Summery

This thesis presents a designing of a regeneration system for liquid desiccant dehumidification system (LDDS), development of a mathematical model to regeneration process simulation and optimization of the system with multi objective genetic algorithm. New design for the regenerator is compact, efficient and can implement with secondary level heat source. Developed model for desorption process and condensation process is efficient, simple and accurate comparing to the other conventional models. The contribution of this thesis includes:

1. Designing of a new regenerator for desorption application of the LDDS consider overcoming drawbacks of conventional solution to air regeneration cycles. The performance of the regeneration system relies on several design parameters like generator heat exchanger and condenser heat exchanger heat and mass transfer area and driving force, solution flow method through the heat exchanger, condenser tube arrangement, solution accumulation amount, vacuum rate of the pump, condensed water removal rate and liquid desiccant properties. The system was designed in vacuumed condition to reduce the required heat source temperature and also to increase the mass transfer driving force. The system is a fully closed one to overcome the carry over effect of the desiccant. Vacuumed chamber is divided into two sections namely generator heat exchanger and condenser heat exchanger. Solution circulates through the generator heat exchanger cycle and absorbs the required latent load and vaporizes. Vacuum pressure increases in generator side and water vapor travels to condenser side, releases latent heat to the cooling water and then condenses. Different tests are carried out by varying hot water temperature and flow rate, chilled water temperature and flow rate, solution flow rate, initial solution concentration and initial vacuum level of the chamber.

2. Developed mathematical model for newly designed vacuumed regeneration system of LDDS is validated within 10% error band. Heat and mass transfer study for generator heat exchanger and condenser heat exchanger is developed. Heat transfer Nusselt number and mass transfer Sherwood number is developed for the generator heat exchanger and condenser heat exchanger. Non-linear least square method is used to fit the general heat and mass transfer solution with the actual test data with less than 10% relative error. Heat transfer rate of the generator is a function of heat exchanger area, mean temperature difference between hot water and solution, hot water mass flow rate, solution mass flow rate, solution density and solution heat capacity. Condenser heat exchanger is modeled by considering external natural condensation over a tube bank and internal convection of a cylindrical tube. Heat transfer rate of the condenser is a function of chilled water flow rate, mean temperature difference and the number of rows of tubes. Nusselt number relationship with Reynolds number, Prandlt number and friction factor is used. Generator heat exchanger mass transfer Sherwood number is a function of two phases Reynolds number, Schmidt number, concentration gradient and heat flux. The vacuum amount inside the chamber has a significant effect to the final result.

3. Optimization of the developed model has been conducted using multi objective genetic algorithm (GA). Heat and mass transfer of both generator and condenser heat exchanger and total energy consumption of the system are set as objective functions and optimized according to six constraints with upper and lower bounds of restricting parameters. Global optimum condition of the system with multi objectives can be achieved efficiently using the GA efficiently.