



## REVIEW PAPER OF EXPERIMENTAL STUDY OF MINI CHANNEL HEAT EXCHANGER WETTED WITH LIQUID DESICCANT FOR A.C. SYSTEM

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**Abstract:** *Micro-channel and Mini channel heat exchangers are being used in air conditioning applications due to its favorable characteristics like higher heat and mass transfer, compact system and lower cost etc. In this review paper, characteristics of air conditioning system with mini channel and micro channel heat exchangers are analyzed. Mini-channel and micro-channel heat exchangers have higher surface contact area to volume ratio. Mini channel and micro-channel heat exchangers are lighter in weight because they are made of aluminum only. Also the cost of mini channel heat exchanger is less because of aluminum structure. Mini channel uses less power and refrigerant charge so it is also good for environment. Effectiveness of mini channel heat exchanger is increased by using fin at internal and external both the side. Mini-channel heat exchanger and micro-channel heat exchanger can be used in refrigeration and air conditioning system. In air conditioning system at both mini channel and micro-channel heat exchanger can be applied as both the condenser and evaporator. In Mini-channel and micro-channel heat exchanger the sensible and latent both cooling capacity increases and overall efficiency of air conditioning system increases.*

**Keywords:** *Mini channel Heat Exchanger, Micro channel Heat Exchanger, Liquid desiccant, Air-conditioning, Heat transfer, Compact System*

### I. "INTRODUCTION"

Development of compact heat exchangers with high effectiveness is one method for improving the efficiency of vapor compression refrigeration systems and reducing their environmental impact by lowering the power consumption to provide specific cooling effect. According to Kandlikar's heat transfer tube classification, the hydraulic diameter ( $D_h$ ) range of mini channel tube is between 0.2 mm and 3 mm (Kandlikar & Grande). Mini-channel heat exchangers with  $D_h$  less than 3 mm are widely used in modern air conditioning, heat pumps, and refrigeration systems for a variety of residential, industrial and process industry applications. One of the principal ideas behind using mini and micro (micro channels with  $D_h$  less than 0.2mm) scales heat exchangers is their potential for enhanced heat transfer coefficients. Mini-channel tube technology is currently used in R134a automobile air conditioning systems. The control of indoor temperature and humidity ratio is the main task of air-conditioning systems.[11] Usually, outdoor air will be cooled and dehumidified in summer and heated and humidified in winter before being supplied into occupied spaces. In conventional HVAC systems, the process of dehumidifying air is implemented by condensing dehumidification method, in which the air contacts cold coil surface (lower than the dew point of the air) so that moisture in the air will condense into water. Sometimes, the air passing the cooling coil is so cold that it has to be reheated before being supplied into occupied spaces. Furthermore; the condensed surface creates a suitable environment for bacteria, which will impair the indoor air quality. In winter, other electrical humidifier or steam humidifier has to be adopted to meet the humidification requirement. Liquid desiccant air conditioning systems have developed quickly in recent years. The air is dehumidified by contacting concentrated liquid desiccant directly and vice versa. It is humidified by contacting

warm and diluted liquid desiccant. Compared with conventional HVAC systems, the advantages of liquid desiccant systems can be summarized as 1) The air can be dehumidified at a temperature higher than its dew point temperature by contacting concentrated liquid desiccant: therefore, reheat is no longer needed; 2) liquid desiccant system can be driven by low grade heat, such as solar energy or waste heat; 3) A number of pollutants will be removed by the system from the processed air; and 4) The air can be easily humidified in the same handling unit by contacting diluted liquid desiccant.[12]

The energy consumption of liquid desiccant air-conditioning systems mainly relies on the regeneration process of the desiccant solution. In general, the liquid desiccant air-conditioning system is driven by thermal energy, which can be obtained from low-temperature heat sources. As a kind of renewable energy, solar energy can be used to regenerate the desiccant solution for the liquid desiccant air-conditioning system.

## **II. “OBJECTIVE”**

- Extensive study of mini channel heat exchanger.
- Literature survey on performance parameter comparison between air conditioning with mini channel heat exchanger and with conventional type heat exchanger.
- CFD analysis on liquid desiccant air conditioning with mini channel heat exchanger.
- To check the dehumidification and cooling effectiveness of the system.
- Enhancement of latent as well as total cooling in a conventional chilled water coil.

## **III. “LITERATURE REVIEW”**

- Thanhtrung Dang, Jyh-Tong Teng said that the heat transfer rate obtained from mini channel heat exchanger was higher than those obtained from the mini channel heat exchanger. Pressure drop obtained from the micro channel were also higher than obtained from the mini channel heat exchanger. Heat exchanger rate in these mini channel are higher than those in conventional channel as a result for given heat transfer capacity mini channel heat exchanger are more compact and lighter in weight.[3]
- Nicholas concluded that roughness had no effect on laminar flow. Large inaccuracies in measurements such as pressure drop and surface geometry were reasons behind erroneous. Transition to turbulence as the relative roughness increased that the use of the constricted hydraulic diameter would cause the data to collapse on to the conventional theory line for laminar flow.[4]
- X.L.Xie, Z.J.Liu, Y.L.He, W.Q.Tao said that Pressure drop, an important parameter for mini channel heat sink design is a strong function of the channel geometry. From heat transfer, a narrow and deep channel is better than that of a wide and shallow channel, in spite of the high pressure drop penalty. Both channel wall thickness and bottom plate thickness have an optimum value at which thermal resistance reaches its minimum according to the limited bottom surface area.[5]
- Paisarn Naphon, Osod Khonseur said that the heat transfer characteristics and pressure drop in the micro channel heat sinks with various geometrical configurations are investigated experimentally. It is found that the shape & size of roughness irregularities of the micro channel surface have significant effect on enhancement of heat transfer performance and pressure drop variations.[2]
- S. G. Kandlikar said that The Micro channel exchangers are expected to provide high heat flux rates in many applications. The coupling of the heat transfer within micro channels with the substrate conduction and its connection with the heat source, either electric, nuclear, laser or another fluid stream needs to be developed for facilitating the efficient designs. The length scales being dramatically smaller, the conventional thinking derived from large sized heat exchangers will no doubt undergo a paradigm change.[1]
- Andrew Lowenstein said that in LDAC system,
  - Peak electrical demand created by compressor based air conditioners.
  - Poor indoor air quality and high indoor humidity that can be difficult to correct with conventional A.C.
  - Carbon emissions from the power plants that supports electric A.C.

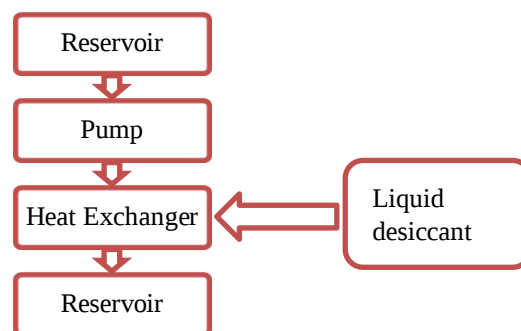
- Most promising early markets for an LDAC will be those where its exceptional cooling of latent and low electrical demand give it competitive advantage.

- Solar energy can be effectively applied to A.C. by using relatively low cost solar thermal collectors to supply hot water to run an LDAC.[8]

- Seiichi Yamaguchi, jongsoo jeong, kiyoshi saito, Hikoo Miyanchi, Masatoshi Harada said that in performance evaluation test of a hybrid liquid desiccant air conditioning system, the process air was dehumidified from 14 to 8.1 g/kg (DA) and was cooled from 30 to 22.2 C. Furthermore,  $COP_{sys}$  and  $COP_{hp}$  were 2.7 and 3.8 respectively. The calculation results show that both  $COP_{sys}$  and  $COP_{hp}$  can become significantly higher by improving the compressor isentropic efficiency and the temperature efficiency of solution heat exchanger.[10]
- Sanjeev Jain, P.L.Dhar, S.C.Kaushik said that Liquid desiccant system essentially consists of an absorber for dehumidifying the air, a regenerator for regenerating the solution, a series of heat exchangers and evaporative coolers for sensible cooling and heating of air and solution. Packed towers have a high pressure drop and initial cost but provide high contact area per unit volume between air and desiccant for mass transfer to take place. Spray chambers are not very effective but have low initial cost and pressure drop.[9]

#### IV. "METHODOLOGY"

Methodology of this system can be different in different experiments but standard methodology which can be used in air conditioning which is run by liquid desiccant is given.



- A. First of all, water from the reservoir comes to the inlet of the pump.
- B. Pressurized water from the outlet of the pump will go to the inlet of heat exchanger.
- C. From the outlet of heat exchanger it will go to another reservoir.
- D. When water comes into the heat exchanger, liquid desiccant ( $CaCl_2$ ) will be sprayed onto heat exchanger. It will lead to make the system dehumidified and make it cooler.

#### V. "RESULTS"

The results taken from the air dehumidification in novel liquid desiccant-air contacting device conducted at Baroda shows that,

- Using LD helps to remove latent load more effectively, more so at higher water temperatures, when the dew point temperature of air could be very near to cooling water temperature.
- The decrease in enthalpy and moisture effectiveness is due to lower water vapour pressure exerted by LD at given inlet water temperature.
- When the moisture removal rate increases, latent heat generation increases and cooling provided by water is not very effective.
- If lower dew point of supply air is required, air velocity may be reduced, but that will lead to reduction in capacity of the system for a given coil.
- Moisture and humidity effectiveness of the system rises but LHF changes marginally when air velocity is reduced.[7]

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## **VII. “CONCLUSION”**

From the literature, it can be concluded that there is a great literature available on this philosophy, which gives a broad view of past practices and researches carried out across the globe. This system is developing philosophy in air conditioning industries and also more research work is required in this field, and we feel that, this philosophy can also be applied to air conditioning industry. Thus a great scope of research is available for new researchers in this field. So more research is required which could improve the awareness aspects, as these factors are highly important for the success of this philosophy in most of the air conditioning industries across the world.

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