C-HELIX

WATER-BASED AIR CONDITIONER

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Objective:-

Current air conditioner in a central heating and cooling system provides cool air through ductwork inside your home, by providing a process that draws out the warm air inside, removing its heat.
Air conditioning operates based on the principles of phase conversion, which is the transformation of a material from one state (or phase) of matter to another, such as when a material changes from a liquid to a gas. When a liquid to gas change occurs, the material absorbs heat.
The systems require a large amount of energy to remove moisture and to cool the dehumidified air.
A new water-based air-conditioning system cools air to as low as 18 degrees Celsius (about 64 degrees Fahrenheit) without using energy-intensive compressors and environmentally harmful chemical refrigerants. This technology could potentially replace the century-old air-cooling principle that is still used in modern-day air-conditioners. Suitable for both indoor and outdoor use, the new system is portable and can be customized for all types of weather conditions.

Learning outcomes:-

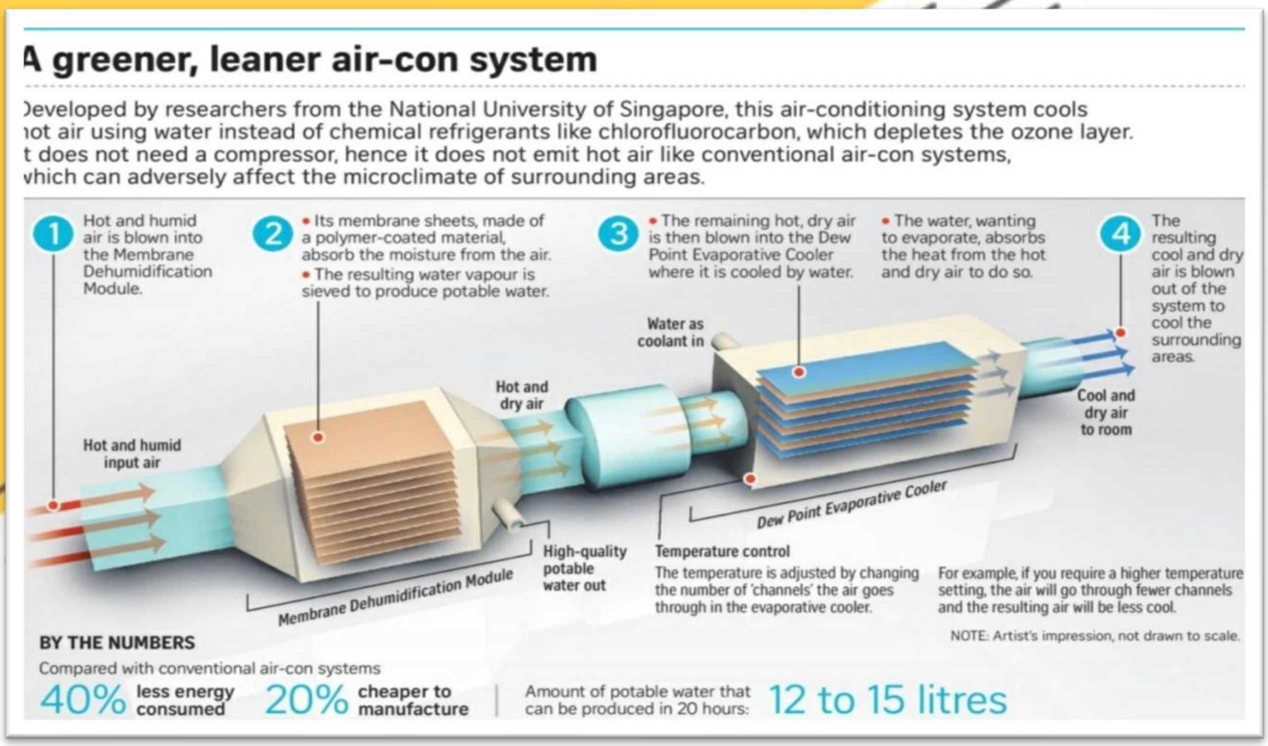
- This project help us to produce water by dehumidifier process.
- This project uses water as coolant and don't use any chemicals which protect environment.
- This project consume less power which teaches us to consume less energy.

Present Technology:-

- The air conditioner in a central heating and cooling system provides cool air through ductwork inside your home, by providing a process that draws out the warm air inside, removing its heat.
- **Air conditioning operates** based on the **principles** of phase conversion, which is the transformation of a material from one state (or phase) of matter to another, such as when a material changes from a liquid to a gas. When a liquid to gas change occurs, the material absorbs heat.

Working:-

- By developing two systems to perform these two processes separately, the researchers can better control each process and achieve greater energy efficiency.
- To remove moisture from humid outdoor air, the air-conditioning system first uses an **innovative membrane technology**—a paper-like material.
- It separates the moisture from the humid air by using a selective membrane, through which only vapor molecules can transfer from one of the membrane at a high concentration to the other side at a low concentration.
- **A dew-point evaporative cooling system** that uses water as the cooling medium instead of harmful chemical refrigerants then cools the dehumidified air.



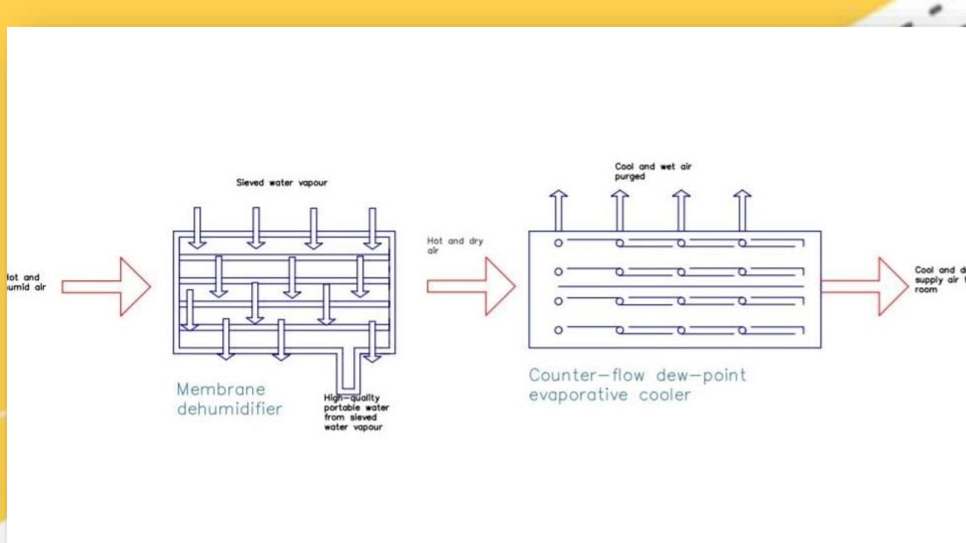
It can cool outdoor air to temperature below its wet bulb temperature.

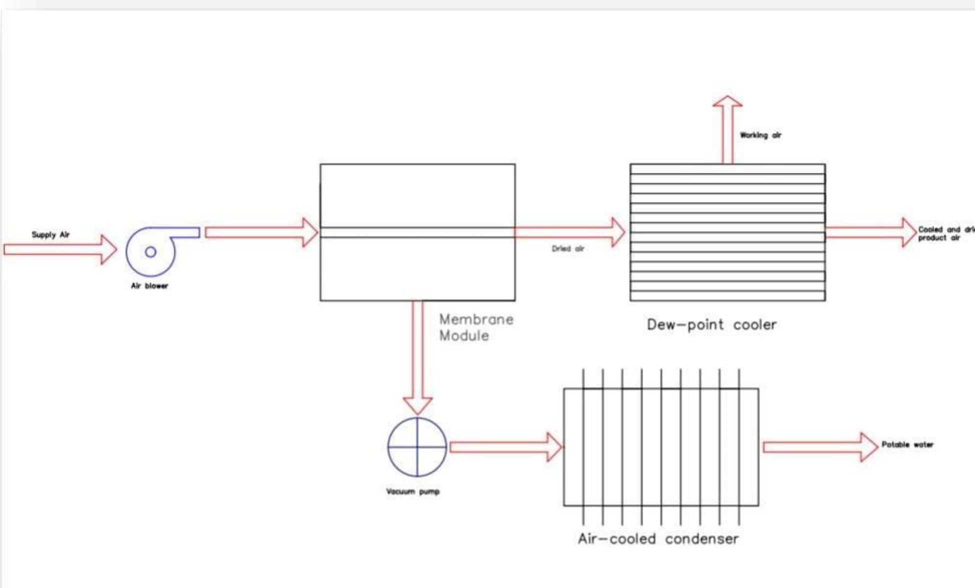
Unlike vapor compression air- conditioners, the novel system does not release hot air to the environment. Instead, a cool stream that is comparatively less humid than environmental humidity discharged- negating the effect of micro climate. About 12 to 15 liters of potable drinking water can also be harvested after operating the air-conditioner system for a day.

Membrane-Based Dehumidification

- Membrane-based dehumidification is based on moisture transfer driven by mass transfer potential difference between membrane’s two sides called feed side and permeate side, respectively.
- As we know the absolute separation of water and air is impossible, since air can also get through membrane pores to some extent, although the proportion is very small versus vapour.

- Membrane materials applied to dehumidification includes organics (polymers mainly, more commonly used) and inorganics such as silicate. Since nitrogen accounts for the main component of air, H_2O/N_2 separation properties determine air dehumidification performance to a great extent.
- Permeability and selectivity are incompatible with each other for most membranes of simple structure and property. Therefore, membrane module is usually fabricated with composite membranes, or taken modification technology. Sometimes the two technologies are utilized together.

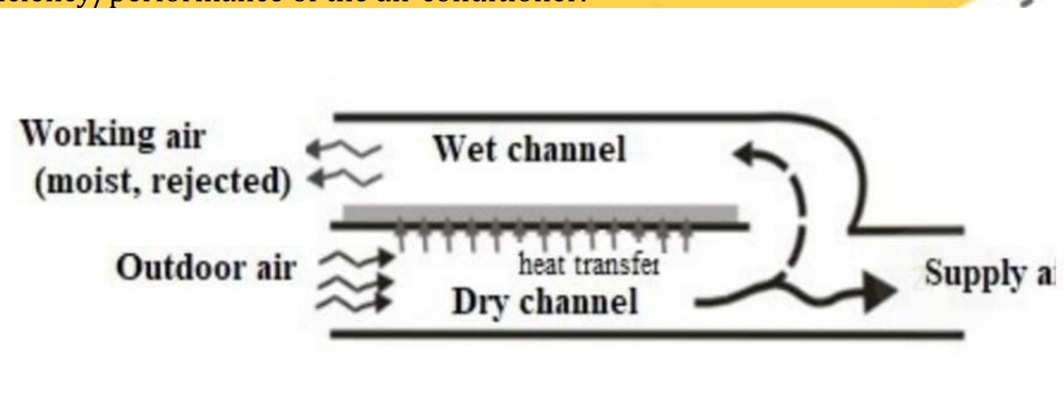


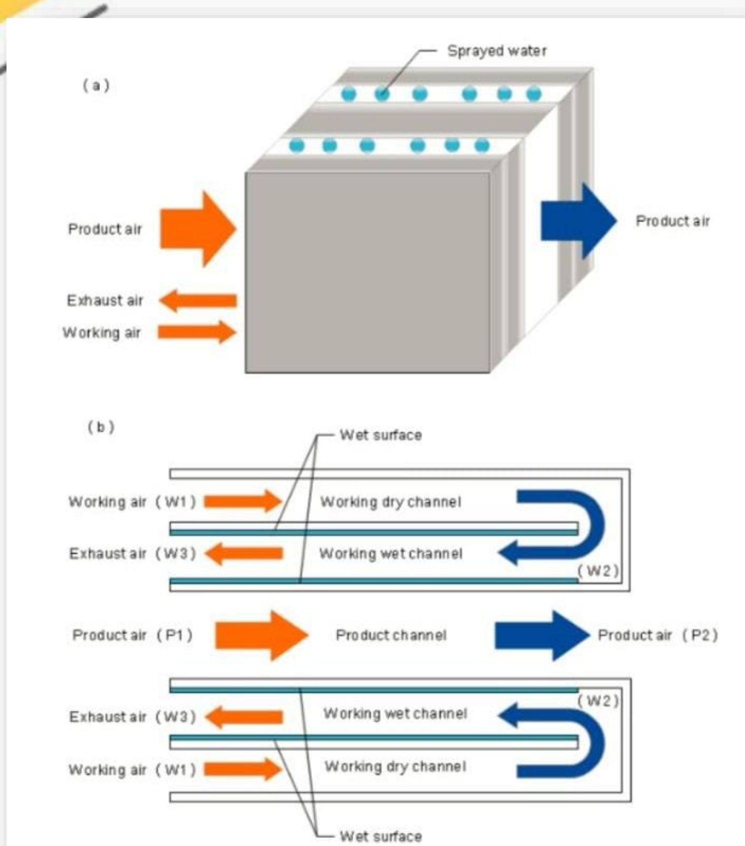


<u>Flow diagrams for the Water based Air-Conditioning System</u>

media whereas it is made impermeable to moisture in its back surface in contact with dry channel. Intake outdoor air enters the dry channel and loses heat to the wet channel . At the end of the channel, it splits into two parts: supply dry air which is delivered to the conditioned space and the remaining part called working air is diverted into the wet channel, it absorbs heat from the dry channel as well as moisture evaporating from the wet wall. The ratio of airflow in the wet channel to that of the dry is called working air ratio and it generally varies between 0.3 and 0.7.

It's life span is expected to be 7-8 years. This can vary With water quality and local conditions. With any Evaporative cooler, failure to replace filterpads when they are past their useful life may result in reduced efficiency/performance of the air conditioner.





Schematic of the novel dew-point evaporative cooler

(a) One-unit channel pair (b) Plan view

Social Benefits:-

- This translates into more than 40 percent reduction in carbon emissions.
- The device is fully portable and can be customized to work in all weather conditions.
- In addition, it adopts a water-based cooling technology instead of using chemical refrigerants such as chlorofluorocarbon and hydrochlorofluorocarbon for cooling, thus making it safer and more environmentally-friendly.

Merits:-

- Minimum possible volume of refrigerant.
- Reduction of potential leaks.
- Water is flexible.
- Made-to-measure efficiency.

Demerits:-

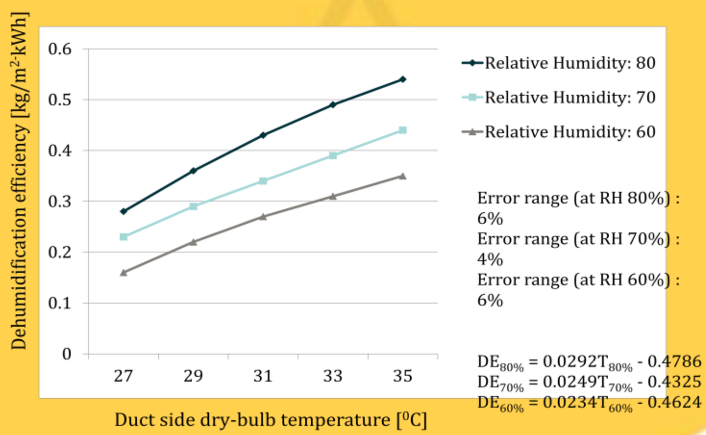
- It doesn't incorporate smart features such as pre programmed thermal settings based on human occupancy and real time tracking of its energy efficiency.

Advantages

- The system consumes about 40% less electricity than current compressor-based air-conditioner used in homes and commercial buildings.
- It is suitable for both indoor and outdoor use.
- This novel system generates potable drinking water while it cools ambient air.

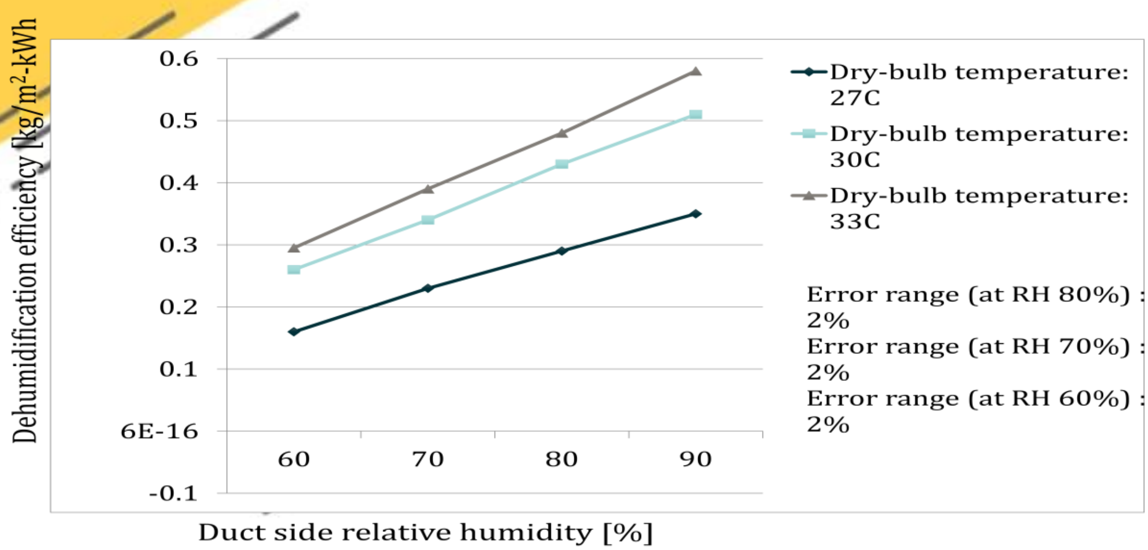
How it is different from the traditional cooling systems?

- The system is much more energy efficient than the traditional units, uses plain water instead of chemicals refrigerants, and produces drinking water to boot.
- Our current systems employ chemical refrigerants such as chlorofluorocarbons and hydrochlorofluorocarbons for cooling, which are quite nasty for the environment. More directly important is that these compounds are quite expensive to manufacture and very deadly if leaks occur indoors.



Variation of dehumidification efficiency according to the dry bulb temperature at the duct side

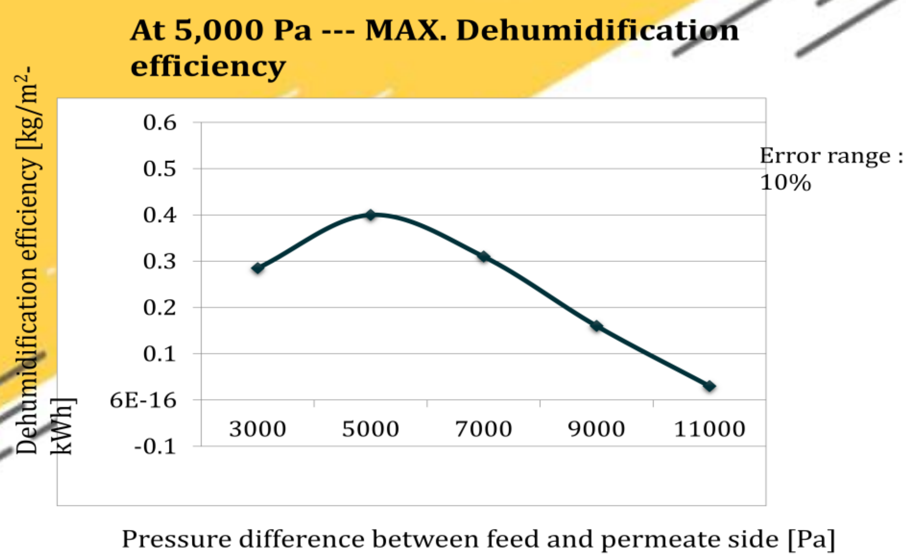
For the comparison analysis of the MDS performance, the correlation of dehumidification efficiency obtained using the TRNSYS (Type 688) dehumidifier model. This comparison results in terms of the dehumidification efficiency (performance) per unit area of the membrane, obtained by changing the dry bulb temperature at the duct side. The membrane performance improved with the increase in the dry bulb temperature.



Variation of the dehumidification efficiency according to the relative humidity at the duct side

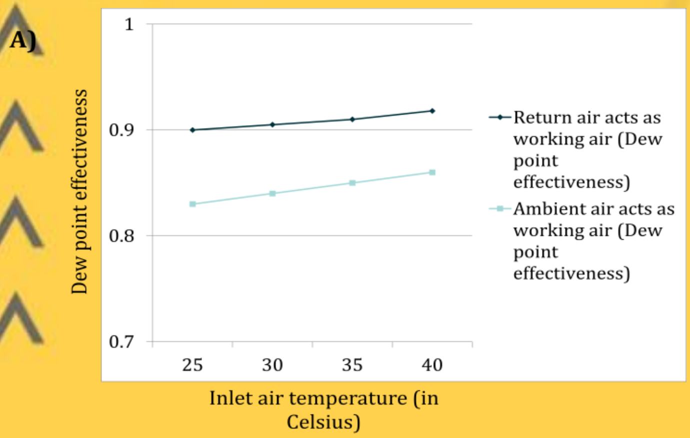
$$DE_{33C} = 0.0102RH_{33C} - 0.3246$$
$$DE_{30C} = 0.0102RH_{30C} - 0.2690$$
$$DE_{27C} = 0.0102RH_{27C} - 0.2478$$

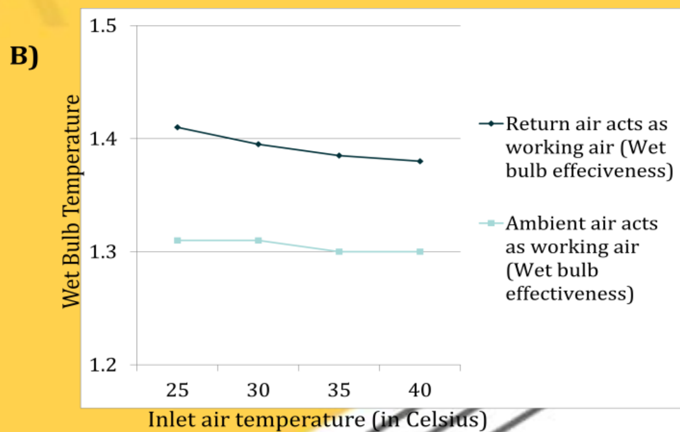
This graph shows the variation in the dehumidification efficiency per unit area of the membrane, obtained by changing the relative humidity at the duct side. The results showed that the dehumidification efficiency increased linearly with the increase in the relative humidity. The dehumidification efficiency of the membrane was related to the variation in the dry bulb temperature and relative humidity at the primary side(duct side). It can be seen that the increase in the dehumidification efficiency as the dry bulb temperature increased resulted in a change in the diffusion coefficient that increases the activation energy and the increase of the dehumidification efficiency due to the increase in the relative humidity caused by the increase of the water flux rate in the membrane.



Variation of dehumidification efficiency according to the pressure difference between feed and permeate side

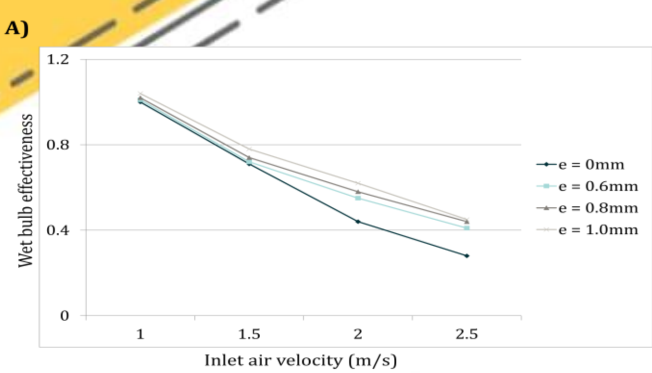
The variation in dehumidification efficiency was observed by changing the pressure difference between the feed side and the permeate side. As shown in the above graph, the dehumidification efficiency was maximized at a pressure difference of around 5000 Pa. This was because, when the pressure difference increased, the dehumidification rate also increased but the power consumption showed a further rise. Accordingly, the simulation applied the pressure difference of 5000 Pa and also assumed that the corresponding power consumption was constant.

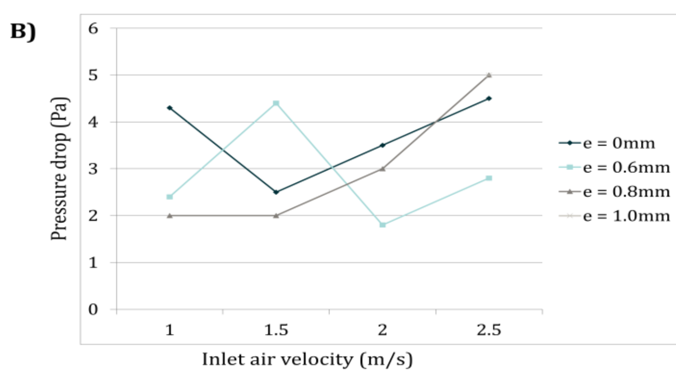




Comparison of the effectiveness of the cooler running in two modes

The above graphs compares the performance of the cooler operating in two modes. In mode 1, the working air, which has the same condition of the product air, is the ambient air. In mode 2, the working air in the room return air. It can be inferred from the figure that the cooling effectiveness can be effectively increased by using the room return air as the working air





Simulated results on the performance of the cooler with ribs in the channel under different inlet velocities. (a) Wet bulb effectiveness (b) Pressure drop

This graph presents the performance of the cooler under different inlet velocities. The cooling effectiveness of the cooler with the installed ribs is effectively increased compared with the plain channel. When the inlet velocity is more than 1.5 m/s, the wet bulb effectiveness would increase by 10-20% for the cooler with ribs. The ribs enable local turbulence to be created near the wall and break the laminar boundary layer, which reduce the thermal resistance and significantly enhance the convective heat transfer. However, the use of ribs results in higher friction and high pressure drop through the channel. As shown B), the pressure drop increases with increasing rib height and increasing air velocity. The larger pressure drop translates to higher pumping power requirements. In practice, Therefore, it is necessary to achieve balance between the increased power consumption and the cooling effectiveness.

- A compact hybrid dew point evaporative cooling system was demonstrated with a sensible energy efficiency ratio (EER) in excess of 40, corresponding to a Coefficient of Performance (COP) of 12.0 . For reference, minimum Seasonal Energy Efficiency Ratio (SEER) for an air conditioning system is 13, with Energy Star systems rated at exceeding (SEER) of 14. These SEERs correspond to COPs 3.4 and 3.7 .