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Flow Analysis of Car AC Duct to Find Temperature, Velocity and Pressure Difference

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Abstract: *Car AC ducts are consisting of two types of cross sections, rectangular and circular. Their performance also varies with the type of duct used. In most of the cases sharp turnings are avoided so as to avoid direct contact with duct inner surface. At some places the conditioned air flow also regulated with the help of duct wings. These types of conditions affect the performance of the duct. Rectangular AC duct is commonly used and well-known type of ducting system which is implemented for the transport of conditioned air. These are cost effective and sophisticated ducting systems. At many places we find the cross section of duct decreases gradually which may affect the air flow inside the duct. It may be done intentionally to control flow inside the duct. But if it is not, then the study of their effects on the flow must be done.*

Hence it is found that the study of air behavior in AC duct is very important to know the nature of air flow in duct. There are several methods are available to simulate air flow in AC duct. But the CFD analysis method is one of the best and simple method which gives us more approximate results.

In this project CFD analysis of Car AC duct is performed for efficiency test. Pressure, velocity and temperature counters can explain the change in behavior of flow. Also coated duct is analyzed with CFD tool. Further conclusion will be drawn according to results obtained.

Keywords: CFD Tool, AC Duct

I. INTRODUCTION

1.1 Car AC Duct

An automotive air duct is assembled in your car for heating, air conditioning and ventilating your vehicle. Flaps and walls isolate two chambers of an air duct in automobiles. Vehicles have a climate control system to maintain temperature inside the vehicle. Automobiles include heating, ventilating and air conditioning (hvAC) assembly for air handling in climate control system. This assembly consists of ducts and vents to control the flow of air in and out of the vehicle. An air duct is functionally responsible for controlling transfer of air flow into and out of the occupant compartment of automobiles. Additionally, the air duct is also designed to reduce noise or vibration to a minimum. There are two types of air ducts: conventional air duct and twinsheet thermoformed air duct. Conventional air ducts are made of solid material due to which they tend to occupy a lot more space in cars and uses a lot of thermal energy. Twin sheet thermoformed air ducts are the most advanced ducts in the automotive industry.

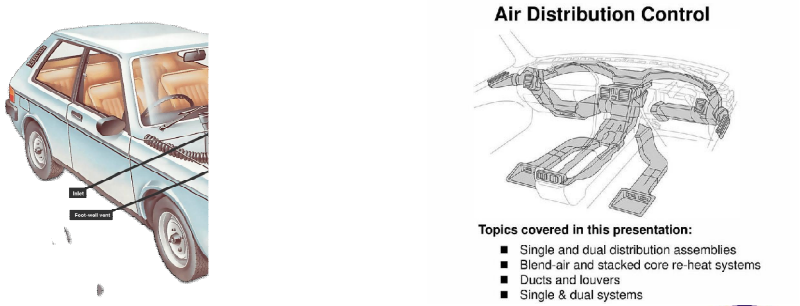

Fig. 1.1: Car Air Conditioning System

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We all love the ultimate chill blasting from the car's vents, especially when we have to survive from the hot and humid climate. When the car AC is turned on and it emits cool and refreshing air, the whole travelling becomes easy and relish. However, believe it or not, no car comes with an ice machine that is full of multiple ice cubes. In fact, the cold air that we get from the AC vents is converted from the hot air. The hot air has to go through multiple steps to convert into the cool and fresh air.

The thermodynamic process is involved here and that's what maintains the temperature inside your car room. Here, the pressure is involved and it causes changes in the inside temperature. You simply have to turn the ac on and the compressor will do the further work. However, it's not that simple as it looks.

In this blog, we will talk about the overall process involved with the working of car AC. But before that, let's dig down into reasons to have AC in your car and all components of AC.

1.2 The Basic Refrigeration Cycle

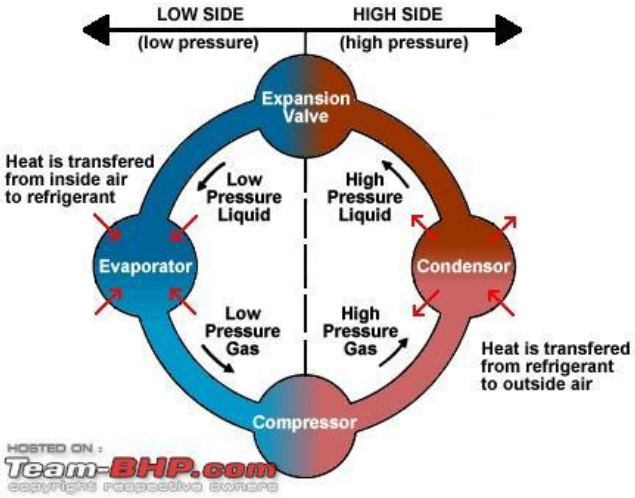

Fig. 1.2: The principle of refrigeration is based on a physical property of matter:

All liquids absorb heat when changing state from liquid to gaseous.

All gases give off heat when changing state from gaseous to liquid.

The refrigeration cycle shows how the refrigerant is transformed in the closed loop system, and in so doing, absorbs heat on the left (blue low pressure side) and sheds heat on the right (red high pressure side).

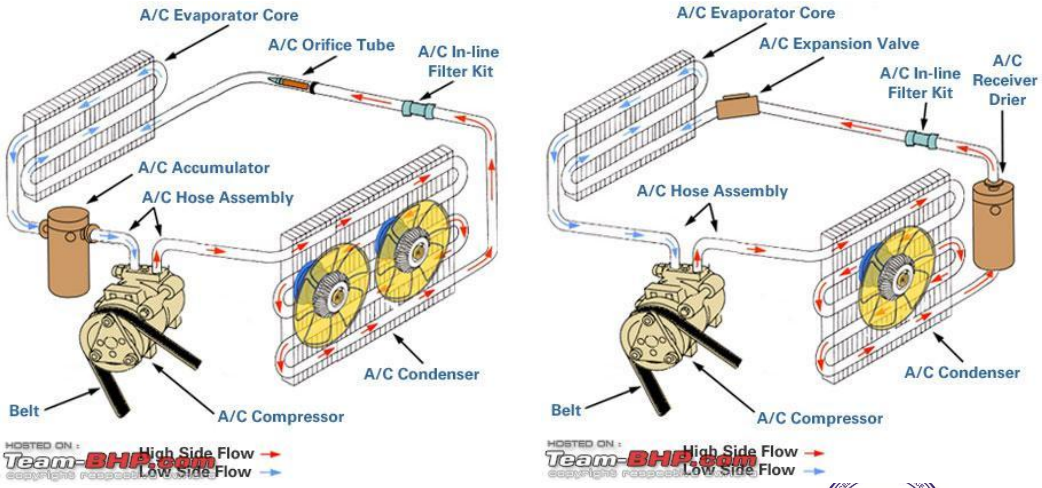

Fig. 1.3: A) Orifice tube and accumulator system -b) expansion valve and receiver/drier system

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The refrigerant gas at a low pressure enters the compressor and is pressurized to a higher pressure.the pressurized gas then flows to the condenser where it condenses to a liquid, and gives off its heat to the outside air.the pressurized liquid then moves to the expansion valve. This valve restricts the flow of the liquid, and this reduces its pressure. The low-pressure liquid then moves to the evaporator, where heat from the inside air is absorbed and changes it from a liquid to a gas. As a hot low-pressure gas, the refrigerant again moves to the compressor where the entire refrigeration cycle is repeated.

In vehicles too the same design is used. With one additional feature - the removal of moisture.

In vehicles, there are two variants of the above basic system.

From a physics perspective the main difference between the two systems is about which side the moisture gets out of the system. In a) the moisture is removed in the low-pressure side. In b) the moisture is removed in the high-pressure side.

1.3 Refrigerant

Usually described by the generic name "freon" the refrigerant gas is provided in pressurized containers and is usually a derivative of a haloalkaline refrigerant named 1,1,1,2-tetrafluoroethane or r134a. This class of refrigerant and its variants and various trade names have less ozone depleting potential than the earlier r12 based refrigerants.

This gas is also the cynosure of stewards of the environment. From earlier experiences of this gas being responsible for degenerating ozone molecules in the upper atmosphere, to today - there has been a sea change in people's attitudes towards, producing, consuming and disposing the product. Responsible manufacturers such as dupont will often certify their product with the atmospheric lifetime (in days) beyond which the product itself degenerates and ceases further harm to the planet.

Example : one kind of refrigerant used in automobiles

Fig. 1.4: Refrigerator

II. CONCLUSION

By observing all the results generated through CFD analysis for both coated and non-coated AC duct, it is found that the filament coatings can prevent the temperature losses and can improve the efficiency of the Car AC. The pressure and velocity will increase during increase of velocity value. But the temperature and density values are same for all condition. Only the region of getting maximum temperature is different in coated and non-coated AC duct. Hence implementation of filament insulation is desirable to achieve maximum efficiency of the car AC duct.

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