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ARE
ARTHUR RUSHMER ENGINEERING ENT cc
THE BEST SOLUTION
CK Reg. Number: 1997/063529/23

11 Beryllium Street, Alrode Extension 14, Alberton, 1449

P.O. Box 167173, Brackendowns, 1454

TEL: 011 908 4169
FAX: 011 864 1588
SMS: 083 703 1291

Email: info@are.co.za
Web: www.are.co.za

VARIOUS COMPRESSOR TECHNOLOGIES AND MAINTENANCE OF DIFFERENT TYPES OF AIR COMPRESSORS

A screw compressor is most efficient when it is new. Its clearances, compression cycle leakage and Energy consumption (specific energy requirement) is at a minimum and most effective.

As the compressor runs it losses efficiency due to microscopic dirt particles that are drawn in via the air intake element which only filters the air particles down to 5 micron. The dirt particles that do not pass through clog the filter element impacting on efficiency and those that pass through eventually start acting like grinding paste or acid when mixed with the lubricant and in conjunction with thrust bearing clearance deflections these factors cause a reduction in efficiency.

The deviation in air end clearances inevitably results in air blowing back between the male and female rotors causing a blow-hole effect.
Leakage of air back to intake or preceding pressure cells increase and energy consumption goes up, meaning that more kilowatts are required to produce each cubic meter of air, fundamentally increasing Specific Energy requirement.

This is the primary reason why screw compressor manufacturers recommend air end exchanges between 20 to 50 thousand operating hours and invest a lot of time and money on rotor profile designing and production requirements which they imply justifies their monopolization of the Rotary compressor market.

Rotary Vane compressors on the other hand will not degrade due to the inherent microscopic dirt intake, but will actually improve and remain efficient consistently, as the blades seat in on the stator and rotor slots, leakage and power is reduced and the compressor efficiency stabilizes.
This clearance level is maintained at minimum throughout the life of the compressor by controlling friction factors primarily through the use of superior lubricants and materials of construction.

A decade ago old type lubricants forced Rotary vane manufacturers to replace lubricant every 400 hours to ensure long bearing life.
Modern Rotary Vane compressors run on a heavyweight lubricant with unctuous characteristic, most compatible with cast iron, porous materials and white metal as opposed to the lightweight lubricant designed for Screw compressor, which is mostly suited to non porous metals.

The rotors of a screw compressor are made of malleable mild grade steel. This is because of the large amount of metal removal during the numerous machining operations that need to take place when creating a specific profile on the rotors. This type of steel is prone to galling under marginal lubrication conditions.

A pair of rotors that have been in service for less than 2000 hours will have gaps in the seal landings on the outer diameter of the rotor lobes, and numerous scars on the flanks of the lobes. As a result of metal to metal contact during each consecutive start up, galling occurs as the result of the fusing/welding that takes place between similar malleable metals without lubrication.

The surface of the metal is not porous and does not retain lubricant for start up. Upon commissioning, the Intake of a screw compressor has to be bled to ensure that metal to metal contact is avoided during the initial start up.
If a screw compressor stands dormant for a few months the air end dries up and galling may occur on start up.
In a screw compressor it is impossible to produce lobe forms that Mesh perfectly throughout the compression cycle.
This is unlike a Rotary vane compressor where volumes of air are captured between blades in a compression chamber created by the stator and rotor during their eccentric-rotational path.

During most of the screw compression cycle, leakage paths exist which allows air to escape from the H.P. zone to the intake.
The leakage through these paths is constant and subject to speed variation, as the displacement of the compressor is a function of speed.
The effect of this is that the percentage of leakage lessens at higher speed and increases at lower speed. This low speed characteristic will cause the screw compressor to absorb high KW at low rotational speed even if the speed is regulated by inverter technology.

There is a threshold of 40% on the speed vs. efficiency.

Screw air end efficiency is compromised to a greater degree than Rotary vane efficiency with speed, a fact easily observed when the relationship is depicted graphically.

Rotary Vane compressors do not have these blow back paths, the compressor flow will remain consistent as the speed reduces or varies.
This fact is confirmation that VSD is more adept to Rotary Vane technology, besides the other most profound feature of Rotary Vane technology being that the compressor can run much slower and still be more efficient.

The vane compressor has a single rotor with matched alloy blades, two white metal bearings housed in end covers and a stator manufactured from high quality porous material. Cast iron is a superb absorber and bearing material because of the free carbons, hard iron carbides creating their lubricant retaining qualities.
There is physically no metal to metal contact between moving parts, not even between the blades and the stator as they are constantly protected by the unctuously formulated lubricant working together with the various porous materials to achieve almost zero friction.

Rotor blades are made of a material that is dissimilar to the stator and the materials frictionless when combined with an unctuous lubricant, therefore galling is eliminated and wear almost totally zero over the life of the compressor.

Modern Rotary Vane compressor blades are today made of superior quality alloy materials and machined and processed robotically to produce a high quality standard and superior resistance when used with the most conducive lubricant. Modern Rotary vane compressor blades have a life expectancy of 100 000 hours-plus.

The number of bearings required in a screw compressor are double on each rotor due to the thrust created during compression, they have to be fitted with expensive high quality thrust bearings to ensure fixed clearances and space between the rotor to absorb radial and axial loading and to avoid galling.

Generally angular contact ball bearings have limited capacity in all directions and subsequently a predetermined life expectancy of +- 20 000 operating hours. This is further complicated by the high speed that these machines run at to obtain output, especially oil free type.
The effect of bearing failure on a Rotary Screw rotating at 3000rpm is often complete destruction of the screw air end.

Fixed speed Rotary Vane compressors on the other hand all run at 4 pole 1450 rpm and are all directly coupled with no thrust on compressor or motor bearings orientated horizontally, generating radial loading only.
This has proven to be the best solution and by incorporating white metal bearings of sufficient size that have a much higher radial loading capability than a thrust bearing, it is probable to assume that the majority of Rotary vane compressors will use only one set of bearings throughout their life.
This is quite normal unless the units are run on inferior lubricant or not serviced and maintained correctly.

The auxiliary components of both the vane and screw compressors are similar. They both use an oil tank, separator, oil cooler, thermal bypass, minimum pressure valve, high temperature switch, and some means of controlling capacity.

The screw compressor is confined to on/off load cycling unless driven by variable speed, while Rotary vane compressors offer on/off load or servo modulating control as a standard feature.

The maintenance aspect of items such as synthetic lubricant, lubricant filters and separator changes, are not always similar.

Certain types of Rotary vane compressors have superior lubricant separation systems and separator element changes are only necessary after 10 000 operating hours while others designs of separation are confined to separator element changes at 6000 hours.

Subsequently maintenance costs are higher, especially Air end bearing replacement costs.
In most cases air end repairs are handled on a factory exchange basis to ensure guarantees and reliability.

The failure of an air-end in a screw compressor can however reach seventy percent of the cost of a similar sized replacement.

While Rotary vane compressor elements are easily repaired back to original and like new status at a very economical cost.