iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** IX **Month of publication:** September 2016

DOI:

www.ijraset.com
IC Value: 13.98
Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

A Research Paper on Optimum Energy in Air Conditioning System

Prince Singh[1], Satish Singh[2]
[1]M.Tech Scholar , [2]Astt. Professor, Mech.Engg. Department
VIST Bhopal

Abstract--Thermal system cannot always be optimized by means of mathematical or numerical techniques, because a complete model of the plant is not always available; and in case mathematical difficulties are often great, even for particularly complex system and the help of computerized algorithms is needed. Furthermore, mathematical or numerical optimization simply applies to one specified structure of the system, where's, often, structural modifications would be able to improve the cost effeteness of the system.Thermoeconomics is a discipline, which combines the concept of Exergy method with those belonging to economic analysis. The purpose of thermo economic optimizations is to achieve, within a given system structure, a balance between expenditure on capital cost and energy costs, which will give the minimum cost of the plant product. In this thesis, an attempt has been made to optimize an Air conditioning system(vapor compression refrigeration cycle) with the help of thrmoeconomi analysis. First of all, energy (thermodynamic) analysis of the different components of the system is carried out to understand the performance of the components. On exergy basis theological and total irreversibility of the system are found out and exergy basis the local and total irreversibility of the system are found and exergy losses in the different components has been presented in the form of grass man diagram[16]. The costs assigned for exergy, losses are combined with the capital and recovery cost and equations for thermo economic optimum of the components are derived.

Key Words--Air Condition, Exergy ,Energy,refrigeration

I. INTRODUCTION

Literally Air Conditioning is defined as the simultaneous thermal and mechanical control of temperature, humidity, air purity and air motion of an atmospheric environment either for the comfort of human's being or for the proper performance of some industrial or scientific processes [2]. Refrigeration and Air Conditioning can be achieved by processes such as vapor compression, Vapor absorption, water/air refrigeration, thermoelectric refrigeration, steam jet refrigeration etc., but the most widely used process is the vapor compression. No one system will economically fulfill the requirements of all applications. This is because of job variables, which includes [3] cost of equipment, source, quantity and cost of power (steam, gas, Oil, electricity), source purity, quantity and temperature of water or air available for condensing purposes, Space available for system components, safety requirement, service and maintenance problems and usage of load factor.

Based on the above described criteria the vapour compression refrigeration cycle is generally used in numerous fields of application of refrigeration and air conditioning. The key components of a vapour compression air condition system are a compressor, a condenser, throttle valve, an evaporator and of course electric motor to drive the compressor. There are many factors that comes in to picture, whenever the need arises to select an air conditioning system for a particular application. The example first cost of equipment, energy prices, maintenance etc. so the designer or manufacturing has to consider all these aspects before he include to produce any desired product, with a constraint that the product will economically and thermodynamically feasible. Usually a maximum cost is set for each part of the sytem and the market prices determine to what extent an efficient components and the afforded. Such system always cost at least, as much as and after more than they would if thermodynamic optimization were used [4].

For this purpose exergoeconomic(thermodynamics) a relatively new field of thermal science, combines a details exergy (II Law) analysis with appropriate cost balance to study and optimize the performance of energy system from the cost point of view. The analysis and balance are usually formulated for single component of the system [5]. EI sayed and Tribus [6] developed the concept of thermodynamics, in which the objective functions optimized, subject to given economic and technical constraints. The purpose of thermodynamic is improve analysis of the system by introducing ways of concurrently suggestion improvements.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

The system is described in relation to the physical and economic environment. These two environments are interrelated by cost relations for physical quantities [fig 1.1]

II. LITERATURE REVIEW

Thermo economics is a discipline which combines the concept of Exergy method with those belonging to economic analysis.

Massimo Dentice d' Accadia and rossi [1] reports that the incremental cost of the components of the Air Conditioning system may be expressed in terms of exergy losses of the element and also in terms of overall plant running cost.**Goran wall** [14] states that when constructing a system, an attempt should be made to attain the highest possible technical efficiency at the lowest cost, within the existing technical, economic and legal constraints.

Saraf and Dhar [15] writes that the minimum total cost should be the criteria for the optimization of chiller of refrigeration machinery.**Adrian Bejan** [17] has outline the procedure for thermo economic optimization of various processes with the concept of entropy generation minimization.**Vanoli and D' Accadia** [9] investigated a tube in tube condenser of a conventional vapor compression heat pump, by using the structural method of thermo economics. In this investigation he shows the influence of the condenser performance on the remaining system components. Approximate correlation is assumed between the local exergy destruction rate in a given component and that of the system as a whole.**Sahoo, Mishra and gupta** [8] used the theory of exergetic cost and shows significant reduction in produce cost with a small increment in investigated cost for an aqua- ammonia absorption refrigeration system.

III. THERMO ECONOMIC ANALYSIS

A. Structural Coefficients

The way in which the local irrerverslbility rates and exergy fluxes alter in relation to the overall plant irreversibility rate or the exergy input to the plant among the various components of a steadily operating plant with changes in a selected operating parameter. These changes can be expressed conveniently by two types of structural coefficients (i.e. CSB, coefficient of structural bonds & CEB, coefficient of external bonds, however CEB is not considered here). The concept of structural coefficients was put forward by Beyer. Structural Coefficients are used in the study of system structure, optimization of plant components and product pricing in multi-product plants.

1) The Coefficient Of Structural Bonds

The coefficient of structural bonds (CS8) is defined by [10]

$$\sigma_{k,i} = \frac{\left(\dfrac{\partial I_T}{\partial x_i}\right)}{\left(\dfrac{\partial I_k}{\partial x_i}\right)} \tag{5.1}$$

Where,

I_T=Irreversibility rate of the whole system

I_k= Irreversibility rate of the K-th component of the system

X_i= parameter of the system which products changes

Alternately,

$$\sigma_{k,i} = \left(\frac{\partial I_T}{\partial I_k}\right)_{x_i = \text{variable}} \tag{5.2}$$

Here, the system a thermal or chemical plant, is assumed to operate in a steady fashion and the input to the system is assumed to be of invariable quality, a condition satisfied by an input of fuel, electric energy or steam supply at a fixed pressure and temperature. The effect of a change in x_i on the system would be to alter the rate of exergy input while leaving the output constant. This assumption conforms with the usual practice of specifying a plant in terms of its output rather than its input. From the exergy balance of the system.

$$E_{IN} = E_{out} + I_T \tag{5.3}$$

Volume 4 Issue IX, September 2016
ISSN: 2321-9653

It is clear that with E_{out}= constant

$$\Delta E_{IN} = \Delta I_T \tag{5.4}$$

Or, in other words, change in the irreversibility of the system are equivalent to change in the input

1) IF

$$\sigma_{k,i} > 1$$

The reduction in the input to the system (saving in primary exergy) is greater than the reduction in the irreversibility of the element under consideration (k-th element).Clearly, the change in X_i improves not only

The K-th element but, owing to the bonds, betwbeen them, other elements also. In this situation it is particualry advantageous to optimize the k-th elements because of the potentioal favourable on the overall plant efficiency.

2) When

$$\sigma_{k,i} < 1$$

The reduction in the input to the system is less than the reduction in the irreversibility of K-th element. Clearly, here a reduction in the irreversibility rate in the k-th element is accompanied by increased in the irrevesility rates in other elements of the plant. This range in the $\sigma_{k,i}$, demonstrates an unfavorable structure of the system.

3) A special case of case (ii) is:

$$\sigma_{k,i} = 0$$

Where improvement in the performance of the k-th element is counterbalanced by the equal reduction in performance of other elements (as measured by I) so that there is no effect on the overall plant efficiency. This case demonstrates a rigid system structure, which does not permit the benefits of a local improvement in performance to be passed on to the plant as a whole.

4) It is possible to have :

$$\sigma_{k,i} < 0$$

Indicating that x. affects other elements more strongly than the k-th element, and in the opposite sense, i.e, when the irreversibility rate the k-th element decreases. It increased in other plant elements by a greater amount. This value of $\sigma_{k,i}$ characteristics a very unfavorable system.

Structure which, subject to economic constraints, should be changed through plant modifications.

The CSB is useful in investigating the structure of a system, and in thermodynamic optimization of components of a plant.

B. The Structure Method Of Thermo Economic Optimization

In the thesis structural method of thermo economic optimization is carried out to determine for a selected component (system element) the capital cost corresponding to the minimum annual operating cost of the plant for a given plant output and thus, by implication, to the minimum unit cost of the product.

Assume that ttere is aplant parameter

$X_i(\eta_{EM1}, \eta_{cp}, \varepsilon_{co}, \varepsilon_{EV})$ Effecting performance of any one of the plant elements of the system and thus in most cases, also indirectly affecting the performance of the system. Any variation in $X_i(\eta_{EM1}, \eta_{cp}, \varepsilon_{co}, \varepsilon_{EV})$ will also in general cause change in the irreversibility rates of other elements of the system and necessitate changes in the capital cost of the different element. The

Energy balance for the system as a whole can be written

$$I_T(X_i) = E_{in} - E_{out} \tag{5.5}$$

And as discussed ealier that the plant output remains constant. So E_{out} is independent of plant parameter (X_i) affecting the system. The terms E_{out} which reperesents the join exergy of the plant products is taken to be independent of X_i. the irrevesivility rate $I_T(X_i)$. may looked upon as the consumption of exergy in the system, necessary to generate the produce exergy E_{out} any increase I exergy consumption willnecessitante corresponding addition exergy input, $\Delta E_{IN}(X_i)$

The nature of the techniques that exergy input to the plant should have single single fixed unit cost. This condition can be satisfied fuel or electric energy. Alternately, the input could be made up of more than one form of exergy of invariable quality in fixed proportions.

For this optimization, take object function to be the annual cost of plant operation, C_T, which can be expressed as

$$C_T(X_i) = t_{op} C_{in}^{\varepsilon} E_{in}(x_i) + a^c \sum_{l=1}^{n} C_l^c(x_i) + b^c$$

Where,

t_{op}= period of operation per year

C_{IN}^{ξ} = Unit cost of input exergy to the system

a^c = Capital recovery factor

C_l^c = Capital cost of the I[th] element of the system consisting of n elements.

b^c =Part of the annual cost which is not affected by the optimization.

Our objective is to minimize annual cost of plant operation with respect to the following design parameters, assumed to be variable in the cost minimization problem

Electromechanical efficiency of the electric moor $X_1 = \eta_{EM1}$

The isentropic efficiency of the compressor, $X_2 = \eta_{cp}$

The thermal effectiveness of the condenser, $X_3 = \xi_{co}$

The thermal effectiveness of the evaporator, $X_4 = \xi_{ev}$

So,

$$C_T(X_i) = f(\eta_{EM1}, \eta_{cp}, \varepsilon_{co}, \varepsilon_{EV})$$

C. Optimization Procedure

One of the most important decisions in this type of optimization method is the correct choice of the variable parameter, $X_i(\eta_{EM1}, \eta_{cp}, \varepsilon_{co}, \varepsilon_{EV})$, since both $X_k(I_{EM1}, I_{cp}, I_{co}, I_{EV})$ and $C_l^c(or, C_{EM1}^c, C_{cp}^c, C_{co}^c, C_{EV}^c)$ must be related to this parameter in the most direct manner. For this purpose calculation for calculative costs of the system components (i.e., Electric motor, compressor, condenser and evaporator) are given in appendix [1, 18].

$$C_T(x_i) = t_{op} C_{in}^{\varepsilon} E_{in}(x_i) + a^c \sum_{l=1}^{n} C_l^c(x_i) + b^c \tag{5.7}$$

The objecting function is to be differentiated with respect to X_i

$$\frac{\partial C_T}{\partial X_i} = t_{top} C_{IN}^{\varepsilon} \frac{\partial E_{IN}}{\partial X_1}(x_i) + a^c \sum_{l=1}^{n} \frac{\partial C_l^c}{\partial X_i} \tag{5.8}$$

From equation 4.15

$$\frac{\partial E_{IN}}{\partial X_i} = \frac{\partial I_T}{\partial X_i} \tag{5.9}$$

So equations 5.5 become (5.10)

$$\frac{\partial C_T}{\partial X_i} = t_{top} C_{IN}^{\varepsilon} \frac{\partial I_T}{\partial X_i} + a^c \sum_{l=1}^{n} \frac{\partial C_l^c}{\partial X_i} \tag{5.10}$$

1) Electric motor

For electric motor-1, the parameters affecting the system is η_{EM1},

So,

$$\frac{\partial C_T}{\partial \eta_{EM1}} = t_{op} C_{IN}^{\varepsilon} \frac{\partial I_T}{\partial X_i} + a^c \frac{\partial C_{EM1}^c}{\partial \eta_{EM1}} \tag{5.11}$$

From the definition of coefficient of structural bonds (CSB)

$$\frac{\partial I_T}{\partial x_i} = \sigma_{k,i} \frac{\partial I_k}{\partial x_i} \tag{5.12}$$

So,

$$\frac{\partial I_T}{\partial \eta_{EM1}} = (\sigma_{EM1}) \frac{\partial I_{EM1}}{\partial \eta_{EM1}} \tag{5.13}$$

$$\frac{\partial C_T}{\partial \eta_{EM1}} = t_{op} C_{IN}^{1} (\sigma_{EM1}) \frac{\partial I_{EM1}}{\partial \eta_{EM1}} + a^c \frac{\partial C_{EM1}^c}{\partial \eta_{EM1}} \tag{5.14}$$

To optimize make equation (5.14), zero.

Thus,

$$\left(\frac{\partial I_{EM1}}{\partial \eta_{EM1}}\right)_{OPT} = -\frac{a^c}{t_{top} C_{IN}^{\varepsilon} (\sigma_{EM1})} \times \frac{\partial C_{EM1}^c}{\partial \eta_{EM1}} \tag{5.15}$$

2) Compressor

Similarly for compressor we can write

$$\left(\frac{\partial I_{cp}}{\partial \eta_{cp}}\right)_{OPT} = -\frac{a^c}{t_{top} C_{IN}^{\varepsilon}(\sigma_{cp})} \times \frac{\partial C_{cp}^c}{\partial \eta_{cp}} \qquad (5.16)$$

(iii) Condenser

$$\left(\frac{\partial I_{co}}{\partial \xi_{co}}\right)_{OPT} = -\frac{a^c}{t_{top} C_{IN}^{\varepsilon}(\sigma_{co})} \times \frac{\partial C_{co}^c}{\partial \xi_{co}} \qquad (5.17)$$

3) Evaporator

$$\left(\frac{\partial I_{EV}}{\partial \xi_{EV}}\right)_{OPT} = -\frac{a^c}{t_{top} C_{IN}^{\varepsilon}(\sigma_{EV})} \times \frac{\partial C_{EV}^c}{\partial \xi_{EV}} \qquad (5.18)$$

For obtaining optimum efficiency of electric motor-1 and Compressor, optimum thermal effeteness of condenser and evaporator, graphs were drawn between:

For motor -1

$$\eta_{EM1} VS \left(\frac{\partial I_{EM1}}{\partial \eta_{EM1}}\right)_{OPT}, \left(\frac{\Delta I_{EM1}}{\Delta \eta_{EM1}}\right)$$

From this graph optimum efficiency of electric motor-1 is obtained at intersection point.

For compressor

The graph is

$$\eta_{cp} VS \left(\frac{\partial I_{cp}}{\partial \eta_{cp}}\right)_{OPT}, \left(\frac{\Delta I_{cp}}{\Delta \eta_{cp}}\right)$$

Point of intersection give optimum efficiency of compressor.

For condenser

$$\xi_{co} VS \left(\frac{\partial I_{co}}{\partial \xi_{co}}\right)_{OPT}, \left(\frac{\Delta I_{co}}{\Delta \xi_{co}}\right)$$

Point of intersection give the optimum efficiency of condenser.
For evaporator
The graph is

$$\xi_{EV} VS \left(\frac{\partial I_{EV}}{\partial \xi_{EV}}\right)_{OPT}, \left(\frac{\Delta I_{EV}}{\Delta \xi_{EV}}\right)$$

Point of intersection is optimum efficiency

D. Reference Case Data
To examine the above defined analysis, an air conditioning pant with a natural convection cooling is considered as shown in fig. 4.1 and a set of data identifying one possible operating condition for this plant is reported have such a state of the system will be assumed as the reference case state of the numerical example to be developed in the following :
Set of data for reference case operating conditions

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Total load on the plant: 40 tons
Working fluid: R22
P_c = 18 bar,
P_e = 6.5 bar
T_7, = 25°C
T_8 = 38°C
P_7 = 3 bar
T_5 = 27°°C
T_6 = 16.2°C

Air mass flow rate to the evaporator $\left(m_A\right)$=12.95Kg/

Water mass flow rate to the condenser $\left(m_{w,co}\right)$=2.94Kg/s

Refrigerant pressure loss in the evaporator=0.1 bar
Refrigerant pressure loss in the condenser=0.15 bar

Sub cooling degree= $4^{\circ}C$

Superheating degree= $5^{\circ}C$

Thermal effectiveness of condenser $\xi_{co} = 0.7$

Thermal effectiveness of evaporator $\xi_{EV} = 0.6$

Electric motor (EM1) efficiency $\eta_{EM1} = 0.9$

Compressor isentropic efficiency $\eta_{cp} = 0.8$

Electric motor (EM2) efficiency $\eta_{EM2} = 0.8$

Pump isentropic efficiency $\eta_{pm} = 0.75$

Unit cost of electric $C_{IN}^{\xi} = Rs.420/GJ$

Interest rate

$$i_R = 0.18$$

Period of repayment

$$N_y = 15$$

Period of operation per Year

$$t_{op} = 3000 hrs/Yr.$$

E. Assumption Made In The Analysis

For the purpose of analysis of the system the following assumption are made,

1) The system is in steady state.
2) Refrigerant at the condenser exit and the evaporate exit are in saturated states.
3) The reference environmental state for the system is

$$T_0 = 35^{\circ}$$
$$P_0 = 1 bar$$

4) Exergy input to the plant should be of invariable quality.
5) Pressure losses in the pipelines are negligible.

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

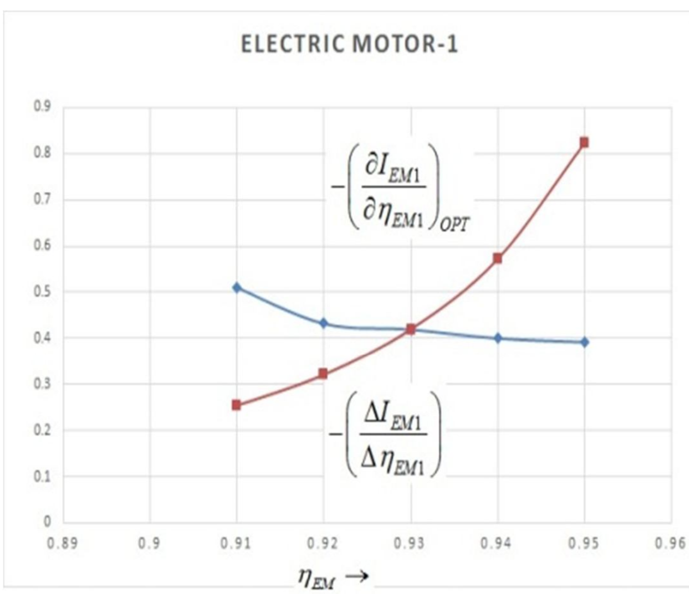
IV. RESULT DISCUSSION

In this thesis structural method of thermo economic optimization technique is used to optimize a vapor compression air conditioning plant of 40 ton capacity using R22 as the refrigerant. Our objective is to minimize overall annual cost for plant operation (capital and running) with respect to the no. of design parameters. They are the electromechanical efficiency of electric motor, the isentropic efficiency of the compressor, the thermal effectiveness of the condenser, the thermal effectiveness of the evaporator. The purpose of this optimization is to determine, for a selected component (system element) the capital cost corresponding to the minimum annual operating cost of the plant for a given plant output.

For optimizing individual components, the system component is analyzed thermodynamically using the concept of exergy analysis. As the performance of each component is a function of operating design variable (i.e., efficiency or effectiveness), irreversibility in each component and that of the whole plant are calculated, by using relations discussed in chapter 4. From local irreversibility in the component and the total plant irreversibility, coefficient of structural bonds is calculated using equation (5.1). Then the capital cost equation is expressed as the partial derivative for each component of the system with respect to the design variable of the element. Since both irreversibility rate in the system component under consideration and the partial derivative of the irreversibility of each component are related to the design variable, graphs are drawn between these two values to get the optimum operating value (table 5.1 to 5.4).

The optimization has been carried out unit by unit separately, to obtain the optimum operating value for each unit. The results; obtained are compared to that of Acadia and de Rossi ($\eta_{Em1} = 0.923$, $\eta_{cp} = 0.83$, $\xi_{cp} = 0.76$, $\xi_{EV} = 0.66$). The results obtained (table 6.5), by using Structural method are ($\eta_{EM1} = 0.923$, $\eta_{co} = 0.82$, $\xi_{co} = 0.775$, $\xi_{EV} = 0.679$) very close to the one obtained by Acadia and de Rossi.

The energy loss in various system components are presented in the form of bar chart (fig.6.6) & also on Grossman diagram (fig. 6.7& 6.8) for better understanding. It is observed that maximum percentage of losses are occurring in the lectric motor and compressor sub system(28%) for reference case and minimum in the throttle valve value(1.88%). For reference case total losses contributed 74.95% of the given input and for optimized case the same has been reduced to (66.54%). Although the capital cost for each element has increased for optimized case, the power input to the system has been reduced by 2.49. As a result, the total annual cost for plant operation has been reduced by Rs.1332. so it may be commented that the higher is the cost of electric energy that the final user has to afforded, the greeter is the probability for him of investing money in capital costs of the components. This induces a reduction of the irreversibility in the components, leading to energy and money savings during system operation.

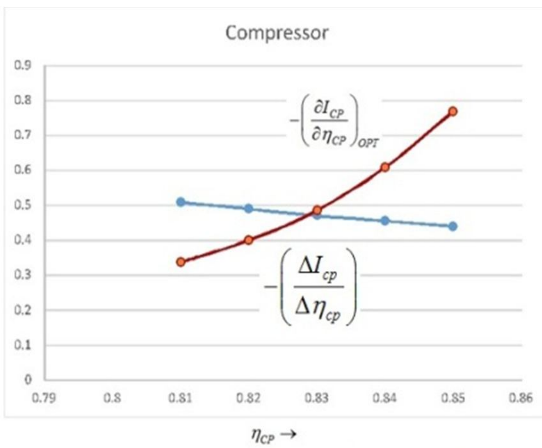


Graphical Determination of optimum Efficiency of the Electric Motor 1

Volume 4 Issue IX, September 2016
ISSN: 2321-9653

η_{EM1}	$W_1(KW)$	$-\Delta I_{EM1}$ (KW)	$-\Delta I_{EMT}$ (KW)	σ_{EM1}	$-\left(\frac{\partial I_{EM1}}{\partial \eta_{EM1}}\right)_{OPT}$ (KW)
0.9	37.046	-	-	-	-
0.91	36.639	0.407	0.407	1	0.254
0.92	36.241	0.398	0.39	1	0.321
0.93	35.851	0.39	0.39	1	0.42
0.94	35.47	0.381	0.381	1	0.572
0.95	35.096	0.373	0.371	1	0.823

Table 6.1 Electromechanical parameters of electric motor 1

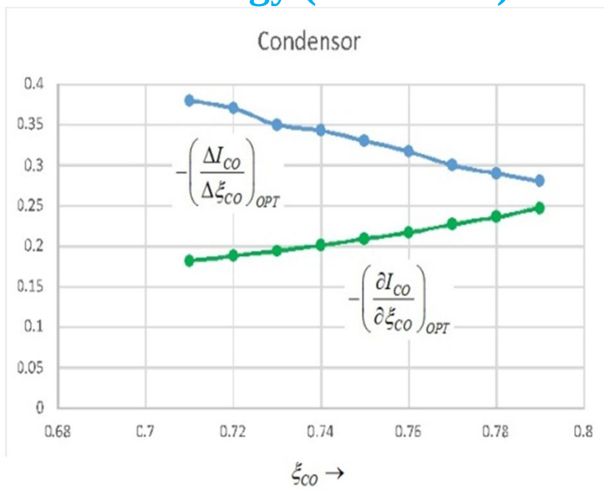


Graphical determination of optimum efficiency of the compressor

η_{cp}	W_2 (KW)	$-\Delta I_{cp}$ (KW)	W_1 (KW)	$-\Delta I_{EM1}$ (KW)	$-\Delta I_T$ (KW)	σ_{cp}	$-\left(\frac{\partial I_{cp}}{\partial \eta_{cp}}\right)_{OPT}$ (KW)
0.8	33.341		37.046	-		-	-
0.81	32.93	0.412	36.589	0.457	0.869	2.111	0.337
0.82	32.528	0.402	36.143	0.446	0.848	2.111	0.4
0.83	32.136	0.392	35.707	0.435	0.827	2.111	0.486
0.84	31.754	0.383	35.282	0.425	0.808	2.111	0.609
0.85	31.38	0.374	34.867	0.415	0.789	2.111	0.769

Table 6.2 Mechanical parameters of compressor

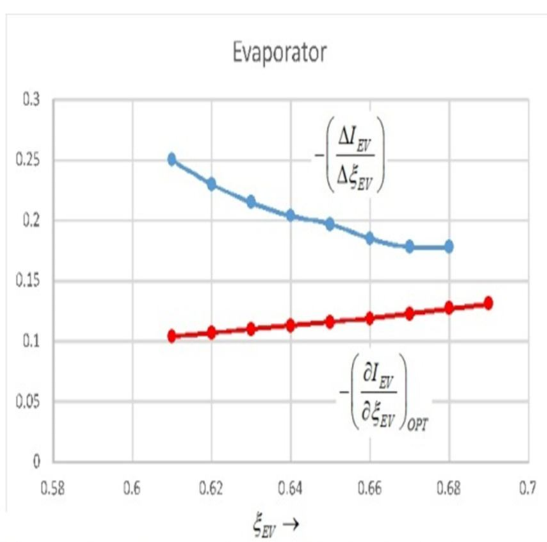
Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)



Graphical determination of optimum efficiency of the Thermal Effectiveness of condenser

ξ_{co}	I_{co} (KW)	$-\Delta I_{co}$ (KW)	$-\Delta I_{TV}$ (KW)	$-\Delta I_{T}$ (KW)	σ_{CO} (KW)	$-\left(\frac{\partial I_{co}}{\partial \xi_{co}}\right)_{OPT}$ (KW)
0.7	134.839	-		-	-	-
0.71	134.563	0.276	0.145	0.421	1.525	0.182
0.72	139.294	0.268	0.141	0.41	1.525	0.188
0.73	134.031	0.261	0.137	0.339	1.525	0.194
0.74	133.777	0.254	0.133	0.338	1.525	0.201
0.75	133.528	0.248	0.13	0.378	1.525	0.209
0.76	133.286	0.241	0.127	0.368	1.525	0.217
0.77	133.051	0.235	0.123	0.359	1.525	0.227
0.78	132.821	0.229	0.12	0.35	1.525	0.236
0.79	132.597	0.224	0.117	0.341	1.525	0.247

Table 6.3 Thermodynamic parameters of condenser



Graphical determination of optimum efficiency of the Thermal effectiveness of Evaporator

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

ξ_{EV}	I_{EV} (KW)	$-\Delta I_{EV}$ (KW)	$-\Delta I_T$ (KW)	σ_{EV} (KW)	$-\left(\frac{\partial I_{EV}}{\partial \xi_{EV}}\right)_{OPT}$ (KW)
0.6	6.573	-	-	-	-
0.61	6.412	0.16	0.199	1.034	0.14
0.62	6.257	0.155	0.16	1.034	0.107
0.63	6.107	0.149	0.155	1.034	0.11
0.64	5.962	1449	0.15	1.034	0.113
0.65	5.822	0.14	0.145	1.034	0.116
0.66	5.686	0.135	0.14	1.034	0.119
0.67	5.554	0.132	0.137	1.034	0.123
0.68	5.428	0.126	0.13	1.034	0.127
0.69	5.304	0.123	0.127	1.034	0.131

Table 6.4 Thermodynamic parameters of Evaporator

Component	Reference case	Optimized case
Electric motor efficiency	**0.9**	**0.923**
Compressor isentropic efficiency	**0.8**	**0.82**
Condenser effectiveness	**0.7**	**0.775**
Evaporator thermal effectiveness	**0.6**	**0.679**

Table 6.5 design parameters for reference and optimized case

Component	Capital cost for reference case(Rs.)	Capital cost for optimized case(Rs.)
Electric motor	6415	8484
Compressor	3772	4270
Condenser	32208	40562
Evaporator	13378	16590

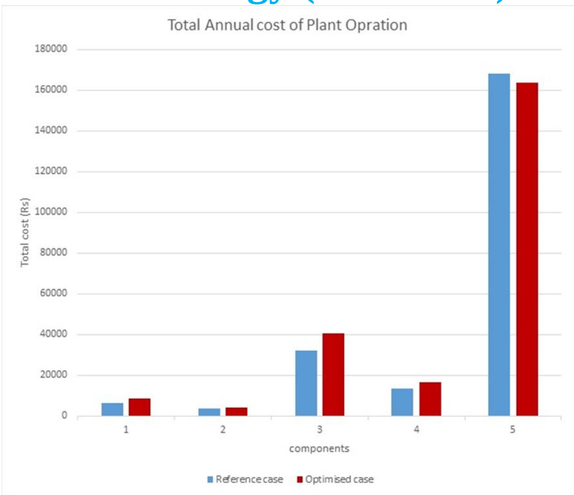
Table 6.6 total capital costs of various components of air conditioning plant reference and optimized case

Case	Electric cost (Rs. Per Year)	total capital costs of all components (Rs. Per Year)	total operation cost of the system (Rs. Per Year)
Reference case	168045	10950	178995
Optimised case	163940	13730	177670

Total saving cost per year=Rs.1325

Table 6.7 total annual costs of plant operation both for reference and optimized case

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)



1.Electric motor 2. compressor 3.condenser 4.Evaporator 5. Electricity cost per year

V. CONCLUSIONS

The structural method of thermo economic optimization is a very powerful tool for the optimization in process plants. The methodology is a simple, with no great loss of accuracy in comparison with conventional and most sophisticated procedures.

In addition, it can be generally observed that, differently from mathematical or numerical techniques, thermo economic analysis is also able to provide suggestions about potential cost-effectiveness improvements achievable by means of changes in the structure of the system, allowing the analyst to achieve a better knowledge of the cost formation process through the units which make up the plant. Even then one must pay attention to the following factors to use this method of optimization:

Correct choice of the variable parameter x_i. In the present case variables used are electromechanical efficiency of electric motor, compressor isentropic efficiency, condenser thermal effectiveness and evaporator thermal effectiveness.

THIS optimization method imposes a condition that irreversibility rate and capital cost equation of the system component must be related to the variable parameter x_i in the most direct manner.

VI. SCOPE FOR FUTURE WORK

Lot of possibilities in this areas can be possible. Computer programs may be prepared to reduce the time in calculation of the cost equations. Sensitivity analysis can be done for various governing parameters of the system. The effect of operation time of the plant and change of variations in the cost of input exergy can be evaluated. The effect of variation in the environmental state is also a field for further improvement in the analysis. In the thesis R_{22} is taken as working fluid, an analysis can be done for various refrigerants and their comparative results can be visualize. Analysis may be done by taking more than one form of exegy for different system components.

Work that can be extracted, we call the exergy. This is the part of the energy, which is completely convertible into any other forms of energy i.e., especially work. Other forms of energy, e.g., kinetic and potential.

REFERENCES

[1] Filippo de Rossi, Massimo Dentice D' accadia," thermoeconomic optimization of a refrigernet plant", international Journal of Refrigerantion, Vol. 21, No Pp 42-54, 1998
[2] Jones, W.P.,"Air condition Engineerring'', Edward Arnold Publishers, London, second Edition
[3] Carer, W. H., Grant, W.a., Charne R>E>, "modern air conditioning, heating and vetilstion", pitmsn publishing, New York, Second Eddition.
[4] Goran Wall, "Optimisation of refrigeration Machinery", International Journal of Refrigeration, Vol. 14, PP 336 - 340, November 1991.
[5] T satsaronis, G., Lin L, Pisa, "Exergy costing in Exergoeconomics", Journal of Energy Resources Technology, vol.115, Pp 9-16, March 1993.
[6] El Sayed, Y. M., Tribus, M., "Strategic Use of Thermoeconomics for system improvement. In Efficiency and Costing" (Ed. A Gaggioli), ACS Symposium Series No. 235 (.1983), Ch, 11-238.
[7] Tribus, M., Evans R.B. , "Thermoeconomics and Design of Hem Systems", ASSME Journal of Engineering for Power, pp 27-35, January 1990.
[8] P. K. Sahoo, R. D. Mishra , & A. Gupta, "Exergoeconomic Optimisation of an aqua – ammonia absorption Refrigeration system", International Journal of Exergy , Vol.1, No. 1, Pp 82-89, 2004. 5

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

[9] Massimo Dentice d' Accadia, Laura Vanoli , "Thermoeconomic- Optimisation of the condenser in a vapor compression heat pump", International Journal of Refrigeration, Volume 27, issue 4, pp 433- 441, June 2004 .
[10] Kotas, T.J., "The exergy Method of Thermal Plant Analysis",Butterworths, U.K. 1995.
[11] Aurchar, H, "Thermodynamic fundamentals and Use of Exergy: Saving of Energy in Refrigerent", XV International Congress of Refrigerantion, Pp 1-26, 1980.
[12] Wall Goran, Physical Resource Theory Group., Chalmers University ofTechnology, Goteborg, Sweden, ISBN 91-7032-269-4, 1986.
[13] Maczek, K., "A Method of Technical and Economic Optimisation in the course of Design of Refrigeration System and its Components Using computer", XIII Congress of Refrigeration, Washington 1979.
[14] Wall Goran, "On the Optimization of Refrigeration Machinery, Progress in Design and Construction of Refrigeration System", Puredue International Institute of Refrigeration (IIR) Conference, July 18-21, pp 92-97, 1988
[15] Saraf, G.R., Dhar, P.L., "Optimisation of Flooded Chiller Design" Indian Journal of Technology, Vol. 18, pp 214-218, May 1980.
[16] Banaerjee, R., et. AI, "Exergy analysis of pressure swing adsorption processes for air separation", Chemical engineering Science 45(2), pg 567, 1990.
[17] Bejan, Adian, "Entropy generation minimization: The new thermodynamics of finite size devices and finete — time processes" Journal of Applied Physics, Vol. 79, No. 3, Feb 1996.
[18] Bohehm, R.F., "Design Analysis of Thermal Systems" , Wiley Publication, New York 1987.
[19] Mcgovern, J.A., "Exergy Analysis - a different perspective on energy, part -1 : The concept of energy", Proceedings, Institute of Mechanical Engineers, Journal of Power and Energy, Vol. 204, Pp 253-262, 1990.
[20] Wall, G., "Optimisation of Refrigeration Machinery", International Journal of refrigeration, Vol. 14, Pp 336-340, 1991.