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Student Name : Sazaad Hasan

Supervisor Name : Prof. Mohammad Emran Khan

Topic: Prediction of Energy Saving In Solar Thermal Hybrid Vrf System in DSelhi

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Keywords : Variable refrigerant flow(Vrf),Adaptive neuro-fuzzy interface system (ANFIS), Tonnage of refrigeration (TR), Heating, ventilation & air conditioning (HVAC), Root mean square error (RSME)

Findings

The key findings of the thesis titled "**Prediction of Energy Saving in Solar Thermal Hybrid VRF System**" are presented blow with special emphasis of results of each chapter on thesis. Energy efficiency is indisputably the cheapest and the most sustainable option that is easily accessible today. Over the years researchers kept finding a suitable alternative to conventional HVAC system which could furnish cooling or heating load based on the current demand of a particular building while simultaneously maintaining a balance between efficiency and operating costs. The researchers after regressive effort came out with an ideal system known as Variable Refrigerant Flow (VRF) system capable simulating operation based on the overall load applied on the building. Understandably considerable research and development has gone into VRF design over a few years considering its dominance over other HVAC equipment's. There is a need of simple energy efficient system which does not require expert operation and maintenance team unlike solar operated vapor absorption and vapor adsorption air-conditioning system. Our objective is to develop solar thermal hybrid Variable Refrigerant Flow (VRF) air-conditioning system and predict energy saving in this system while comparing its performance characteristics with normal VRF air conditioning system.

- Percent opening of each expansion valve is communicated to PCB located in condensing unit through communication cable. Percent opening of expansion valve depends on inside temperature setting which is done through remote control.
- Controller located in condensing unit calculate total requirement for refrigerant (mass flow rate of refrigerant) based on % opening of all the expansion valves. This calculated refrigerant mass flow rate is the basis of controller to change the compressor's DC motor speed. At part load DC motor speed is reduce by changing frequency of power thereby saving in energy.
- Experiments have been done with LG make 4 number 1.56 TR wall mounted air conditioner connected with central outdoor condensing unit. Refrigerant tube from compressor discharge passed into hot water tank to heat the refrigerant gas which increase its temperature and pressure.
- Power consumption of the system is measured at 100%, 75%,50% and 25% load.100% load when all 4 units running, 75% load when 3 unit were running, at 50% two AC units were running and at 25% load only one unit was running out of four units. Power

consumption of solar thermal hybrid system then compared with normal VRF system to find energy saving.

- The results showed that through various models of ANFIS, gaussian model is accurately close the experimental data with lower RSME value (0.017).
- Application of this predictive control algorithm remarkably lowered the energy consumption rate by approximately 40.12 % compared to a conventional setup.
- In R 410a based VRF system compressor works to increase approx. 8 ℃, 9.6 bar (compressor suction condition) to approx. 80 ℃, 34.39 bar (compressor discharge condition) whereas in solar thermal hybrid VRF system, compressor works partially from approx. 8 ℃, 9.6 bar (compressor suction condition) to approx. 45-55 ℃, 17-27 bar (compressor discharge condition). Further increase in temperature and pressure from approx. 45-55 ℃, 17-26 bar (Solar heat exchanger inlet) to 70-88 ℃, 22.96-333.4 bar (Solar heat exchanger outlet) is achieved with the help of evacuated tube type solar collector based heat exchanger.
- So, compressor speed is further reduced in hybrid system which reduce motor power consumption. In solar thermal VRF system, controller change compressor motor speed through % opening of electronic expansion valve and temperature of refrigerant entering into condenser.
- The calculation of energy saving in solar thermal hybrid VRF system has been compared with fully electric-fired VRF system. We calculate energy saving in solar thermal hybrid VRF system compared normal VRF system. The energy saving of approximate 35-47 % can be achieved in solar thermal hybrid VRF system compared to normal VRF system.
- Further economic analysis also done. It is found that payback period of additional investment in solar thermal hybrid VRF system is approximately 6 years.
- Rate of return on additional investment with modified system (Solar thermal hybrid) is 16.54%. Saving in terms of money also worked out considering net present value money concept for 20 years life cycle of the system and it is found that during life cycle of the solar thermal hybrid system saving of Rs. 27104 per TR of refrigeration was achieved.