



Part I of this two-part series (LUBRICATION MANAGEMENT & TECHNOLOGY, Jan./Feb. 2008) emphasized the application ranges and volume control options of twin-screw compressors. It explained the general features of these dual-shaft rotary machines, which operate on the principle of positive displacement combined with internal compression. Operation of oil-free (dry) vs. liquid flooded (wet) rotary screw compressors and available seal design options are the primary focus of this concluding installment.

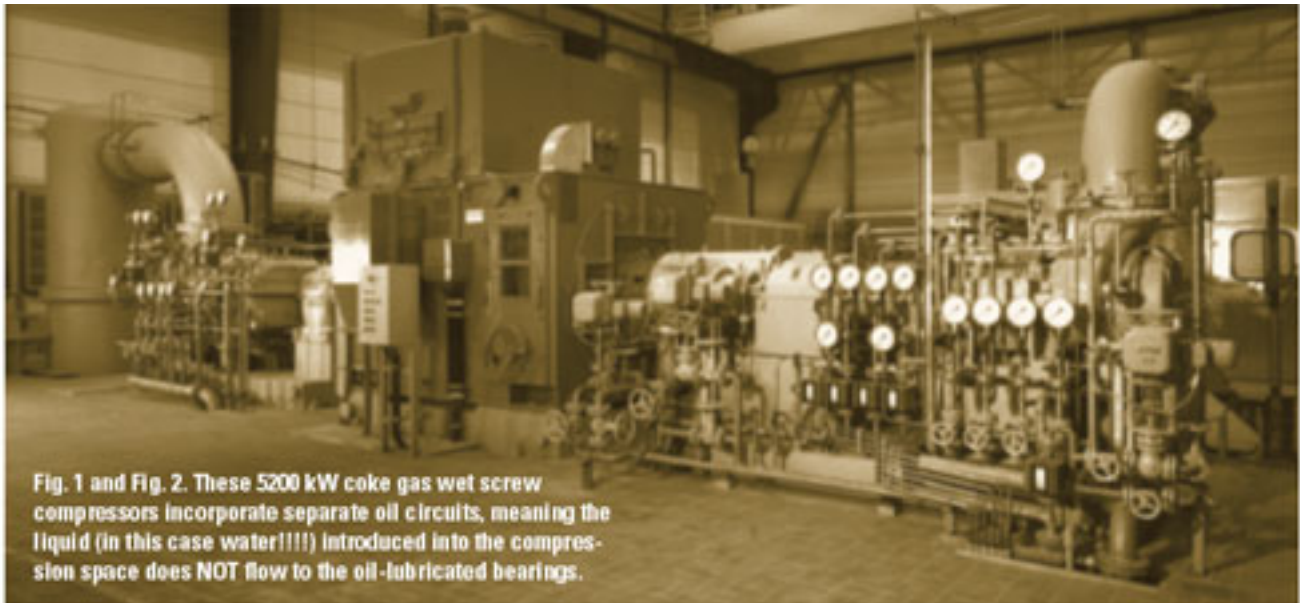
Operation

Regardless of whether a screw compressor is executed for oil-free (“dry”) compression or oil or water injection (the “wet” method), the gas is compressed in chambers that progressively decrease in size. These progressive chambers are formed by the intermeshing action of the two helical rotors and by the surrounding housing wall. Dry machines, however, incorporate timing gears that keep the two counter-rotating screws in the exact relationship to each other. Oil-injected (sometimes called “oil-flooded”) compressors do not incorporate timing gears and the driven male rotor interacts directly with the female rotor. The oil that is injected into the compressor cavity provides intensive lubrication and a large portion of the compression heat is absorbed. At the same time, the clearances between rotors and cylinder (casing) walls also are filled with oil. This prevents the reverse flow of compressed gas and increases the overall compression efficiency.

After leaving the compressor discharge flange, gas and oil exit through a check valve to the oil reservoir where most of the oil is separated from the gas. In oil-flooded compressors, the remaining oil is removed in a downstream separator, and only residual oil amounts of typically five parts per million (ppm) continue to remain in the gas stream. Even this oil carryover can be further lowered by downstream cooling and final moisture separation. The oil separation unit has to be properly maintained and the pressure drop across the separator cartridges taken into account to determine the overall performance of the compressor package. It should also be

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recognized that the efficiency of oil separation changes as the separator elements become progressively more contaminated.



On small rotary screw compressors, the housing is vertically parted on the suction side. Cylinder (generally called “casing”) and discharge side plate are frequently combined in a single housing. The housings of larger machines usually are parted horizontally for easy assembly. Rotors and shafts are milled out of one piece of either forged or stainless steel. Some manufacturers provide rotors with non-metallic coatings. In severe service, where loss of coating occurs on the rotor edges, a rapid drop in compressor efficiency could be encountered.

Process gas machines typically are designed with the direction of flow from the top to the bottom. This facilitates liquid removal from the compression space whenever liquid is injected into the rotor chamber for cooling, or for cleaning during operation. On-stream cleaning is highly advantageous in services where gases are contaminated or tend to polymerize. The sealing area is equipped with connections for sealing medium supply and relief. In principle, it is possible to apply a cooling medium to the cylinder wall, but non-cooled cylinder housings (or casings) can be used as well. Part 1 illustrated typical rotor combinations, including an asymmetrical rotor profile. The profile combination 4+6 means that the male rotor has four teeth and the female rotor, six. Due to this profile combination, the diameter of the rotor core is relatively thick. This allows for operation with large differential pressures.

Bearing concerns...

Although air machines often are equipped with rolling element bearings, the majority of dry and wet process gas compressors are furnished with journal bearings and thrust bearings of the type commonly found in centrifugal process gas compressors. The service life of these bearings

is practically unlimited as long as proper lubricating and operating procedures are in force. Rolling element bearings are acceptable for (relatively) light loads and where oil cleanliness is assured. Needless to say, selecting a separate closed-loop bearing oil circuit is a powerful step in the direction of maintaining a clean bearing environment.

If a vendor offers a wet screw machine with a single “same oil serves all” support system, the purchaser-owner may be taking a big risk—unless prepared to run up operating and maintenance costs by planning very frequent oil changes, or major investment in oil purification equipment. If that’s not in your plans, make sure you specify twin-screw compressors with separate oil circuits. In other words, do not buy wet screw machines where the oil introduced into the compression space also flows to the bearings. Separate circuits are used in the 5200 kW coke gas compressors illustrated in Fig. 1 and Fig. 2. However, instead of oil, water is being used in these coke gas services.

Seals

In many oil-free rotary screw compressor applications, it is best to provide a sealing barrier between the process gas and the bearings. A number of different seal types are feasible (see Figs. 3, A-G). Included are:

- Carbon ring seals (3A)
- Carbon ring and ejector-inductor porting (3B)
- Carbon rings, ejector-inductor and purge gas porting (3C)
- Combined floating rings and mechanical seals (3D)
- Mechanical seals and carbon rings (3E)
- Water as the sealing liquid (3F)
- Water in small quantities as the sealing liquid (3G)

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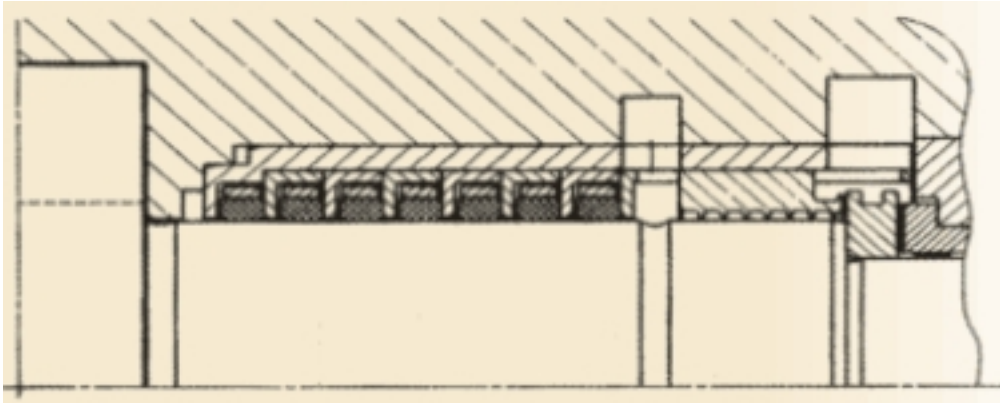


Fig. 3 A:
Carbon ring seals
for clean, harmless
gases

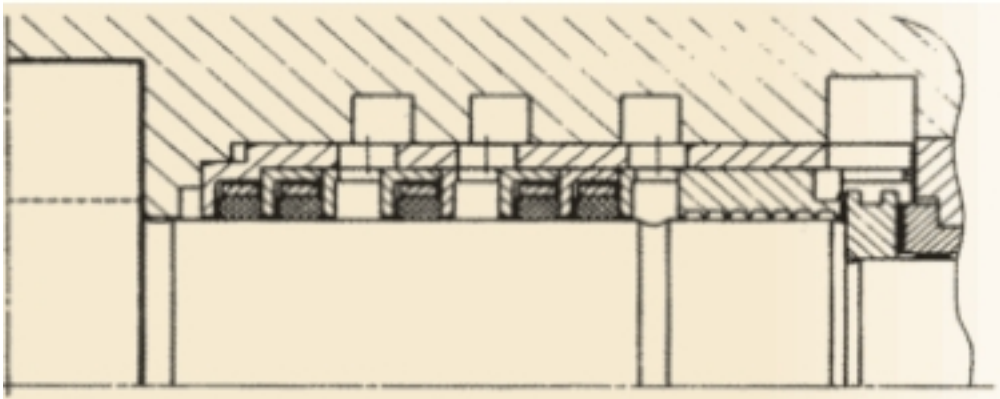


Fig. 3 B:
Process gas cannot
be vented—
(a) letdown to lower
pressure
(b) extraction using
an ejector
(c) atmospheric vent

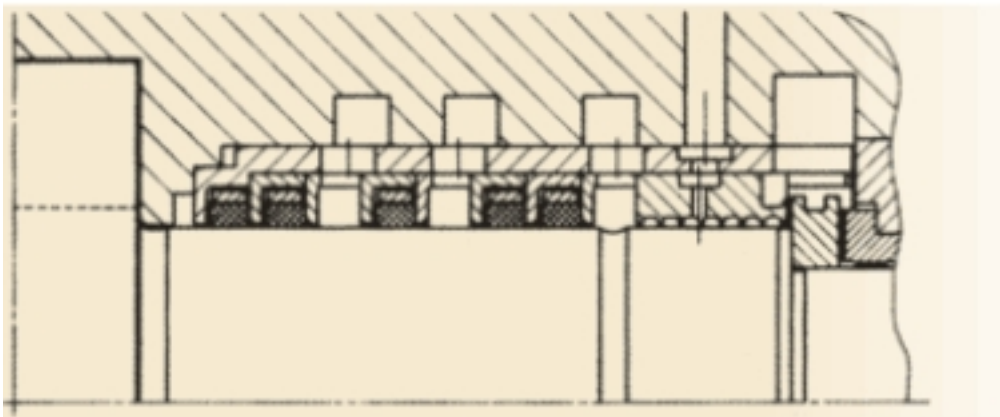


Fig. 3 C:
As shown in B, but
with additional
purge gas

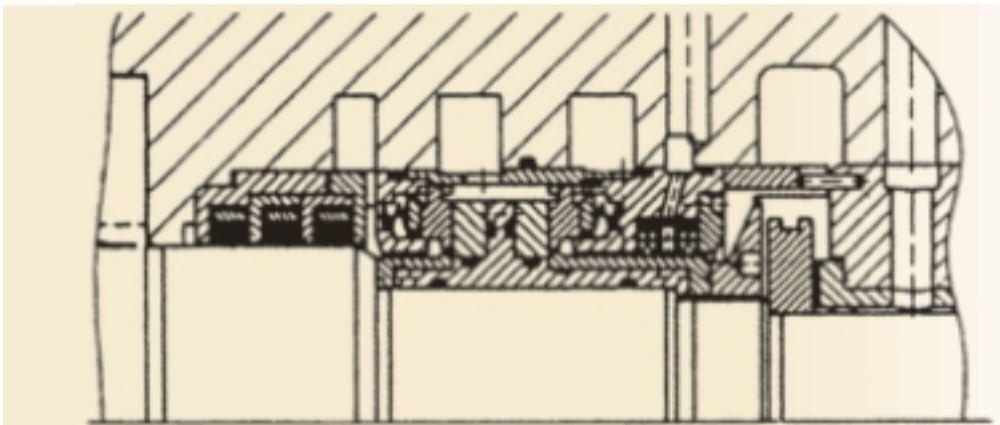


Fig. 3 D:
When positive
sealing is required

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Fig. 3 E:
Mechanical seal
and carbon rings

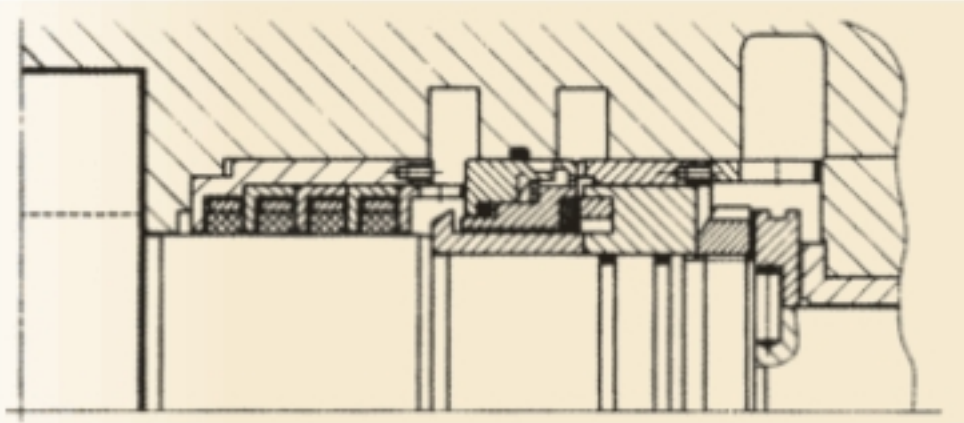


Fig. 3 F:
Water is the
sealing liquid.

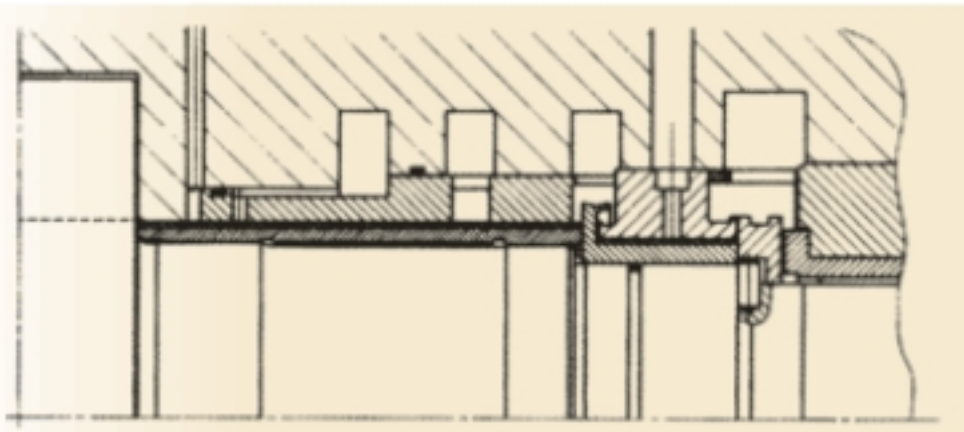
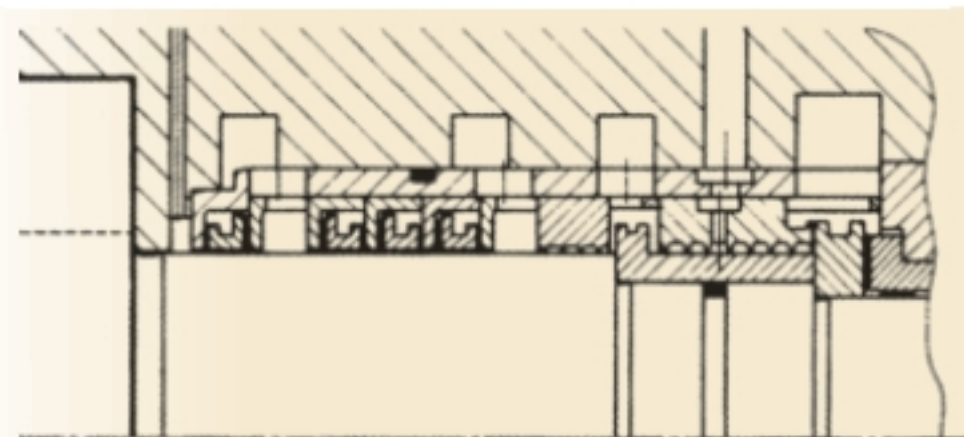


Fig. 3 G:
Water in small
quantities is the
sealing liquid.



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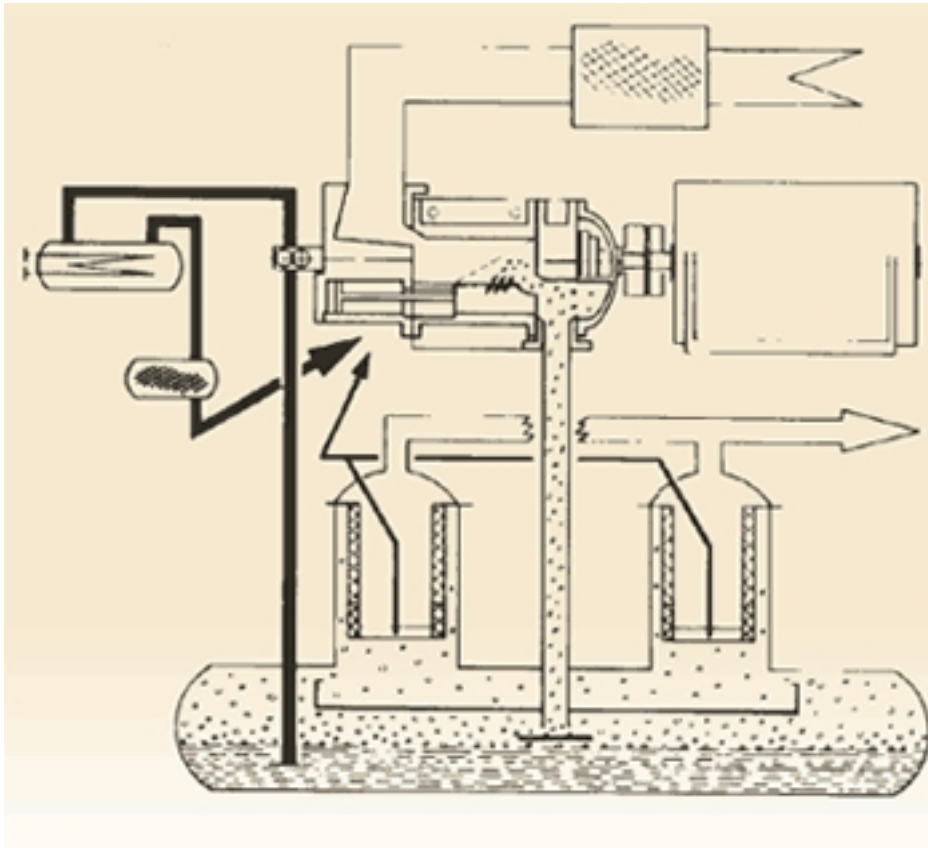


Fig. 4. Principle of oil separation in wet screw compressors

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