HEAT PUMP TECHNOLOGY FOR UNDERFLOOR HEATING

ComfortHeat
SUPERIOR FLOOR HEATING SYSTEMS

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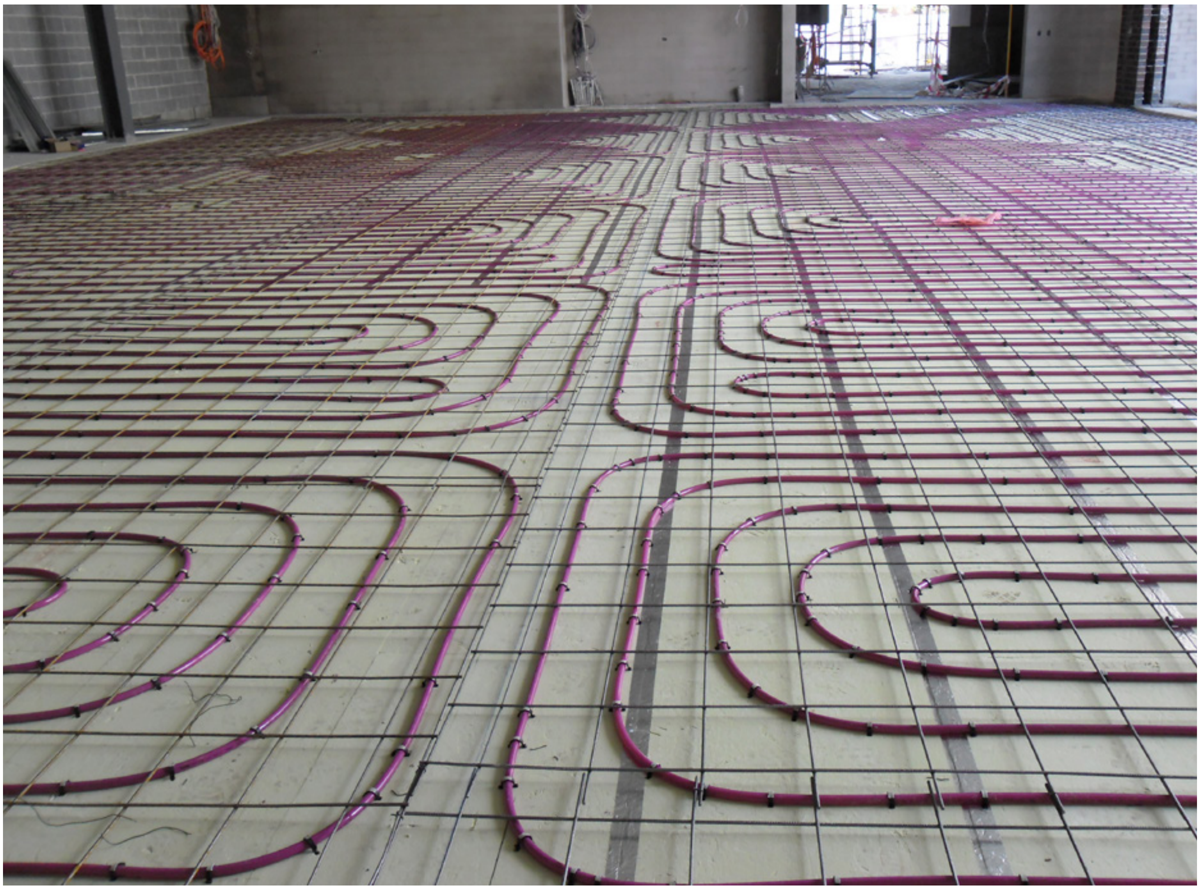
INTRODUCTION

As temperatures fall to new lows in winter and rise to unprecedented peaks in summer, energy consumption via heating and cooling is a mounting concern in Australian climates. Heating and cooling costs make up 40% of the average Australian household's energy consumption- far outstripping any other energy need[1]. With heating and cooling also comprising anywhere between 40 and 60% of non-residential energy usage[2], it is clear that more efficient climate control measures than ducted air conditioning and other common methods need to be investigated.

Thanks to recent innovations and a growing number of options in the market, hydronic in- or under-floor heating has become an attractive cost-efficient and low energy solution for residential and commercial projects alike. Suitable for installation in-slab or on subfloors under various floor coverings including timber, hydronic systems can use heat pump technology to take advantage of convection, encouraging heat to rise up through a space instead of forcing it down. As an alternative to other heating and cooling systems, hydronic solutions utilising heat pump technology offer significant potential for zoned control: instead of automatically heating an entire floor of a building or a whole home, individual rooms and spaces can be heated on an as-needed basis. The versatility of heat pump systems is bolstered by their ability to switch between heating and cooling as well as their easy integration with photovoltaic systems and battery banks, allowing energy to be purchased off-grid.



ABOVE IMAGE: COMFORT HEAT UNDERFOOR HEATING TECHNOLOGY

COVER IMAGE: PHOTO BY BREATHER ON UNSPLASH, ABOVE IMAGE: PHOTO PHOTO BY DANIEL FRANK ON UNSPLASH

AN OVERVIEW OF HEAT PUMPS

There are numerous methods for extracting heat from the environment, but the two most common are geothermal and air-to-water heat pumps. More efficient and offering greater design flexibility than conventional heat sources such as gas boilers and ducted heating/cooling systems, both methods operate using the same basic principles. Heat pumps draw in heat from the heat source or 'heat sink' around them- either the air or the ground- and transfer this heat to water. This water is then circulated through pipes set in or beneath the floor, in the process releasing heat that rises up through the floor and warms the space above. Since heat energy is always stored in the air and ground, both methods can be used effectively on demand.

EFFICIENCY AND COST BENEFITS

Though run on electricity, heat pump technology is significantly more efficient. The typical heat pump used as part of an underfloor heating system has an average Coefficient Of Performance (COP) of 4.5, whereas a natural gas boiler has a COP of 0.93 and a diesel boiler a COP of 0.9[3]. Put simply, a heat pump system will consume around 4.44kW of electricity in order to support a 20kW heat load in a building, while a natural gas boiler will require over 21.5kW to produce the same yield. In a practical sense, the result of this difference is that heat pumps offer operational cost savings of up to 70% of the average household's electricity bill[4].

ENVIRONMENTAL BENEFITS

In an age where climate change and greenhouse gas emissions remain topical, the environmental impact and sustainability of any heating or cooling system cannot be ignored. In addition to surpassing their efficiency, heat pumps have been found to outperform conventional boilers in terms of CO2 emissions in kilograms per year (kg/year). Heat pumps produce CO2 indirectly through the electricity they use to operate, unlike wood fired and natural gas boilers, which themselves contribute directly to emissions. Assuming an output of 20, 000 kilowatt hours (kWh) of energy per year, ground source heat pumps will release 2000 kg/year of CO2 into the air and air-to-water pumps 2200 kg/year[5]. In comparison, in order to generate the same 20,000 kWh per year, wood pellet boilers will emit on average 1400 kg/year of CO2, natural gas boilers 4540 kg/year, and electric boilers 11800 kg/year[6].

Although these figures at first suggest that wood pellet boilers are the most environmentally friendly heating option, this is offset by the reality that timber used to make the pellets is often dubiously sourced. According to the Yale School of Forestry & Environmental Studies, tens of thousands of acres of wetland forest are at high risk of being cut down to produce wood pellets[7]. In this regard heat pumps are more sustainable, drawing from the fully renewable resource of heat stored naturally within the air and ground, as opposed to finite (in the case of natural gas) or slow-replenishing (in the case of wood pellets) resources.

GEOTHERMAL HEAT PUMPS

The more efficient, albeit costlier, option of the two main types of heat pumps, geothermal heat pumps are quieter and require less maintenance than their air-to-water counterparts. Notably, significant excavation is required in order to lay the necessary closed-loop pipework, posing a potential difficulty in the case of retrofits and renovations. Cost-conscious architects, engineers, and builders may also be concerned by the high up-front costs of geothermal heat pump systems, which are markedly higher than those of more widely used heating options. This may not be the case for much longer, however, as technical advances make the technology easier to produce and thus more readily available.

In spite of this, the initial cost and labour requirements of geothermal heat pump systems are often offset in the long run by their efficiency and reliability. Unlike air-to-water heat pumps, geothermal pumps draw heat from the relatively constant heat source of the ground, and are not dependent on outdoor weather conditions. This lack of reliance on the temperature of outside air allows geothermal heat pumps to perform consistently regardless of sudden changes in weather conditions, making them ideal for installation in environments where the temperature is extreme or unpredictable.

Geothermal heat pumps also feature a streamlined design where a reduced number of moving parts offers benefits in terms of quieter operation when compared with air-to-water heat pumps and other heating technologies. Geothermal heat pumps require low levels of maintenance and have a long projected lifespan: it is estimated that they offer an average return on investment time of 5 to 10 years[8], as well as an expected 25-year lifespan for internal components[9].

AIR-TO-WATER HEAT PUMPS

Where budget is a key constraint or other factors make geothermal heat pumps unfeasible, air-to-water pumps are a viable alternative that can also be run in reverse for cooling. Cheaper to install and easier to integrate into existing buildings than geothermal pumps, air-to-water pumps draw in heat energy from the surrounding air. As a consequence, they are heavily dependent on climatic conditions. Their heat output and efficiency varies according to the weather, with colder temperatures meaning that less heat can be extracted from the air and used to heat the water in circulation. Air-to-water pumps also generate a noticeable noise output, which should be taken into account when considering their usage.

As with all heating systems, a number of factors are central to the specification process when air-to-water pumps are being considered. Design of the heating/cooling system is crucial to ensuring that the heat pump operates correctly and with maximum efficiency. Firstly, in order to combat low flow- the most common problem arising from design flaws- attention should be paid to each heat pump’s minimum floor area requirement. Like gas boilers, air-to-water heat pumps must cover a minimum floor area in order to function consistently and efficiently: designers should be mindful of not designing separate heating zones which are too small for pumps to operate in. Similar to gas and wood boiler systems experiencing limitations in terms of floor areas to be heated, heat pump systems can incorporate a buffer tank to overcome these. Heat pumps are supplied with their own controllers, but can also be integrated with local thermostats within a building to manage the temperature of an entire floor.

Secondly, the placement of the heat pump itself is crucial. Location of the heat pump within an enclosed space without an air flow- for example, within a plant room- means that the warm air that is drawn in by the mechanism cannot be replaced. As a result, the air around the pump grows gradually colder until the heat pump can no longer operate efficiently. The air may become so cold that issues such as condensation and icing begin to appear and affect any other equipment in proximity to the heat pump. Ideally, air-to-water pumps should be installed outdoors.

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COMFORT HEAT

Catering for everything from large industrial projects to smaller home renovations, Comfort Heat is a leading Australian importer and supplier of world-leading underfloor heating solutions. The Australian-owned company provides a range of services throughout the design process, including technical advice and support at the specification stage, installation services, and after-sales support and product services. Their suite of hydronic and electric underfloor heating systems includes Intaflo's Intabloc inverter heat pumps, a product family of quiet, small, and economical air-to-water heat pumps.

Offering a 30% increase in efficiency when compared with other heat pumps, Intabloc heat pumps have a COP of 4, meaning that they are able to produce 4kW of heat for every 1kW of electricity that they consume. This makes them approximately four times more efficient than condensing gas boilers, which yield roughly 1kW of heat for every 1kW of gas consumed.

Intabloc heat pumps also outperform conventional heating systems in terms of their low environmental impact: in addition to utilising a completely renewable resource- air- they produce low levels of CO2 per year of operation. The outstanding environmental performance of the heat pumps can be further enhanced through pairing with photovoltaic panels with a solar battery bank system, which allows electricity to be stored for later use by the heat pump for heating.

Recognising that all installation environments are different and space and noise can be critical issues, Intaflo heat pumps feature a compact, monobloc design that means that they require minimal outdoor space for installation while a night time setting allows for quieter operation. All units are supplied with an inbuilt water pump, LCD controller, and inbuilt anti-frosting function.

REFERENCES

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