Improving COP of Domestic Air Conditioning by CFD Analysis of Flow

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Abstract: *The use of split type air-conditioner is popular in residential buildings of India. Its' Aim is to improve the coefficient of performance of system, which is based on vapor compression cycle. To improve the coefficient of performance, it requires that the compressor work should be decreased, and refrigeration effect should be increased. This topic considers how the use of variable speed condenser fans enables Air Conditioner to operate more efficiently. The thermodynamic model of 1.5 tones Air Conditioner will be developed by using the CAD software like solid work and ANSYS and validated using the field data and specifications of the A.C. The staging of condenser fans and the control of their speed in various operating conditions. To increase the refrigeration effect and COP of the system in minimum time.*

Keywords: - Condenser, COP, CFD

I. Introduction

Air conditioning is the process of removing heat and moisture from the interior of occupied space, to improve the comfort of occupants. Air conditioner has four main parts, named as compressor, condenser, capillary tube and evaporator. The compressor and condenser are usually located on the outside air portion of the air conditioner. The capillary tube and evaporator located inside the indoor unit.

This project relates generally to air conditioning and more particularly to a method and apparatus for optimizing the outdoor air flow for overall system efficiency and reliability. In the design of air conditioning, it is common practice to use an outdoor fan motor equipped to operate at one speed. As such, the design is performance and efficiency optimized at specific operating conditions. While performance at other operating conditions is not as efficient, it has generally been considered acceptable on the basis of system design economy.

One problem with such conventional design is that, while the design is economical in terms of first cost, the overall cost of the system, when including operating costs for its lifetime, are substantially increased by these operational characteristics. To elaborate, the speed and the corresponding power consumption of the outdoor fan motor is set at a relatively high level to meet the capacity and efficiency requirements of the system at extremes of outdoor temperature.

Systems use the single speed motor to operate at this power consumption rate throughout the operating range even when the higher air flow is not required to meet the system needs: Specifically, at milder outdoor temperatures, for either heating or cooling, less air flow is required to perform the work required on the coil, than that required at the extreme temperatures.

Similarly, on windy days when the volume of air flowing through the coil is increased by the wind itself, the fan tends to do more work than is necessary. On the other hand, if a condition should exist such that the effectiveness of the coil is diminished, such as a buildup of dirt in the coil, or an obstruction in the inlet or discharge path of the air, then the point for which the system has been optimized will no longer be correct for normal optimized operating conditions.

II. Compressor

The compressor is most important part of the any air conditioner. It compresses the refrigerant and increases its pressure before sending it to the condenser. The size of the compressor varies depending on the desired air conditioning load. In most of the domestic split air conditioners hermetically sealed type of compressor is used. In such compressors the motor used for driving the shaft is located inside the sealed unit and it is not visible externally. External power has to be supplied to the compressor, which is utilized for compressing the refrigerant and during these process lots of heat is generated in the compressor, which has to be removed by some means.

1. III. Evaporator Coil:

The refrigerant from the tubing at very low temperature and very low pressure enters the cooling coil. The blower absorbs the hot room air or the atmospheric air and in doing so the air passes over the cooling coil which leads to the cooling of the air. This air is then blown to the room where the cooling effect has to be produced. The air, after producing the cooling effect is again sucked by the blower and the process of cooling the room continues.

After absorbing the heat from the room air, the temperature of the refrigerant inside the cooling coil becomes high and it flows back through the return copper tubing to the compressor inside the outdoor unit. The refrigerant tubing supplying the refrigerant from the outdoor unit to the indoor unit and that supplying the refrigerant from indoor unit to the outdoor unit are both covered with the insulation tape.

IV. Components of Split Air Conditioner

1. Compressor
2. Condenser
3. Condenser Fan
4. Capillary tube
5. Evaporator coil
6. Air filter
7. Blower

8. Drain pipe
9. Fins
10. Refrigerant piping

V. Objectives of Work

- Improve the efficiency and COP of VCR system.
- Improve the condenser fan performance.
- Provide better human comfort.
- Provide refrigeration effect in minimum time.
- Using next generation refrigerant global warming point is low.

V.I. Motivation

The split air conditioner is one of the most widely used air conditioners in Residencies. Earlier window air conditioner was used most widely, but the split air conditioner is now catching up with it. The major reasons behind the selection of Split Air Conditioners are popularity, Increasing Efficiency, Human comfort, Global Warming.

VI. MODELING OF CONDENSER

VI.I. Modeling

After performing simple calculation, the modeling has been performed on the Solid work version and then after the analysis work has been performed on the ANSYS version.

VI.II About Solid work

Solid work is a computer graphics system for modeling various mechanical designs for performing related design and manufacturing operations. The system uses a 3D solid modeling system as the core and applies the feature base parametric modeling method. In short Solid work is a feature based parametric solid modeling system with many extended design and manufacturing applications.

VI.III Difference between Solid work and other CAD systems

Solid work is the first commercial CAD system entirely based upon the feature based design and parametric modeling philosophy. Today many software producers have recognized the advantage of this approach and started to shift their product on to this platform. Nevertheless, the differences between a feature based, parametric solid modeling.

Solid work	Conventional CAD systems
Solid model	Wire frame and solid model

Parametric model	Fixed-dimension model
Feature based modeling	Primitive-based modeling
Subject oriented sub-modeling systems	A single geometry based system

VI.IV Feature of Solid work

- Ease of use

  Solid work was designed to begin where the design engineers begins with features and design criteria. Solid work means flow in the manner that is easily understood. This makes it simple to learn and utilize even for the most casual user. Because Solid work provides the ability to sketch directly on the solid model, feature placement is simple and accurate.

- Full associatively

  Solid work is based on a single data structure with the ability to make change built into the system. Therefore, when a change is made anywhere in the development process it is propagated throughout the entire design through manufacturing process, ensuring consistency in all engineering deliverables.

- Parametric & feature based modeling

  Solid work features are process plans with embedded intelligence and are easy to use while at the same time powerful enough to most complex geometry.

- Powerful assembly capabilities

  Assembling components is easy with Solid work simply tell the system to "mate", "insert", or "align" the components and they are assembled, always maintaining the design intent. Also, the components "know" how they are related, so if one changes, either position ally or geometrically, the other will change accordingly. Parts can be designed right in the assembly and defined by other components, so if they move or change size, the part will automatically update to reflect the change.

- Robustness

  This provides the engineer with the most accurate representation, of geometry, mass properties, and interference checking available.

- Change management

  Powerful change capabilities are inherent with Solid work full associatively, enabling design through manufacturing disciplines to execute their functions in parallel.

- Hardware independence

  Solid work runs on all of the major UNIX and Windows NT platforms, maintaining the same look and feel on every system. Users can select the most economical hardware configuration for their needs and mix and match any combination of platform.

VI.V Functions of Solid work

- Part design
  - Create sketch of the parts.
  - Sketch cosmetic features,
  - Create geometric tolerances and surface finishes on models.
  - Assign the properties like density, mass, units, materials etc.
- Assembly design:
  - Create full product assembly.
  - Disassemble components from assembly.
  - Modify part dimensions.
  - Additional functionality is also available.
- Design documentation (drawings):
  - Create, detailed, exploded, auxiliary, cross-sectional prospective drawing views,
  - Perform extensive view modifications.
  - Modify dimension values and number of digits.
  - Include existing geometric tolerances.
- General functionality
  - Database management commands.
  - Larger control of placing items.
  - Measurement commands.
  - Viewing capabilities.

3D Model is generated using Solid work CAD software. In present thesis assembly is considered for analysis. In reference literature only single plates are considered for analysis. Initially 4 plates assembly used to realize settings for conjugate interface coupling and boundary conditions. Later in CFX solver mesh is duplicated to match required number of plates.

VII. CFD Analysis

Trial is completed and same situation when investigated utilizing programming the result obtained is practically fulfilling. This demonstrates the exactness of CFD and Experimental methodologies. Here by test and CFD investigation result has 1.06 % deviation which is low and insignificant, which contrast appeared in above in table. So for the further investigation to enhance execution of the heat exchanger we can utilize CFD examination.

An improved outside get together for a warmth siphon arrangement of the sort having a variable speed blower, an open air loop, and a fan with a variable speed engine, involving; detecting implies for detecting the speed of the blower over a scope of working rates; detecting implies for detecting the temperature of the refrigerant in the outside curl; and control implies for controlling the speed of the fan

in light of both the blower speed and the refrigerant temperature in such a way as to advance the working proficiency of the fan task over the full scope of working paces.

An improved open air loop as set for wherein said control implies incorporates implies for applying

A steady multiplier incentive to said detected refrigerant temperature.

Where in said control implies controls the speed of the fan as per the accompanying calculation;

Fan speed % = a+b (CS)+c (TOC)

where:

Fan speed 7% is the percent of the greatest outside fan RPM at which the fan engine is mentioned to run;

CS is the speed of the blower standardized to its all out speed go;

TOC is the working temperature of the open air loop;

what's more,

a, b and c are constants.

6. A strategy for controlling the fan speed in the warmth siphon arrangement of a sort having a variable speed blower, an open air loop and a variable speed fan engine containing the means of: detecting the speed of the blower over a scope of working velocities; detecting the temperature of the refrigerant in the open air curl; and controlling the speed of the fan in light of the both detected blower speed and the detected refrigerant temperature in order to upgrade the working proficiency of the fan activity over the full scope of blower working rates.

VIII. Conclusion

From the test, the outcomes were watched, the end was determined that our thermodynamic temperature perusing on split climate control system is almost to CFD examination result. By utilizing variable speed of condenser fan, we saw that control necessity of split forced air system has been diminished by encompassing temperature and blower work has additionally been decreased. By utilizing variable speed of condenser fan we have expanded COP of part forced air system too. We have seen that we can limit cooling impact time on the off chance that we increment the condenser fan speed.

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