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OIL- FREE SCREW COMPRESSOR OR OIL-INJECTED SCREW COMPRESSOR?

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Abstract

Atlas Copco China /HK Ltd. has taken the biggest one in the Chinese compressor market shares.

1. The description of two types of screw compressor
 2. The main applications of air compressor in China
 3. Chinese customers' choices mainly upon air quality requirement
 4. We promote oil-free compressor for customer's economy
 5. Unique attraction of oil-injected compressor
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As we know, compressors may be simply classified as dynamic compressor and displacement compressor, the displacement compressors confine successive volumes of gas within a closed space and increase the pressure by reducing the volume of the space. The displacement compressors are also classified as two types: rotary compressor and reciprocating compressor. As a major type of rotary and positive displacement compressor, the screw compressor has been playing more and more important role in the applications of compressors.

1. THE DESCRIPTION OF TWO TYPES OF SCREW COMPRESSOR

The beginning of screw compressors concept was with a design of the Swedish inventor Alf Lysholm, who had patented, when its practical application had not yet to be seen. The complex screws were difficult to manufacture with sufficient precision, avoiding deformation, breakage and leakage. In 1954 Atlas Copco acquired the rights to manufacture and sell screw compressors made according to the Lysholm principle, and in 1955 the first compressor was delivered to a mine of the Swedish company LKAB.

After several years' innovative research, the first oil-injected screw compressor by simply using screw element was brought onto the market by Atlas Copco in 1958. In 1967 Atlas Copco presented oil-free compressor, it met the requirement of textile, food and pharmaceutical industries because no oil is

injected in the compression chamber, no oil is stayed in the compressed air at all. With oil-free compressor Atlas Copco broadened its market further.

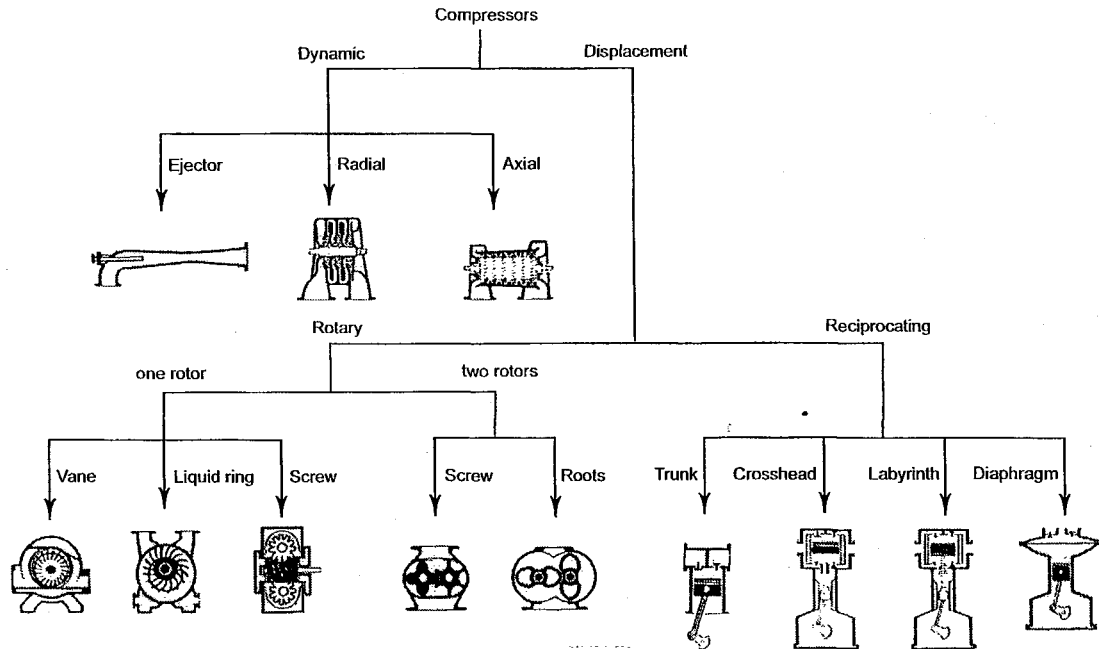


Fig 1: Basic compressor types

There are no inlet and outlet valves and no unbalanced mechanical forces, the screw compressor operates at high shaft-speeds. Consequently it combines high flow rates with small exterior dimensions.

To maintain compressor efficiency at low flow rates calls for high shaft-speed, oil-free screw compressors use external timing-gears to synchronize the counter-rotating male and female rotors. As the rotors touch neither each other nor the casing, lubrication is not required within the compression space, so the compressed air discharged from compression chamber is absolutely oil-free.

WIS - Water-injected screw compressor sometimes is considered as oil-free screw compressor because there is not oil but water injected in compression chamber, and no oil stayed in the discharged compressed air though injected process is happened during compression. It is the new version in recent years, but its fatal weakness is the interior rusty problem. So water-injected screw compressor has not been the mature technology until now. In China, A Joint-venture beer plant in Shanghai who bought 3 sets of water-injected screw compressor has fallen in trouble with serious rusty problem, and stopped operating them for years.

However, due to oil injected in the compression chamber, three functions:

- to seal the internal clearances
- to cool the air during compression
- to lubricate the rotor,

Oil-injected screw compressors operates at lower shaft-speeds. Male and female rotors are engaged just like two gears, so the timing-gear is not required in oil-injected screw compressor. The injected oil is reclaimed and re-circulated after compression. Oil-separator is required to separate oil

from compressed air. Through after-filters, there is still a little oil stayed in the compressed air, it is not absolutely oil-free compressed air. It should be called oil-less compressed air,

2. THE MAIN APPLICATIONS OF AIR COMPRESSOR IN CHINA

In China, compressors are used at many industry sectors, such as Textile, Electronic, Automotive, Iron and Steel, Food and Beverage, Tobacco, Petroleum & Petrochemical, Pharmaceutical, Power station, Chemical and Machinery sectors and etc. The demands for compressors from all industry sectors have been changing much recently owing to the rapid development of Chinese Economy.

Textile Sector:

During the 1980s and early 1990s, Chinese domestic textile industry developed rapidly, but their concentration was more on quantity of goods produced than quantity. Functional stability and technological improvement were ignored.

Since 1994, Chinese State-owned textile industry had been unprofitable. Taking advantage of the country's decision in 1997 to restructure it and upgrade its equipment to shuttle-less looms, Chinese State-owned textile industries began recovering gradually. Meanwhile, many Non-state textile enterprises have been found in the eastern China, Zhejiang Province. They invested to purchase mostly advanced technological equipment.

Oil-free screw compressors are used at air-jet weaving mills because compressed air is an ideal means of weft insertion, is gentle to yarn and allows high-quality weaving of almost all current staple fiber and filament yarn. Oil-free compressors prevent accidental oil pollution should failure occur in the filtering chain of the regular air supply.

Oil-free screw compressor is the best choice to be the complete set for the textile sector. The number of shuttle-less looms in China will be doubled to 200,000 before 2005. It is a new opportunity for oil-free screw compressors.

Electronic Sector:

Due to the strict environment limitation of electronic products manufacturing processes, oil-free compressor is the first choice for electronic industry sector. Since China started its opening policy, foreign electronic enterprises have invested in China, mainly in the eastern China, especially in Shanghai and Jiangsu Province. These joint-venture enterprises have been interested in purchasing oil-free screw compressors. But most of State-owned enterprises bought oil-injected compressors for short of money.

Most of foreign mobile communication companies came to invest in China, for instance, Siemens, Motorola, Ericsson, Nokia and etc. All of these enterprises bought our oil-free screw compressors. As a fast growing country with the largest population in the world, China is an important market for telecommunication equipment, heating competition will continue. It is one of the biggest potential market for oil-free screw compressors.

Automotive Sector:

The demand for compressors from automotive sector has been increasing stronger since many foreign automotive manufacturers entered the China's automobile market. In the eastern China, there

are two big famous joint-venture automotive plants. Shanghai Volkswagen and Shanghai General Motors. They are the users of oil-free screw compressors. In the other areas of China, many Chinese local automotive plants also develop rapidly and strongly because of the enormous potential requirements about the home-use automobile, for instance, in Chongqing, Sichuan province in the southwestern China, in Shenyang, Liaoning Province and Changchun, Jilin province in the Northeastern China, in Fuzhou, Fujian province in Southeastern China, in Wuhan, Hubei province in the Central China. In order to maintain the quality of outlook painting, oil-free compressed air is the best partner.

Iron And Steel:

Iron and Steel are the pillar industrial in China. There are many big State-owned iron and steel enterprises in every area. Chinese Steel Giant – Shanghai Baosteel Group is striving to become one of the world's top 500 companies, developing the high-tech industry is it's the best choice. Seven big enterprises including Shanghai-based Bao-steel Iron and Steel Group Corp. Anshan Iron and Steel Corp. Taiyuan Iron and Steel have discarded a lot of their backward equipment last year. It contributed to stronger demand for compressors recently. The oil-free and oil-injected screw compressor are the both choices for this sector.

Food and Beverage:

The brewing industry was the first to set standards for quality air in its manufacturing process, which is not surprising since it is one of those sectors – food and beverages are others – where compressed air is used as active air and comes into direct contact with the end-product. Compressed air is used for operating machines, in fermenting and in bottling. Consequently, high-quality oil-free air is essential.

China has been developing its food and beverage industries recently, especially in beverage sector. There are several big beverage local enterprises, such as Wahaha, It takes about 30% share of China's mineral water market, has been competing fiercely with Robust which ranks number two with a 20 % market share. Zhejiang Yangshengtang which makes Nongfu mineral water is the number three in the market.

Foreign beverage industries are stronger forces in Chinese beverage market. For instance, Coca-Cola Company and its partners have invested more than USD1.1 billion in China since Coca-Cola resumed its business in the country in 1979, when China started its opening policy. The Coca-Cola Company recently announced the opening of its 24th bottling plant in China.

Tobacco sector:

Tobacco industry is one of the most profitable industry sector in China, there are many tobacco plant in the southwestern China. It is the pillar industry sector in the areas. The oil-free screw compressor is the best choice for tobacco sector because compressed air comes into direct contact with the end-product- cigarette. The quality of cigarette relies on the quality of compressed air. Most of our customers in tobacco sector chose the oil-free screw compressors mainly because of these two reasons – quality air requirement and profitable situation.

Petroleum & Petrochemical:

Increases in prices of petroleum products on current world market are threatening the security of China's oil supply. Oil price rise on the international oil market has had a mixed effect on China's

petroleum and petrochemical sectors. Upstream oil exploration firms can benefit because they can sell their products at higher prices than before. However, high crude prices increase production costs for the country's downstream refining and petrochemical enterprises, which have a small manufacturing capacity and will suffer in the competition with foreign giant rival.

In this year, a strategic development will be exploited in the western China. There is rich natural resources in these areas. To date, three major oil and gas production bases – eastern Sichuan, Xinjiang and the Ordos Basin - have taken shape in the west. The Chinese Government is considering new incentives designed to encourage foreign businesses to invest in the country's vast central and western regions. So petroleum and petrochemical industries are the potential developing sectors for compressors in the western China in the near future.

3. CHINESE CUSTOMERS' CHOICES MAINLY UPON AIR QUALITY REQUIREMENT

Chinese customers choose compressors according to their requirements. After many years of their experiences in choosing and operating air compressors, Chinese customers have changed their initial attitude. In the past, they almost believed everything sales people talked to them, but now they are thinking about everything which you said about compressors. In general, there are some features as the following:

3.1 Their Choices Mainly Upon Quality Requirement

Oil-free screw compressor or oil-injected screw compressor? It relies on the different industry sectors. When compressed air comes into direct contact with the end products, most of customers would choose oil-free screw compressor in order to keep the quality of end products.

In Chinese compressor market, in textile sector, about 70% of our customers purchased oil-free screw compressors. In tobacco sector, about 60% of our customers purchased oil-free screw compressors. In food and beverage sectors, about 35% of our customers purchased oil-free screw compressors. In iron and steel sector, 20% of our customers purchased oil-free screw compressors. In automotive sector, there is 20% of our customers purchased oil-free screw compressors.

3.2 Their Choices Are Affected By Their Economic Factor

Although customers purchased compressors mainly upon quality requirement of compressed air, they had to think about the pricing when they decided to choose compressors, They believe that oil-free screw compressor is better than oil-injected screw compressor in quality of compressed air, but they are hesitant facing to the price of oil-free screw compressor because the investment of oil-free screw compressor is higher than that of oil-injected screw compressor. Most of our customers purchased oil-free screw compressors are profitable enterprises. Such as Joint-venture enterprises, some large State-owned enterprises in the coast city in the eastern China and non-State-owned enterprises.

3.3 Customers Think Enough To Meet The Requirement Of Compressed Air

It is a common opinion which type of compressors is chosen based on the quality requirement of compressed air, It doesn't pay to buy oil-free screw compressor if they don't need oil-free compressed air. In fact, the total cost, including investment cost, operation cost and maintenance cost of oil-free screw compressors during several operating years are not higher than oil-injected compressors. It is a bargain deal to customers. I will introduce it in the following paragraphs.

4. WE PROMOTE OIL-FREE COMPRESSOR FOR CUSTOMER'S ECONOMY

The first advantage of oil-free screw compressor is protection to the end products, no any oil is injected in compression chamber, so there is no any risk to pollute the end product. The second advantage is environment protection, there is no oil flowed into the drain water, then avoid polluting water resources, no oil mixed in the compressed air, then avoid polluting the atmosphere.

If customers chose oil-injected screw compressors instead of oil-free screw compressors when oil-free compressed air is actually needed for their processes, there is a potential risk existed in the near future because using filters is just an initially cheaper alternative to receive **oil-less** compressed air. Without proper maintenance or in-time replacement of filter element, filters can not work effectively, more oil will remained in the filtered compressed air. The other risk is when ambient temperature is higher, the efficiency of filters drops much lower than at the normal working condition. (See the following fig about it at the next page.) Many terrible troubles have been found in the southern China when customers tried using filters for oil-less compressed air system because of high ambient temperature in that area.

Except for these advantages, another advantage of oil-free screw compressor has been neglected by many customers, that is the third advantage – **Economy!**

If customers choose oil-injected screw compressors, filters and water-oil separators are required for oil-less air system. The total initial investment of oil-injected compressors, filters and other accessories is just a little cheaper than that of oil-free compressors. However, installation cost of oil-free compressors is more cheaper than that of oil-injected screw compressors and other accessories in the whole compressed air system.

If customers choose oil-inject screw compressors for oil-less compressed air requirement, it causes pressure dropping more because pressure drops are added up through every equipment. Customers have to choose the compressor which can discharge pressure higher than that is finally required at the air end because there are many accessories in the oil-injected compressor system. The higher discharge pressure, the more power will be consumed in compressors. It is not bargain deal to buy oil-injected compressors for oil-less compressed air system customers will find after several years' operation.

In general, an oil-less compressed air system includes one set of oil-injected compressor, one set of pre-filter, one set of refrigeration dryer and two sets of after-filter, in order to obtain high quality compressed air. There are pressure drops about 0.2 bar in the oil separator, 0.2 bar in the pre-filter, 0.1 bar in the air dryer and 0.5 bar in the two sets of after-filter. The total pressure drop is 1.0 bar in the compressed air system. Then the quality of discharge compressed air is 0.003 ppm and PDP is 2~3 °C in the standard working condition. If discharge pressure is 6.7 bar(e) in the air end, the working pressure is required 7.7 bar(e) for the compressor.

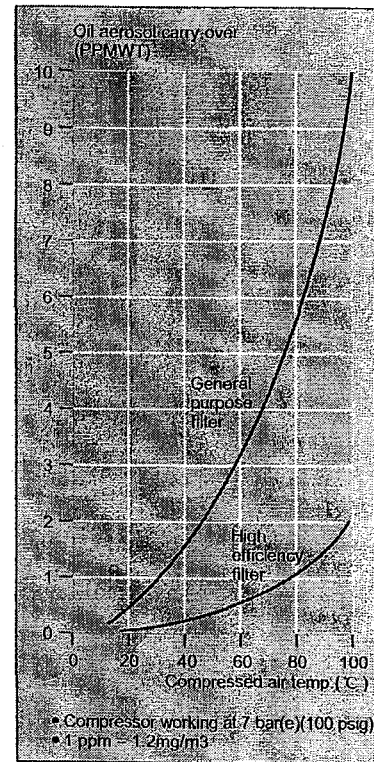


Fig.2 Temperature of compressor

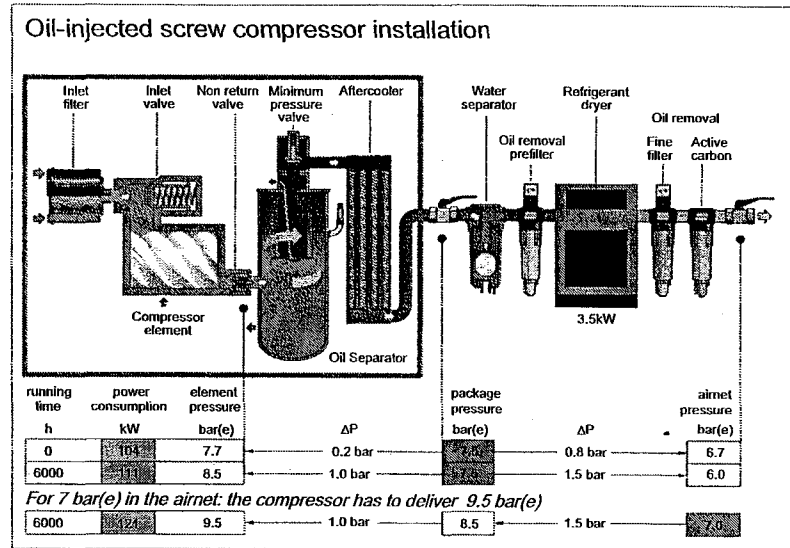


Fig3 Oil-injected screw compressor installation

After one year's operation, pressure drops in the filters and oil separator are higher because filter elements and oil-separator element are saturated just as a saturated sponge does. The pressure drop in a filter normally increases to 0.5 bar, and the pressure drop in the oil-separator increases to 1.0 bar. The total pressure drops of whole compressed air system increase to 2.5 bar. The more pressure drop increases, the more power will be consumed after years' operation.

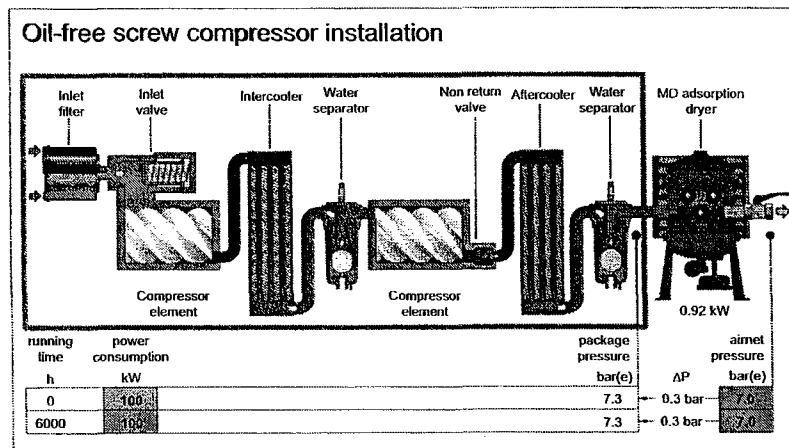


Fig 4 Oil-free screw compressor installation

If an oil-free compressed air system is chosen, it includes just one set of oil-free screw compressor and one set of adsorption dryer. There is only pressure drop about 0.3 bar in the dryer. If discharge pressure is 7.0 bar(e), the oil-free compressor of working pressure 7.3 bar(e) is enough to be chosen. Otherwise, the quality of compressed air is absolutely oil free and PDP is -30°C . The total pressure drop is only 0.3 bar in the whole compressed air system. After several years' operation, no any more pressure drop increases because there are not filter elements or oil-separator element existed in the oil-free compressed air system. Oil-free screw compressors allow the installation to operate at a reduced

working pressure resulting in a lower electrical energy consumption. It is important that the energy cost of oil-free screw compressor is much lower than that of oil-injected screw compressor, because energy cost is the biggest one in the total costs, it can account 90% of the total costs over a ten year working life. You can find benefits of oil-free compressor after one years' operation as the capital cost is usually exceeded by the energy cost.

Except the capital cost and energy cost, the maintenance costs of two different compressors are different. It is required more for oil-injected screw compressor than for oil-free screw compressor because filter elements and oil separator elements have to be replaced in the oil-less compressed air system.

Thinking about these three costs of buying compressors, capital cost for the full scope of equipment, energy cost and maintenance cost for compressed air system. Oil-free compressor is more economic choice for customers.

5. UNIQUE ATTRACTION OF OIL-INJECTED COMPRESSOR

Although oil-free screw compressor is the best choice for customers in most of applications, oil-injected compressor has its unique attraction to customers. When customers are short of money, they consider that the lower capital cost is the first choice to them. In China, many customers in backward areas bought oil-injected compressors, for instance the Northeastern China and the Northwestern China. In another hand, some customers insisted on that oil-injected screw compressor is more reliable than oil-free screw compressor because the principle of oil-injected compressor is more simple than oil-free screw compressor.

In other areas where electrical cost is much lower, the energy cost is not considered as the important factor when customers choose compressors, for instance the areas near a hydroelectric power station or a nuclear power station. Customers often pay more attention to oil-injected screw compressors.

In some industry sectors, if compressed air with a little oil is required for special purposes, customers would choose oil-injected screw compressors, for instance, compressed air used in the assembly line contains a little oil can lubricate the mechanical components.

CONCLUSIONS

Both oil-free and oil-injected screw compressors are the main types of compressors in current Chinese compressor market. They are the advanced and mature technology for more than 40 years' development. Choosing oil-free screw compressor or oil-injected screw compressor, it is up to you!