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# A Compact Membrane-based Absorption Heat Pump

Energy & Environment

Manufacturing

Energy Conservation/Generation/Management/Storage (Battery)

Waste Treatment/Management

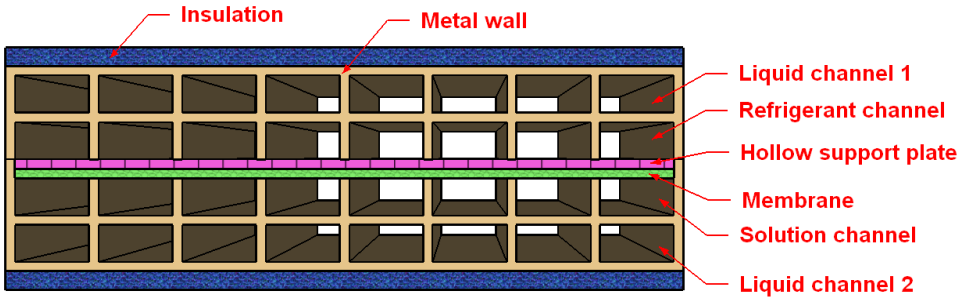


Fig. 1. Structure of the membrane-based solution/refrigerant module

**IP Status**
Patent filed

Technology Readiness Level (TRL) 4

**Inventor(s)**
Prof. WU Wei
Mr. DING Zhixiong
Mr. SUI Zengguang
Mr. SUI Yunren
Mr. ZHAI Chong
**Enquiry: kto@cityu.edu.hk**

## Opportunity

HVAC equipment generates greenhouse gases (GHGs) by consuming energy and leaking hydrofluorocarbon (HFC) working fluids. The future sustainability of HVAC units depends on reducing both energy consumption and HFC pollution. Absorption heat pumps are a promising solution, as they can significantly reduce both sources of GHGs in HVAC units. Unfortunately, the large size of current absorption heat pumps has reduced their widespread adoption. This invention is a compact absorption heat pump that employs a membrane-based generator/condenser unit and a membrane-based absorber/evaporator unit. These units utilize membranes with a large specific surface area while integrating solution/refrigerant flows, thereby allowing the heat pump to be both highly compact and exhibit highly efficient heat exchange. The compactness of the unit can facilitate widespread adoption, while the energy efficiency can make a major contribution to sustainability.

## Technology

This invention is a novel membrane-based, combined solution/refrigeration unit. The module consists of four channels: a solution channel, a refrigerant channel, and two liquid channels. The membrane is semi-permeable, allowing small-size molecules (in this case, vapor refrigerant) to pass through while restricting large-size molecules (e.g., absorbent molecules). Since the membrane has a large specific surface area, the unit is able to produce high performance within a small volume. In addition, the invention can be used as a combined generator/condenser, thereby eliminating the necessity for connection tubes between different processors. This in turn can reduce pressure drops and increase the overall compactness. Furthermore, the invention conducts the desorption process prior to the solution being heated

to the boiling point, and this allows for lower driving temperature. As the invention can provide cooling via an evaporation effect and heating via an absorption effect, the unit can be used for both cooling and heating.

## Advantages

- The invention utilizes a membrane with a large specific surface area and also integrates solution/refrigerant flows, allowing for high compactness and efficient heat exchange.
- The invention's absorption/desorption rates improve the energy efficiency of the absorption heat pump system.
- The direct diffusion of water molecules through the membrane enables the desorption process to occur before the solution is heated to the boiling point, thereby reducing the required heat source temperature.
- In comparison with existing electric heat pump technologies, the invention consumes nearly zero commercial energy.
- In comparison with existing thermal heat pump technologies, the invention features higher compactness with higher efficiency and lower driving temperatures.

## Applications

- Space cooling in residential, commercial, and industrial sectors
- Space heating in residential, commercial, and industrial sectors
- Water heating in residential, commercial, and industrial sectors