

# AUTOMOBILE AIR CONDITIONING SYSTEM

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**Abstract** -This paper studies the dynamics of temperature and humidity of atmosphere in a car compartment by the concept of enthalpy in analyzing the heat exchange involved. With heat change decomposed into sensible heat and latent heat, we are able to derive dynamics of temperature and humidity of the car compartment after taking into account of the difference of apparatus sensible heat factor and room sensible heat factor. These two formulas are used in conjunction with two control strategies on flow rates of supply air to simulate the intended controlled car compartment at constant enthalpy and of constant temperature. The contribution of this work is to provide a framework for automobile air-conditioning analysis and simulation.



(Fig-1: Air conditioning in car)

## 1. INTRODUCTION

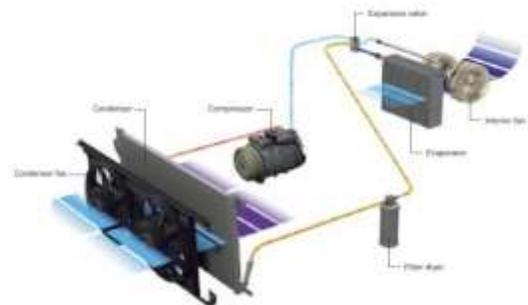
Automobile air conditioning systems cool the occupants of a vehicle in hot weather.

Automotive air conditioning is the process by which the air is cooled and cleaned, the humidity lowered and the air circulated. The quantity and quality of the air is also controlled. Under ideal conditions the air-conditioning system can be expected to accomplish all these tasks at the same time.

The air-conditioning system in modern vehicles is designed to lower the temperature to therefore assess the system's performance. The manifold and hand valves allow the system to be purged of refrigerant, evacuated of air and moisture, and recharged with new refrigerant.

Most modern gauge sets use two gauges, but some air-conditioning systems that use a pressure control regulator for the evaporator may require a second low-pressure gauge.

## 2.AIR CONDITIONING CIRCUIT IMAGE



(Fig-2: Air conditioning circuit)

## 3.COMPONENTS OF THE AIR CONDITIONING SYSTEM

1. Compressors.
2. Condensers
3. Filter Dryer
4. Expansion Valve
5. Evaporator
6. Pressure Switch
7. Ventilation Fan
8. Condenser Fan

#### 4. TYPES OF AIR CONDITIONING SYSTEM

##### 4.1 NASH INTEGRATED SYSTEMS

First American automobile to have a front-end, fully integrated heating, ventilating, and air-conditioning system. The Nash-Kelvinator Corporation used its experience in refrigeration to introduce the automobile industry's first compact and affordable, single-unit heating and air conditioning system optional for its Nash models. This was the first mass market system with controls on the dash and an electric clutch. This system was also compact and easily serviceable with all of its components installed under the hood or in the cowl area. Combining heating, cooling, and ventilating, the new air conditioning system for the Nash cars was called the "All-Weather Eye". This followed the marketing name of "Weather Eye" for Nash's fresh-air automotive heating and ventilating system that was first used in 1938. With a single thermostatic control, the Nash passenger compartment air cooling option was described as "a good and remarkably inexpensive" system. Entirely incorporated within the engine bay, the combined heating and cooling system had cold air for passengers enter through dash-mounted vents. Nash's exclusive "remarkable advance" was not only the "sophisticated" unified system, but also its \$345 price that beat all other systems.

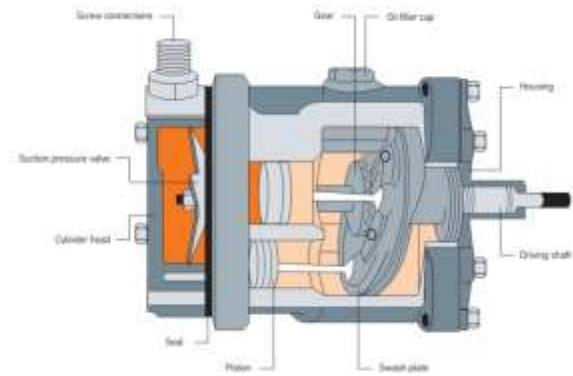
##### 4.2 AUTOMATIC CLIMATE CONTROL

Most competing systems used a separate heating system and an engine-mounted compressor, driven off of the crankshaft of the engine via a belt, with an evaporator in the car's trunk to deliver cold air through the rear parcel shelf and overhead vents. General Motors made a front mounted air conditioning system optional in 1954 on Pontiacs with a straight-eight engine that added separate controls and air distribution. The alternative layout pioneered by Nash "became established practice and continues to form the basis of the modern and more sophisticated **automatic climate control** systems."

#### 5. AIR CONDITIONING COMPONENTS WORKING

##### 1. Compressors

The air conditioning compressor is usually driven by the engine via a belt or ribbed V-belt. The compressor compresses and transports the refrigerant in the system. There are different designs available.



(Fig-3: Compressor)

##### 2. Condensers

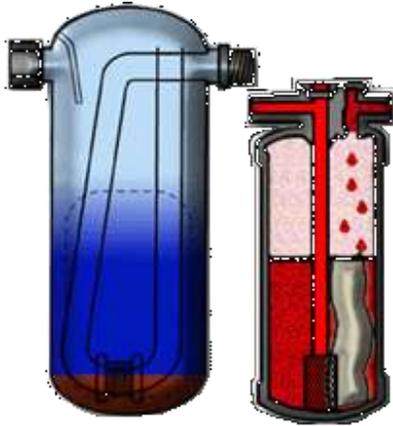
The capacitor is needed in order to cool the refrigerant that is heated up by the compression in the compressor. The hot refrigerant gas flows into the condenser and transfers heat to the surroundings via the pipe and fins. As it cools down, the state of the refrigerant changes again from gaseous to liquid.



(Fig-4: Condenser)

##### 3. Filter Dryer

The filter elements of the air conditioning system are either referred to as filter dryers or accumulators, depending on the type of system. The task of the filter dryer is to remove impurities from the refrigerant and to dehumidify it



(Fig-5: Filter dryer)



(Fig-7: Evaporator)

#### 4.Expansion Valve

The expansion valve represents the point of separation between the high pressure and low pressure sections in the refrigerant circuit. It is installed in upstream of the evaporator. To achieve optimum cooling capacity in the evaporator, the refrigerant flow is controlled by the expansion valve depending on the temperature. As a result, complete evaporation of the liquid refrigerant is ensured and gaseous refrigerant arrives at the compressor only. Expansion valves may differ in their design.



(Fig-6:Expansion valve)

#### 5.Evaporator

The evaporator is used to exchange heat between the ambient air and the refrigerant in the air conditioning system.

#### 6.Presure Switch

Pressure switches are responsible for protecting the air conditioning system against damage caused by too high or too low pressures. There are low pressure switches, high pressure switches and trinary switches. The trinary switch comprises the high pressure switch and the low pressure switch and an additional switch contact for the condenser fan.



(Fig-8:Presure switch)

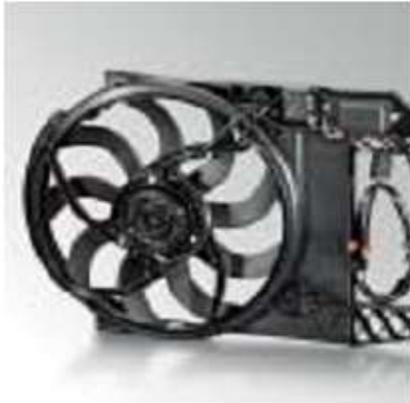
#### 7.Ventilation Fan

The ventilation fan is used to ventilate the passenger car. It ensures clear visibility and a pleasant interior climate. Major pre-requisites for safe and comfortable driving.

#### 8.Condenser Fan

The condenser fan helps to ensure the optimal liquefaction of the refrigerant no matter what operating state the vehicle is in. It is mounted upstream or downstream of the

condenser and/or engine cooling system as an additional or combination fan.



(Fig-8:Condenser fan)

## 6. OPERATING PRINCIPLES OF A.C.

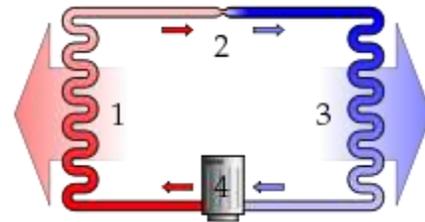
### 1. Refrigeration Cycles

In the refrigeration cycle, heat is transported from the passenger compartment to the environment. A refrigerator is an example of such a system, as it transports the heat out of the interior and into its environment (i.e. the room).

Circulating refrigerant vapor enters the compressor (located in the engine bay) and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed refrigerant vapor is now at a temperature and pressure at which it can be condensed and is routed through a condenser, usually located in front of the car's radiator. Here the refrigerant is cooled by air flowing across the condenser coils and condensed into a liquid. Thus, the circulating refrigerant rejects heat from the system and the heat is carried away by the air.

The condensed and pressurized liquid refrigerant is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in flash evaporation of a part of the liquid refrigerant, lowering its temperature. The cold refrigerant is then routed through the evaporator which is located in the passenger compartment. The air (which is to be cooled) blows across the evaporator, causing the liquid part of the cold refrigerant mixture to evaporate as well, further lowering the temperature. The warm air is therefore cooled.

To complete the refrigeration cycle, the refrigerant vapor is routed back into the compressor.



(Fig-9:Refrigeration system simple diagram)

- 1) Condensing coil,
- 2) Expansion valve,
- 3) Evaporator coil,
- 4) Compressor.

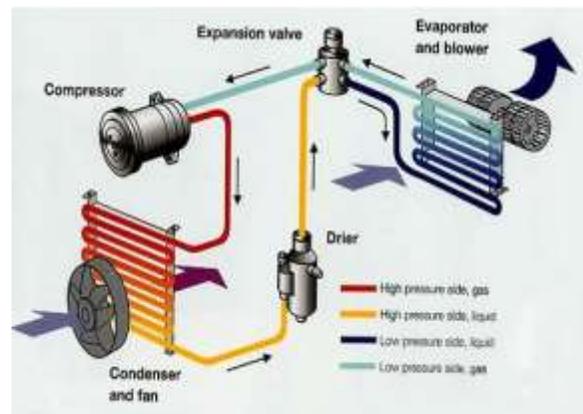
### 2. Evaporative Cooling

A car cooler is an automobile window-mounted evaporative air cooler, sometimes referred to as a swamp cooler. It was an early type of automobile air conditioner and is not used anymore in modern cars.

To cool the air it used latent cooling of vaporization (in other words, cooling by water evaporation). Water inside the cooler evaporates and in the process transfers heat from the surrounding air. The cool moisture-laden air is directed to the inside of the car. The lower the humidity, the better the system works. Because of the dry desert air, car coolers were popular in the southwestern United States states of California, Arizona, Texas, New Mexico, and Nevada.

### 3. Power Consumption

In a modern automobile, the A/C system will use around 4 horsepower (3 kW) of the engine's power, thus increasing fuel consumption of the vehicle.



(Fig-10:Operating cycles)

## 6.RESULTS AND DISCUSSION

In this project, we have tried to consolidate the idea of the Automotive Air conditioning from its conceptualization to its current status and future implications. The Automotive Air conditioning outweighs the current modes of conditioning in several ways, making it a ground-breaking application. It has a clear edge over present conditioning, travel and automobiles as it causes very less pollution.

It is thus safe to say that if the Air Conditioning in automobiles are beneficial, it will lead to a decline in the previous superior mode of conditioning. And similar to the concept of general air conditioning system.

Not only is the Automotive Air conditioning much cheaper but also overcomes most of the disadvantages of general air conditioners. Initially, the fuel prices might prevent a wide clientele, but over time, these issues can be fixed and the Air conditioning System is our next big step in the automobile industry.

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