aalberts hydronic flow control

Water-based cooling systems

whitepaper

Future-proof cooling for residential and commercial buildings

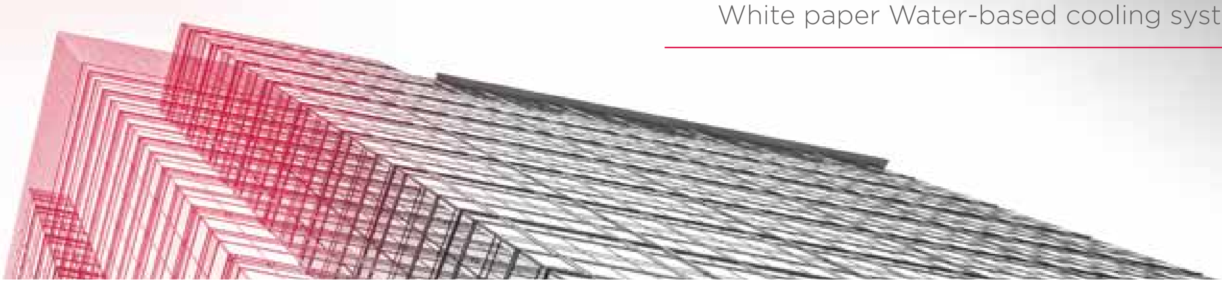
This white paper describes the features and benefits of water-based cooling systems. The pipework of these systems is filled with water between the cold thermal source and the cold thermal emitter. Systems where the pipes contain a refrigerant (liquid or gas) are excluded from this scope.

Risk of overheating

European countries are faced with an increasing risk of overheating in homes, residential buildings and commercial buildings. The main causes are climate change (warming), sustainability (increased thermal insulation and higher air tightness to generate energy savings), urbanization and increasing internal heat load (from appliances, installations and people). Excess heat issues will occur more frequently and with increasing severity.

Rising outdoor and indoor temperatures increase the risk of heat stress. Heat has a negative impact on the health, well-being and performance of people (and animals). A cool building, on the other hand, has many advantages. A cooled indoor climate ensures better mental concentration, higher productivity and lower absenteeism due to illness. Cooling even contributes to a lower mortality rate, which is especially important with an aging population. Cooling also improves the living and working experience, comfort and general well-being of the building's users. In addition, cooling contributes to better overall health by reducing the risk of vermin and mold.
As a result of these issues there is increasing attention on the indoor climate, and a growing demand for cooling. However, in the current economy there is a lot of emphasis on improving energy performance and making thermal sources more sustainable. Focus on the insulation of the building envelope, energy-efficient installations and the use of sustainable energy.

However the increasing demand for cooling and the associated energy consumption is being overlooked. It is therefore important to identify the possibilities for sustainably meeting the cooling demand.



Cooling solutions

Various measures are possible to cool a building. A distinction is made between passive and active cooling. Passive (natural) cooling is more sustainable than active cooling, mainly because it requires little or no energy consumption. Yet active cooling is sometimes the only practical solution.

Passive cooling

Passive cooling can be done in different ways. Starting with preventing heat from entering (e.g. using sun blinds) or dissipating heat (e.g. using night ventilation or Mediterranean cooling). In addition, passive cooling is possible with ground/water heat pumps. The low temperature of the earth's surface (soil/water heat pump) or of the groundwater (water/water heat pump) is piped from the underfloor heating or low temperature (LT) convectors and pumped around to cool the building. Heat is extracted from the building via the heat exchanger and transferred to the soil or groundwater. With passive cooling, only the circulation pump works and the compressor remains off.

Active cooling

With active cooling, the heat pump is in full operation, but its operation is reversed from the heating process to instead cool the building. Active cooling is possible with two types of heat pumps:

- an air/air heat pump
- an air/water heat pump.

An air/air heat pump is a split unit for air conditioning. The indoor unit extracts heat and transfers it to the outdoor unit using a refrigerant. An air conditioning unit with multiple indoor units (multi-split) has an individual pipe circuit per indoor unit. To cool entire buildings, you can opt for a VRF (Variable Refrigerant Flow) system, consisting of one or more outdoor units and several indoor units that run on one pipe circuit, are connected. You can therefore heat and/or cool multiple rooms with one VRF system.
An air/water heat pump cools the water and pumps it through the pipes of the underfloor heating or LT radiators so that heat is extracted from the indoor air. That heat is released to the outside air via the outdoor unit. To remove that indoor heat, to warmer outdoor air, the heat pump must have a compressor. With active cooling, both the circulation pump and the compressor are active and you consume more power than with a passive cooling heat pump.

Refrigerants

Active cooling through air conditioning uses refrigerants to transport heat in a refrigeration system or heat pump. These can be synthetic (chemical) or natural refrigerants. Synthetic refrigerants are industrially manufactured and are divided into chlorinated fluoro(hydro)carbons or (H)CFCs and fluorocarbons or HFCs. Natural refrigerants occur in nature and are divided into water, carbon dioxide (CO_2), ammonia and hydrocarbons, such as ethane, propane, propylene and (iso)butane.

Synthetic refrigerants are harmful to the environment and can escape from an installation. (H)CFCs damage the ozone layer and HFCs increase the greenhouse effect. To protect the environment, the use of synthetic refrigerants is subject to European regulations. For ozone layer depleting substances or (H)CFCs this is the Ozone Layer Depleting Substances Regulation (EC No. 1005/2009) and for fluorinated greenhouse gases or HFCs this is the F-gas Regulation (EU) No. 517/2014.

Natural refrigerants do not deplete the ozone layer and have a very low or no global warming potential (GWP or Global Warming Potential). However, if they leak, they can pose a risk to their immediate environment. That is why regulations have been laid down for these refrigerants in the Activities Decree. This obliges, among other things, owners of refrigeration installations to have a preventive inspection carried out annually.

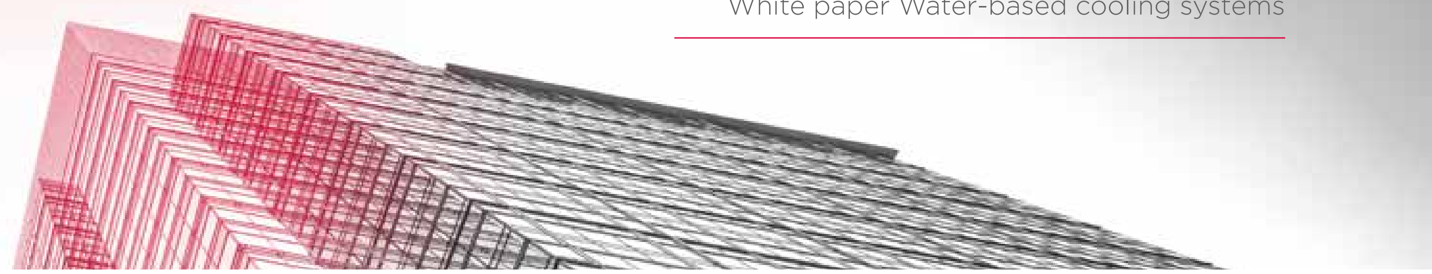
Europe wants to reduce the use of environmentally harmful cooling technology. Topping up with (H) CFCs, such as R22, has been prohibited since 2015. The use of HFCs will be phased out until 2030 in the F-gas regulation. For example, there will be a ban on the use of heavier HFCs with a GWP that is too high and the trade and production of F-gases will be sharply reduced. The use of natural refrigerants is becoming increasingly attractive from an environmental and economic point of view. This is partly because the use of synthetic refrigerants has a negative effect on BREEAM scores.

Water-based cooling systems

Water-based cooling is one of the most sustainable and efficient alternatives to cooling systems with F-gases. Water is natural and a water-based system uses much less energy. This is partly because water has a high specific heat and can store a lot of energy per unit volume. Water is also safe and manageable.

Another advantage is that an installer does not need to be certified to install and maintain such a water-based cooling system, unlike systems based on synthetic and natural refrigerants. Adjusting the system is also easy due to the decentralized operation. The installer can install the system easily expand or contract with connections, both during and after the construction process. This is much more drastic and complicated with a DX system.
Furthermore, a water-based cooling system, if properly degassed, has a much longer lifespan.

Water-based cooling systems are forward-looking solutions to meet the challenge of overheating. Each system contains a pipe network (distribution) and emitter system.
A water-based cooling system can function through both passive and active cooling.



Select cooling system

To design a cooling installation, you need an indication of the cooling capacity required to guarantee an optimal indoor climate, with a pleasant temperature in the summer. Based on a building simulation, you can assess the cooling requirement at room and building level and determine the amount of cooling capacity to keep it comfortable. Such a simulation takes into account internal heat gains (equipment, people) and facade orientation (east-south-west solar radiation). The total cooling loads partly determine the choice of the cooling system.

Floor and ceiling cooling

For cooling of rooms, different emitter systems can be distinguished: floor cooling (and wall cooling) or ceiling cooling. Both systems pump cold water through pipes, for example via a heat pump, to remove ambient heat. They operate quietly and are energy efficient and require little maintenance. These systems are often combined with a reversible heat pump, which can also pump hot water to heat spaces. In addition, fan coil units and air handling units can also provide water-based cooling.

Floor cooling (and wall cooling) with a heat pump can lower the indoor temperature by a few degrees, but due to the lower power, floor cooling works less quickly and less powerfully than ceiling cooling. Ceiling cooling is accompanied by a little more convection, but is more suitable to reach a specific temperature. If there is no specific cooling system prescribed, floor cooling is usually chosen.
Ceiling cooling is more reserved for utilities due to the higher investment costs. Due to the rise of heat pumps, homes and residential buildings almost always use underfloor cooling. This can be done with an air/water heat pump (active cooling) or with a ground/water heat pump or water/water heat pump (passive cooling). The passive systems are cheaper to purchase, but have less cooling capacity and operate less acurately.

Based on the selected system, the installer can choose the required system components. In general, underfloor cooling, especially the passive systems, are simpler and smaller in design.

Condensation and gas formation

Water-based cooling systems work differently than heating systems. Therefore, special measures may be necessary to prevent condensation and gas formation.

Due to cooling, condensation can occur on the cold pipes. This reduces the insulation and allows even more moisture to precipitate. Typically, a water temperature of 16 ºC (dew point) is sufficient to prevent condensation on the underfloor heating pipes. The dew point partly depends on the relative humidity (RH) at a given temperature. At a certain temperature the RH becomes lower, respectively the dew point will also be lower. But in extreme heat and/or high humidity, the dew point can also be higher. Vapor-tight insulation of the (supply) pipes can prevent condensation (and corrosion). There is less heat loss (condensation affects heat) and the cooling system has to work less hard.
Low-temperature systems are vulnerable to entrapped air, which can eventually cause corrosion and biofilm. As a result, the systems no longer work optimally. Conventional air separators are inefficient at low temperatures. For effective air separation it is necessary to use a vacuum degasser.

Support and advice

Aalberts hydronic flow control (Flamco and Comap) supports and advises installers in designing a cooling installation. In addition, Aalberts HFC offers a wide range of products to install and maintain the distribution and release of cold in homes, residential buildings and utility buildings. Think of pump groups, floor cooling systems, pipes, distributors, control systems, adjustment valves, expansion vessels, safety valves, air and dirt separators and vacuum degassers.
Curious about the possibilities? Please contact our Technical Support department.

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