MULTI FUNCTIONAL COMPRESSOR

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Abstract *Renewable energy is generally defined as energy that comes from resources which are naturally replenished on a human timescale such as sunlight, wind, rain, tides, waves and geothermal heat. Renewable energy replaces conventional fuels in four distinct areas i.e. electricity generation, hot water/ space heating, motor fuels and rural (off-grid) energy services.*

While many renewable energy projects are large scale, renewable technologies are also suited to rural areas and developing countries, where energy is often crucial in human development. To hardness the energy from renewable energy resources is a big issue, because for the purpose a large set up is required and the initial cost is higher than that of a single unit which works with electricity.

This paper will focus on the design of a multi-functional compressor which is the combination of Air conditioning, Water cooling and Refrigeration system.

Key Words: Multifunctional compressor, refrigeration, air conditioning, heat transfer

1. INTRODUCTION

Demand of electricity is increasing day by day. Its consumption is more than its production. It is due to the fact that the population is uncontrollably increasing but the resources for fulfilling their requirements are limited and diminishing at faster rate. To overcome the problem of limited resources either we should move towards the renewable energy resources or design such an appliance which can save electricity.

While many renewable energy projects are large scale, renewable technologies are also suited to rural and remote areas and developing countries, where energy is often crucial in human development. To harness the energy from the renewable energy resources is a big issue because for the purpose a large set up is required and the initial cost is higher than that of a single unit which works with electricity.

To fulfill the energy demand, it is the easier way to make improvement in the existing system. It solves two problems one is electricity consumption another one is the improved efficiency at low cost availability.

In this paper, we have used a single compressor with three different manifolds. These manifolds are connected are connected to different output devices. In this case, the output devices are water cooler, air conditioner and a refrigerator. We have designed a combination of these devices. It can be used at home, small departmental stores or shops.

2. MULTIFUNCTIONAL COMPRESSOR

This paper is based on the designing of a complete system which produces chilled water, chilled air and also refrigerates the items simultaneously. It means that a system which is capable of fulfilling the demand of all the three required and expensive systems. They are as follows:-

Air conditioning system
This can refer to any form of technological cooling, heating, ventilation or disinfection that modifies the condition of air.

Water cooling system
A water cooler or water dispenser is a device which cools and dispenses water.

Refrigerating system
In refrigeration, heat is removed continuously from a system or space at a lower temperature and transfer to surrounding at higher temperature.

3. WORKING PRINCIPLE

Components used in this paper along with their working principle are as follows:-

Compressor
It converts low pressure and low temperature vapor to high pressure and high temperature vapor refrigerant.

Condenser
It converts high pressure and high temperature vapor refrigerant to high pressure and low temperature liquid refrigerant.

Diffusion tube
It maintains the flow of the refrigerant in respective compartments.

Expansion valve
It converts high pressure and low temperature liquid refrigerant into low pressure and low temperature liquid refrigerant.

Evaporation
It converts low pressure and low temperature liquid refrigerant into low pressure and low temperature vapor refrigerant.

Back pressure valve
It maintains the equal proportion of the refrigerant to avoid load on the compressor.

4. APPLICATIONS-

1. It is very useful system that can be used in home, kitchen, departmental stores, small kiosk, shops, etc.
2. The system is capable of saving power because one system is applied for different useful work.
3. It doesn't cost more. It is much cheaper than the available separate system.
4. It is suitable for small scale industries.
5. It is quite useful for future applications.
6. It is smaller than the separate system, so occupies less space.

5. Advantages and disadvantages of the system

5.1 Advantages-

1. It consumes less power because it works for three separate systems alone.
2. Its design is quite simple.
3. It is less spacious.
4. Maintenance is easy.
5. It can be installed anywhere.
6. Its installation cost is very low.
7. It's an efficient system.

5.2 Limitations-

1. It does not contain stabilizers in it.
2. It is not suitable for large scale or big industries.
3. It is a low capacity device.

6. DESIGNING OF MULTIFUNCTIONAL COMPRESSOR

6.1Design of evaporator-

An evaporator should transfer enough heat from as small size as possible. It should be light, compact, safe and durable. The pressure loss should be as low as possible.

Heat absorbed by refrigerant vapor= 7.014 KJ/min= 116.9W= 1.6679 kcal/min

Temperature of air surrounding evaporator, T_{hi}= 20 C

Temperature of air after 1 min, T_{co}= 30 C

Temperature of refrigerant liquid entering evaporator, T_{ci}= -180˚C

Temperature of refrigerant liquid leaving evaporator, T_{co}= -180˚C

Assuming counter flow type heat exchanger,

$$LMTD=\frac{\Delta T1-\Delta T2}{\ln(\frac{\Delta T1}{\Delta T2})}$$

$\Delta T1$= Thi-Tco$\Delta T2$

= Tco-Tci

$Q = [U * A * LMTD]$

To find U:

Let outer diameter=12mm

Inner diameter= 10mm

Inside the tube is refrigerant liquid.

Therefore, h_i=220* (ΔT)

Where ΔT= 2-(-18) =20 C

Therefore h_i= 220*20= 4400kcal/m2hrk

To find h_0:

Outside fluid is air,

Let v=2m/sec

Properties of air at film temperature 2.5 C

ρ= 1.284 Kg/m3

6.2 Design of condenser

Temperature of hot solution at inlet, T_{hi}= 34˚C

Temperature of hot solution at outlet, T_{h2}= 30˚C

Temperature of cold solution at inlet, T_{c1}= 5 ˚C

Temperature of cold solution at outlet, T_{c2}= 15˚C

Assuming counter flow type heat exchanger,

$$LMTD=\frac{\Delta T1-\Delta T2}{\ln(\frac{\Delta T1}{\Delta T2})}$$

ΔT1= Th2-Tc2ΔT2
= Th1-Tc1
LMTD= [34-15]-[30-5]/ln[(34-15)/(30-5)]
$Q = [U * A * LMTD]$
Overall heat transfer coefficient:
I/U= {1/h_0+ (d_0/k)*[(d_0-d_i)/(d_0-d_i)+(1/h_1)*d_0/d_i}

To find h_0:
Average temperature of cold solution= 15+5/2=10˚C
Properties of water at 100˚C
ρ= 0.625 Kg/m3
T= 21.05*10-3 w/m^2.k
U= 13.1*(10-6)
Pr= 0.898
To find h1:
Average temperature of hot solution= 34+34/2 = 32 ˚C
Properties at 32˚C:
ρ= 592 Kg/m^3
T= 507.1*10-3 w/m^2.k
U= 0.355*(10-6)
Pr= 2.16

Equating mass flow rate
1/5.92*0.04853/60= N/4* (0.012)2*V
V=0.012m/sec
Re= v*do/W= 0.012*0.012/0.3558 (10-6) = 432.734
For external flow of constant wall temperature
Nu= 0.193*Re*0.618*Pr*0.333
Nu= 0.193*7710.91*0.618*0.898*0.333
Nu=47.014
Therefore, h_0= Nu*k/d_0= 70.68 w/m^2.k

Nu= 0.023*re*0.8*Pr*0.333
Nu= 0.432.73*0.8*2.16*0.333
Nu=3.72
Therefore, h_1=Nu*k/di= 3.72*505.1*10-3/0.012= 157.34w/m2.k
From h_i. Ho values, U , overall heat transfer coefficient is calculated.

I/U={(1/h_0+d_0/k)*(d_0-d_i/d_0+d_i)+(1/h_i)*d_o/d_i}
=[1/77.69]+[0.014/53.3]*[(14-12)/(14+12)]+[1/157.34]*[0.014/0.012]
U=46.33 w/m^2.k

Q=m*S*DT
Q=0.04853/60*4.8*103*10=38.848 W
Q=U*A* LMTD
38.838=46.44*A*21.86
A=0.0384

6.3 Design of compressor

The combination of air can be assumed to be reversible polytropic process,
P.v=constant

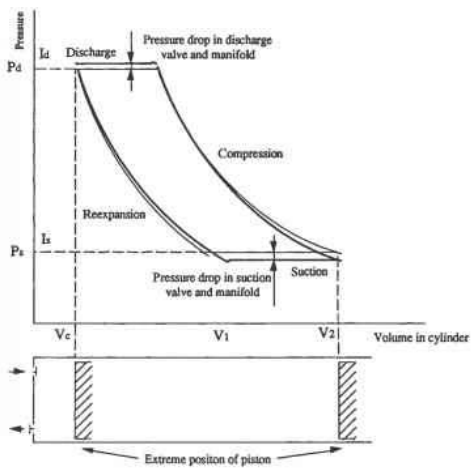

Fig -1. Design of Compressor

The net work done by a compression cycle is shown by
Work input= $\frac{n}{n-1} m.R(T2 - T1)$
Also
T2=T1(p2-p1)$^{(n-1)/n}$
Where,
n=constant or polytrophic index
m- mass flow rate of air
R= specific gas constant
T2=Air delivery temperature
T1=Air suction temperature
P2=Air delivery pressure
P1=Air suction pressure

CONCLUSION-

This paper is based on solving the live problems of more power consumption. It contains the three different units which are more expensive and low efficient. The efficiency of the designed system can be enhanced when it is converted into the actual product. Many accessories can be attached to it for making it more sophisticated. As the demand of electricity is increasing day by day and the consumption is higher than its production, so we should move towards renewable sources of energy which are available in abundance.

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