

## **Design, Modification and Analysis of Industrial Air Compressor (Type: Vt4):A Review**

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### **1. Introduction**

#### **Abstract**

This essay reviews the significance of air compressor intercooling and how crucial it is to a successful procedure. Air compression basically means to decrease a certain volume, which causes an increase in pressure. Several stages of compression are used in the system to increase efficiency, and an intercooler is given between each level. Air quality is increased, and incoming air temperature is decreased, using the intercooler. Before the air enters the high pressure cylinder and as it exits the low pressure cylinder, the intercooler's job is to cool it. This increases the compressor's effectiveness and guarantees that the air receiver exit valves are at the ideal temperature for the best performance of the compressor's attached equipment. The tabular core or sheet metal plate components make up the cooler. The most common use of the Type VT4 compressor, a two-stage reciprocating air compressor, is for industrial purposes. The diverse efforts of the numerous researchers are highlighted in this study. On the basis of numerous studies, it is suggested that altering the intercooler's size will prevent high pressure cylinder heating in the long term.

A VT4 type two-stage reciprocating air compressor is a machine that compresses air to increase pressure, converting power (often from an electric motor, diesel engine, or gasoline engine) into potential energy. When the air is still under pressure, the energy in the compressed air can be stored in the tank. Using the kinetic energy of the air when it is depressurized is one of the many uses for the energy.

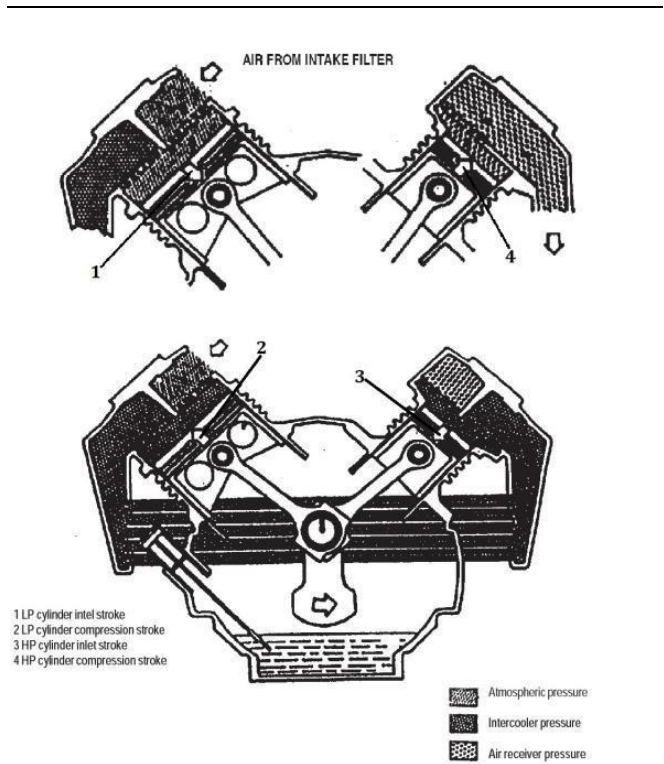
Heat transmission in reciprocating compressors has traditionally taken a back seat. The topic of the amount to which heat transfer affects compressor performance has recently attracted renewed interest, heated debate, and conflicting viewpoints. Heat transfer is a factor in compressor performance, but so are design, operation, and reliability.

In industrial plants, compressed air units are utilised for both production and maintenance tasks, with power ratings ranging from 5 horsepower to over 50,000 horsepower. The price of a compressor is far less than the valueless cost of its ongoing operation. Compression is performed in multiple stages (in this case, two stages) to increase efficiency, and an intercooler is provided between each stage. Air quality is improved, and incoming air temperature is somewhat reduced, thanks to the intercooler.

The main limitation in the design of Industrial Air Compressor (Type VT4) is the temperature of air goes higher at the inlet port of the High Pressure Cylinder which results in large discharge temperature. Due to large discharge temperature, the hose between the discharge pipe and air receiver tank get damaged regularly. Whenever temperature becomes defining parameter in the operation of Air Compressor, multi staging is required and the intercooler plays a vital role in increasing efficiency of the system. In many cases, the operational pressure ratio needs to be limited depending upon the inlet temperature, in order to keep the discharge temperature within the limits of working environment and handling air temperature.

The material properties are affected by temperature, in addition to dimensional stability and

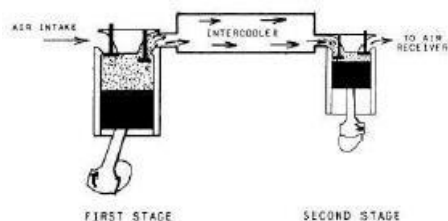
integrity of the component itself. It is the matter of concern that the outlet valves which are located above the High Pressure Cylinder becomes faulty. The faulty valve must be attended immediately. Serious damage can result if a compressor is operated with a broken valves or valve plate. In the AIR Compressor (Type VT4), Low Pressure Cylinder has two inlet or suction valves and two outlet or delivery valves. Each High Pressure Cylinder has one input or suction valve and one output or delivery valve. All valves are located in the respective Low Pressure and High Pressure Cylinder Heads.



**Fig.1:** Front View of Compressor Element

Designers have started searching for energy savings at whatever cost, since the efficiency of compressor is approaching their limits and energy deficiencies have started looming on the horizon[2]. This is driving researchers to take another look at the effect of heat transfer on the performance and efficiency of compressors. The early stages of such effort were clouded with conflicts of opinion between different groups and it is only since the 80's, that the importance of the influence of heat transfer on compressor performance has been recognized[2].

Larger Two Stage Reciprocating Compressors up to 1,000 hp are compression between the stages of each compression. Inter cooling of pressurized air affects the overall efficiency of the machine[2].



**Fig. 2:** Example of an intercooler on a two-stage reciprocating air compressor.

## 2. Literature Survey

Kanwar JS Gill et al. [1] studied designing and fabrication of intercooler and control of three phase digitalized reciprocating air compressor test rig with automatic control drive unit, international

conference of advance research and innovation.

The air compressor test rig is designed to study the characteristics of a two stage reciprocating air compressor and the compressed airflow through flow arrangement. This unit is self-contained and fully and efficient designs. Also this investigation is concerned with improving the efficiency of two stage reciprocating air compressor by providing water cooling source, radiator coolant and ethylene glycol. The experiments with air, water and different inter coolants are performed on a two stage double cylinder reciprocating compressor system.

this work. Actual volume of free air delivered by this compressor is

0.020 m<sup>3</sup>/sec with a work done of 77 N-m was the result obtained during test. Moreover it was also found that the capacity to deliver air is about 1.02 kg/minute of this compressor, when the isothermal efficiency of the compressor is 45 %. If an intercooler is specially designed it has capacity of 2.049 kilojoules/kg of heat rejection.

Ravur et al. find the compressed air tusage is increasing quickly now a day. But the efficiency of compressor is low due to the many reasons like location, elevation, length of pipe lines, inter cooler performance, even atmosphere conditions also effects the efficiency of the compressor, which increases the power consumption of the compressor. The inter cooling is the best method to reduce the coolant. In this study we are extending the investigating by changing the temperature of the water and mixing of the different types of the coolants in water at different proportions. The selection of the coolants is depends upon their properties like miscibility, self- ignition temperature, boiling point and exploding range. For this investigation ethylene glycol and glycerol as coolants and a two stage reciprocating air compressor fitted with shell and tube heat exchanger is selected. This investigation shows the good arguments between the water, glycerol and ethylene glycol [3].

instrumented with mild steel frame-mounted on raised foundation, with intercooler, air stabilizing tank and air receivers. The compressor is driven by an AC Moor. To provide adequate cooling to the system is the function of the intercooler and is supplied with pressure and temperature measuring instruments at the inlet and outlet. With the introduction of intercooler the volumetric efficiency has been increased to 100 %. In order to measure the air flow rate air stabilizing tank should stabilize the flow of air which is mandatory in Vijaykumar F Pipalia et al. [2], studied heating is an undesirable effect of the compression process at least as far as compressors are concerned and heat transfer is nature's way of driving systems towards stability. This has not only provided food for thought for researchers trying to understand its influence and quantify its effects, but also challenged designers to mitigate its impact and develop safe

Tyagi et al. showed intercooling of air compressors is necessary for increasing its efficiency. A shell and tube type of heat exchanger is particularly suitable as an intercooler between two compression stages of a compressor. A characteristic of heat exchanger design is the procedure of specifying a design, heat transfer area, pressure drops and checking whether the assumed design satisfies all requirements or not. The purpose of this research paper is to provide an easy and efficient way to design an intercooler for air compressor. This paper describes modeling of heat exchanger which is based on

commonly found in large industrial and underground mining operation applications. Discharge pressures such as air compression can range from low pressure i.e. 1 kg/cm<sup>2</sup> to very high pressure i.e. 10 kg/cm<sup>2</sup> is used for various applications, multi stage double-acting compressors are said to be the most efficient compressors available, and are typically larger, and more costly than co rotary units. Another famous type of Reciprocating Compressor is the swash plate compressor, which uses swash plate on which pistons are mounted on a shaft. Most multi-stage compressors use intercoolers in between each stage, which are heat exchangers that remove the heat of

the minimization of heat transfer area and a flow chart is provided showing the designing procedure involved[4].

The two Stage Reciprocating Air Compressors is the mostly used type of compressor found in many industrial applications such as crucial machine in gas transmission pipelines, petrochemical plants, refineries, etc. Since there is requirement of high pressure ratio, reciprocating air compressor is commonly used in locomotives. After certain period of time, unexpected failures of internal components due to miscellaneous reasons occur, which inversely affects the performance of operating system. It is essential to establish the recommended clearances mentioned for the various parts of the compressor. Compressor parts selection between repair and replacement is done on the basis of Dimensional Measurement which leads to easy maintenance in economical point of view [5].

Pawan et al. presents a study on which the main objective is to intercooling of air compressor which is necessary for an efficient process. Basically increase in pressure is a result of reduction of a specified volume which is also known as compression. This paper mainly discuss about reciprocating compressor which is widely used for air compression. Compression is done in more than one stage and between each stage intercooler is provided to improve the efficiency of the system.

Patil, used an experimental test rig has been built to test reciprocating compressors of different size and capacity. The compressors were tested with the help of air as a working fluid .The paper provide us with much needed information regarding the efficiency of the compressors operating under the same conditions with the same system parameters. This paper also highlights reports on investigation carried out on the effect of pressure ratio on indicated power, isothermal efficiency of both compressors. The result shows that the indicated power is increasing as the dischargea pressure increases, but the isothermal efficiency of both the compressor is decreasing with increase in pressure ratio. Both compressor types exhibit the same general characteristics with respect to system parameters. When the experiment was carried out for constant angular speed of compressor, no change in volumetric efficiency is observed. In addition, a comparative study was carried out for two compressors and their differences were analyzed. To verify the model's goodness with the aim of predicting the compressor performance, the study seems to be useful [7].

### **3.Problem Definition**

System under study is Industrial Air Compressor (Type: VT4). In order to investigate the applicability of proposed compressor, the image of the Air Compressor (Type: VT4) is shown in the figure 3.



**Fig. 3:** Air Compressor (Type VT4).

The fig shows Air Compressor Type VT4, the High Pressure Cylinder is getting heated up and can be viewed with the naked eye that the High Pressure Cylinder is becoming red in colour when it is made to run for longer period of time. The objective of this study is to make modification with the help of CAD in the existing model of compressor and to analyze the modified air compressor with the help of Finite Element Analysis. The main objectives were:

1. Inter Cooling of Air Compressors is necessary for achieving efficiency in the entire process. An intercooler between compression stages of a compressor can be a heat exchanger of shell and tube type particularly suitable.

### **5. Conclusions**

Reciprocating in two stages The isothermal effort needed to compress the air has decreased as a result of the many intercooling operations that the air compressor has through. As a result, compared to regular intercooling, the power needed to run the reciprocating compressor has also decreased by 1-2%. From all of the intercooling process data, it can be inferred that radiator coolant intercooling and intercooling using a blend of ethylene glycol and water produce superior volumetric efficiency than other types of intercooling. When the expenses of various coolants are not taken into account, it is possible to employ a two-stage reciprocating air compressor. In this essay, we will discuss the two-stage reciprocating air compressor and the intercooler, the primary part of the air compression system. Also, for developing the air compressor intercooler, we must employ very straightforward and timely algorithms.

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