing valve switches the direction of refrigerant through the cycle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

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

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

Window mounted heat pump

[edit]



Saddle-style window mounted heat pump 3D sketch

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

Water heating

[edit]

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

District heating

[edit]

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

Industrial heating

[edit]

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

Performance

[edit]
Main article: Coefficient of performance

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

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

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

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

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

COP variation with output temperature

Pump type and source	Typical use	35 °C (e.g. heated screed floor)	45 °C (e.g. heated screed floor)
High-efficiency air-source heat pump (ASHP), air at ?20 °C[56]		2.2	2.0
Two-stage ASHP, air at ?20 °C[57]	Low source temperature	*2.4*	2.2
High-efficiency ASHP, air at 0 °C[56]	Low output temperature	*3.8*	2.8
Prototype transcritical CO_2 (R744) heat pump with tripartite gas cooler, source at 0 °C[58]	High output temperature	3.3	ÃƒÆ’Ã†â€™Ãƒâ€šÃ‚Â¢ÃƒÆ’Ã‚Â¢ÃƒÂ¢Ã¢â€šÂ¬Ã…Â¡Ãƒâ€šÃ‚
Ground-source heat pump (GSHP), water at 0 °C[56]		5.0	3.7
GSHP, ground at 10 °C[56]	Low output temperature	*7.2*	5.0

Theoretical Carnot cycle limit, source ?20 °C	5.6	4.9
Theoretical Carnot cycle limit, source 0 °C	8.8	7.1
Theoretical Lorentzen cycle limit (CO_2 pump), return fluid 25 °C, source 0 °C[58]	10.1	8.8
Theoretical Carnot cycle limit, source 10 °C	12.3	9.1

Carbon footprint

[edit]

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

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

heat pump electricity by lignite (old power plant) and low performance	1221 gCO_2/kWh[61]	300% (COP=3)	407 gCO_2/kWh

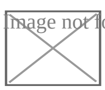
In most settings, heat pumps will reduce CO_2 emissions compared to heating systems powered by fossil fuels.[62] In regions accounting for 70% of world energy consumption, the emissions savings of heat pumps compared with a high-efficiency gas boiler are on average above 45% and reach 80% in countries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

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

Operation

[edit]

See also: Vapor-compression refrigeration



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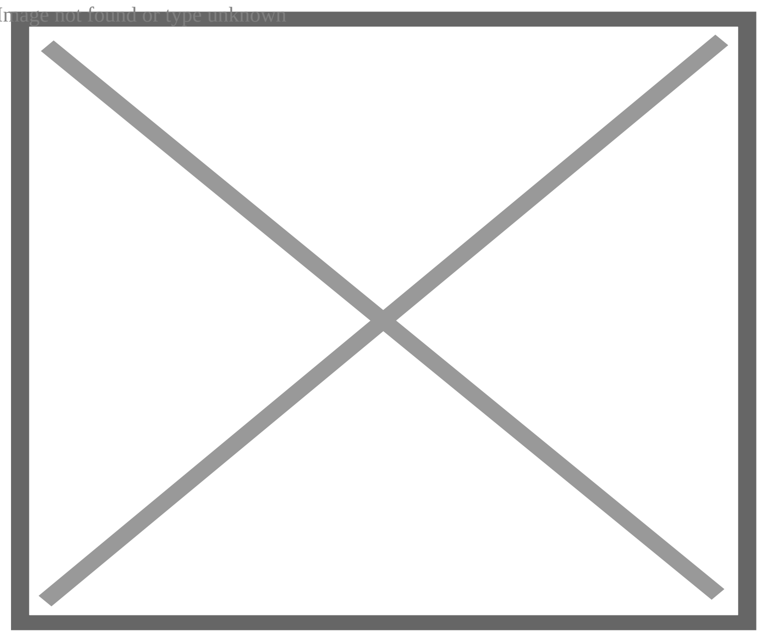
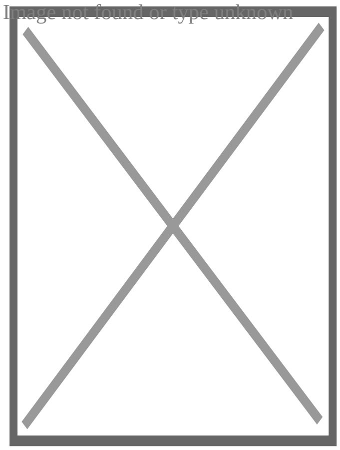
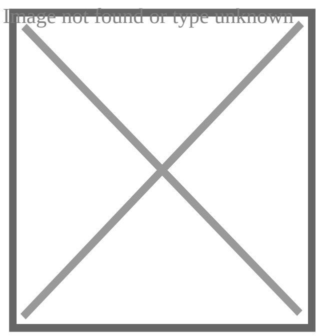


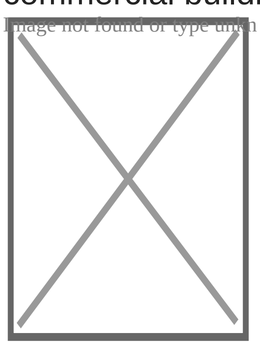
Figure 2: Temperature–entropy diagram of the vapor-compression cycle



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



Large heat pump setup for a commercial building



Wiring and connections to a central air unit inside

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

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

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

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

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

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

Improvement of coefficient of performance by subcooling

[edit]
Main article: Subcooling

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

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

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

Refrigerant choice

[edit]
Main article: Refrigerant

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

In the past 200 years, the standards and requirements for new refrigerants have changed. Nowadays low global warming potential (GWP) is required, in addition to all the previous requirements for safety, practicality, material compatibility, appropriate atmospheric life,[*clarificatio* and compatibility with high-efficiency products. By 2022, devices using refrigerants with a very low GWP still have a small market share but are expected to play an increasing role due to enforced regulations,[71] as most countries have now ratified the Kigali Amendment to ban HFCs.[72] Isobutane (R600A) and propane (R290) are far less harmful to the environment than conventional hydrofluorocarbons (HFC) and are already being used in air-source heat pumps.[73] Propane may be the most suitable for high temperature heat pumps.[74] Ammonia (R717) and carbon dioxide (R-744) also have a low GWP. As of 2023 smaller CO

2 heat pumps are not widely available and research and development of them continues.[75] A 2024 report said that refrigerants with GWP are vulnerable to further international restrictions.[76]

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

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

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

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

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

Government incentives

[edit]

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

Australia

[edit]

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

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

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

Canada

[edit]

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

China

[edit]

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

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

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

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

European Union

[edit]

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

United Kingdom

[edit]

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

United States

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

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

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

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

Notes

[edit]

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

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[edit]

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Heating, ventilation, and air conditioning

Fundamental concepts

- Air changes per hour
- Bake-out
- Building envelope
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- Domestic energy consumption
- Enthalpy
- Fluid dynamics
- Gas compressor
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- Noise control
- Outgassing
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- Thermal destratification
- Thermal mass
- Thermodynamics
- Vapour pressure of water

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- Absorption refrigerator
- Air barrier
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- Chilled beam
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- Solar heating

- Air conditioner inverter
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- Air filter
- Air handler
- Air ionizer
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- Air purifier
- Air source heat pump
- Attic fan
- Automatic balancing valve
- Back boiler
- Barrier pipe
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- Ceramic heater
- Chiller
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- Freeze stat
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- Gas compressor
- Gas heater
- Gasoline heater
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Components

- 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
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About Fan coil unit

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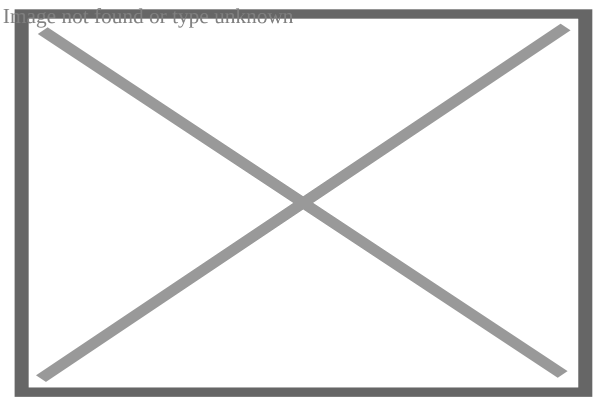
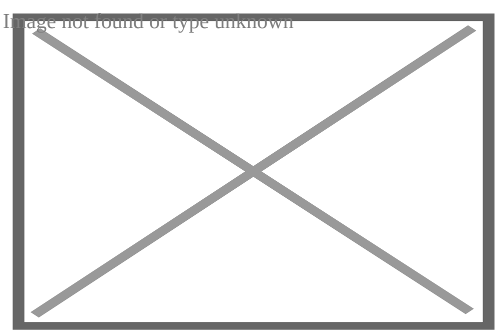
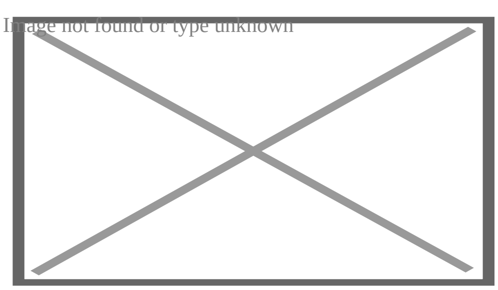


Refrigerant based Fan-Coil Unit. Other variants utilize a chilled, or heated water loop for space cooling, or heating, respectively.





A **fan coil unit** (**FCU**), also known as a **Vertical Fan Coil Unit** (**VFCU**), is a device consisting of a heat exchanger (coil) and a fan. FCUs are commonly used in HVAC systems of residential, commercial, and industrial buildings that use ducted split air conditioning or central plant cooling. FCUs are typically connected to ductwork and a thermostat to regulate the temperature of one or more spaces and to assist the main air handling unit for each space if used with chillers. The thermostat controls the fan speed and/or the flow of water or refrigerant to the heat exchanger using a control valve.

Due to their simplicity, flexibility, and easy maintenance, fan coil units can be more economical to install than ducted 100% fresh air systems (VAV) or central heating systems with air handling units or chilled beams. FCUs come in various configurations, including horizontal (ceiling-mounted) and vertical (floor-mounted), and can be used in a wide range of applications, from small residential units to large commercial and industrial buildings.

Noise output from FCUs, like any other form of air conditioning, depends on the design of the unit and the building materials surrounding it. Some FCUs offer noise levels as low as NR25 or NC25.

The output from an FCU can be established by looking at the temperature of the air entering the unit and the temperature of the air leaving the unit, coupled with the volume of air being moved through the unit. This is a simplistic statement, and there is further reading on sensible heat ratios and the specific heat capacity of air, both of which have an effect on thermal performance.

Design and operation

[edit]

Fan Coil Unit covers a range of products and will mean different things to users, specifiers, and installers in different countries and regions, particularly in relation to product size and output capability.

Fan Coil Unit falls principally into two main types: blow through and draw through. As the names suggest, in the first type the fans are fitted behind the heat exchanger, and in the other type the fans are fitted in front the coil such that they draw air through it. Draw through units are considered thermally superior, as ordinarily they make better use of the heat exchanger. However they are more expensive, as they require a chassis to hold the fans whereas a blow-through unit typically consists of a set of fans bolted straight to a coil.

A fan coil unit may be concealed or exposed within the room or area that it serves.

An exposed fan coil unit may be wall-mounted, freestanding or ceiling mounted, and will typically include an appropriate enclosure to protect and conceal the fan coil unit itself, with return air grille and supply air diffuser set into that enclosure to distribute the air.

A concealed fan coil unit will typically be installed within an accessible ceiling void or services zone. The return air grille and supply air diffuser, typically set flush into the ceiling, will be ducted to and from the fan coil unit and thus allows a great degree of flexibility for locating the grilles to suit the ceiling layout and/or the partition layout within a space. It is quite common for the return air not to be ducted and to use the ceiling void as a return air plenum.

The coil receives hot or cold water from a central plant, and removes heat from or adds heat to the air through heat transfer. Traditionally fan coil units can contain their own internal thermostat, or can be wired to operate with a remote thermostat. However, and as is common in most modern buildings with a Building Energy Management System (BEMS), the control of the fan coil unit will be by a local digital controller or outstation (along with associated room temperature sensor and control valve actuators) linked to the BEMS via a communication network, and therefore adjustable and controllable from a central point, such as a supervisors head end computer.

Fan coil units circulate hot or cold water through a coil in order to condition a space. The unit gets its hot or cold water from a central plant, or mechanical room containing equipment for removing heat from the central building's closed-loop. The equipment used can consist of machines used to remove heat such as a chiller or a cooling tower and equipment for adding heat to the building's water such as a boiler or a commercial water heater.

Hydronic fan coil units can be generally divided into two types: Two-pipe fan coil units or four-pipe fan coil units. Two-pipe fan coil units have one supply and one return pipe. The supply pipe supplies either cold or hot water to the unit depending on the time of year. Four-pipe fan coil units have two supply pipes and two return pipes. This allows either hot or cold water to enter the unit at any given time. Since it is often necessary to heat and cool different areas of a building at the same time, due to differences in internal heat loss or heat gains, the four-pipe fan coil unit is most commonly used.

Fan coil units may be connected to piping networks using various topology designs, such as "direct return", "reverse return", or "series decoupled". See ASHRAE Handbook "2008 Systems & Equipment", Chapter 12.

Depending upon the selected chilled water temperatures and the relative humidity of the space, it's likely that the cooling coil will dehumidify the entering air stream, and as a by product of this process, it will at times produce a condensate which will need to be carried to drain. The fan coil unit will contain a purpose designed drip tray with drain connection for this purpose. The simplest means to drain the condensate from multiple fan coil units will be by a network of pipework laid to falls to a suitable point. Alternatively a condensate pump may be employed where space for such gravity pipework is limited.

The fan motors within a fan coil unit are responsible for regulating the desired heating and cooling output of the unit. Different manufacturers employ various methods for controlling the motor speed. Some utilize an AC transformer, adjusting the taps to modulate the power supplied to the fan motor. This adjustment is typically performed during the commissioning stage of building construction and remains fixed for the lifespan of the unit.

Alternatively, certain manufacturers employ custom-wound Permanent Split Capacitor (PSC) motors with speed taps in the windings. These taps are set to the desired speed levels for the specific design of the fan coil unit. To enable local control, a simple speed selector switch (Off-High-Medium-Low) is provided for the occupants of the room. This switch is often integrated into the room thermostat and can be manually set or automatically controlled by a digital room thermostat.

For automatic fan speed and temperature control, Building Energy Management Systems are employed. The fan motors commonly used in these units are typically AC Shaded Pole or Permanent Split Capacitor motors. Recent advancements include the use of brushless DC designs with electronic commutation. Compared to units equipped with asynchronous 3-speed motors, fan coil units utilizing brushless motors can reduce power consumption by up to 70%.[1]

Fan coil units linked to ducted split air conditioning units use refrigerant in the cooling coil instead of chilled coolant and linked to a large condenser unit instead of a chiller. They might also be linked to liquid-cooled condenser units which use an intermediate coolant to cool the condenser using cooling towers.

DC/EC motor powered units

[edit]

These motors are sometimes called DC motors, sometimes EC motors and occasionally DC/EC motors. DC stands for direct current and EC stands for electronically commutated.

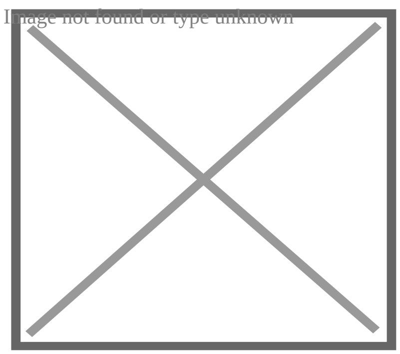
DC motors allow the speed of the fans within a fan coil unit to be controlled by means of a 0-10 Volt input control signal to the motor/s, the transformers and speed switches associated with AC fan coils are not required. Up to a signal voltage of 2.5 Volts (which may vary with different fan/motor manufacturers) the fan will be in a stopped condition but as the signal voltage is increased, the fan will seamlessly increase in speed until the maximum is reached at a signal Voltage of 10 Volts. fan coils will generally operate between approximately 4 Volts and 7.5 Volts because below 4 Volts the air volumes are ineffective and above 7.5 Volts the fan coil is likely to be too noisy for most commercial applications.

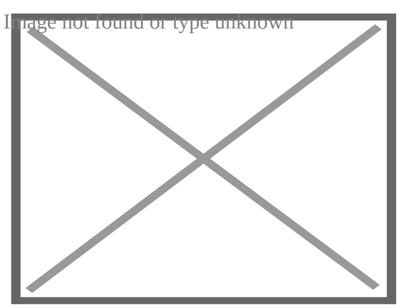
The 0-10 Volt signal voltage can be set via a simple potentiometer and left or the 0-10 Volt signal voltage can be delivered to the fan motors by the terminal controller on each of the Fan Coil Units. The former is very simple and cheap but the latter opens up the opportunity to continuously alter the fan speed depending on various external conditions/influences. These conditions/criteria could be the 'real time' demand for either heating or cooling, occupancy levels, window switches, time clocks or any number of other inputs from either the unit itself, the Building Management System or both.

The reason that these DC Fan Coil Units are, despite their apparent relative complexity, becoming more popular is their improved energy efficiency levels compared to their AC motor-driven counterparts of only a few years ago. A straight swap, AC to DC, will reduce electrical consumption by 50% but applying Demand and Occupancy dependent fan speed control can take the savings to as much as 80%. In areas of the world where there are legally enforceable energy efficiency requirements for fan coils (such as the UK), DC Fan Coil Units are rapidly becoming the only choice.

Areas of use

[edit]





In high-rise buildings, fan coils may be vertically stacked, located one above the other from floor to floor and all interconnected by the same piping loop.

Fan coil units are an excellent delivery mechanism for hydronic chiller boiler systems in large residential and light commercial applications. In these applications the fan coil units are mounted in bathroom ceilings and can be used to provide unlimited comfort zones - with the ability to turn off unused areas of the structure to save energy.

Installation

[edit]

In high-rise residential construction, typically each fan coil unit requires a rectangular through-penetration in the concrete slab on top of which it sits. Usually, there are either 2 or 4 pipes made of ABS, steel or copper that go through the floor. The pipes are usually insulated with refrigeration insulation, such as acrylonitrile butadiene/polyvinyl chloride (AB/PVC) flexible foam (Rubatex or Armaflex brands) on all pipes, or at least on the chilled water lines to prevent condensate from forming.

Unit ventilator

[edit]

A unit ventilator is a fan coil unit that is used mainly in classrooms, hotels, apartments and condominium applications. A unit ventilator can be a wall mounted or ceiling hung cabinet, and is designed to use a fan to blow outside air across a coil, thus conditioning and ventilating the space which it is serving.

European market

[edit]

The Fan Coil is composed of one quarter of 2-pipe-units and three quarters of 4-pipe-units, and the most sold products are "with casing" (35%), "without casing" (28%), "cassette" (18%) and "ducted" (16%).[2]

The market by region was split in 2010 as follows:

Region	Sales Volume in units[2]	Share
Benelux	33 725	2.6%
France	168 028	13.2%
Germany	63 256	5.0%
Greece	33 292	2.6%
Italy	409 830	32.1%
Poland	32 987	2.6%
Portugal	22 957	1.8%
Russia, Ukraine and CIS countries	87 054	6.8%
Scandinavia and Baltic countries	39 124	3.1%
Spain	91 575	7.2%
Turkey	70 682	5.5%

UK and Ireland	69 169	5.4%
Eastern Europe	153 847	12.1%

See also

[edit]
Image not found or type unknown
Wikimedia Commons has media related to ***Fan coil units***.

- Thermal insulation
- HVAC
- Construction
- Intumescent
- Firestop

References

[edit]

1. **^** *"Fan Coil Unit". Heinen & Hopman. Retrieved 2023-08-30.*
2. ^ ***a b*** *"Home". Eurovent Market Intelligence.*

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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

- 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

Components

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

About Royal Supply South

Things To Do in Arapahoe County

Photo

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Big Blue Bear

4.6 (1429)

Photo

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Aurora History Museum

4.6 (251)

Photo

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Wings Over the Rockies Air & Space Museum

4.7 (5324)

Photo

Plains Conservation Center (Visitor Center)

4.6 (393)

Photo

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Colorado Freedom Memorial

4.8 (191)

Photo

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Morrison Nature Center

4.7 (128)

Driving Directions in Arapahoe County

Driving Directions From Mullen High School to Royal Supply South

Driving Directions From Costco Vision Center to Royal Supply South

Driving Directions From Regal River Point to Royal Supply South

Driving Directions From Costco Wholesale to Royal Supply South

Driving Directions From Tandy Leather South Denver - 151 to Royal Supply South

Driving Directions From King Soopers to Royal Supply South

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Driving Directions From Museum of Outdoor Arts to Royal Supply South

Driving Directions From Molly Brown House Museum to Royal Supply South

Driving Directions From Aurora Reservoir to Royal Supply South

Driving Directions From Cherry Creek State Park to Royal Supply South

Driving Directions From Cherry Creek State Park to Royal Supply South

Driving Directions From Aurora Reservoir to Royal Supply South

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Reviews for Royal Supply South

Reviewing Part Replacement Clauses in Detail**View GBP**

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- **Assessing Multi year Agreements for Homeowners**
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- **Transferring Warranty Benefits to New Owners**

Frequently Asked Questions

What are the key components that should typically be covered under part replacement clauses for a mobile home HVAC system?

Part replacement clauses for a mobile home HVAC system should typically cover essential components such as the compressor, condenser, evaporator coil, fan motors, and thermostats. These parts are critical to the functioning of the system and are often subject to wear and tear over time.

Are there any exclusions or limitations commonly found in part replacement clauses for mobile home HVAC systems?

Yes, common exclusions or limitations may include coverage for parts damaged by improper installation, lack of maintenance, or external factors like weather damage. Additionally, some warranties might limit coverage to specific brands or require regular servicing by authorized technicians to remain valid.

How does the duration of coverage affect the effectiveness of part replacement clauses in HVAC warranties for mobile homes?

The duration of coverage is crucial as it determines how long the homeowner can rely on warranty protection. Longer durations offer extended security against unexpected repair costs but may come at a higher initial cost. Its important to evaluate whether the length matches your usage expectations and potential risks associated with older systems.

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