BOOSTER VALVES

By Ian Speer

Why do booster valves sometimes fail very quickly and sometimes last for very long periods? How effectively can they be repaired? What are the pros and cons of using concentric style valves?

Right from the start it should be said that there are thousands of types of valves and piston compressors. In this article we will only consider the two types of valves used in the most common brands of air boosters found in Australia as supplied by several major valve manufacturers of the many in the marketplace.

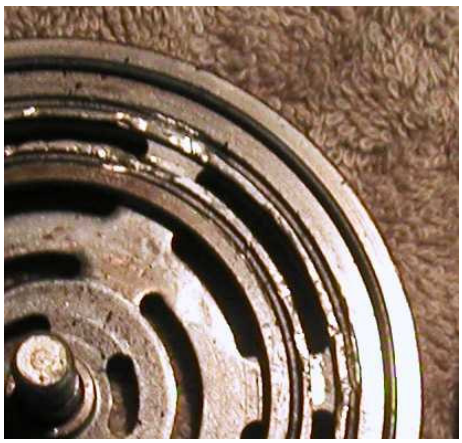
In no particular order they are the Ariel, Hurricane and Airesearch booster units. There are others such as the LAFCO units from GD however we will consider the valves that suit the first three mentioned. We will also only consider the more common models sold in Australia as both Hurricane and Ariel produce a very wide range of products.

Plate valves as used in booster compressors are influenced by a number of factors and if we address each factor in turn there are potential gains in life as well as reliability to be achieved. The valve manufacturers mentioned are Hoerbigger and Klaus.

Unit operating speed

Simply put the faster a plate valve has to operate the shorter its life will be as in general the faster a valve operates the higher the force (stronger spring) to close it will be. Of course clever valve designers can make the moving parts progressively lighter but then durability becomes an issue.

Inlet Temperature



All materials; be they steels or any of the multitude of plastics used in the manufacture of valve plates are adversely effected if exposed to excessive heat. The nylons are the least heat resistant followed by thermoplastics then PEEK a high temperature non metallic material and then steel plates. There are some other less common materials in use being ceramics and Teflon however these are not normally found in the valves we are considering.

Pressure rise across the booster

If one divides the discharge pressure out of a booster by the inlet pressure the result is a number which is the pressure ratio. For example if we are drilling using a booster with the inlet pressure at 300 psig and the booster is delivering compressed air at 750 psig then the result is 750/300 = 2.5.

The higher the pressure ratio the higher the discharge temperature out of the booster cylinder will be. You may have read in other articles that in air compression service if the pressure ratio goes above 2.5 in a booster then reduced valve life will almost certainly result. If possible the pressure ratio is better kept in the 1.8 to 2.0 area where all other things being equal valve life will be acceptable.

Valve operating temperature

The hotter the valve the shorter its life will be and in the case of steel valve plates prolonged operation over 350ºF will shorten valve life. Steel valve plates can operate up to 450ºF intermittently however lower temperatures will result in longer life.

In the case of the non metallic materials the valve operating temperatures are restricted to lower values. All valves we are considering will benefit from lower operating temperatures.

Contaminants in the incoming air/gas stream

Any contaminants in the air stream will have to pass through the valve and as the valve opens and closes. If a particle is caught between the plate and the seat damage will result. A second effect is that the valve will run hotter as it cannot close fully and thus air will leak through the gap and start to scour the surface of the valve plate and seat as well as creating additional heat.

Valve plates are heated by the hot air passing through them and there is some cooling of the valve plate as it seats on the body in some valve designs. This cooling is lost if the valve plate fails to seat correctly.

Unloading systems

Some unloading systems hold valve plates off their seats when the booster is not required to deliver compressed air others either dump air or recirculate the compressed air within the booster itself. Other boosters have a bypass system to recirculate air within the unit while others bleed

off air and go into a low pressure bypass mode.

Whichever unloading system is used it is important that some sir movement is possible and that the cooling system can cool the unit while it is unloaded.

Type of valve concentric v/s standard valve

The Airesearch and Hurricane boosters use a concentric style valve which combines the inlet and discharge valve functions within a single valve body while the Ariel units use separate valves for inlet and discharge duty.

Advantages and drawbacks of each type of valve

Which is better? The concentric units have an advantage in that they have the cooler inlet air passing through the centre of the valve and there is some external cooling around the outside of the valve. Hence the hot discharge air passes through an annulus and heat can be dissipated in several directions.

The dedicated valves in the Aerial units are deeply pocketed in heavy metal castings and the inlet and discharge valves are completely separate. As a result any overheating or transient high temperatures in these units will more than likely result in reduced valve life.

The concentric valves have limitations in their design and the individual valves often achieve higher efficiencies. The concentric valves are more complex and more expensive as well as harder to repair and if not well designed can have structural problems.

Materials used in valve construction.

Concentric valves almost all have steel valve plates and steel valve springs. The individual valves as used in the Ariel units can have any of 3 common non metallic materials previously mentioned as well as steel plates.

Which is better? Steel is more durable but heavier. If a steel valve plate fails and fragments get into the booster cylinders considerable damage will result. On the other hand some plastic fragments from a non metallic valve will probably not result in much damage.

Steel valve plates require precision lapped sealing surfaces while the non metallic valve plates conform more easily to the valve seat and are generally more tolerant of contamination.

Steel plates will tolerate higher temperatures however being heavier require careful spring design as greater seat wear can be an issue. Steel plates will generally withstand higher cyclic rates than non metallic valve plates.

Actual duty v/s design point

This is a really important issue and must be considered in detail as it is at the heart of many problems. Different booster manufacturers design their units using different procedures and with different applications in mind.

One only has to look at the Ariel units to see the very heavy construction and massive bearing assemblies. These units are built for the long run and if correctly applied and maintained will give very long service.

The Ariel Company guarantees the performance of their units at a single design point which is listed in the manual supplied with EVERY unit.

The Hurricane and Airesearch units are much lighter in construction and made using readily available diesel engine components as building blocks. These units are far less expensive to service and overhaul as well as being easy to work on.

The performance of these units is listed by the makers at a range of inlet and discharge pressures as well as at various operating speeds.

What does this mean? If you have a well understood operating scenario then the Ariel unit correctly matched to your application will give great service. If however you have a range of conditions and occasionally operate outside the makers recommendations the Hurricane and Airesearch units may prove more durable.

Valve dynamics and types of analysis.

Valve makers use a variety of methods starting with theoretical calculation based on the operating conditions as described to them by the booster designer. These calculations are very complex and yield an initial design.

Prototype valves are then made and tested at the manufacturers design conditions. If problems emerge then several approaches are used by different valve manufacturers.

Hoerbigger use a sophisticated piece of equipment the US designed programme called ***Recip-Trap*** to analyse valve performance in the field.

Klaus use a mathematical modelling process which takes into account **all** of the operating conditions as described by an owner to derive a best fit valve design for all performance points.

Valves can be optimised for Low power consumption, High volumetric efficiency or Durability. Sadly all three do not occur in any single design and the valve designer has to best fit their product to the customer's ACTUAL full range of operations.

Valve repair issues.

The single valves as used in the Ariel units are relatively simple to repair as long as the correct lift and spring pressures are used in conjunction with suitable plate materials. After a long time in service and possibly a number of replacements of internal components it may be necessary to refinish the valve seats as well as to check for any cracking and to ensure the valves are of acceptable dimensions when reassembled.

The concentric valves are a different issue and they require more rigorous attention whenever they are disassembled. Any rebuild will involve stringent cleaning, crack detection procedures, dimensional checking, refinishing the seats and lapping, check and adjust plate lift, re-clean all components, assemble and leak test in both inlet and discharge directions. The finished valve assembly must be within the OEM's total valve height tolerance otherwise assembly problems may occur when the valve is fitted into a booster.

Concentric valves are not a field repairable item and should only be serviced in well equipped valve repair facilities.

What can you do to increase valve life?

- Reduce the air inlet temperature into the booster from your compressors.
- Monitor the pressure ratio and keep it around 2.0 if possible.
- Try to share the load between your booster and the primary compressors. For example you would not want to have a pair of primary compressors operating at 350 psig on their limit and the booster discharging at 450 psig. Much better to have the primaries at 250 – 270 psig and the booster doing the rest of the work up to 450 psig at a modest pressure ratio of 1.66.
- Keep the booster inlet air as clean as possible.
- Reduce the booster rpm within **the maker's limits** to the slowest speed that will give acceptable performance.
- If you have valve problems try some alternative material types or arrangements as there is NO single valve for every application.
- Keep the precoolers in particular and also the rest of the booster coolers clean and ensure the cooling fan is working well.
- Ensure the condensate drain in the booster scrubber is functional
- Ensure the booster inlet air scrubber is not blocked. If you do not have an inlet scrubber consider fitting one particularly if you use hoses that are regularly disconnected to feed the booster inlet. We frequently see 2 to 4 times longer life in booster valves where the booster is permanently connected to its primary compressor/s.

Notes and statement of interest.

The Author is the Australian distributor for Klaus valves. The preceding are his personal opinions based on many years of involvement with the type of equipment under discussion.

Every endeavour has been made to present the facts in a balanced way that will be of interest to the readership. If there are any errors or if any party mentioned feels inclined then material acceptable to the editor which clarifies the situation will be considered for publication.

It was felt that by detailing the actual products that the article would be more relevant and interesting to the readers rather than a more general discussion. Again any feed back in relation to this style of presentation would be most welcome.

In the end accessible information leading to more informed users is the intention of all of these articles.

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