

# 500 PSIG TWO-STAGE COMPRESSORS AND WHY THEY CAN BE DIFFICULT TO MANAGE

By Ian Speer

500 psig rated two-stage compressors date back to the early 1990s in Australia, however, their introduction into the market has not been without development difficulties and this article will focus on some of the challenges that face the compressor designer when trying to build a unit that can withstand the rigours of use in drilling operations.

## WHY A 500 PSIG UNIT AT ALL?

In short, for shallow DTH drilling work any increase in the pressure drop across the hammer translates into more energy at the drill bit and if correctly applied will result in greater penetration rates.

For deeper DTH holes, particularly when using RC techniques, the use of boosters is almost universal. However, for shallower work as well as grade control and blast hole drilling, the use of a booster and compressor can be avoided by using a 500 psig compressor which will have a lower capital cost.

When the operating pressure of a two stage oil-flooded rotary screw compressor is increased from 350 to 500 psig several interesting things happen.

## WATER IN THE OIL/COMPRESSOR SYSTEM

When a compressor is operating it ingests water vapour along with the air it is compressing and this water will cause problems if it remains inside the compressor, becoming mixed with the oil and then being fed to the bearings.

To prevent this occurring, the compressor designers fit thermostats to raise the system temperatures and allow the water to pass out of the unit along with the compressed air.

When the operating pressure is increased then the temperature of the oil must be increased to prevent water build-up. Those who remember the old 100 psig compressors will recall that they operated at 80-85°C and as pressures increased the 350 psig machines went to 95-100°C to keep water out of the system. (Current shutdown temperatures are around 125°C).

## BEARING LOADS

As the pressures rise, the loads on the bearings rise while the actual space for the bearings remains the same or can be smaller resulting in far greater bearing loads. Rising temperatures also shorten the service life of rolling element bearings.

## LUBRICATION ISSUES WITHIN THE SYSTEM

Due to the increasing temperatures in the oil circuit, and the oil being returned to the compressor and fed to the bearings being hotter than in the case of previous 350 psig units, the viscosity of the oil is lower.

All rolling element bearing makers have information that advises users of bearings that the viscosity of the oil being fed to the bearing must be sufficient to separate the rolling element from the race.

Put simply, if the oil is too thin the bearing will break through the lubricant film and premature bearing failure will result. The bearing makers specify an oil viscosity of 9 Centistokes at the operating temperature and when the oil being fed to the compressor bearings on a hot day is over 100°C this is difficult to achieve.

Having regard for these issues, compressor designers have adopted several approaches in an attempt to produce reliable products these approaches are as follows.

- High internal oil circulation rates and low temperature drop system.
- Lower internal oil circulation rates and a higher temperature drop system.

Each system has merit and we will discuss both here.

The high internal circulation machines circulate their working fluid at rates from 400-450 litres/minute while the alternative machines have lower circulation rates from 200-300 litres/minute. The effect of decreasing the circulation volume results in the oil being returned to the compressor being cooled to a lower temperature than is the case for a machine of equal output that circulates its working fluid at a higher rate. (Note both units must have

the same discharge temperature to keep water out of the system).

The high circulation rate machines will therefore feed their bearings with hotter oil than the low circulation volume machines and this places extra demands on the oil and the bearings as oil viscosity decreases as its temperature rises.

The whole system must be considered as a single entity and a circulating fluid selected that will provide good sealing, good heat transfer properties for cooling and good lubrication properties at the PEAK operating temperatures that the system can operate at. This is NOT the normal operating temperature but just under the shutdown temperature for the machine as this will be the temperature seen on very hot days.

In the past I have not made specific product recommendations and I have NOT checked with the suppliers of the fluids listed below nor do they give me a commission on sales! However, on the information available to me the Ultracool/XHP605 fluid from IR which Dow makes for them in the USA is a 46 weight fluid which retains its viscosity better than any product that I am aware of at this time. Sullair also have a 32 weight fluid called Sullube which I understand is also sourced from Dow.

Should you be thinking about which fluid to use in your 500 psig compressor it might be worth asking any potential supplier if their product at least meets the performance of Ultracool/XHP605. Both of these fluids are expensive and considerable attention should be given to air filters, oil filters and all hoses in any system that you propose to fill with these fluids as a burst hose will result in a serious loss.

There are other synthetic products available from reputable manufacturers however be sure to ascertain that they will meet the requirements set out above if you intend to operate your 500 psig compressor at full load and peak pressure in hot weather.

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