

Compressors as standard

Currently, the demand for hydrogen is increasing dramatically all over the world. Hydrogen traditionally has been used for the cracking process in oil refineries and for material surface treatment, but now it is also needed for desulfurisation in oil refining processes, and as fuel. Currently the demand for hydrogen is also strongly influenced by environmental requirements.

For the above processes, hydrogen needs to be compressed for chemical reaction and transportation, but hydrogen has certain unique features, such as:

- Low molecular weight.
- High k value.
- Hydrogen embrittlement.

Generally speaking therefore it is a difficult gas to compress, especially for centrifugals, due to the difficulty in compressing such a light gas and oil free screw compressors due to gas return in the clearance of rotors. This is why reciprocating compressors have been used for hydrogen services typically in case of high discharge pressure required in oil refinery processes. Because the reciprocating compressor is a

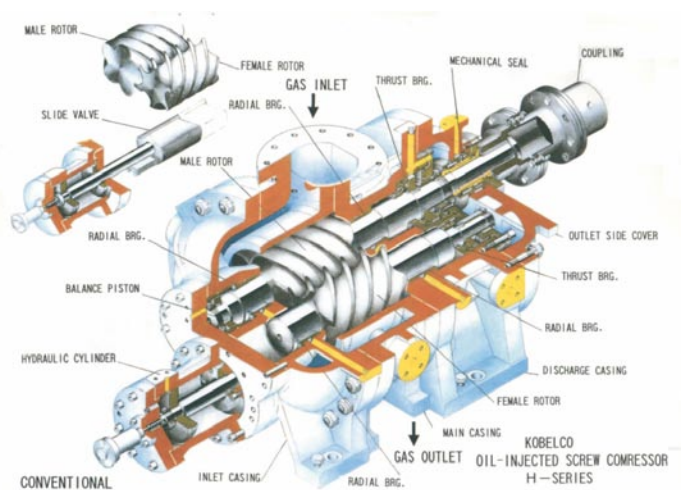


Figure 1. Oil injected screw compressor cutaway.

Takao Koga,
Kobelco EDTI
Compressors Inc.,
USA, discusses oil
injected screw gas
compressors for
hydrogen services.



Figure 2. Hydrogen (94%) recycles gas for gasoline desulfurisation unit (GDU) process.



Figure 3. Hydrogen (94%) booster for continuous catalytic reformer (CCR) process.



Figure 5. Hydrogen (99.9%) booster for steam methane reformer (SMR) process.

typically positive displacement type it is not affected by gas composition and has the simplest compression mechanism. It can also achieve the high pressure levels (200 barg or 3000 psig) required by some oil refinery processes. However, the main problem with reciprocating compressors is the frequent maintenance that is required during operating periods that can increase the running costs (including man power and replacement parts) and limit capacity handling volumes. Therefore, given the case that large volumes of hydrogen are required due to the current trend for larger capacity industrial plants, centrifugal compressors are sometimes used when the compression ratio is low.

On the other hand, in the last 10 - 20 years a third option has been gradually appearing in the market. It is another



Figure 4. Hydrogen (90%) recycle gas for heavy catalytic cracked gasoline (HCCG) process.



Figure 6. Hydrogen (99.5%) booster for dissociation process.

positive displacement compressor, the oil injected screw compressor.

Originally, this compressor was developed for light duty services such as air and refrigeration, which are not heavy duty services and do not require API standards. The oil injected screw compressor has established a good reputation for high reliability and low maintenance, resulting in long term continuous operation in the air and refrigeration markets. Based on its good reputation, the oil injected screw compressor has also been used for process gas services since the 1970s. Some of these services are:

- Coke oven gas (hydrogen rich gas).
- Helium (low molecular weight gas).
- Natural gas.
- Hydrocarbon gas.
- Carbon monoxide.
- Carbon dioxide.

In addition, it has been used for hydrogen services, for example, low discharge pressure (approximately 10 barg or 150 psig) and tail gas compression of the pressure swing adsorption (PSA) process.

Mechanical features

The mechanical features of oil injected screw compressors are, by nature, suitable for the compression of hydrogen, because they are the positive displacement type, the same as reciprocating compressors. Also, they have lube oil injection to the compressor itself, which acts as a sealant at the clearance between rotor and casing, in addition to lubricant and coolant,

which means higher efficiency in case of compression of low molecular weight gas (Figure 1).

Despite the oil injected screw compressor having established a good reputation and having suitable mechanical features for hydrogen services, it did not reach its full potential quickly. This is because it was designed for light duty service (Non-API standard machine) and had a pressure limit of approximately 20 barg or 300 psig.

Developments

As time passed, thanks to the well established reputation of high reliability and low maintenance its uses developed into long term continuous operation in the heavy duty and high pressure markets. Oil injected screw compressors have been utilised to replace reciprocating compressors in applicable services within these markets.

In the late 1990s, the high pressure oil injected screw compressors were improved and started to penetrate a wider market. At that time, the maximum pressure range was approximately 60 barg or 900 psig. After successful operation in the various process gas applications at such pressure ranges, advanced high pressure oil injected screw compressors were developed in the early 2000s based on the market's requirements.

Now, oil injected screw compressors can achieve up to 100 barg or 1500 psig. The reciprocating compressor is still used for high pressure (up to 200 barg or 3000 psig) in oil refinery processes, as oil injected screw compressors still cannot cover all pressure ranges. However, oil injected screw compressors can cover more than 50% of applications in oil refinery processes, since the required gas pressure is lowering.

Unique oil injected screw compressor applications

- Hydrogen (94%) recycles gas for gasoline desulfurisation unit (GDU) process (Figure 2).
- Hydrogen (94%) booster for continuous catalytic reformer (CCR) process (Figure 3).
- Hydrogen (90%) recycles gas for heavy catalytic cracked gasoline (HCCG) process (Figure 4).
- Hydrogen (99.9%) booster for steam methane reformer (SMR) process (Figure 5).
- Hydrogen (99.5%) booster for dissociation process (Figure 6).
- Hydrogen (91%) booster for linear alkyl benzene (LAB) process.
- Hydrogen (99.9%) fuel booster for gas turbine power plant.
- Hydrogen (50%) tail gas for pressure swing adsorption (PSA) process.

The future

Since the worldwide demand of hydrogen is increasing and reliable plant operation is important to all heavy industries such as oil refining, petrochemicals, chemicals, steel and power, oil injected screw compressors will be required more and more for upcoming new projects and also for replacing old reciprocating compressors installed 20 - 30 years ago.

For discharge pressures of approximately 60 barg or 900 psig, oil injected screw compressors are already recognised as the standard compressor in the market instead of the traditional reciprocating compressor. From now, it will be a standard for more applications up to 100 barg or 1500 psig in various industries and fields with great benefits for the market and users. 