Quality and Economics in Compressed Air System

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Compressed Air is an Important Cost Factor in Modern Foundries

Few Foundry Managers ask themselves; "How much does it cost to run my compressed air system?" Over the years it has being recognized that this is because many users do not know the operating cost of compressor and compressed air treatment equipment , or how can they calculate the cost. Also, knowledge of air quality and cost of its production remains a grey area.

Proper air quality level required for successful production is an important factor in containing compressed air energy and other operating costs, because higher quality air is more expensive to produce. It requires additional air treatment equipment, which increases capital costs as well as energy consumption and maintenance needs. The quality of air produced should be guided by the degree of dryness and filtration needed and by the minimum acceptable contaminant level to the end users.

Quality of Compressed Air:

High quality compressed air reduces the need for maintenance, increases operating reliability of the pneumatic system, control system and instrumentation and at the same time wear and tear to air-powered machines reduces.

Knowing the proper air quality level required for successful production is an important factor in containing compressed air energy and other operating costs. Higher quality air requires additional air treatment equipment, which increases capital costs as well as energy consumption and maintenance needs. The quality of air required should be according to that stated by the manufacturer of air powered machines or requirements of the process.

Sources of Contaminations in Compressed Air:

To understand the international standards for compressed air quality, sources of contaminations should be understood, the individual contaminants found within a compressed air system and the problems that contaminants can cause:

Sources of contaminations in compressed air are:

Quality of air being drawn in to the compressor

Type and operation of the air compressor

Compressed air storage devices, air treatment equipments and distribution pipes.

Quality of Air Being Drawn Into the Compressor:

The effect of intake of the compressor is important. Intake air which is contaminated or hot can impair compressor performance and result in excess energy and maintenance costs. Air compressors draw-in large volumes of air from the surrounding atmosphere containing large numbers of airborne contaminants. Such contaminants build up on compressor components like valves, impeller, rotor etc, which reduces the capacity of the compressor and increases the electrical consumption of the

compressor. This increases the operating cost of compressor for the same quantity of air for which it was operating at low operating cost while the intake air was clean.

Type and Operation of Compressor:

The quality of compressed air is also affected by the selection of the compressor. Compressor itself adds contamination particles in air, lubricator and coolant by wear and tear, resulting in reducing the life of air treatment equipment..

Compressed Air Storage Devices, Air Treatment and Distribution pipes:

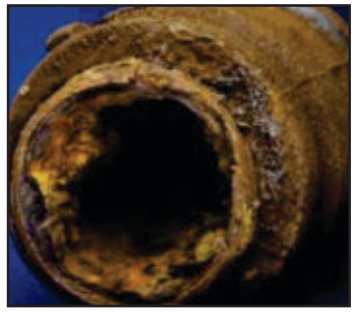
The air receiver and system piping are designed to store and distribute the compressed air. As a consequence they also store the large amounts of contamination drawn into the system. Additionally, piping and air receivers will also cool the moist compressed air forming condensate which causes damage and corrosion. As a result of this corrosion, leakages may occur in the pipes or pipe joints, which are the major cause of wastage of compressed air. Approximately 20-25 % of compressed air is wasted in leaks.

Rusted Compressed Air Tanks

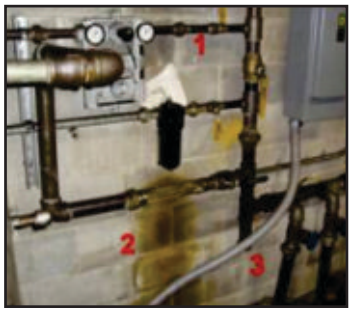
Contaminants in Compressed Air:

- Atmospheric Dirt
- Water Vapors, Condensate Water and Water Aerosols
- Rust and Pipe Scales
- Liquid Oil and Oil Aerosols
- Oil Vapors

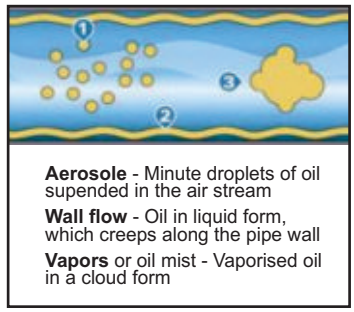
Atmospheric Dirt



Rusty Pipe



Leaks due to rust



Liquid Oil and Oil aerosols

Atmospheric Dirt

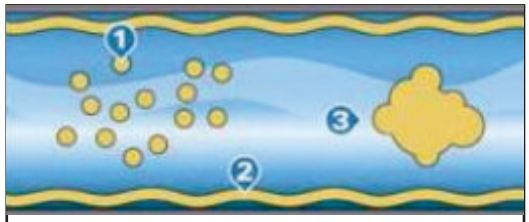
Atmospheric air in an industrial environment typically contains approximately 140 million dirt particles for every cubic meter of air.

Approximately 80% of these particles are less than 2 microns in size and are too small to be captured by the compressor intake filter, therefore passing directly into the compressed air system. Due to these particles efficiency of compressor starts to decrease with time and it starts to consume more electric energy to meet the requirements of air resulting in increased operating cost.

Water Vapour, Condensed Water and Water Aerosols

Atmospheric air contains water vapour. The ability of compressed air to hold water vapour is dependent upon its temperature. The higher the temperature, the more water vapour that can be held by the air. During compression, the air temperature is increased significantly, which allows it to easily retain the incoming moisture. After the compression stage, air is normally cooled to a usable temperature. This reduces the air's ability to retain water vapour, resulting in a proportion of the water vapour being condensed into liquid water which is removed by a condensate drain fitted to the compressor after-cooler. The air leaving the after-cooler is now 100% saturated with water vapour and any further cooling of the air will result in more water vapour condensing into liquid water. Condensation occurs at various stages throughout the system as the air is cooled further by the air receiver, piping and the expansion of air in valves, cylinders, tools and machinery. The condensed water and water aerosols cause corrosion to the storage and distribution system, damage production equipment and the end product. It also reduces production efficiency and increases maintenance costs. Water in any form must be removed to enable the system to run correctly and efficiently.

Rust and pipe scale can be found in air receivers and the piping of "wet systems" or systems which were operated "wet" prior to purification equipment being installed. Over time, this contamination breaks away to cause damage or blockage in production equipment which can also contaminate final product and process Liquid Oil and Oil Aerosols Most air compressors use oil in the compression stage for sealing, lubrication and cooling. During operation, lubricating oil is carried over into the compressed air system as liquid oil and aerosols. This oil mixes with water vapour in the air and is often very acidic, causing damage to the compressed air storage and distribution system, production equipment and final product.



Aerosole - Minute droplets of oil supended in the air stream

Wall flow - Oil in liquid form, which creeps along the pipe wall

Vapors or oil mist - Vaporised oil in a cloud form

Oil VapourIn addition to dirt and water vapour, atmospheric air also contains oil in the form of unburned hydrocarbons. The unburned hydrocarbons drawn into the compressor intake as well as vaporized oil from the compression stage of a lubricated compressor will carry over into a compressed air system where it can cool and condense, causing the same contamination issues as liquid oil. Typical oil vapour concentrations can vary between 0.05 and 0.5mg per cubic meter of ambient air.

Compressed Air System Economics:Delivering compressed air to a manufacturing facility is an expensive operation. It requires costly equipment that consumes significant amounts of electricity and needs frequent maintenance. In spite of this, many facilities have no idea how much their compressed air systems cost on an annual basis, or how much money they could save by improving the performance of these systems.

The initial cost for a 100-hp compressor is PKR 3,000,000 to PKR 5,000,000 depending on the type of compressor and manufacturer, while annual electricity charges for the same system can reach approximately PKR 5,000,000. Added to this are annual maintenance costs, which can be 10 percent or more of the initial cost of the system.

Operating Cost of Compressor:

Full Load Operation:Even if compressor is not monitored regularly the calculation of operating cost of compressor is very simple.

Following data is required to calculate the operating cost of compressor:

1. Compressor name plate rating
2. Annual hours of operation
3. Motor efficiency
4. Cost per unit of electricity

Annual Electricity Cost	(Motor Rating x Annul Hours of Operation x Electric Cost PKR/Kwh)/Motor Efficiency		
Motor Rating	55 KW	Efficiency	0.9
Annual Operating Hours	7200		
Cost Per Kwh	13PKR / Kwh		
Annual Electricity Cost	(55 x 5760 x 13) /0.9 = 4,576, 000 PKR per Year		

Based on two shift operation (8+8=16 hours a day)

Part Load Operation:

If a compressor operates below full load at times and has a good control system, electrical cost will be lower than if the compressor runs at full load during all hours of operation.

Annual Electricity Cost	[(Motor Rating x Annul Hours of Operation x Electric Cost PKR/Kwh)]/Motor Efficiency x [(percentage time running fully loaded)+ (0.3)x (percentage time unloaded)]		
Motor Rating	55 KW	Efficiency	0.9
Annual Operating Hours	7200		
Cost Per Kwh	13PKR / Kwh		
Annual Electricity Cost	[(55 x 5760 x 13) /0.9] x [0.80+ (.3)(.20)] = 3,935,360 PKR		

Based on two shift operation (8+8=16 hours a day)

Inappropriate Use of Compressed Air:

Compressed air is not cheapest energy to produce and deliver. As a result compressed air should not be chosen for applications where another source of energy is more economical. Always use a cost-effective source of power before considering use of compressed air.Many operations can be accomplished by using alternate energy sources. Some examples:

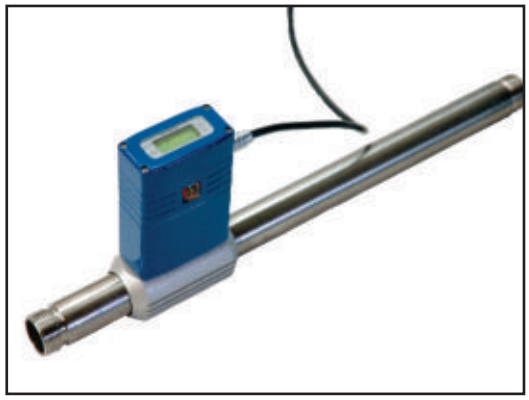
- Apply a vacuum system instead of creating a vacuum using compressed air venture methods that flow high pressure air past an orifice.
- Use compact air conditioning or fan to cool electric cabinets instead of compressed air vortex tube
- Use blowers instead of compressed air to provide cooling, aspirating, agitating, mixing, or to inflate packaging
- Use brushes, blowers, or vacuum systems instead of compressed air to clean parts or remove debris;
- Use blowers, electric actuators, or hydraulics instead of compressed air blasts to move parts;
- Use low pressure air instead of compressed air for blow guns, air lances, and agitation
- Use efficient electric motors for tools or actuators (although electric tools can have less precise torque control, shorter lives, and lack the safety of compressed air powered tools).

Other improper uses of compressed air are:

- Unregulated end uses: A pressure regulator is used to limit maximum end-of-use pressure and is placed in the distribution system just prior to the tool. If a tool operates without a regulator, it uses full system pressure. This results in increased system air demand and energy use, since the tool is using air at its higher pressure. High pressure levels can also increase equipment wear, resulting in higher maintenance costs and shorter tool life.

- Abandoned Equipment: Many plants undergo numerous equipment configuration changes over time. In some cases, plant equipment is no longer used. Air flow to this unused equipment should be stopped, preferably as far back in the distribution system as possible without affecting operating equipment

Effective Monitoring Can Reduce Compressed Air System Related Cost



Compressed air is expensive to produce and deliver. Many opportunities are available to reduce the cost of compressed air system. One way to reduce the cost is to properly using different monitoring equipments like mass flow meters, pressure meters and temperature meters because if you can not measure youcan not improve your compressed air system. Compressor performance can be checked by monitoring equipment placed right after the compressor in the compressed air line. If it is not delivering air according to settings, it means there is some problem in the compressor or it needs maintenance. If there is no monitoring equipment, there is no indication of compressor maintenance requirement as a result compressor will consume extra electrical energy to meet the demand of compressed air. Similarly machine performance can be monitored by installing monitoring equipment right before machine on a compressed air line showing machine air is consumption. If it is consumes extra air, it needs to be repaired, this will save energy as well as reduce burden on the compressed air installation.

Another opportunity to reduce the compressed air system cost is an air audit. An Air Audit can identify inefficiencies in your compressed air system and assist with entire system performance optimization, leak reduction and practical air management processes. It will help you to identify and fix leaks as they are a significant source of wastage of energy in a compressed air system. Approximately 20-25 % of compressed air is wasted in the forms of leaks from pipe joints and valves which can be brought to approximately 5% after air audit; it means it will be saving approximately 15-20% cost. It will not only reduce power consumption but will also reduce compressed air system load and wear and tear, which in turn will extend the life of the compressed air system. This can help the plant manager to take steps to improve the compressed air system. While planning new installations work on design, layout and installation of a compressor installation and air distribution system should be extracted to a capable firm, so that this beginning is made on the right foot.

Compressed Air Intelligent system Controller:

The intelligent control for compressed air system avoids unnecessary loss of compressed air, thus permitting considerable energy savings. Compressed air user must give top priority to the energy efficiency as energy accounts for up to 80 % of the total cost of owning a compressor. To optimize energy usage and energy efficiency in any system using multiple compressors, an intelligent system controller is essential. In a compressed air system where many compressors run individually without any central intelligent control system, they waste 10 to 50% of compressed air which put an extra cost in compressed air system operation.

Variable Speed Drives:

Air Compressors with VSDs are able to meet temporary peak demands without adding big connected load, and large capital expenditure of a fixed speed compressor which is generally purchased in view of the peak demand requirements. Choice of a VSD results in lower MDI cost, lower running cost and lower capital cost.

Summary:

While designing a compressed air system, quality of compressed air and cost to produce and deliver that quality to end user must be kept in mind. It is expensive, because it needs more air treatment equipments. This increases capital cost of installation and results in recurring energy cost as well as a certain amount of pressure loss. Main causes of contamination in compressed air are ambient condition of compressor, type of operation of compressor and compressed air storage treatment and distribution pipes. Several types of compressed air contaminations in the compressed air system which includes atmospheric dirt, water vapors, condensate water and water aerosols, rust and pipe oil and scales, liquid oil aerosols have been discussed.Cost of the compressor includes operating cost which is in the form of electric bills, maintenance and replacement of equipments. Approximately 20% of air is wasted in the form of leaks which can be reduced to approximately 5 % by air audit. Air audit should not just look for the leaks in the compressed air system but it should be an air quality audit to check the quality of air being delivered to the particular tool. Other than leakages, there are other inappropriate uses of compressed air which can be very expensive. There are tools and methods which are cheaper for those applications. Quality of air may be different for ever machine and equipment which is given by the manufacturer of the machine.

These inappropriate uses of compressed air can be avoided if there is a relationship between compressor user and compressor supplier company. Compressor supplier company should not be just the supplier of compressor but it should be a compressed air system expert which helps the compressor user company to train the end user staff and give guideline tutorials to the compressor user company. Staff training will help to reduce the inappropriate use of compressed air which will definitely lead to reduction in the cost of compressed air.