CHAPTER 1

INTRODUCTION

1.1 AUTOMOTIVE AIR CONDITIONING STUDY

Air conditioning system is defined as the simultaneous mechanical control of temperature, humidity, and air motion [8]. Majority of automotive air conditioning is used the vapor compression refrigeration systems in its cycle. The schematic diagram as shown in Figure 1.1 has illustrated the operation of the automotive air conditioning system.

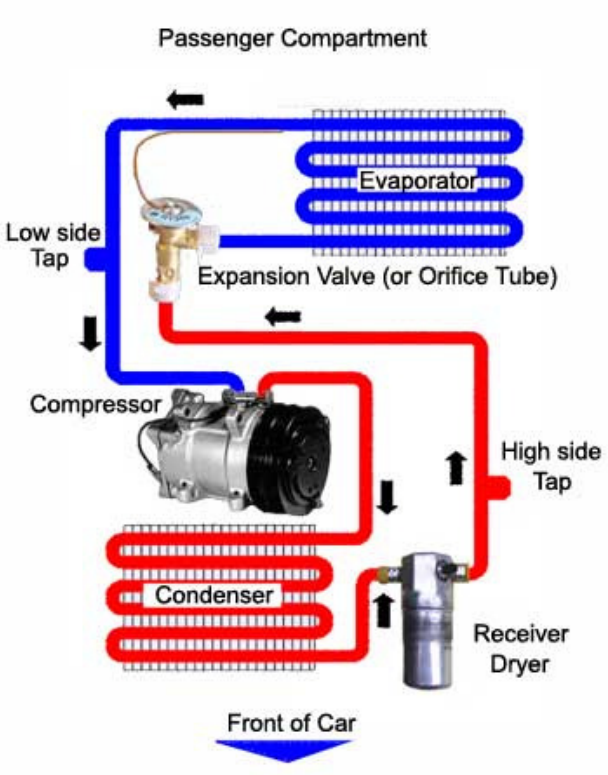

Figure 1.1: Schematic Diagram of Automotive Air Conditioning System

The major components of the automotive air conditioning system are a compressor, an evaporator, a condenser, and an expansion valve. The compressor is the heart of the air conditioning system. The compressor continuously cycles on and off to meet the cooling requirements of the passenger compartment and is mounted to the engine and is belt driven and its cycling rate is directly related to the automobile vehicle speed. At the front of the compressor is the magnetic clutch which when given power engages the compressor. The condenser is usually in front of the radiator. The expansion valve controls the flow of refrigerant into the evaporator. The expansion valve has a capillary tube with a thermal bulb that controls how far open or closed it is. The thermal bulb and the internal pressure of the refrigerant balance to control just the exact amount of refrigerant needed. The thermal bulb is clamped to the output of the evaporator. If not enough refrigerant is flowing to cool the evaporator, this bulb is sense it and open more or vice versa. The evaporator is the heat exchanger that removes heat from the inside of the vehicle. It is located in or adjacent to the passenger compartment, usually mounted on the fire wall. As the refrigerant-134a passes through the evaporator, heat transfer from the air flowing across results in the vaporization of the refrigerant. Vapor refrigerant leaving the evaporator is compressed to a relatively high pressure and temperature by the compressor. Next, the refrigerant passes through the condenser, where the refrigerant condenses and there is heat transfer from the refrigerant to the air flow across the condenser. Finally, the refrigerant enters the expansion valve and expands to the evaporator pressure. The refrigerant exits the valve as a two-phase liquid-vapor mixture and gets in to the evaporator to begin the cycle again. The airflow across the evaporator is either re-circulated air from the passenger compartment or fresh air drawn from the outside, or some combination of the two.

The refrigerant system reaches to a steady-state operating condition when the mass flow rate through the compressor is equal to the amount of vapor generated in the evaporator [4]. The automotive air conditioning system is designed to operate under a wide range of heat conditions, and as such the capacity of the fixed volume compressor is larger than needed under most operating conditions. To allow the system to function across a wide range of environmental conditions, the compressor is cycled on and off based on the low-side refrigerant pressure. The compressor is shut off when the pressure in the evaporator falls below the preset value which is

chosen to assure that condensate does not freeze on the evaporator. Even after the compressor shuts off, there will still persist a pressure imbalance across the expansion valve that will force refrigerant to flow from condenser to the evaporator. As the evaporator fills with the refrigerant, its pressure will increase. Once the low side refrigerant pressure reaches the preset level, the compressor will restart. The compressor is continuously turned on and off in this manner. Since the compressor is belt driven device coupled to the engine, when the engine speed changes so does the compressor speed, which results in a fluctuation of the refrigerant mass flow rate. Turning the compressor on and off position is provided by an electro-magnetic clutch.

There are several different types of automotive air conditioning systems which are the Receiver Drier (Filter Drier) – Expansion Valve System which uses the valve to control refrigerant flow and cycles the compressor clutch to control evaporator temperature and the Accumulator – Orifice Tube System which uses a fixed orifice and an accumulator to control refrigerant flow and cycles the compressor clutch to control evaporator temperature, and Suction Throttling Valve System which uses an expansion valve to control refrigerant flow into the evaporator and a suction throttling valve to control refrigerant flow out of the evaporator. The last system does not cycles the compressor clutch, rather it cycles the compressor suction to the evaporator.