Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes the PhD subject and supervisor proposed by the French Polytech network of 15 university engineering schools. Please contact the PhD supervisor by email or Skype for further information regarding your application.

Supervisor information	
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Polytech name	Polytech Annecy Chambéry
University name	Université Savoie Mont Blanc
Country	France

PhD information	
Title	Performance evaluation of compact evaporators in confined geometries : application to absorption solar chillers

Main topics regards to CSC list (3 topics at maximum)	V.4 New high performance energy saving technology
Required skills in science and engineering	good knowledge in fluid mechanics, chemical engineering, energetics, numerical analysis

Subject description (two pages maximum)

There is an alarming increase in the global energy demand and substantial dependence on fossil fuels that generate global warming. Currently, the cooling demand in buildings is essentially met by traditional heat pump systems that involve high electricity use. Moreover, the refrigerant fluids generally used for air conditioning contribute substantially to global warming. To meet these climatic challenges and fulfil the commitments made during the latest climate conferences, it is now urgent to develop innovative low-energy cooling systems. Absorption chillers will be of great interest over the coming years because they can run on renewable heat such as solar energy and waste heat, which could significantly contribute to the reduction of fossil fuel consumption and harmful emissions to the environment. Simple absorption refrigeration systems are composed of an evaporator, a condenser, an absorber, a generator, a solution pump, and two valves that operate at two pressure levels (Altamirano et al., 2019). The solution at the generator absorbs heat and desorbs absorbate vapor at high pressures. This vapor goes through the condenser before passing through an expansion valve, after which it is evaporated at low pressures and low temperatures. The cooling effect occurs at the evaporator, which produces vapor that is absorbed by the highly concentrated solution in the absorber. The resulting solution (rich in refrigerant) is sent to the generator by means of a pump, and the cycle starts again. Low compactness and elevated costs are two of the most important downsides of absorption chillers compared to conventional compression cooling systems. The particularity of these systems is that they possess multifunctional exchangers (with coupled heat and mass transfers) where a sorption phenomenon (in the desorber or the absorber) or a phase change (in the condenser or the evaporator) take place. These heat and mass transfer exchangers have been pointed out as the limiting components (or bottlenecks) in the system's performance. Up to now, the design of these components was based on rules of thumb, which led to heavy, expensive, and bulky equipment. However, more research is needed to better understand the fundamental issues governing these components and the enhancement methods needed to obtain more efficient designs.
Historically, tubular exchangers are the most commonly used exchangers in commercial machines. Nevertheless, research groups have constantly been looking for new technologies which could provide more compact and low-cost systems, for example, plate heat exchangers (PHEs).
This project aims to focus on the study of heat and mass transfers in this type of exchangers, where confined evaporation can happen between the plates. Emphasis will be put on two aspects: the hydrodynamics of the refrigerant film and the thermodynamic behavior of this film, in the specific case

of confined evaporation. The coupling of these two approaches will lead to better understanding of the thermophysical behavior of the film. This understanding aims to quantify the evaporative coefficients and the evaporator performance, as a function of the functioning parameters (geometry of the exchanger, pressure, temperature of the fluid and the plates, temperature of the plates, characteristics of the working fluid…).

Refs:

Altamirano A., Le Pierrès N., Stutz B, Review of small-capacity single-stage continuous absorption systems operating on binary working fluids for cooling: Theoretical, experimental and commercial cycles, International Journal of Refrigeration, 106, p. 350-373, 2019.
https://doi.org/10.1016/j.ijrefrig.2019.06.033