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# IMPROVED AIR COMPRESSION SYSTEM

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## ABSTRACT

Intercooling of air compressors is necessary for an efficient process. A heat exchanger of shell and tube typeparticularly suitable as an intercooler between compression stages of a compressor. A characteristic of heatexchanger design is the procedure of specifying a design, heat transfer area and pressure drops and checkingwhether the assumed design satisfies all requirements or not. The purpose of my research paper is to providean easy and efficient way to design of an air compressor intercooler. This paper describes modelling of heatexchanger which is based on the minimization of heat transfer area and a flow chart is provided showing thedesigning procedure involved. Computer codesfor design are organized to vary systematically the exchanger parameters such as, shell diameter, bafflespacing, number of tube-side pass to identify configurations that satisfy the specified heat transfer and pressuredrops. A case study is provided for which the program is run and the results obtained are compared with theavailable from industry data.

## 1. INTRODUCTION

Industrial plants use compressed air throughout their production operations, which is produced by compressedair units ranging from 5 hp to over 50,000 hp. It is worth noting that the running cost of a compressed airsystem is far higher than the cost of a compressor itself. The US Department of Energy (2003) reports that70% to 90% of compressed air is lost in the form of unusable heat, friction, misuse and noise. For this reason,compressors and compressed air systems are important areas to improve energy efficiency at industrial plants.

For improving efficiency compression is done in more than one stage and between each stage intercooler isprovided. Intercooler improves the quality of air and reduces inlet air temperature. On doing this largequantities of condensate (water) are formed. Disentrainment of liquids can be a problem in intercooler systemsof compressor plants, so proper separator arrangement should be made without considerable pressure drop. Inindustry, reciprocating compressors are the most widely used type for air compression.


Fig no-1 multistage air compressor

## RESONS FOR ENERGY REDUCTION

### leakage

For a particular installation get a feel for the percentage of air lost to leaks. Tests need to be conducted at night or other time when manufacturing is closed. Allow the compressor to fill the system to normal working pressure, then record the timing of the load/off-loadcycle of the compressor as it does nothing more than sustain the leaks.Compare this with the normal daily compressor cycle to estimate thelosses. The actual losses are likely to be more. Devices andcomponents used in machinery may well have dynamic leakage occurring during their normal cycle of use but no leak when notrunning.Identify leaks by listening for a characteristic hiss. Examine suspectareas and if necessary spray on a leak detection liquid and watch forbubbles. Static leak rates to individual machines and local sections canbe measured using a plug in flow meter.Please note: audio leak detection equipment is available for plant-wideaudits of large leaks even while production is operating

The basis for calculating the costs of flow losses is the waste formula:

*Total cost = 0.19 x operating hours per year x flow scfm x energy cost per kWh. (0.19 is a factor relating kW to scfm for typical compressors).*

The cost of a single continuous leak from a 0.08 in (2mm) diameter orifice with 8 scfm

is:
0.19 x 8400 x 8 x 0.068 = $ 868 / year
The average leak will take around half a man-hour to fix and offer quick payback.

## Misuse of jets

A major waste of compressed air is lack of consideration for the detailed specification and application of equipment. Frequently within a machine cycle, jets of air from nozzlesare used to carry out processes such as dusting, cooling, separating and other tasks.Sometimes due to the normal high throughput of a machine these jets are leftpermanently running. With most machines there will be times when the production

## Leakage rate for different hole diameters

How to improve energy efficiencySafety issues of hand held blowguns are of extremeimportance. Selecting pressure regulation andblowgun types of the air saver and safety design,good practice can be adopted to reduce the risk ofinjury as well as saving costs *(D2 - d2) x L x (CR1 - CR2) x N4/1728= saving in scfm,*
*Where:*
*D* = cylinder diameter (in)
*d* = piston rod diameter (in)
*L* = stroke length (in)
*CRx*= compression ratio = (P*x*+ 14.7)/14.7
*P1* = applied pressure (psig) - outstroke
*P2* = applied pressure (psig) - return stroke
*N* = cycles per minute

Fig-1 safety blow gun

## Overpressurization

Many systems run at full line pressure with the only control being the compressor cut offswitch. Pneumatic systems and individual components have an optimum operatingpressure and flow for their particular application. Both under and over pressurization will slow down production rates and over pressurization additionally increases the amount ofair consumed and wear in components.The absence of pressure regulators in a system may indicate that equipment is being usedat excessive pressures. Savings can be realized in many areas, including air tools, control valves and on the return stroke of large double acting cylinders. Check for correctLubrication, high friction will demand higher set pressures.For a device or system that is over pressurized, the cost can be calculated by using asimple calculation. For example, a system is designed to run at 45 psig and consume airat 17 cfm. If it is supplied at 100 psig, the waste of air in scfm can be found using the
Following approach:
*Compression Ratio*
*CR1 = (14.7 + P1) / 14.7 = (14.7+45) / 14.7 = 4.06*
*CR2* = (14.7 + P2) / 14.7 = (14.7+100) / 14.7 = 7.8
*To convert cfm into scfm:*
*Air usage at normal pressure = CR1 x air consumption = 4.06 x 17 = 69 scfm*
*Air usage at high pressure = CR2 x air consumption = 7.8 x 17 = 132.6 scfm*
This represents a wastage of compressed air of 63.6 scfm. Using the formula from the previous page and the same operation time this wastage represents $ 6900 / year.

# COMPRESSED AIR SYSTEM CONTROLS

## Filtration

Filtration in various parts of a system is essential for the removal of water and solidparticles. This ensures long life and trouble free operation of components in compressedair systems. The micrometer size of the filter elements determines the air quality.
The standard size for the vast majority of applications is 40 μm. Finer sizes of 5 μm and 0.01 μm are available for special applications but size for size will be more restrictive. Fine grade filters should be installed based on their specific applications. Do not filter the whole of a sub-system to a fine grade if the majority of connections to it need only standard grade.

**Dryer.**Dryer appropriateness is assessed based onthe facility's end-use applications. Dryer size, pressure drop, and efficiency are measured and evaluated. Modifications and replacements are recommended if needed.

**Automatic Drains.**Location, application, andeffectiveness of both supply-side and demand-side drains are evaluated and alternatives recommended if necessary.

**Air Receiver/Storage.**The effectiveness of the receivertank is evaluated in terms of location and size, and the receiver drain trap is examined to see if it is operating properly. Storage solutions to control demand events should also be investigated.

process is intermittent or even at a halt. Jets that continue to run in these circumstancesare incurring unnecessary costs. With a suitable valve and sensor, these can be controlledautomatically so they are only on when required.When applying jets ensure that the distance between the exit nozzle and the product is as short as possible, this will allow the supply pressure to be reduced. Air saver nozzles aredesigned to entrain and accelerate air, these produce the desired outputs with reducedsupply pressures (typically 30 psig). Savings of up to twenty times can result.

## Maintenance

Evaluate maintenance procedures, records and training. Ensure that procedures are inplace for operating and maintaining the compressed air system, and that employees are trained in these procedures.

## Compressormanagement

Large compressor installations are likely to be fitted with sophisticated power and loadmanagement systems as part of the package. Simpler compressor installations withintermittent use could also benefit from automatic compressor management systems. These use figures of expected consumption rate, storage volume and pressure to tell thecompressor how long to run in an off load condition before shutting down during times oflow or no demand.

## A safety conscious system helps to save energy

Much of the legislation, standards and codes of practice necessary to ensure safe systems deal with correct selection, installation and maintenance of equipment and systems. This includes safety details such as the use of air fuses and replacement of old polycarbonatebowls with new ones or with metal bowls.Compliance with safety requirements and advice inherently addresses many of the issuesappropriate to energy efficient systems. Add specific energy saving awareness and a few fast pay back techniques and pneumatic systems of all sizes can realize significantlyreduced operational costs and increased reliability for years to come.

## EXPERIMENTALRESULTS

The efficiency of the compressed air system increased with the reduction of the loses like air leakage, heat increased, over pressure, misuse of jet, different hole diameter etc. in this paper we see that use of some accessories like filters, dryer, intercooler, pressure switch, safety relies valve can increase the efficiency upto 10% .

## CONCLUSION

In this paper we have studied about multistage air compressor & main components used in air compressionsystem mainly intercooler. In this paper, we have used very simple and time efficient algorithms for designingof air compressor intercooler. Placement of the fluidin shell or tube side is done mainly on basis of corrosion and fouling basis which affects more on the cost ofintercooler. In this paper effect of tube length, number of tubes, fluid velocity, number of baffles and bafflesspacing on heat transfer coefficient of both side fluid is illustrated with the help of proper graph. To increase tube density, so that heat transfer will increase, triangular pitch pattern is used. Pressure drop for both sides istrying to reduce with proper spacing of baffle and baffle cut and also with tube diameter and tube length.

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