# Design & Fabrication of Commercial Walk in Cooler

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*Abstract*— In this project designed a model of expanded air refrigeration systems easy carrying and maintain. This project design address and overcome problems of air cooled refrigeration systems of commercial shops, business areas and also domestically usage cooling systems. Project model mainly focused to reducing cooling lose transforming from one place another place through pipes in case of centralized chilled water cooling system and also Focus of walk in cooler system weight and size minimizing to carrying easily from one place to another place within the premises by this structure saving energy comparatively more than nowadays usage cooling system. This type Design was user friendly and ecofriendly by minimizing power consumption. This cooling system easily settled anywhere like fit in rooftop package of a commercial building in the hot and dry climate condition. The optimal supply air temperature and refrigerant flow rate are calculated based on the cooling load and ambient dry-bulb temperature in summer session. Checked project performance with other of using empirically based models of the refrigeration system components for place taking and commercial advantages and also energy savings. The results are promising as approximately 12% saving of the average power consumption can be achieved in this project to a predetermined comfort constraint on the ambient temperature. Project approach will make an attractive contribution to residential and commercial shops and also stores applications for easy carrying and energy saving.

***Key words:*** Commercial Walk, Cooler

## I. Introduction

A direct expansion air conditioning (walk in cooler) system uses a refrigerant vapor expansion/compression (RVEC) cycle to directly cool the supply air to an occupied space. Walk in cooler systems (both packaged and split) directly cools the air supplied to the building because the evaporator is in direct contact with the supply air, expansion refers to the treatment of the refrigerant (a valve reduces its pressure and temperature) prior to it entering the evaporator. walk in cooler systems can come equipped with all the components in the unit (packaged system) intended for installation on the rooftop or by the side of a building; or it may have some components installed inside the building and some outside (split system). Walk in cooler systems require a ventilation fan to distribute the cool air and resupply/re-circulate it. A RVEC cycle has four basic components; an evaporator, compressor, condenser, and thermal expansion control device. The evaporator (located inside the supply air ductwork) absorbs heat through the process of expanding the refrigerant flowing within it. The refrigerant then flows to a compressor which compresses it causing it to condense in the condenser and release the heat it removed from the supply air. The condensed liquid refrigerant then flows through the thermal expansion control device which controls the flow and pressure of the refrigerant back into the evaporator. Packaged Systems – Packaged walk in cooler units contain all 4 parts of the RVEC system, as well as fans and internal ducting. These units are designed to be installed easily to serve local zones cooling needs; multiple units can be installed to service multiple zones in a building. Split Systems – These systems generally have the evaporator and fans inside the building, while the rest of the RVEC system components are a separate unit placed outside the building. This allows system designs that are more flexible, allowing performance that can satisfy greater variations on system demands. Split units are made to an incremental performance scale, meaning only certain working load sizes are available.

## II. Design & Fabrication Walk in Cooler

### A. *Specifications*

| Materials | Application |
|---|---|
| Compressor | 1/2 HP |
| Relay connections | for electrical |
| 5/6' copper tube | for evaporator |
| Capillary tube feet) | for expansion (12 |
| Condenser liquid | Air-cooled; for condensing the |
| Filter drier | Dehydrator |
| Thermostat | Automatic defrost control |
| ¼ tubes | Joining the tubings (4 feet) |
| Oil | for lubrication |
| Brazing rod | for brazing the tubings |
| Lead | For soldering |
| Wooden planks | For making the outer cabine |
| Wires | For electrical connections insulating the wires |

Table 1:

### B. *Tools Required*

- Soldering Iron
- Brazing Rod
- Tube Cutter
- Hammer
- Carpentry Tools
- Charging Line Gauge
- Vacuum Pump

### C. *Designing of Container & Assembling Parts*

The sheet of 6mm gauge wooden sheet was used for making of container for refrigeration system. The sheet of 4feet ×2 feet was made use of and the development calculations are evolved. Now as the sheet is not big enough to take the center of 120 cm, hence the point was taken outside the sheet. The point was marketed making use of a string and marker pin.

 

The angle was $90^0$c after wards the height of 135 cm was marked and the undesired portion of the sheet is cut off, in a rectangular are on both ends of the sheet and attached in the shape of L as show in fig. Thus, the sheet metal of required tapering dimensions be obtained which is then soldered from the sides to get the internal container. Marketed the box for placing the evaporator with dimension of 45x25x35 cm arranging with help on hack saw, hammer and pines attachments as shown in fig

Fig. 1: Walk in Cooler Side View

Fig. 2: Walk in Cooler Top View

The sheet of 8mm gauge wooden sheet was used for making of container for refrigeration system. The sheet of 4feet ×2 feet was made use of and the development calculations are evolved. Now as the sheet is not big enough to take the center of 120 cm, hence the point was taken outside the sheet. The point was marketed making use of a string and marker pin. The angle was $90^0$c after wards the height of 135 cm was marked and the undesired portion of the sheet is cut off, in a rectangular are on both ends of the sheet and attached in the shape of L as show in fig3.1. Thus, the sheet metal of required tapering dimensions be obtained which is then soldered from the sides to get the internal container.

*D. Assembling Process of Double Condensing Cooling System*

Brazing Process it is process of joining metal pieces by means of hard solder. Brass is mainly the main constituent of this solder. The brazing solder used in modern practice is commercially known as smelter, which is mixture of Cu, Zn and Sn. The most important phenomenon in this that the pieces to be joined are heated instead of the tube. Winding of Cu Tubes Once the internal container is repaired, it is soldered at its ends. Now 5/6" copper tubes of length one feet was wound around the outer surface of the sheet metal internal container, with equal spacing between them. These "Cu" tubes were positioned in their place firmly and rigidly with the help of soldering at place. Now these assembly functions as our Evaporator and these coils are called as Evaporator Coils. Both the ends of the Cu tubes Viz, the top and bottom of the internal container, where left free or unwound the upper portion of the tube was taken below along the external surface of the container and finally taken out of the bottom of the plastic bucket through a small boring. The other end of the coil was connected to the accumulator which is placed in between the bottoms of the bucket and the container. Ten this end was also taken out of the same boring and connected to the capillary tubes.

*E. Capillary Connection*

One end of the capillary was brazed inside the accumulator to prevent leakage. The total length used for the purpose was 12feet. Initially, some portion of the capillary was wound around the 5/16' tube coming out from the lop surface of the container. Then, this capillary is made in the form of a uniform coil and was suspended freely. This capillary tube acts as an expansion valve.

*F. Dehydrator*

The dehydrator or the filter drier is located in the fluid line at the outlet end of the condenser. Its purpose is to filter, trap minute particles of foreign materials and absorb any moisture which may be in the system. Fine mesh screens filter out foreign particles and the desiccant absorbs the moisture. The one used in this refrigerator desiccants is silica gel (silicon dioxide).

*G. Condenser Connections*

Now a small piece of copper tubes id again brazed to the free end of the filter drier, which is then connected to the condenser. The condenser used in this unit is of air cooled type. In this the tube is bent in the shape of U and placed in conjunction with the fins are responsible for holding the air in their gaps that extract heat from the hot refrigerant flowing in the tubes of the condenser.

The evaporator coils surrounding the internal container absorb the heat from the hot boy inside the container and this heat is taken by the refrigerant. This refrigerant which is ultimate passing through the condenser radiates heat to the atmosphere with help of the condenser fins.

In our unit the condenser is fixed to the rear side of the cabinet, facing the atmosphere air.

*H. Compressor Connection*

The 5/6' copper tube of the evaporator oil is connected to one end the compressor with the help of brazing. The outgoing end of the compressor is brazed to the condenser to complete the circuit.

The compressor used in this case is reciprocating type sealed unit. The horsepower of the compressor is 1/6 HP.

 

Compressor is used to establish a pressure difference and thus cause the refrigerant to flow from one part of the system to the other. At the same time the compressor raises the refrigerants pressure above the condensing pint.

At the temperature of the room air, so it will condense. It is this difference in pressure between the high low sides forces liquid refrigerant through the capillary tube into the evaporator.

### I. Thermostat

This is a temperature controlled electrical switch located on the evaporator wall. It is fastened to the evaporator will with a clamp at the lower region of the internal container. When the sensing element mounted on the evaporator wall senses the temperature lower than the operating conditions then it sends the signal to the thermostat switch immediately breaks the circuit in the relay and thus gets Tripped Off. The thermostat switch is connected to the relay. Rely thermostat has the bimetal strips, which is responsible for the make and break of the circuit.

### J. Gas Charging

When the whole of the connections has been made then gas is charged with the help of the charging cylinder and the value is closed. The whole is now checked for the leakage by applying soap solution to the joints formed by brazing. Now when no leakage was there then the gas was filled. The amount of gas by weight was 15 ibs. The gas used for this was refrigerant R134A.

## III. Result & Analysis

### A. Mathematical Analysis

- Ambient Temperature = 30
- Evaporator Temperature – $14^0$c
- From PT chart for R413a,
- Pressure at $14^0$c = 53.88 psi
- lpc cut-in Pressure = 57 psi
- Differential (Diff.) = 10 psig
- LPC cut-out Pressure = LPC CUT-IN Pressure – Differential
- LPC cut-out Pressure = 57 – 10
- LPC cut-out Pressure = 47 psig
- From P/T Chart for R413a,
- lpc cut-out Temperature at 47 psig = $12^0$

### B. Calculate Total Electrical Load of Walk in Cooler

#### 1) Compressor

- HP: ½ HP (330 watts)
- Rated Load Amperage (RLA): 0.13 Amps
- Voltage: 230 Volts
- Input Volt Ampère (VA) = Voltage x RLA
- Input Volt Ampère (VA) = 230 Volts x 1.3 Amps
- Input Volt Ampère (VA) = 299 VA
- Compressor Efficiency: 330 watts/30 watts = 11%

#### 2) Cooling Fan Motor

Electrical Data for Evaporator Model KLP104MA-S1B:

- HP: 1/15 HP
- Watts: 100 watts PSC Motor x 1
- Voltage: 230 Volts
- MCA: 1.3 Amps
- Max. Fuse: 15 Amps
- Max. Overcurrent Protection (MOP): 15 Amps
- Full Load Amps (FLA): 1 Amp
- Motor Efficiency: 100 watts/230 watts = 43%
- Input Volt Ampere (VA) = 230 Volts x 1 Amp
- Input Volt Ampere (VA) = 230 VA

#### 3) Controls Load - Thermostat

From PENN/Johnson Controls A419 Thermostat specifications,

- Voltage: 120 Volts
- Power Consomption: 1.8 VA
- Input AMP: 0.015 A
- Input Volt Ampère (VA) = 1.8 VA
- Light load Inside the container 30va
- Control load of Electric al accessories 200VA
- Total Input In Va: 299+230+1.8+30+200=760.8VA=761 watts

1) The above result shows the walk in cooler is consuming less amount electricity comparing the existed air cooling system In market least electricity consuming air condition consumes 1000 watt. But designed walk in cooler consuming 761watts.So the difference was 299watts.By this result our walk in cooler was less electricity consuming system
2) so this system can use middle class families at low maintenance cost and also it can take very less space so small houses also it can keep
3) Arrangement of this walk in cooler also take easily less skilled persons also arranged easily without any heavy effort
4) Increasing of compressor power it can use commercial building and it can replace easily in less space anywhere.

## IV. Conclusion

This project addressed the modeling and optimization problem of walk in cooler to target energy savings in a commercial building. Explicit relationships of the heating, ventilation air conditioning process characteristics with respect to the controlled and uncontrolled variables under operating conditions are established by using experimentally-collected data and empirically-based regression. The power consumption of the walk in cooler air conditioning system can then be expressed as a function of these variables in a proposed quadratic equation to facilitate the derivation of maximum energy saving conditions. A case study of a commercial building in hot and dry summer time shows the effectiveness of the proposed method.

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