Simulation of Solar Assisted Solid Desiccant Cooling Systems using TRNSYS

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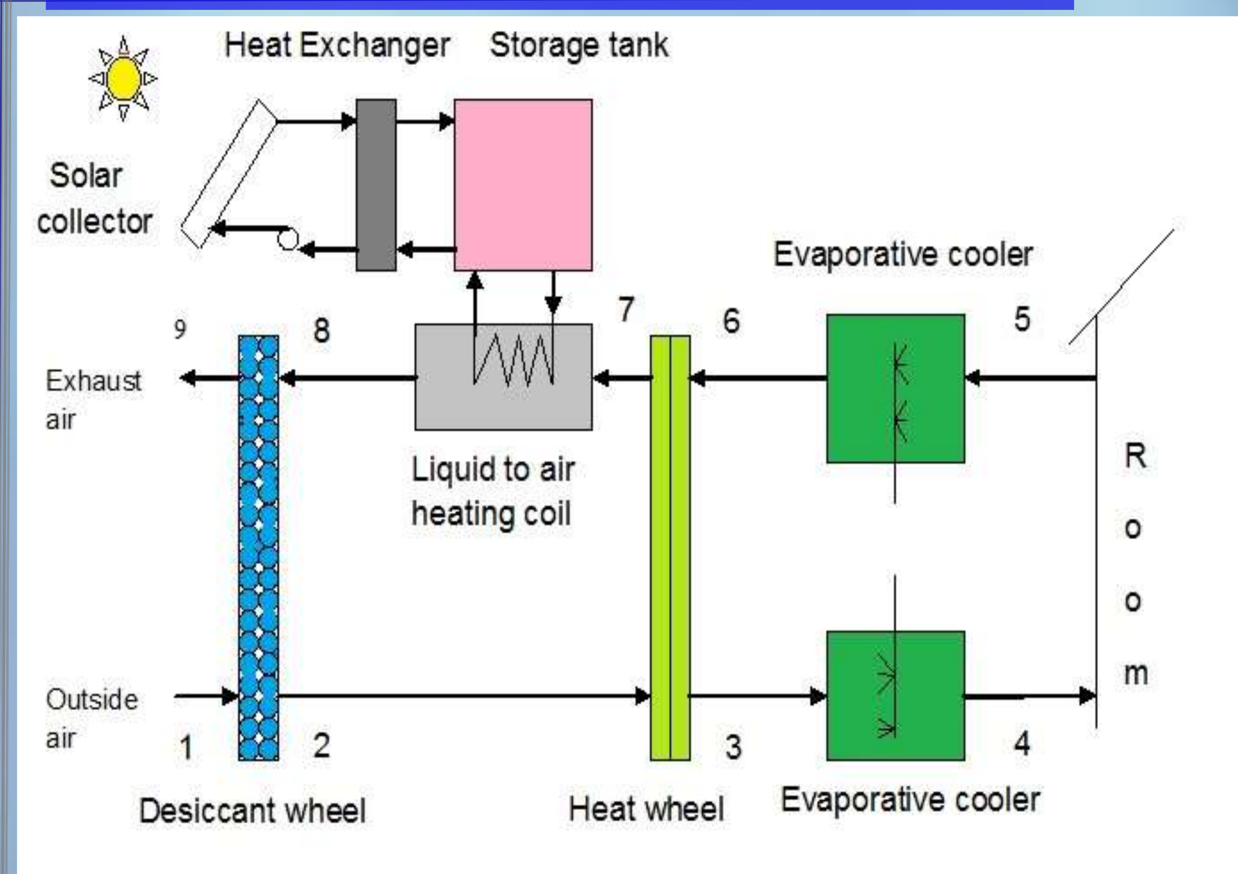
Abstract

Solar assisted solid desiccant cooling systems are simulated for ventilation and recirculation mode using TRNSYS for a lecture hall of 30 kW cooling capacity at hot and humid climate of India. Reactivation heat needed for desorption of dehumidifier is supplied by solar water heater system. The COP for ventilation and recirculation mode is obtained as 0.494 and 0.693 respectively. The simulation results show that the recirculation cycle is more efficient than the ventilation cycle for a given capacity.

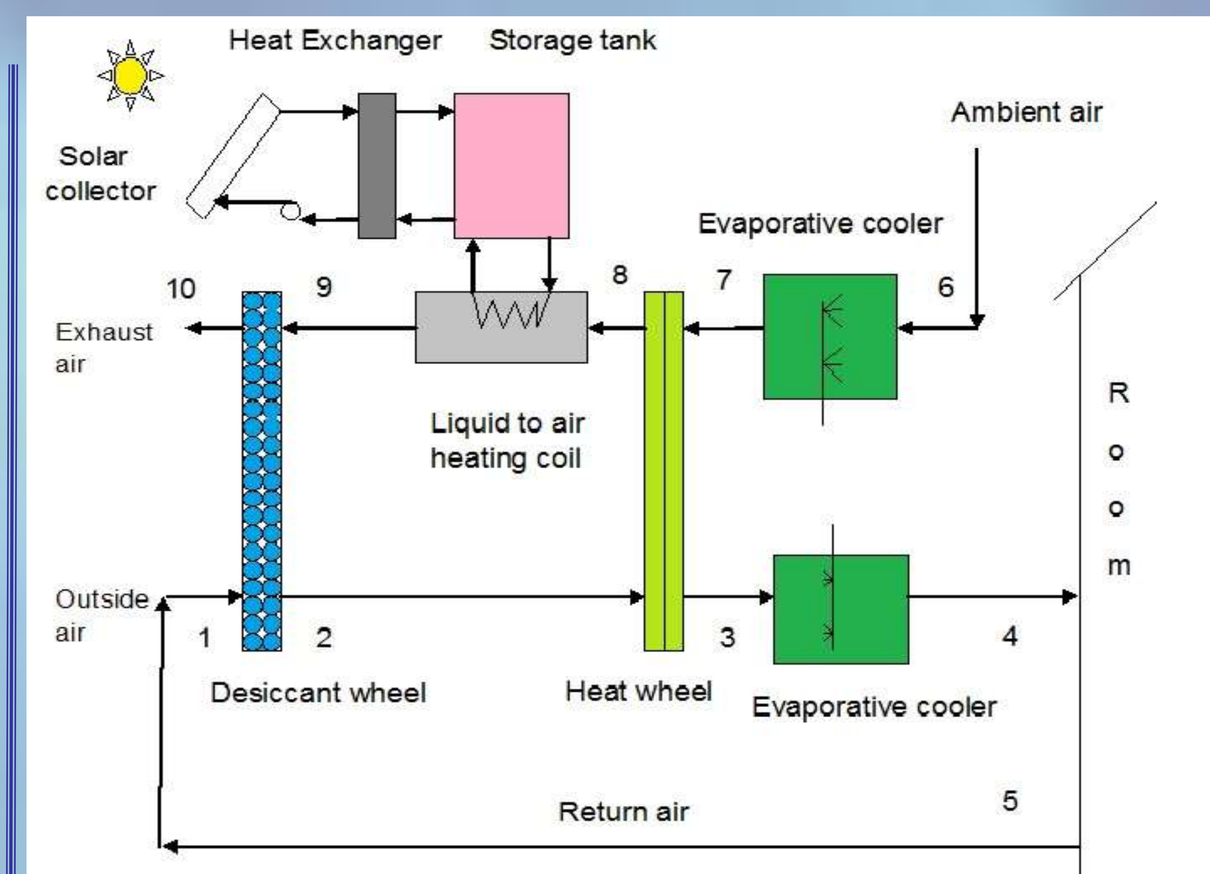
Introduction

Emphasis on solid desiccant cooling is becoming a priority in the light of continuing rise in energy demand, increasing cost and various environmental problems most notably the climate change. The use of solid desiccant cooling systems can improve the humidity control independent of temperature of supply air. Besides, the desiccant cooling systems allow higher percentage of fresh air to achieve better air quality at lower energy cost. The peak cooling demand in summer is associated with the high solar radiation giving an excellent opportunity to exploit solar assisted solid desiccant cooling technology.

Description of the system

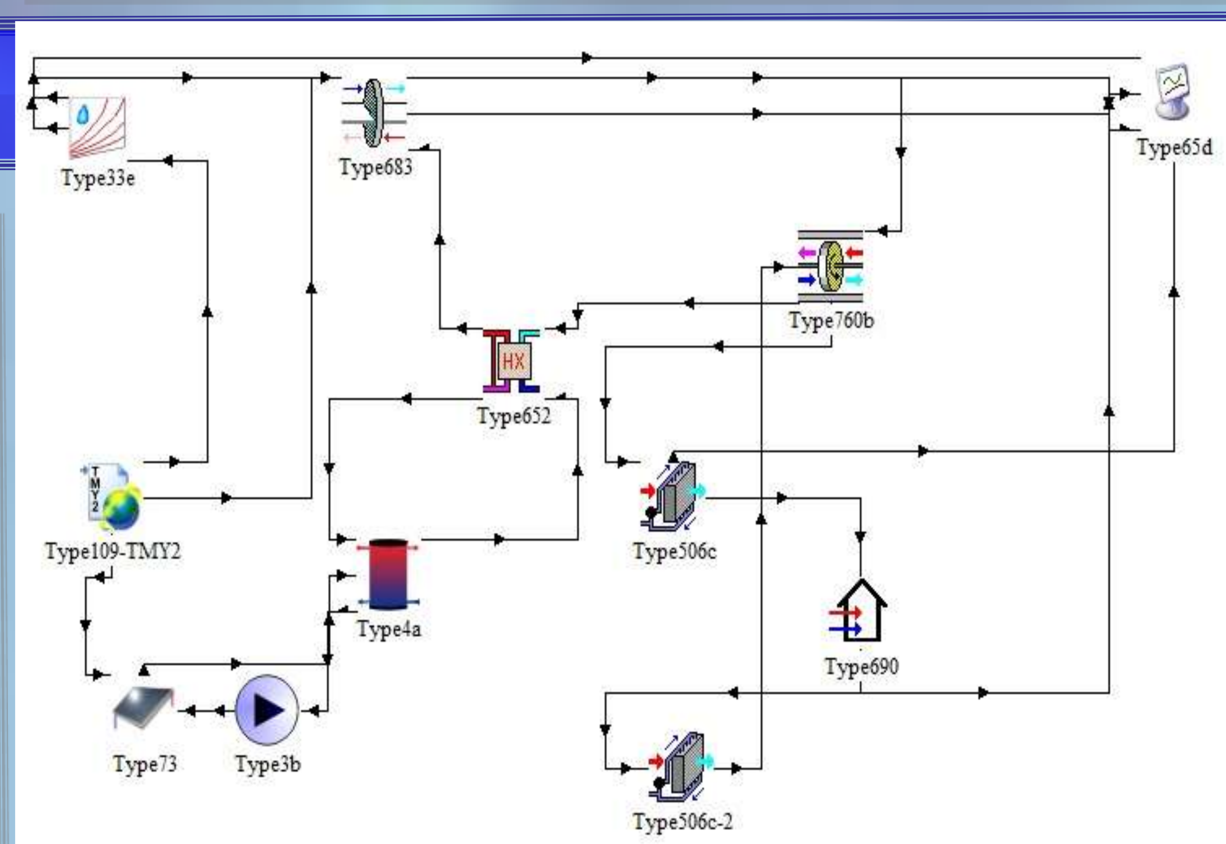


SOLAR ASSISTED SOLID DESICCANT COOLING (VENTILATION MODE)

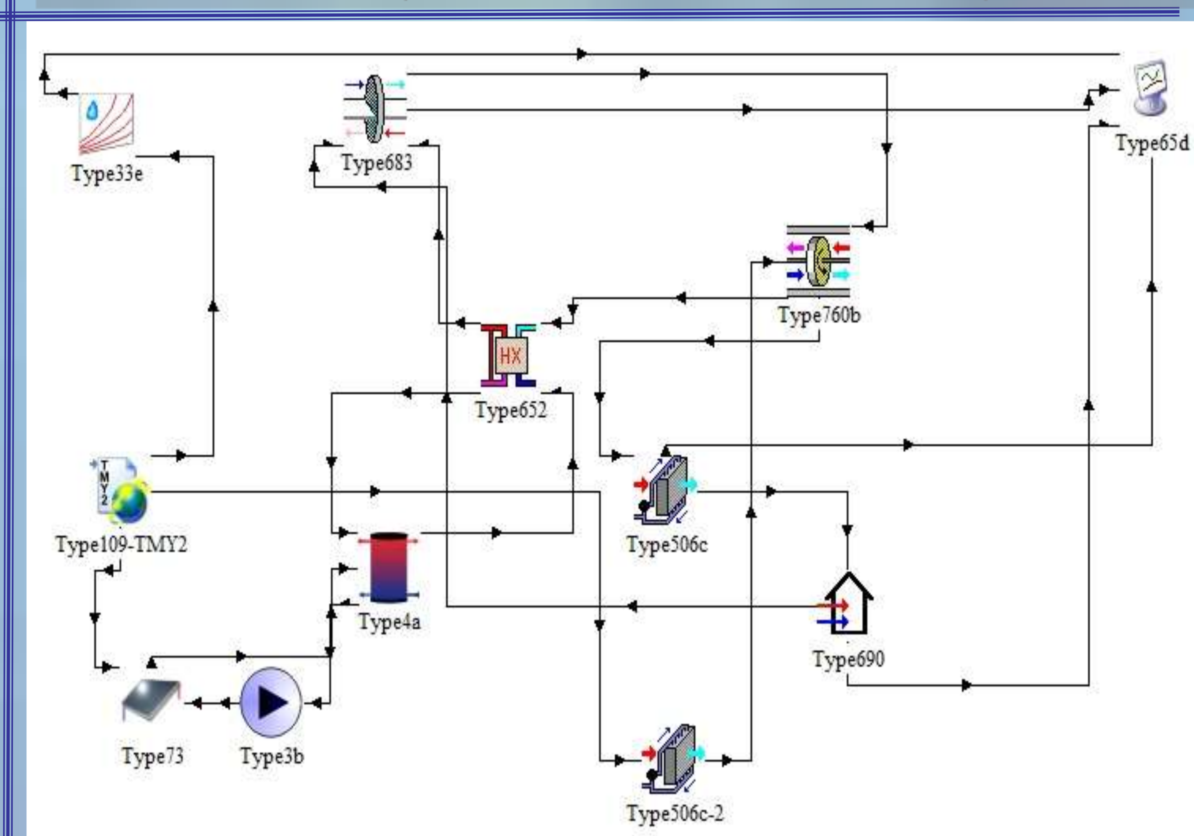


SOLAR ASSISTED SOLID DESICCANT COOLING (RECIRCULATION MODE)

System modelling using TRNSYS



TRNSYS SIMULATION STUDIO PROJECT (VENTILATION MODE)



TRNSYS SIMULATION STUDIO PROJECT (RECIRCULATION MODE)

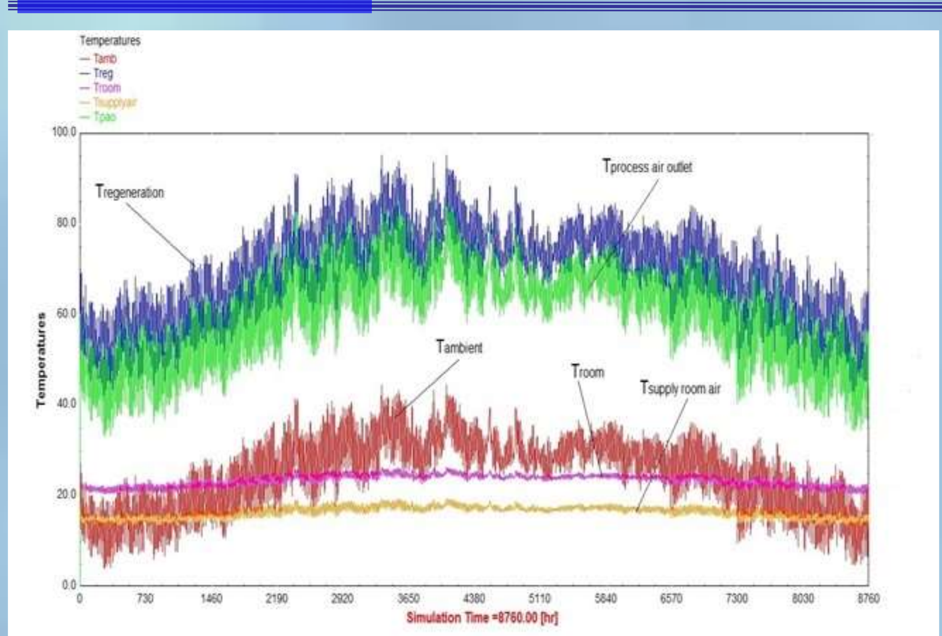
Mathematical description

$$COP_V = \frac{m_p(h_5 - h_4)}{m_r(h_8 - h_7)} \qquad COP_R = \frac{m_p(h_5 - h_4)}{m_r(h_9 - h_8)}$$

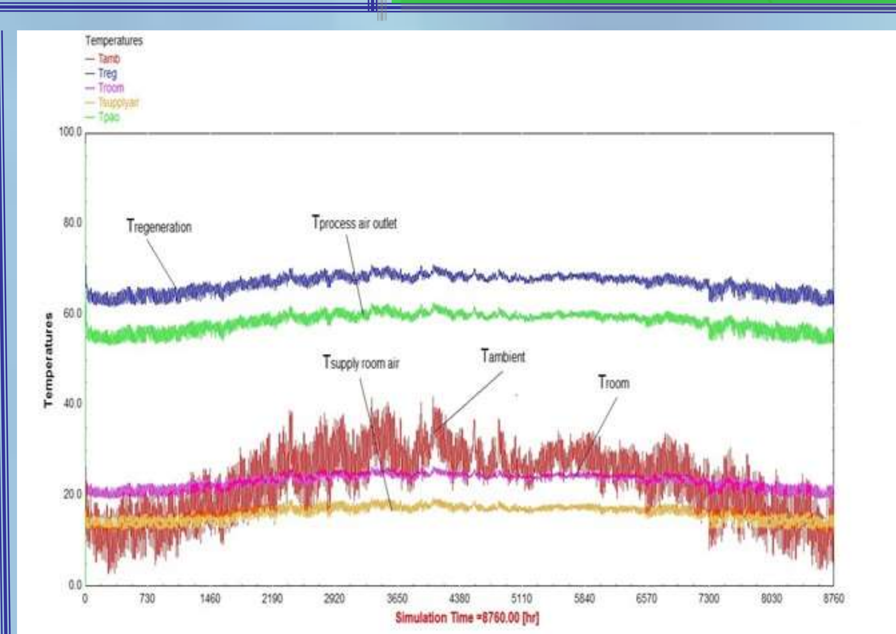
$$\varepsilon_{DW} = \frac{w_1 - w_2}{w_1 - w_{2,ideal}} \qquad \varepsilon_{HRW} = \frac{T_2 - T_3}{T_2 - T_6}$$

$$\varepsilon_{DECpro} = \frac{T_3 - T_4}{T_3 - T_{3w}} \qquad \varepsilon_{DECreg} = \frac{T_5 - T_6}{T_5 - T_{5w}}$$

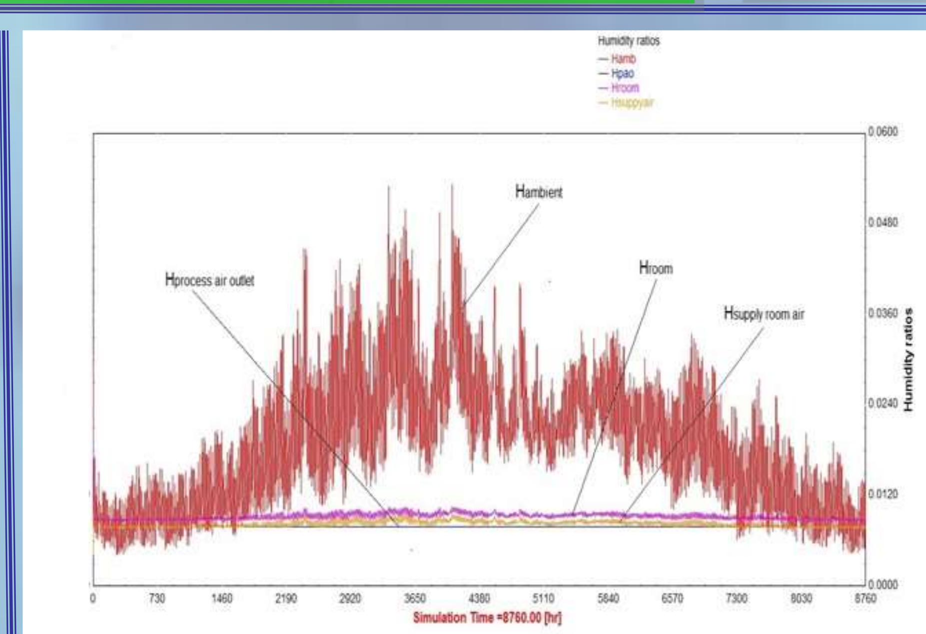
Results



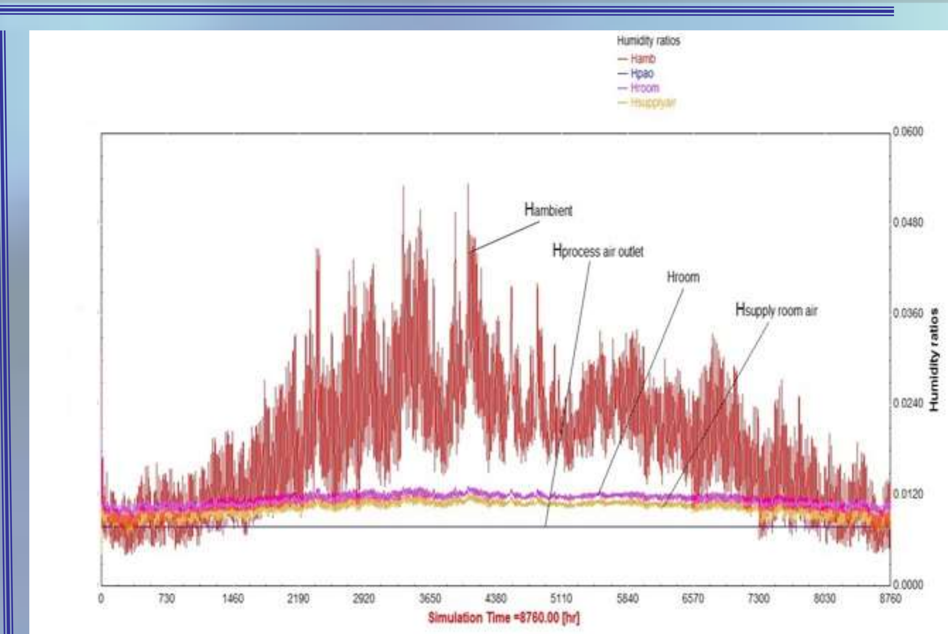
TEMPERATURE AT VARIOUS STATE POINT (VENTILATION MODE)



TEMPERATURE AT VARIOUS STATE POINT (RECIRCULATION MODE)



SP. HUMIDITY AT VARIOUS STATE POINT (VENTILATION MODE)



SP. HUMIDITY AT VARIOUS STATE POINT (RECIRCULATION MODE)

Conditons at main state points

VENTILATION MODE

Temp. (°C)	Sp. Humidity (gr/kg)	Enthalpy (kJ/kg)	COP
T_4=18	0.01003	43.44	0.494
T_5=25	0.01110	53.16	
T_7=63	0.01473	102.62	
T_8=82	0.01473	122.26	

RECIRCULATION MODE

Temp. (°C)	Sp. Humidity (gr/kg)	Enthalpy (kJ/kg)	COP
T_4=17	0.01150	44.95	0.693
T_5=25	0.01248	55.71	
T_8=53	0.01647	94.89	
T_9=68	0.01647	110.41	

Conclusion

The COP for recirculation mode is higher than that in ventilation mode. Also, regeneration temperature required for desorption of dehumidifier is less in recirculation mode. Thus, recirculation cycle proves to be better and more efficient than the ventilation mode because of reduction in thermal energy required for reactivation and successively higher COP for the hot and humid climates.