Application Note

Why scroll compressors are better?

Nitrogen is commonly used in laboratories for different applications. Some demand higher purities, others are less purity-dependent. Such applications are typically nebulizing gas for liquid chromatography coupled with mass spectrometry (LC/MS). Other areas of applications are specific solvent evaporations and low-purity purge gas requirements. In these cases, nitrogen is supplied in situ with generators using membrane technology to reach very high flows. Up to now almost all manufacturers provide reciprocal piston compressors. The new technology with scroll compressors provides several benefits. Although the scroll compressor was patented in 1905, it wasn't until the end of 80's that Volkswagen introduced this technology on the Corrado G60. Today, this technology is mature and LNI have coupled this compressor type with inverter technology for an on-demand gas generation with significant cost and noise reduction.

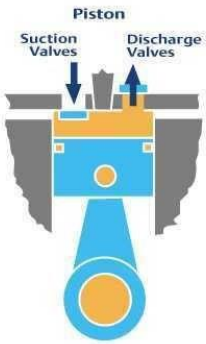

Fig. 1 Standard piston compressor

Fig. 2 Wob-L compressor and eccentric rod

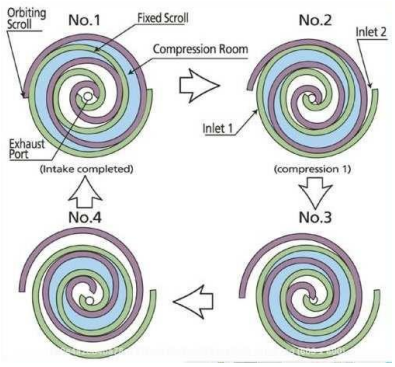

Fig. 3 Scroll operating principle

Fig. 5 Noise equivalence!

Reciprocating compressors and their typical drawbacks

Piston compressors are wide spread and found everywhere. They have a couple of drawbacks which are accepted as part of the technology. When used for analytical applications they should be oil free. This requirement adds stress to the components parts, mechanical devices will have a reduced life span as a result.

- **Limited lifetime** – Many wearing parts (piston, rings, valves) , increase frequency of part replacement and failure rate
- **Maintenance costs** – Low acquisition cost but many wearing parts to be replaced, high maintenance frequency resulting in high ownership cost
- **Alternative displacement of the piston** - flow is pulsated on one single volume with the generation of noise
- **Noise** – higher than 70dB without protection, equivalent to a train
- **Energy consumption** – The major energy losses arising in compressors consist of friction losses, flow losses, heat losses and electrical motor losses. During the short periods when the valve is open, the gas flows through a number of passages (i.e., pipes, flanges on cylinders, cylinder passages, valve cages, valves, valve pockets) until it reaches the cylinder itself. All these different areas impose changes in velocity and direction which result in pressure losses

How a scroll compressor works?

The scroll compressor has one scroll or spiral orbiting in a path defined by a matching fixed scroll. The orbiting scroll is couple to the crankshaft in orbit rather than rotated.
As the orbiting motion continues, the gas is forced toward the center of the scroll and the gas pockets become compressed. When the compressed gas reaches the center, it is discharged into a chamber and to the center of the scroll.
During a single orbit, several pockets of gas are compressed simultaneously, providing smooth, continuous compression. Both the suction process (outer portion of the scroll members) and the discharge process (inner portion) are continuous.

The orbiting motion creates a series of gas pockets traveling between the two scrolls. On the outer portion of the scroll the pocket draws in gas, and then moves the gas, increasing the volume in the smaller inner pocket. The temperature and pressure then increases to the desired discharged pressure.

Benefits of the scroll technology

1. Simplicity

Only two components, a fixed scroll and orbiting scroll, are required to compress gas. These **two** components replace the approximately **fifteen** components in a piston compressor, which are required to do the same work!

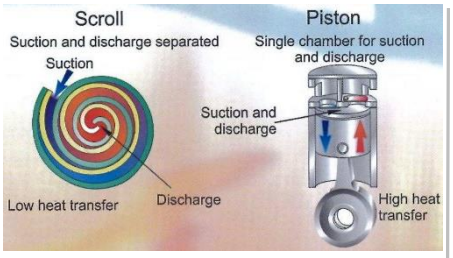

Fig. 4 Suction and discharge locations

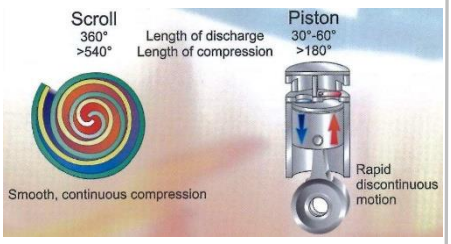

Fig. 5 Compression process differences

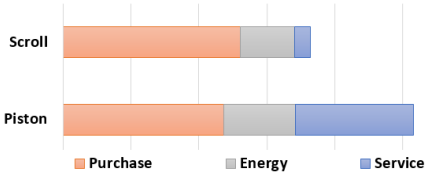

Fig. 6 Ownership costs for 7 years

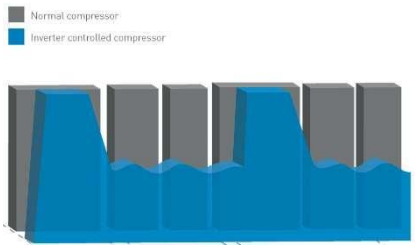

Fig. 7 Energy consumption with different flow conditions

2. Efficiency

The scroll compressor offers three efficiency advantages over a piston compressor:

1. The suction and discharge processes of a scroll compressor are physically separated, reducing heat transfer between suction and discharge gas. In a piston compressor, the cylinder is exposed to both suction and discharge gas, resulting in high heat transfer. This reduces the efficiency of the compressor (see Fig 4).
2. The scroll compression and discharge processes are very smooth. A scroll compresses gas in approximately 11/2 revolutions as compared to less than half of a revolution for a piston compressor. The discharge process occurs for a full 360° of rotation versus 30-60° of rotation for a piston compressor (see Fig 5).
3. The scroll compressor has no valves. While a piston compressor requires suction and discharge valves. This eliminates all valve losses. The result is that the scroll compressor is inherently 10-15% more efficient than a piston compressor.

3. High Volumetric Efficiency

A scroll compressor has no clearance volume. All gas that is trapped in the compression process in the outer pocket of the scroll members is released through the discharge port. This means that the scroll compressor inherently has a higher capacity than a piston compressor at extreme operating conditions.

4. Ownership costs

Even at higher purchase cost, scroll compressors require much less energy and service (maintenance & parts replacement, resulting in lower ownership cots (see Fig 6).

5. Noise Level

A scroll compressor has extremely limited motion, which, unlike a piston compressor, can be perfectly balanced. Because suction and discharge flow is continuous, a scroll compressor has very low gas pulses. No dynamic valves equal no valve noise, a common problem in a piston compressor, is not a factor.

Benefits of the inverter technology

An inverter is used to control the speed of the compressor motor in real time. By ramping up power to the compressor when needed, an Inverter provides a more accurate, on-demand approach to flow control; running at a fraction of full speed is far more efficient in the long run. From an energy perspective, constantly cycling a compressor on and off can be a costly endeavor. Unlike Inverter-driven systems, fixed-speed compressors can't ramp up gradually. It's estimated that standard systems draw 3-4 times as much power on start-up versus an Inverter-driven system. (see Fig 7)

Why go with LNI Swissgas?

Unique combination of technologies for maintenance and cost reduction!

Nitrogen generators with scroll + inverter technologies from LNI Swissgas will provide you significant cost reductions and peace of mind in the lab.

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