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Study of Air Cooling System with the Use of Ice Bank

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***Abstract**: The main aim of proposing this project idea is to achieve low temp air at 20°**C** to 22°**C** in less electricity consumption as well as in less cost compared to air conditioner In this report the Chapter 1 is the introduction of complete project idea. The explanation of the reason of proposing this idea and why it is effective compared to other heat exchangers. All the literature pertaining to the field of RAC in any form like books, papers and websites were which were skimmed through the course of this project finds a mention in Chapter 2. In Chapter 3 there is a full description of complete project. The complete procedure of making ice with the help of vapor compression refrigeration system. The efficient way of exchanging heat between ice and air In Chapter 4 the load calculation is performed on a particular dimensional room to get exact amount of heat to be extracted. Further the comparison of energy consumption by a normal air conditioner and by our model with the help of "Time of Day Tariff" is shown. The result of this calculation will help us to compare the efficiency of our project. The result obtain from the design iteration and load calculation are describe in Chapter 5 Chapter 6 contain the conclusions of the whole study based on the knowledge acquire and the result. The result obtain are scrutinized and proper inferences are mad from them*

I. Introduction

1.1 Over view

In residential and industrial area for per unit electricity consumption we follow the time of day tariff charges which cost is differently in whole day on per hour basis .We are using this concept to replace Air conditioner with "ICE BANK" heat exchange process. In which we will produce ice with help of compressor and coolant in that period where the per unit electricity charges are less and then we will use that ice to exchange heat from air and intake heat in the room.

1.2 Objective

In the countries like India to improve thermal comfort and indoor air quality, AC are used on the large scale. The cooling in AC is achieved through vapor compression refrigeration system, in which compressor and evaporators are use. We are using same components but using the "Time of Day Tariff Charges" which will reduced the electricity consumption charge per unit. We are going to use the compressor and evaporator to make the ICE BANKs in that period which will reduced the cost. With the help of theoretical calculation we are going to use compressor which will consume less electricity.

II. Literature Review

- In this project our mission is to take the existing science of over a hundred year ago, merge it with the innovative thinking of today and shape it into tomorrow's technology.
- One of the key limiting factors in the advancement of modern electronics is the reliable dissipation of heat.
- Currently, forced air cooling has been the preferred solution to addressing the heat problem, unfortunately current air cooling solutions are too bulky.
- We design and build a cooling pump that is up to defense testing standards while ensuring that the pump is small enough to fit in a small pre-determined envelope. We used **TESLA PUMP** to achieve the set requirements.
- Tesla pump was patented by Nikola Tesla in 1909 which uses smooth rotating .

III. Design

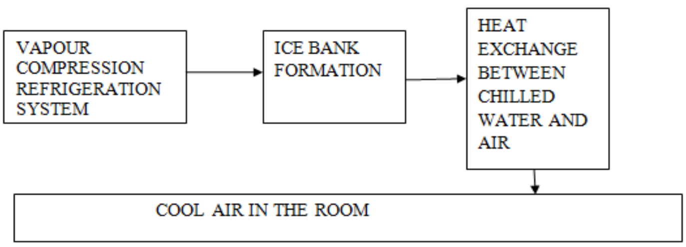

Fig: 3.1

The above layout gives brief description of the project here vapor compression refrigeration system process is used for formation of ice and with the use of heat exchanger. Heat will be extracted from the water and chilling of water will be carried out under specific flow rate, the temperature of water is maintain in the range of 4°C to 8°C and then with the use of annular circular pipe heat will be exchanged between water and blown atmospheric air and then the air is passed to the required room

3.1 VCRS

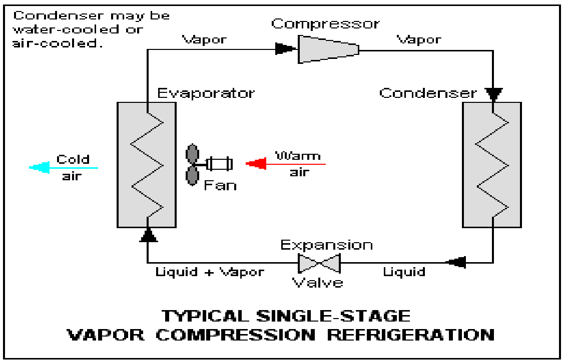

Fig.:3.1

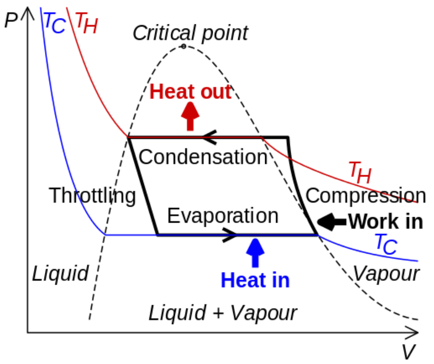

Fig 3.2

In VCRS system, we use different refrigerant to run the system. As per our requirement we can use following refrigerants-

1. R -12 (CCl_2F_2)
2. R – 22 ($CHClF_2$)
3. R -134a (CF_3CH_2F)
4. Ammonia (NH_3)

All the above refrigerant described give high cooling effect,

All such systems have four components: a compressor, a condenser, a thermal expansion valve, and an evaporator.

Circulating refrigerant enters a compressor in the thermodynamic state known as saturated vapor and is compressed to a higher pressure, resulting in a higher temperature as well. The hot compressed vapor is then in the thermodynamic state known as superheated vapor and it is cooled and condensed into a liquid by flowing through coils or tubes with cool water or cool air flowing across the tubes. This is where the circulating refrigerant rejects heat from the system and the rejected heat is carried away by either the way or air.

Then the condensed liquid refrigerant in the thermodynamic state known as the saturated liquid is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. The pressure reduction results in the adiabatic flash evaporation and low pressure and low temperature refrigerant coming out from the throttle valve is vaporized by taking the latent heat from the brine. Hence brine gets cooled which is circulated in the brine circuit. The cooled brine further absorbs the heat from water and converts water into ice.

3.2 Ice Bank And Heat Exchang.

Once ice is produced using VCRS system, it must be stored in insulated area for preventing melting of ice.

We will now using the efficient way the normal water in contact with ice and its temperature will drop to 5°C to 6°C.

We will use the chilled water to extract heat from normal atmospheric air with the help of pipes and blowers. Normally the outside temperature will be around 35 to 37°C and the chilled water temperature is 5 to 6°C. Due to large temperature difference the heat transfer will takes place and at equilibrium condition the air temperature will reduce around 17 to 18°C which we will delivered in the room to give cooling effect.

Since ice formation is going to takes place at the time when there are low charge for per unit electricity consumption. The whole power consumption by compressor and evaporator used in VCRS will at low cost.

According to Time of Day Tariff charges as given below:

Rate Schedule

Consumption Slab	Fixed/ Demand Charge	Energy Charge (Rs./kWh)
(B) > 20 kW and ≤ 50 kW	Rs. 190 per kVA per month	8.44
(C) > 50 kW		10.91

TOD Tariffs (in addition to above base tariffs) (in Rs./kWh)		
0600 to 0900 hours		0.00
0900 to 1200 hours		0.80
1200 to 1800 hours		0.00
1800 to 2200 hours		1.10
2200 to 0600 hours		-1.00

All colleges and industries work during the peak hours of the day. So as per the Time of Day Tariff charges per unit is comparatively more from the off peak charges. Hence we are operating our system between 22.00 to 6.00 am between off peak load condition. And we can deduced the cost per unite electricity consumption.

IV. Load Calculation

4.1 Data:

- GIVEN : GIVEN :
- DIMENSION: 8.5*2.8*3.5 m^3
- NORTH WEST : DOOR [1]: 0.9*2.04 m^2
- SOUTH WEST : WINDOW [2]: 1.8*1.5 m^2
- LIGHTING LOAD : 15 W/m^2 floor area
- SOLAR HEAT GAIN
- [SENSIBLE HEAT GAIN FACTOR]: 150 W/m^2
- NUMBER OF PERSON = 5
- SENSIBLE HEAT GAIN PER PERSON: 75W
- LATENT HEAT GAIN PER PERSON: 55W
- VENTILATION REQUIRE PER PERSON: 0.3 m^3/min
- OUT DOOR CONDITION: 33°C dry air temp
- FOR 43°C HUMIDITY RATIO : 0.0277 kg per kg of dry air
- INDOOR TEMPERATURE : 30°C
- FOR 30°C HUMIDITY RATIO : 0.0270 kg per kg of dry air
- Allowance factor for fluorescent light: 1.25
- Safety factor: 5%
- Factor for fan power: 5%
- Factor for leakage of supply air :1%
- Factor for heat leakage to supply air duct :0.5%
- Area of 1 door = 1.836m^2
- Area of 1 window=2.7m^2

			°C	
North wall	2.5	9.8	8	196
South wall	2.5	9.8	8	196
west wall	2.5	27.91	5	348.87
East wall	2.5	24.35	10	608.75
Roof Floor	2 3	23.8 23.8	5 2.5	238 178.5
Door	1.5	1.836	5	13.77
Window South west(2)	6	5.4	10	324 Total=2103.89W

Solar heat gain from south glass [TOTAL] Sensible heat gain from person Total latent heat from person	=(area of 2 glass window)*150 = Qs * no. of person = Q * no. of person	810W 375W 275W
Amount of infiltrated air [V1]	=L*W*H*Ac/60	1.388m³/min
Sensible heat gain due to infiltration air Latent heat gain due to infiltration air Volume of ventilation or outside air (V)	=0.02044*V1*(Td1-Td2) =50*V1*(W1-W2) =0.3m³/min per person	0.312kW 1.228kW 1.5m³/min
Outside air sensible heat	=0.02044 *V*(Td1-Td2)	0.337kW
Outside air latent heat	=50*V*(W1-W2)	1.327kW
Sensible heat gain due to lighting	= total wattage of light*use factor * allowance factor	2.677kW

In actual cooling ducts are placed below fan in rooms and offices so
(5% increase in heat due to dissipation from fan
+ 1% of leakage of supply air
+ 0.5 % for heat leakage due to duct)
The total room sensible heat (RSH) is to be increased by 6.5%

V. Conclusion

- Total Room sensible heat=[heat gain from wall+ roof + floor+ window + solar heat gain through glasses + sensible heat gain from person + sensible heat gain due to infiltration air +sensible heat gain due to ventilation+ sensible heat gain due to lighting]
  =7.033kW
- Total Room latent heat=1.06*[latent heat gain from person + latent heat gain due to infiltration air + latent heat due to ventilation]
  =3.06kW
- Room sensible heat (RSH) =7.36kW
- Total heat coming
  = total room latent heat (RLH)+ total room sensible heat (RSH)=10.42 kW
- 1 Tone of refrigeration (TR) =3.5 kW
  For 10.42 KW =2.97 TR
- 1 Ton of refrigeration (TR) =3.5 kW
- For 10.42 kW = 2.97 TR
- Calculating mass of ice
  10.42 = ṁ *
  where
  = 335 kJ/ kg ……………..(for ice at 0°C)
- ṁ = 0.031104 kg/s = 67kg/hr
- Hence ice required per hour is around 67kg

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