A Review on an Exergy Analysis of Packaged Air Conditioning System to Improve Its Coefficient of Performance

Hiren K. Bapodara[1] Jaspal B.Dabhi[2]
[1]M.E. Student [2]Assistant Professor
[1,2]Department of Mechanical Engineering
[1,2]L.D.R.P-ITR,Gandhinagar,Gujarat,India

Abstract— The main aim of this research work is to do the exergy analysis of packaged air conditioning system and to find out various losses taking place at different components of the system.as due to the effect of global warming there is high rise in temperature and so use of an air conditioners is must but along with that it also becomes necessary to use efficient system. Thus, here main focus is on reducing the losses by calculating the efficiency of individual components and making necessary changes.

Key words: Air-conditioning, Energy, Efficiency, Exergy coefficient of performance

I. Introduction

Air conditioiong plays a very vital role in industrial, non industrial as well as various other sectors for cooling, heating and food preserving applications. There are lot of applications of such systems but they also consum much of electricity around the world. Energy consumption is related to the economic development of any nation, however this area is thus important to work.because of increase in the cost of conventional fuels and environmental concerns globally. The researchers are looking for new and renewable sources of energy so as to minimize the costs. Due tothe increasing energy demand, degradation of environment,global warming and depletion of ozonelayer etc. There is urgent need of efficient energy utilization and waste heat recovery for useful applications. The researchers are concentrating on the alternate and environment friendly refrigerants.

Thus, here the work is done on each components of the system in order to carry out energy and exergy related analysis in a way to find out the most efficient component or the to improve the efficiency of component which is having less efficiency.

II. Review of Literature

Jun Zhu Wu Chen worked on novel marine rotary desiccant A/C (air-conditioning) system was developed and studied to improve energy utilization efficiency of ship A/C. The orthogonal experiment was first carried out to investigate the influence of various parameters of the marine rotary desiccant A/C system. During the orthogonal experiment the analysis of variance was used to exclude interference from the secondary influencing factor on system performance. The significant influencing factors of system were studied in great detail using the first and second laws of thermodynamics to find optimal setting parameters for best system performance. It is suggested from the analysis results that as regeneration temperature increases, the COPth (thermal coefficient of performance) and exergy efficiency of system (he) decreases by 46.9% and 38.8% respectively. They decrease in proportion to the increase of the temperature. he reaches its maximum value of about 23.5% when the inlet humidity ratio of process air is 22 g/kg. Besides, the exergy loss of system concentrates on the regeneration air heater, the desiccant wheel and the regeneration air leaving the desiccant wheel, which account for 68.4%e81% of the total exergy loss. It can be concluded that applying the marine rotary desiccant A/C in high-temperature and high-humidity marine environment is advantageous.

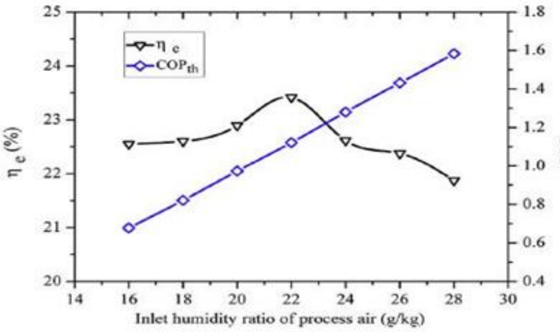

Fig. 1: Copth Varies Linearly W.R.T. The Change Of Inlet Vs Humidity Ratio[1]

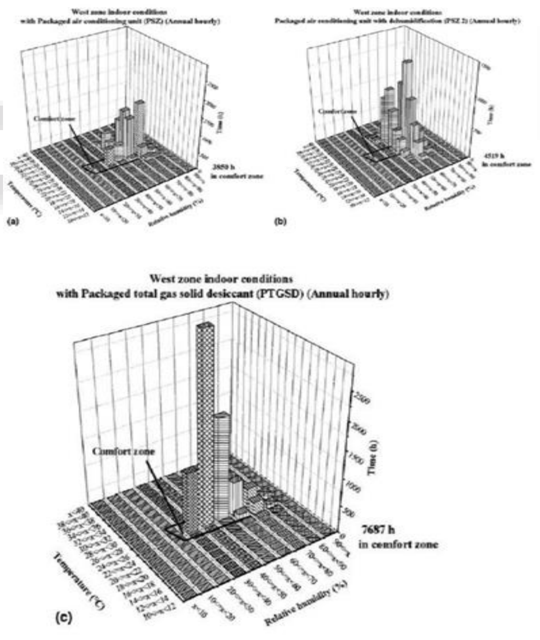

Fig. 2:

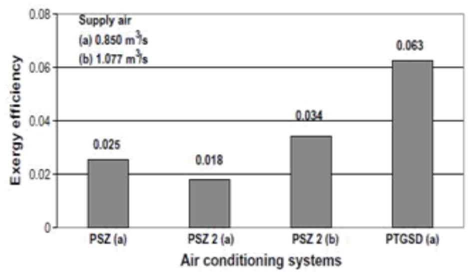

Fig. 2: Annual Exergy efficiency achieved by air conditioning systems[2]

parameter	G /kg·s^{-1}	G_W /kg·s^{-1}	G_1 /kg·s^{-1}	Q_1 /kW	Q_2 /kW	Q_3 /kW	Q_4 /kW
value	1.21	0.363	0.847	2.82	15.3	2	16.12

Table 1: Air Quantity and Cooling Capacity In Summer

parameter	$e_{x,W}$ /kJ·kg^{-1}	e_{x,W_1} /kJ·kg^{-1}	$e_{x,N}$ /kJ·kg^{-1}	$e_{x,C}$ /kJ·kg^{-1}	$e_{x,L}$ /kJ·kg^{-1}	$e_{x,0}$ /kJ·kg^{-1}	E_{x,Q_1} /kW	E_{x,Q_2} /kW	E_{x,Q_3} /kW
value	0.0057	0.1145	1.7534	1.037	1.0037	1.9765	0.0498	1.2271	0.1809

Table 2: The Exergy in Summer

equipment	exergy loss /kW	exergy loss rate /%	coefficient of exergy loss /%	exergy efficiency /%
air-conditioned room	0.7256	66.08	56.73	-
pre-heater	0.0103	0.94	0.81	-
mixing chamber	0.2719	24.76	21.26	-
humidity additioner	0.0403	3.67	3.15	-
reheater	0.05	4.55	3.91	-
system	1.0981	100	85.86	14.14

Table 3: The Exergy loss and Exergy efficiency in summer [3]

Equipment	Exergy loss [kW]	Exergy loss rate [%]	Coefficient of exergy loss[%]	Exergy efficiency [%]
Air-conditioned room	0.8953	66.87	46.76	-
Mixing chamber	0.1821	13.6	9.51	-
Surface air cooler	0.0161	1.20	0.84	-
Re-heater	0.2455	18.33	12.82	-
System	1.339	100	69.93	30.07

Equipment	Exergy loss [kW]	Exergy loss rate [%]	Coefficient of exergy loss[%]	Exergy efficiency [%]
Air-conditioned room	0.5798	83.29	43.39	-
Mixing chamber	0.1159	16.65	8.68	-
Surface air cooler	0.0004	0.06	0.03	-
System	0.6961	100	52.1	47.9

Equipment	Exergy loss [kW]	Exergy loss rate [%]	Coefficient of exergy loss[%]	Exergy efficiency [%]
Air-conditioned room	0.893	83.15	54.13	-
Primary mixing chamber	0.1192	11.1	7.226	-
Surface air cooler	0.001	0.09	0.061	-
Second mixing chamber	0.0608	5.66	3.684	-
System	1.0739	100	65.1	34.9

Table 4,5,6: (IN SUCCESSION) The exergy analysis of primary return AC system ,Primary AC system with apply air in dew point ,The exergy analysis results of AC system..[4]

As shown in Fig.1 COPth varies linearly w.r.t. the change of inlet vs humidity ratio of process air. The exergy efficiency of system he, on the other hand, does not change much. he reaches its maximum value of 23.5% when the inlet humidity ratio of process air is 22 g/ kg. This is because that when other parameters are fixed, the higher the inlet humidity ratio of process air, the greater the mass transfer rate inside the desiccant wheel. The wheel dehumidification ability is enhanced, and more latent heat load can be processed by the wheel. As a result, the COPth is improved.[1]

For figure 2, The exergy method of analysis has been applied to the study of the range of summertime comfort conditions for a hot humid climate. It has been shown to work well for air cooling thermal analysis.The exergy method can provide a benchmark for the analysis of air conditioning systems used to achieve ventilation air conditioning. However since 0the interior air condition is very close to the exterior one, it is indispensable that in this case the exergy method employed for the analysis takes into account the hourly variation of the reference state.

Using information such as that shown in Figs. 2, a minimum exergy benchmark for air conditioning at a given site can be obtained and the performance of real and modelled systems can be evaluated. However the availability of reliable hourly meteorological data is essential. This may not be considered to be a problem in developed countries, but a high proportion of the hot humid regions of the world are to be found in developing countries where this is not a trivial consideration.[2]

From table 1,2,3 shows that,

1) The exergy efficiency is very low in summer and in winter. Relatively, the latter is lower.
2) The exergy loss focuses on air-conditioned room in two conditions.
3) The exergy loss of reheater has obvious difference between summer and winner. (4)The exergy loss of pre-heater, surface cooling and humidiy addtioner is low[3]

And from table 4,5,6 it shows from the research that,

1) The exergy efficiency of three systems is very low. Relatively speaking, the exergy efficiency of primary return air conditioning system with supplying air in dew point is highest.
2) The main exergy loss of three systems is in air-conditioned room, following by mixing chamber. The exergy loss of three systems in surface air cooler is lowest.
3) The exergy loss of re-heater in primary return air conditioning system is larger.
4) The measure using the exhaust air to cool fresh air in summer can reduce the exergy loss of air-conditioned room. The measure to reduce the exergy loss of re-heater in summer is to increase the temperature difference of supply air and to apply secondary return air conditioning system.[4]

III. Conclusion

From the above all research it is concluded that , the exrgy also depends on the weather and atmospheric conditions upon which there also varies tempreture and pressure of the various components of the system.

And overall survey shows that there is very less work done on packegd air conditioning process so using all the data and equations of various research works mentioned in literature survey, I will carry out the exergy analysis of ductable type packaged air conditioning.

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