International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 7, July - 2013

Compressed Air Distribution To Assembly Line Of Automotive Plant- A Case Study

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***Abstract*- This paper is basically a case study of compressed air distribution in assembly line of an automotive plant. Compressed air is used widely throughout industry and is often considered the "fourth utility" at many facilities. Compressed air has broad application in several pneumatic tools which are used in the shop floor in assembly of different parts during manufacturing of an automotive chassis. In this paper focus is made on different aspects of compressed air including its introduction, generation in compressor house with compressors, treatment of compressed air in dryer to remove moisture, measurement of supply of compressed air through flow meters and finally the distribution of compressed air is also discussed. Layout of compressor house of the plant along with the average consumption in different assembly line is also discussed further.**

***Keywords*—Compressed Air, Screw compressor, flow meter**

I. INTRODUCTION

Almost every industrial plant, from a small machine shop to an immense pulp and paper mill, has some type of compressed air system. In many cases, the compressed air system is so vital that the facility cannot operate without it. Plant air compressor systems can vary in size from a small unit of 5 horsepower (hp) to huge systems with more than 50,000 hp. In many industrial facilities, air compressors use more electricity than any other type of equipment. Inefficiencies in compressed air systems can therefore be significant. Energy savings from system improvements can range from 20 to 50 percent or more of electricity consumption. For many facilities this is equivalent to thousands, or even hundreds of thousands of dollars of potential annual savings, depending on use. A properly managed compressed air system can save energy, reduce maintenance, decrease downtime, increase production throughput, and improve product quality. Compressed air systems consist of a supply side, which includes compressors and air treatment, and a demand side, which includes distribution and storage systems and end-use equipment. A properly managed supply side will result in clean, dry, stable air being delivered at the appropriate pressure in a dependable, cost effective manner. A properly managed demand side minimizes wasted air and uses compressed air for appropriate applications. Improving and maintaining peak compressed air system performance requires addressing both the supply and demand sides of the system and how the two interact.

A. *Main Components of Compressed Air Systems*

Compressed air systems consist of following major components are intake air filters, inter-stage coolers, after-coolers, air-dryers, moisture drain traps, receivers, piping network, filters, regulators and lubricators.

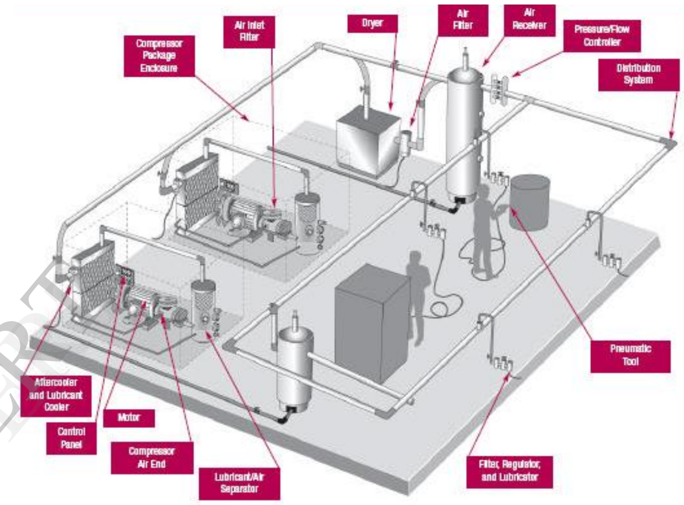

Fig. 1 Types of Compressor Components [1]

Intake air filter prevents dust from entering a compressor; dust causes sticking valves, scoured cylinders, excessive wear etc. Inter-stage cooler reduces the temperature of the air before it enters the next stage to reduce the work of compression and increase efficiency. They are normally water-cooled. After-coolers remove the moisture in the air by reducing the temperature in a water-cooled heat exchanger. The remaining traces of moisture after cooler are removed using air dryers, as air for instrument and pneumatic equipment has to be relatively free of any moisture. The moisture is removed by using adsorbents like silica gel activated carbon, or refrigerant dryers, or heat of compression dryers. Moisture drain traps are used for removal of moisture in the compressed air. These traps resemble steam traps. Various types of traps used are manual drain cocks, timer based / automatic drain valves etc. Air receivers are provided as storage and smoothening pulsating air output reducing pressure variations from the compressor.

B. *Losses and cost components in compressed air system*

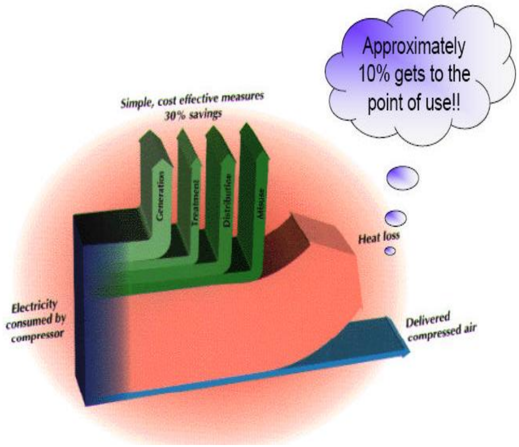

Fig. 2 Shanky Diagram for Compressed Air System (McKane and Medaris, 2003) shows the losses which are present in compressed air systems. [1]

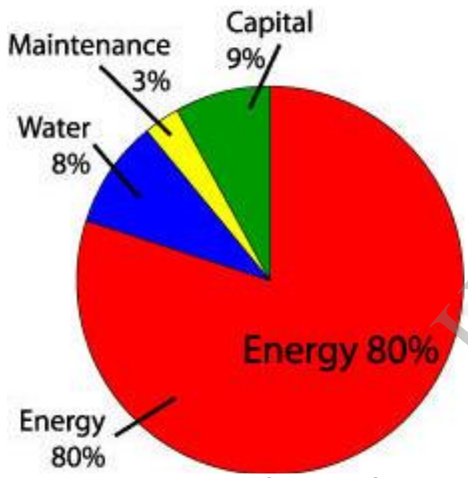

Fig. 3 Cost components in a typical compressed air system [3]

II. GENERATION OF COMRESSED AIR

A compressor is a machine that is used to increase the pressure of a gas. The earliest compressors were bellows, used by blacksmiths to intensify the heat in their furnaces. The first industrial compressors were simple, reciprocating piston-driven machines powered by a water wheel. A modern industrial compressed air system is composed of several major sub-systems and many sub-components. Major sub-systems include the compressor, prime mover, controls, treatment equipment and accessories, and the distribution system. The compressor is the mechanical device that takes in ambient air and increases its pressure. The prime mover powers the compressor. Controls serve to regulate the amount of compressed air being produced. The treatment equipment removes contaminants from the compressed air, and accessories keep the system operating properly. Distribution systems are analogous to wiring in the electrical world—they transport compressed air to where it is needed. Compressed air storage can also serve to improve system performance and efficiency. [1]

A. *Screw compressors*

Screw compressors are becoming more common due to their advantages of simplicity of construction, ease of maintenance, compactness and hence, suitability for location in a sound-proof enclosure.

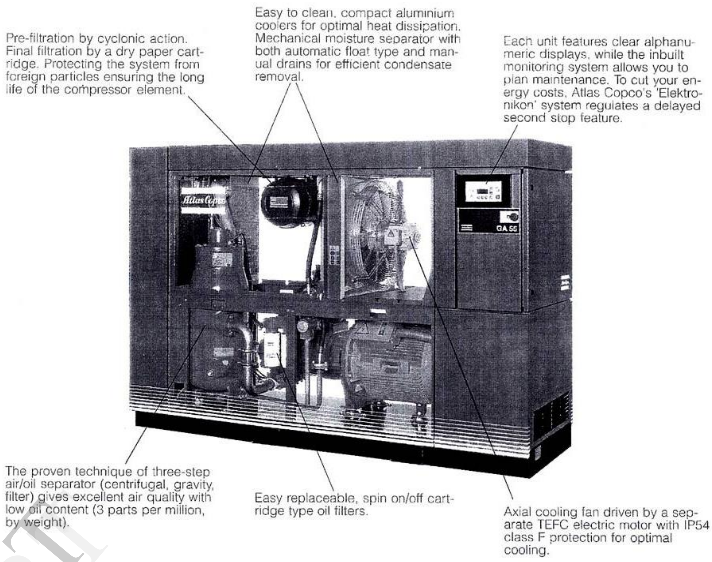

Fig. 4 Typical arrangement of a screw compressor [4]

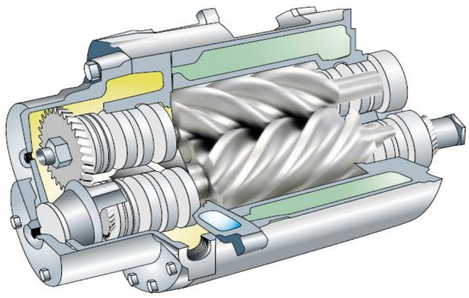

Fig. 5 A stage in an oil-free screw compressor. Male and female rotors are journalled in the rotor housing, which here is water-cooled. The front rotor, with four lobes, is the male, this is connected to the gearbox. The distant rotor, with six lobes, is the female, this is held in place by the synchronizing gear to the left. [4]

B. *Oil- injected screw compressors*

An Oil injected screw compressor is cooled and lubricated by liquid that is injected to the compression chamber and often to the compressor bearings. Its function is to cool and lubricate the compressor element and to reduce the return leakage to the intake. Today oil is the most common liquid due to its good lubricating properties, however, other liquids are also used, for example, water. Liquid injected screw compressor elements can be manufactured for high pressure ratio, which why one compression stage is usually sufficient for pressure up to 13 bar. The element's low return leakage also means that relatively small screw compressors are efficient.

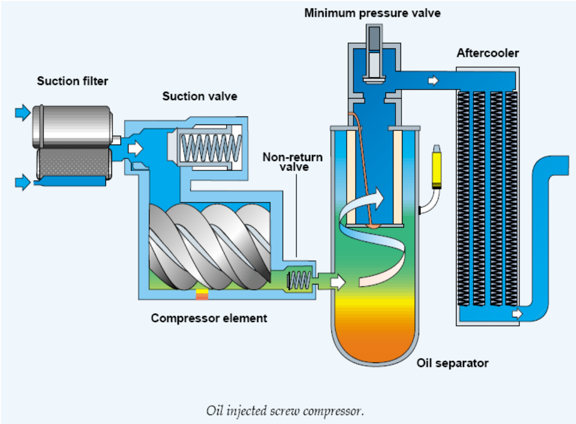

Fig. 6 Oil injected screw compressor [4]

C. *Oil-free screw compressor*

The first screw compressors had a symmetric profile and did not use liquid in the compression chamber, so-called oil-free or dry screw compressors. At the end of the 1960s a high speed, oil-free screw compressor was introduce with an asymmetric screw profile. The new rotor profile resulted in significantly improved efficiency, due to reduced internal leakage. An external gear is used in dry screw compressors to synchronies the counter rotating rotors. As the rotors neither come into contact with each other nor with the compressor housing, no particular lubrication is required in the compression chamber. Consequently the compressed air is completely oil-free. The rotors and housing are manufactured with great precision to minimize leakage from the pressure side to the inlet. The integrated pressure ratio is limited by the temperature difference between the intake and the discharge, this is why oil-free screw compressors are frequently built with several stages. [4]

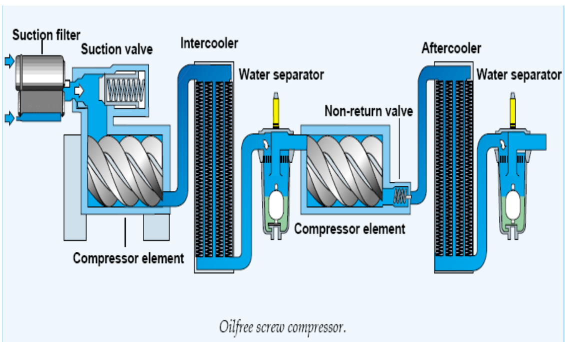

Fig. 7 Oil free compressor

III. TREATMENT OF COMPRESSED AIR

All atmospheric air contains water vapour, more at high temperatures and less at lower temperatures. When the air is compressed the water concentration increases. The term pressure dew point (PDP) is used to describe the water content in the compressed air. It is the temperature at which water vapour transforms into water at the current working pressure. Low PDP values indicate small amounts of water vapour in the compressed air. From a cost point of view, the lower the dew point required the higher the acquisition and operating costs for air drying. In principle, there are four methods to remove the moisture from compressed air: Cooling, over-compression absorption and adsorption. There is equipment available, based on these methods for different types of compressed air systems.

IV. MEASUREMENT OF COMPRESSED AIR

Flowmeters are devices that measure the amount of fluid that passes through them. Flowmeters consist of a primary device, transducer and transmitter. The transducer senses the fluid that passes through the primary device. The transmitter produces a usable flow signal from the raw transducer signal. These components are often combined, so the actual flowmeter may be one or more physical devices. Flow measurement can be described by - $Q = A \cdot v$, which means that the volume of fluid passing through a flowmeter is equal to the cross-sectional area of the pipe (A) times the average velocity of the fluid (v); and $W = r \cdot Q$, which means that the mass flow of fluid passing through a flowmeter (A) is equal to the fluid density (r) times the volume of the fluid (Q). [5]

Fig. 8 A magnetic flow meter at the compressor house of an automotive chassis assembly line.

A. *Layout of Compressor house of assembly line of automotive plant.*

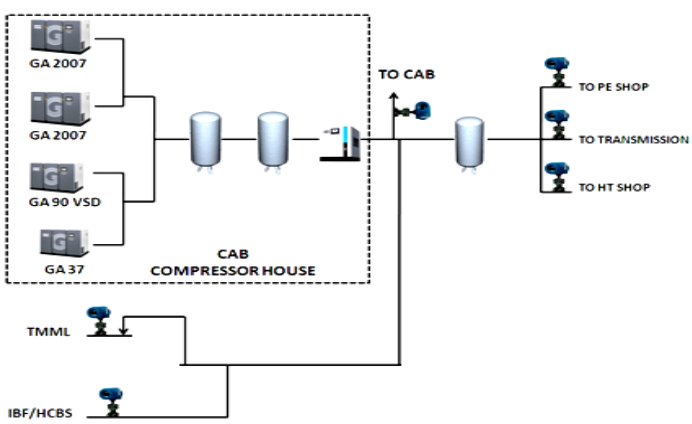

Fig. 9 This figure shows Layout of Compressor house of assembly line of automotive plant which includes CAB line, TMML Line & HCBS line as major consumption

B. *Consumption of compressed air in different sections of assembly line of automotive plant.*

Average consumptions on different shop floors is determined by plotting a graph – Consumption (CFM) vs Time (Hrs). From Graphs of Different shops it is seen that consumption drops due lunch time of Employees. Drop in consumption may be due to some break-down.

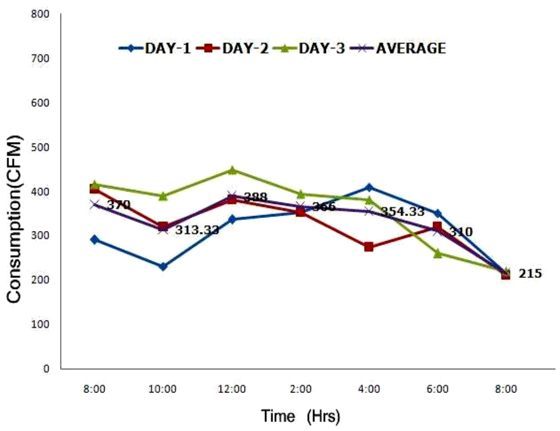

Fig. 10 The Graph shows consumption in CFM with respect to time of CAB line

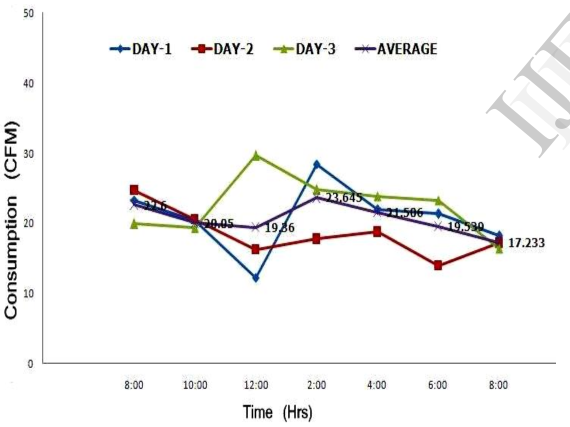

Fig. 11 The Graph shows consumption in CFM with respect to time of HCBS line

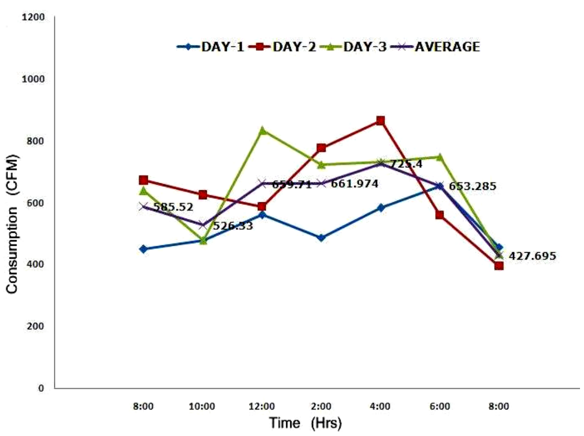

Fig. 12 The Graph shows consumption in CFM with respect to time of TMML line

V. CONCLUSION

In the present scenario, compressed air is used widely throughout industry and is often considered the "fourth utility" at many facilities. Almost every industrial plant, from a small machine shop to an immense pulp and paper mill, has some type of compressed air system. In many cases, the compressed air system is so vital that the facility cannot operate without it. In many industrial facilities, air compressors use more electricity than any other type of equipment. Inefficiencies in compressed air systems can therefore be significant. Energy savings from system improvements can range from 20 to 50 percent or more of electricity consumption. For many facilities this is equivalent to thousands, or even hundreds of thousands of rupees of potential annual savings, depending on use. A properly managed compressed air system can save energy, reduce maintenance, decrease downtime, increase production throughput, and improve product quality. Compressed air systems consist of a supply side, which includes compressors and air treatment, and a demand side, which includes distribution and storage systems and end-use equipment. A properly managed supply side will result in clean, dry, stable air being delivered at the appropriate pressure in a dependable, cost effective manner. A properly managed demand side minimizes wasted air and uses compressed air for appropriate applications. Improving and maintaining peak compressed air system performance requires addressing both the supply and demand sides of the system.

REFERENCES

[1] *Improving Compressed Air System Performance*, US Department of Energy (US DOE), Energy Efficiency and Renewable Energy. DEO/GO-102003-1822. 2003

[2] *The Compressed Air Challenge – Making a difference for US industry*, McKane and Medaris, 2003. http://eetd.lbl.gov/ea/indpart/publications/lbnl_52771.pdf

[3] ECompressedAir. *Compressed Air Audits.* http://ecompressedair.com/air.shtml

[4] Robert Robertson (1998), Compressor Air Manual, Atlas Copco, Uddvägen-7 S-131 82 Nacka Sweden.

[5] Scales, William. Best Practices for Compressed Air Systems, 2003

[6] The Wikipedia website. Available: http://en.wikipedia.org/wiki/Flow_measurement