Inverter scroll compressor advantages

Sales / Technical Guide
Mitsubishi Electric inverter scroll compressor adopts radial compliant mechanism which contributes high efficiency even at the low or high speed operation. This mechanism has no clearance between orbiting and fixed scroll, which means excellent refrigerant seal and high COP.

Digital scroll compressor adopts refrigerant bypass mechanism to control its capacity. Though it can work as inverter type in terms of operation range, the efficiency goes down in light load.
Mechanism of Inverter Scroll

Radial compliant mechanism

\[ F_c : \text{Centrifugal force of Scroll Wrap} \]
\[ F_g : \text{Compressed gass load 1} \]
\[ F_{gr} : \text{Compressed gass load 2} \]

Mitsubishi Electric inverter compressor makes use of the centrifugal force with scroll rotation very well. It runs smoothly and efficiently from 20Hz low speed and up to 120Hz high speed without inner loss in whole range.

Mechanism of Digital Scroll

With digital scroll compressor, one of the scroll is lifted up to control the capacity with electric valve. In light load time or period, the refrigerant leakage is too big to run efficiently. Electric valve is always being used and scroll parts vertically hit each other inside the shell. This means less reliability and shorter lifespan than inverter type.

Compressor Co-efficiency (Inverter and Digital comp.)

Inverter comp.

- Full Frequency =full Capacity(full-load)
  → Power Input is high
- Frequency decreasing=Capacity save(Unload)
  → Power Input drops according to the frequency

Digital Scroll comp.

- Valve:open=full Capacity(full-load)
  → Power Input is high
- Valve:close=Capacity save(Unload)
  → Power Input is not so decreasing against full-load
**Introduction**

- Recently, scroll compressors have been widely used for air conditioners for its high efficiency. There are two types different in the refrigerant flow inside the shell; low pressure shell type and high pressure shell type.
- At this moment, large capacity scroll compressors apply low pressure type shell, and small or middle capacity comp. comes with the high pressure type, depending on functional advantages and disadvantages of each unit usage. The shell durability and reliability of refrigerant amounts are important point of commercialization.

**Low pressure shell comp. (Mitsubishi Electric)**

- Refrigerant is compressed by the rotation of shaft<6> and orbiting scroll<2> which makes a pressured room<3> together with fixed scroll<1>.
- The low pressured gas from suction pipe<16> is divided into 2 way flow. The lower flow runs through low pressured section at the bottom and the rest through the scroll section. They both discharges after circulating the shell and scrolls.
- The lubricating oil for the shaft runs from oil reservoir<15> to oil pump<23> lubricating each part and then, via oil circulating route<26>, returns to the oil reservoir<15>. Some of the oil is mixed with the refrigerant and taken back to the comp.

**High pressure shell comp.**

- The comp. is compressed with the rotating shaft<14> and orbiting scroll<6> and make pressured room<8> together with fixed scroll<5>.
- The low pressured gas from suction pipe<17> is directly sucked into scroll section, pressured, and discharged inside the highly pressured shell. The discharged gas goes through the shell and reaches the refrigerant circuit via oil circulating route<19>.
- The lubricating oil for the shaft lubricate each part from oil reservoir<15> using the compression difference between high pressure gas and low pressure bottom section and returns to the oil reservoir<15> via oil circulating route<14b>. Some of the oil is mixed with the refrigerant and then taken back to the comp.
Comparisons

The following is the functional and latest situation of low/high pressure scroll comp. used for commercial PAC such as VRF.

**Durability for liquid compression**

- When sudden liquid compression occurs in the large capacity PAC, the low pressure shell type comp. shows us high reliability. The low pressure shell type comp. have less possibility for the liquid gas to be injected to the scroll parts because it is once stored in the bottom. Therefore, the gas pressure is always kept at the appropriate level, which results in high reliability of scroll quality.
- On the contrary, the high pressure shell type comp. has a risk of overloading with abnormal high pressure in scroll section occurring with injection of suction gas in sudden liquid compression. This may cause louder operation noise. To avoid these disadvantages, gas relief structure and refrigerant receiver are added to the shell in many cases.

**Durability for contamination**

- The low pressure shell type comp. has a high durability for contamination for the scroll part is stored at the bottom and there is a low possibility of direct contamination.

**Reliability of motor**

- The low pressured type motor is located at the bottom and can be operated in relatively low temperature. Thanks to this, chemical materials such as insulating paper and varnish has a long lifespan. Also, it contributes to the efficient operation with low temperature.
- On the other hand, with the high pressure shell type, the motor temperature is balanced with the discharged gas temperature, which means shorter lifespan and inefficient work. Graph 1 and 2 show the relationship between the operation range and efficiency of motors. Indicating the efficient motor operation realized in low pressured type compressor.
Reliability of lubricating oil

- The low pressure shell type compressor has a oil reservoir at the bottom, which helps the low temperature operation estimated below 85c degrees and contributes to longer lifespan and adequate oil barrier even when we select non-sticky oil to reduce the operation loss.
- On the contrary, the oil temperature of highly pressured shell type compressor must be used under high temperature for it is balanced with the discharged gas temperature. In order to obtain the same amount of oil barrier, an adequate sticky oil is required to use which is generally classified as 56 degree.
- Graph 3 shows you the oil temperature range used for each structure.

Reliability of lubricating oil

- The graph on the left shows the oil temperature range used for each structure.
- The area in yellow indicates the lubricating oil rage where it becomes chemically deteriorated.
- The low pressured compressor can work steadily without any influence on motor and oil by high temperature of discharged gas.
- However, the high pressured compressor usually have to run at level 8 of compression ratio when the discharged gas temperature is influenced by the compression ratio that restricts heating operation to attain a target temperature , usually set at 100c degree.

Safety of shell

- The low pressured compressor is designed up to 20HP. It is produced safely and used because the pressure toward the shell itself is relatively low.
- It is, however, difficult to develop large capacity- high pressure control compressors because the pressure toward the shell itself is high. To develop a large capacity comp., a special thick materials must be used to acquire enough strength to bear the high pressure. It is not easy to produce it with a cheap price. At the moment, the maximum capacity is 6HP and several compressors must be set for large capacity units.
Lubrication comparison

- Low pressure shell type lubricates compulsorily with oil pump and it is also quick in starting.
- Pressure difference system is mostly applied with high pressure shell type. It is simple in structure by lubricating the shaft using the pressure differences of low pressure at the bottom and high pressure at the scrolls. It is, however, poorly lubricated until the pressure inside the shell reaches the adequate amount. Moreover, if large capacity units are not in work for a long time, the compressor may dry due to the refrigerant movement in refrigerant circuit.

Capacity comparison

Nowadays, as DC brushless motor has been used for low pressure type compressor, the suction overheat loss is improved, which had been a big disadvantage to high pressure type.
As shown in graph 4, the efficiency today is no less than the high pressure type's.

Discharge noise

The gas in low pressure shell compressor is discharged to refrigerant circuit without attenuation. A silencer had to be attached beforehand with the compressor to reduce the noise.
We Mitsubishi Electric developed this newly designed compressor with the silencers inside the shell. This contributes to the reduction in production cost and enhancement of reliability.

ISO Authorization System
The ISO 9000 series is a plant authorization system relating to quality management as stipulated by the ISO. ISO 9001 certifies quality management based on the "design, development, production, installation and auxiliary services" for products built at an authorized plant.

Certificate Number EC97J1227


The ISO 14000 series is a set of standards applying to environmental protection set by the International Standard Organization (ISO).