Gritco Equipment

BLASTING & CLEANING TECHNOLOGY

presents:

Compressed air conditioning

FACTS AND THEORY

Compressed air has established itself as a safe and reliable source of energy in all modern industries and is the energy carrier in direct pressure blast operations. With the continuing evolution of production processes, pneumatic equipment has become more precise and sophisticated and at the same time more sensitive to the quality of the compressed air supply.

The quality of compressed air is a crucial factor for both equipment life time, the quality standard of the finished product and above all the proper functioning of blast equipment. The air supply by industrial compressors, regardless the type, is not always suitable for direct use since it can be contaminated both at origin and during compression.

In a standard supply line the treatment of compressed air is done in 3 stages, i.e. cooling, drying and filtering. Depending on suction conditions such as temperature and % of RH, (Relative Humidity), the compressor will deliver hot and contaminated compressed air containing a considerable quantity of moisture in the form of water vapour.

For example, a compressor with a free air intake of 5 m^3/min. (175 CFM) working at a gauge pressure of 7 Bar (100 PSI) can pass 20 litres (4,4 gallon) or more water into the distribution system during a single work shift. By installing an efficient after-cooler and separator, it is possible to reduce the moisture content to less than 6 litres (1,3 gallon), thus eliminating at least 14 litres (3,1 gallon) which would otherwise condense in the pipelines and cause serious and expensive problems.

There are water- and air cooled compressed air aftercoolers and water required for industrial purposes is becoming scarcer and more expensive. Sometimes it is not even available at all or it is of such hardness or quality that it creates big problems with lime deposits inside the heat exchanger of the water cooled aftercooler. The air cooled aftercooler solves this problem cooling the air delivered from the compressor without the need for any water. Cooling air is blown across the compressed air heat exchanger by a motor driven axial fan. They can be supplied with either electric or pneumatic driven ventilators. The moisture which condenses out of the compressed air during the cooling process is removed by a centrifugal action in the condensation separator.

The closer the aftercooler brings the temperature of the compressed air to the temperature of the ambient cooling air the more moisture will be extracted from the compressed air. A sufficient dimensioned aftercooler can take out up to 70% of the moisture present in the compressed air, this depending on the suction conditions and ambient temperature etc.

For direct pressure blast operations executed on site, in 90% of all cases a mobile diesel driven compressor is used of either reciprocating piston, or rotary screw type. Depending on the ambient temperature, being one of the suction conditions, the outlet temperature may vary from 80/90°C (175/195°F) to 120/130°C (250/270°F) this without considering a possible inter- or aftercooler built in the compressor which some brands have.
In this situation an air cooled aftercooler with condensation separator and ceramic filters (further down the line) is sufficient.

With stationary compressor installations it has become a good habit to install refrigeration compressed air dryers, bringing down the content of water to an absolute minimum. This in accordance with the saturation point of water vapour referred to as the *dewpoint*.

Atmospheric air always contains considerable quantities of water vapour. By physical law, the maximum quantity of water vapour that a given mass of air can hold is proportional to its volume (water quantity decreases at increasing pressures), and increases more than proportional with the rise in temperature. When the vapour content is at its maximum under the prevailing conditions, the air is said to be saturated.

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The compression process produces two different effects :

- It increases the pressure by "pushing" more air, thus more water vapour too, into the same physical volume, which, at constant temperature, would cause part of the vapour to condense;
- It increases the temperature, thus enhancing the ability of the air to retain water in vapour form.

The second effect prevails over the first. As a result, the hot compressed air discharged by a compressor is normally not saturated and still carries all its original vapour. However, as the air is cooled down in the distribution lines at virtually constant pressure, it eventually reaches a temperature at which it becomes saturated. This temperature is referred to as its *dewpoint*. Any further decrease in temperature will force the vapour to condense into liquid water.

While vapour as such does not harm a pneumatic system, condensation and water in compressed air causes serious problems in the distribution lines and at the points of use:

- Washing away the lubricant in air tools, increasing wear and shortening their life time;
- Malfunction of pneumatic valves and control equipment and instruments, with blasting the remote control system;
- Blocking the mixing tube where media is entering the transporting air stream;
- Spoiling the product quality of blast- and paint work;
- Rusting and corrosion of distribution lines;
- Freezing of outdoor lines in winter or on expanding nozzles.

In all these cases efficiency is lost, energy is wasted, production and maintenance costs increases. All good reasons to separate and remove any condensing water before the compressed air is used!

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THE COMPLETE INSTALLATION

The installation of a dryer downstream of the air compressor aftercooler solves all mentioned problems. This eliminates the need for sloping pipework, down-legs, in-line separators and drain traps, which could otherwise be required to cope with the water condensing in the distribution system.

As aftercoolers and dryers are taking care off the temperature decrease and the removal of water and oil in the way of vapour and liquids, a filter is required to take out atmospheric and machinery contamination.

Typical urban air contains approximately 140 million particles of dust and other impurities per cubic metre. Statistically, 80% of these particles have a diameter of less than 2 microns and passes unaffected through the compressor intake filters. These intake filters are designed only to stop larger particles that could cause blockages and shorten the life of the mechanical compressor components.
The intake air also includes combustion products, hydrocarbon vapours, unburned gases resulting from industrial pollution and water vapour which is always present in the form of atmospheric humidity. The compression to 7 Bar gauge pressure (100 PSI) multiplies the concentration of all these impurities by a factor 8. This is why 1 cubic metre of compressed air at 7 Bar (100 PSI) can contain over 1,1 billion fine dust particles.

The compressor certainly does not improve the situation. Fragments of the moving parts subject to wear, and lubrication oil oxidizes at the high temperatures reached in the compression chamber are released into the air lines. It is important to bear in mind that even "oil free" compressors cannot guarantee clean air since, although they may not contaminate the air with lubrication oil, they still draw in atmospheric impurities including oil and water which, after compression and cooling, are deposited in the distribution lines. The oil, now deprived of any lubrication properties reacts with the water condensation to form corrosive emulsions which rust and block the distribution lines.

This causes higher pressure drops and reduces the efficiency of the pneumatic equipment. In some cases as with blasting and painting, both equipment and the final products, i.e. blast and paint work, are directly damaged.

The frequent maintenance or replacement of components, plant down time and the lower product quality are effecting the final product costs negatively. This obviously reduces the competitiveness of the final product in its marked.
The rational and economic use of compressed air therefor requires appropriate stages of treatment: cooling, drying and filtering.

It is common for compressed air supplied by a single compressor to have more than one application with different quality requirements. This can be achieved by different types of filtration, considered as follows :
- pre-filtration, to remove large impurities and protect subsequent finer filters.
- fine filtration, to remove micro-drops of liquid, aerosol products and fine dust particles.
- the elimination of odours and oil vapour.

Pre-filtration and fine filtration are mechanical separation processes whilst the last stage is an adsorption process.

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[use the drawing at the last page when reading the following points]

1. MOBILE COMPRESSOR

Air compressors for blast purposes in mobile execution are mostly diesel driven rotary screw compressors, either with or without built-in aftercooler. In case the compressor is not executed with a built-in aftercooler be sure a separate after-cooler is installed downstream, however as close as possible to the compressor. Even for compressors with built-in after coolers, the use of an extra aftercooler as a stand alone directly behind the compressor is advisable, because of the less effectiveness of built-in aftercoolers as they also take care of the cooling of the oil used in the rotary air package.

2. AIR COOLED AFTERCOOLER

The use of the aftercooler has been explained earlier. The size of the unit has to be chosen after the compressor capacity in m^3/min. (CFM) and the expected outlet temperature. Outlet temperature is depending on ambient temperature and type of compression. Cooling efficiency expressed in delta-T, is approximately 10°C (50°F) above cooling media temperature. In case of air cooled after coolers, 10°C (50°F) above ambient temperature.

The selection of the aftercooler could be made easily, by taking the same capacity as the compressor is. It's however also possible to calculate the required capacity by the size of the blast nozzle, working pressure, number of blasters and auxiliary equipment such as airless pump(s), pneumatic agitators, (paint mixers) and other pneumatic equipment. For one operator, working with a 10 mm (⅜") orifice blast nozzle at 7 Bar (100 PSI) gauge, the required capacity of compressed air is 6 m^3/min. (210 CFM).

A lower delta-T, i.e. a higher cooling efficiency can be obtained by an over dimensioned capacity of the aftercooler, for instance using an 8 m^3/min. (280 CFM) aftercooler for 6 m^3/min. (210 CFM) compressor. Delta-T's as low as 3-4-5°C (37-39-41°F) are possible.

3. SEPARATOR

The task of the separator, either the gravity or the centrifugal type, is to remove the condensation mixture of water and oil from the compressed air.

4. AUTOMATIC DRAIN

Every separator and filter, as well as other useful drain points, can be executed with an automatic drain. They are in standard execution delivered with a manual drain. These automatic drains are available in mechanical floating, electromagnetic versions with timers or condensation level controls.

5. AIR RECEIVER

In horizontal or vertical execution of sufficient content to eliminate pressure fluctuations of the compressor at full and down load, as well as from compressed air consumption during operations.

6. COMPRESSED AIR FILTER

The use of a filter has been clarified earlier. The size and type of filter is determined after the consumption (capacity) of the installation or equipment behind the filter. I.e. in case of a blast machine with a 10 mm (⅜") orifice nozzle working at 7 Bar (100 PSI) gauge pressure, the compressed air consumption is mentioned as 6 m^3/min. (210 CFM). The filter should in that case at least be of corresponding capacity or bigger.

7. BLAST MACHINE

Blast machines are available in many types and sizes. Their main task is the pressure levelling over the content of media hold in the tank and the transport air. The adjusted blast pressure and the orifice of the used blast nozzle determine the compressed air consumption. The blast machine itself doesn't consume any compressed air at all, except for pilot air to operate the pneumatic remote control system.

A good blast machine should be executed with :
- separate main air valve;
- separate decompression valve with silencer;
- choke valve;
- filling valve;
- safety valve;
- abrasive metering valve.

It is recommendable to use blast machines with remote control systems, enabling the operator to start and stop the machine himself from the working area. An integrated deadman handle for this remote control system also offers an extra safety for the operator. Remote control systems are available in both pneumatic and electro-pneumatic executions.

8. FILTER, PRESSURE REDUCER AND LUBRICATOR SET

Its advisable to install a filter, pressure regulator, lubricator combination before all rotary and reciprocating equipment like air motors, paint mixers and airless pumps.

9. AIRLESS PAINT SPRAY EQUIPMENT

There are many brands and types of paint spray installations other then the mentioned airless system. However the airless method is mostly used for industrial paint applications. The paint is atomized by the pressure that the reciprocating air motor of the pump transfers to the liquid cylinder inside the fluid section. Pressure ratio may vary from 10:1 to 65:1, meaning that the liquid pressure will be 10 to 65 times higher than the adjusted air pressure.
Every airless paint spray installation should be equipped with the mentioned (8) filter, pressure reducer, lubrication set.
The filter to clean the compressed air, the reducer to set the required pressure ratio and the lubricator to maintain the air motor of the unit.

10. PAINT SPRAY GUN

The paint spray gun is an important tool and should be suitable for the required pressure according to the set pressure ratio of the airless pump. With the use of airless spray guns a tip filter and/or quick clean reversible spray tip are necessities.

11. BREATHING AIR FILTERS

The use of a breathing air filter combination by the operator is a necessity, not to mention an obligation. Due to the confined space inside the helmet, the dusty surrounding at site and the intensity of the labour good quality breathing air is essential. The investment in a filter combination will pay of rapidly, as the operator will last longer and with more attention to the process.

12. VORTEX HELMET AIR CONDITIONER

The Vortex helmet air conditioner is a special tool to cool down or warm up the breathing air, especially appreciated by operators working in hot or cold climates

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13. BLAST HELMET
The use of a blast helmet is obvious. The helmet should offer good visibility, preferably wide view, to the operator and must be light and comfortable to wear. Many brands and types are available, even with built in safety feature indicating that compressed air is present.

14. REMOTE CONTROL
In order to operate a blast machine with a remote control, the main air and decompression valve should be pneumatic types. With respect to safety, the main air valve must be a so called "spring closed type" i.e. normally closed.
The combination of the remote control and the deadman handle enables the operator to start and stop the machine from a distance, in other words from his working site. The best and safest system is a two line positive pneumatic remote control.

15. DEADMAN HANDLE
The deadman handle is a part of the remote control system and is available in different executions. Mainly pneumatically but also electro-pneumatic systems are in use.

16. BLAST NOZZLE
Blast nozzles are chosen in orifice after the compressor capacity and the type of job. All dimensions from 4 mm (1/4") diameter up to 12,5 mm (½") are standard nozzles. Nowadays even bigger dimensions such as 14 mm (9/16") and 16 mm (5/8") are available. Blast nozzles can be delivered with different linings, such as tungsten and boron carbide, silicon carbide and silicon nitride etcetera.

The selection of the blast nozzle depends on the type of abrasive used and the type of work to be processed.

17. STATIONARY PISTON COMPRESSOR

18. STATIONARY ROTARY COMPRESSOR
Instead of the earlier mentioned mobile compressor installation, it is also possible to carry out blast and paint-spray operations from a standard compressed air supply line. These lines are connected to the compressor house where stationary electric driven compressors are installed. Many types and brands are available such as single and multi-stage reciprocating compressors, single or double acting. Rotary screw and vane compressor and many more.

19. AFTERCOOLER
As mentioned under item 2. In case of a mobile installation, the aftercooler is built in a transport frame and is the ventilator connected to an air motor. For stationary installations the aftercooler is installed without the frame and is executed with a electric motor.

20. DIRECT EXPANSION REFRIGERATION DRYER
As explained above, normally only installed in stationary compressor plants.

21. AGITATOR
Pneumatically driven paint mixer in order to prepare paint and lacquers for application. Available from 0,3 to 1,5 HP in power. Power selection depending on the type and quantity of paint to be mixed, from light lacquers to 2 component high built epoxy paints.

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22. PRESSURE INDICATOR

Gives an exact reading of the pressure in Bar or PSI. Indicates whether the vessel is still under pressure.

23. SAFETY VALVE

A spring adjusted safety valve to be set at the maximum allowed pressure of the air receiver. As soon as the pressure will rise over the set safety pressure, the safety valve will be activated releasing compressed air until the set maximum pressure is reached again.

The same type of valve is sometimes mounted on a blast machine to ensure a maximum working pressure for cleaning delicate parts. The safety valve is then set to the maximum allowed working pressure for the process, like 3 or 4 Bar (45 or 60 PSI).

INFORMATION

More detailed information about after coolers and filters as well as a capacity table and price list can be obtained from:

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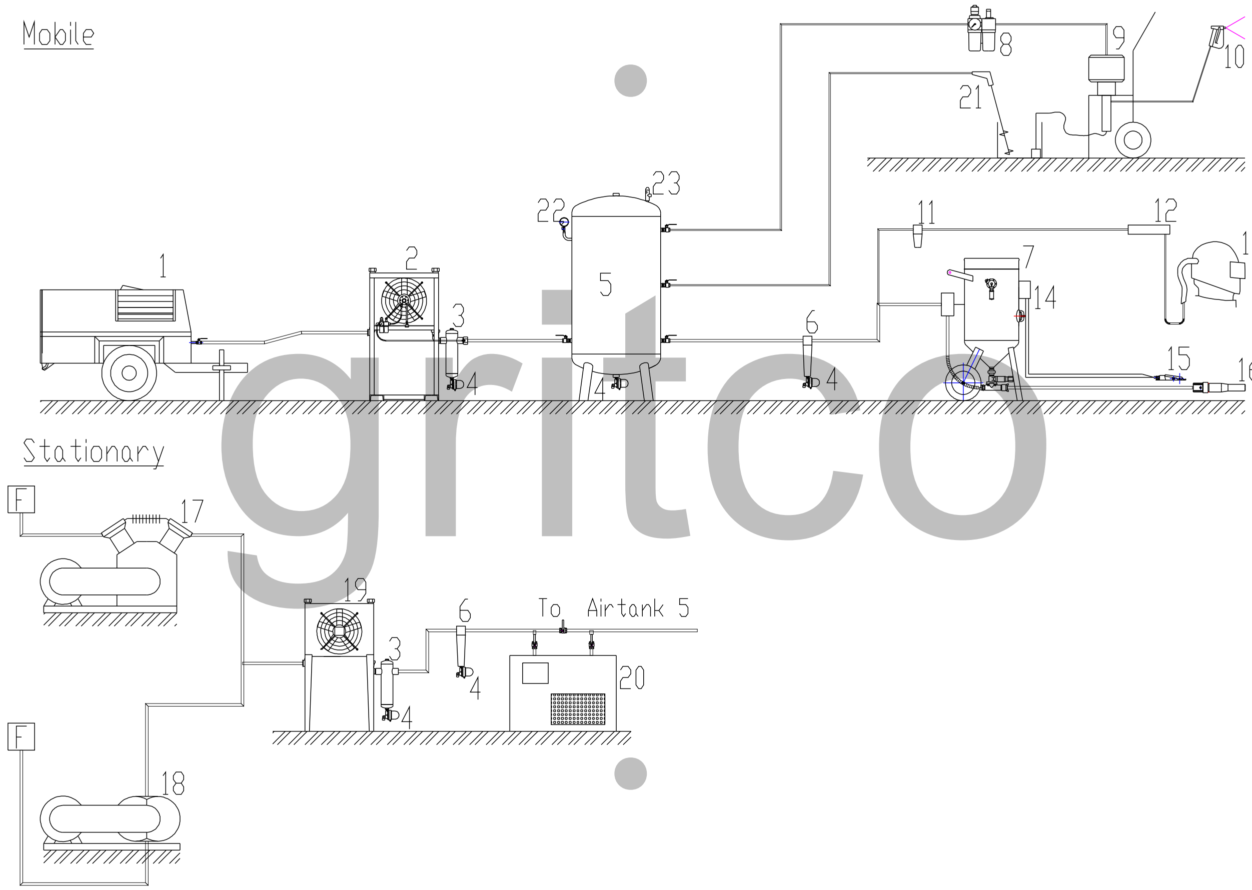

CALCULATING COMPRESSED AIR CONSUMPTION

The compressed air consumption of <u>every</u> blast installation is <u>only</u> determined by nozzle diameter and blast pressure.
Blastpot contents, piping or hose diameter <u>do not</u> influence the consumption.

This consumption can be calculated by multiplying the surface of the nozzle orifice by a certain factor of the set working pressure:

Factor

at 2 Bar = 0,39 (ltr/sec)/mm^2
at 3 Bar = 0,59 (ltr/sec)/mm^2
at 4 Bar = 0,78 (ltr/sec)/mm^2
at 5 Bar = 0,98 (ltr/sec)/mm^2
at 6 Bar = 1,18 (ltr/sec)/mm^2
at 7 Bar = 1,37 (ltr/sec)/mm^2
at 8 Bar = 1,57 (ltr/sec)/mm^2

Different nozzles at 3 Bar

Nozzle 3 mm = 7,07 mm^2 x 0,59 x 60 = 250,28 ltr/min = 0,25 m^3/min
Nozzle 4 mm = 12,57 mm^2 x 0,59 x 60 = 444,98 ltr/min = 0,45 m^3/min
Nozzle 5 mm = 19,64 mm^2 x 0,59 x 60 = 695,26 ltr/min = 0,70 m^3/min
Nozzle 6 mm = 28,28 mm^2 x 0,59 x 60 = 1001,11 ltr/min = 1,00 m^3/min
Nozzle 7 mm = 38,47 mm^2 x 0,59 x 60 = 1361,84 ltr/min = 1,40 m^3/min
Nozzle 8 mm = 50,27 mm^2 x 0,59 x 60 = 1779,56 ltr/min = 1,80 m^3/min
Nozzle 9 mm = 63,59 mm^2 x 0,59 x 60 = 2250,90 ltr/min = 2,30 m^3/min
Nozzle 10 mm = 78,55 mm^2 x 0,59 x 60 = 2780,67 ltr/min = 2,80 m^3/min
Nozzle 11 mm = 94,99 mm^2 x 0,59 x 60 = 3362,65 ltr/min = 3,40 m^3/min
Nozzle 12 mm = 113,10 mm^2 x 0,59 x 60 = 4003,74 ltr/min = 4,00 m^3/min

Different nozzles at 6 Bar

Nozzle 3 mm = 7,07 mm^2 x 1,18 x 60 = 500,46 ltr/min = 0,50 m^3/min
Nozzle 4 mm = 12,57 mm^2 x 1,18 x 60 = 889,95 ltr/min = 0,90 m^3/min
Nozzle 5 mm = 19,64 mm^2 x 1,18 x 60 = 1390,51 ltr/min = 1,40 m^3/min
Nozzle 6 mm = 28,28 mm^2 x 1,18 x 60 = 2002,22 ltr/min = 2,00 m^3/min
Nozzle 7 mm = 38,47 mm^2 x 1,18 x 60 = 2723,68 ltr/min = 2,70 m^3/min
Nozzle 8 mm = 50,27 mm^2 x 1,18 x 60 = 3559,11 ltr/min = 3,60 m^3/min
Nozzle 9 mm = 63,59 mm^2 x 1,18 x 60 = 4501,81 ltr/min = 4,50 m^3/min
Nozzle 10 mm = 78,55 mm^2 x 1,18 x 60 = 5561,34 ltr/min = 5,60 m^3/min
Nozzle 11 mm = 94,99 mm^2 x 1,18 x 60 = 6725,29 ltr/min = 6,70 m^3/min
Nozzle 12 mm = 113,10 mm^2 x 1,18 x 60 = 8007,48 ltr/min = 8,00 m^3/min

When choosing the capacity of compressor, after cooler and filter also add up the air consumption of air motors, pump units etc.

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