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IMPRESSORS
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Volume: / Issue:

Oil-Free Compressor

Ideal Partner for the Rubber Industry

Compressed air finds innumerable applications in modern life. To name just a few of these, dentists operate high-speed drills using compressed air; tyres of vehicles are inflated with compressed air; and blowers send compressed air into converters that convert pig iron to steel.

Compressed air has such widespread usage because of the advantages that it offers. It can be used to operate a wide range of machinery, and compared with using manual labour, it saves time and increases production. It also results in savings through reduced labour requirements.

In the manufacture of rubber goods too, compressed air finds uses. For example, it is convenient to use compressed air to strip rubber products, such as gloves, off formers in the final stage of production.

Compressed air is produced using compressors, which are machines that increase the pressure of air by reducing its volume. Special care is required in selecting compressors for use in applications where compressed air comes in contact with rubber—either raw materials or finished products. This is because the air delivered by the majority of compressors carries a small amount of oil. This oil is derived from petroleum (mineral oil). As is well known, petroleum oils attack rubber chemically, causing its physical properties to change and leading to the possible failure of rubber components.

Why are there traces of oil in compressed air? Is it not possible to remove the oil? Most of the compressors used in industrial applications belong to one of two types: piston compressors and screw compressors. These are also referred to as reciprocating compressors and twin-screw compressors, respectively.

In reciprocating compressors, air gets compressed by the movement of a piston fitting snugly within a cylinder. When the compressor operates, the piston moves up and down in the cylinder. A system of valves is used to let air (at atmospheric pressure) into the machine and to let compressed air out.

At the heart of a screw compressor is a component known as an airend. In the airend, there are two rotors with lobes that mesh with each other. Air is trapped within the spaces between the lobes and gets progressively compressed as the rotors turn. Compressed air is discharged from the outlet of the airend.

In both reciprocating and twin-screw compressors, the compression process is swift. This process causes the temperature of the compressed air to rise. The extent to which the air is heated depends on the pressure generated: with a higher pressure, the air is hotter. The temperature of the air is typically above 100 degrees Celsius.

But the compressed air from a service line cannot be delivered this hot. The acceptable temperature may be no more than 10 degrees Celsius above the ambient temperature. So the temperature of the hot air is brought down by different means in reciprocating compressors and screw compressors.

Smaller reciprocating compressors are provided with cooling fins that radiate heat from the hot compression chamber. Larger reciprocating machines are provided with jackets that have cooling water circulating through them. The compressed air is usually passed through a cooler before it is finally delivered from the compressor.

In a screw compressor, it is more expedient to use a fluid such as oil to reduce its temperature. The oil is injected into the air that is being compressed. As it mixes with the air, it absorbs much of the heat generated by compression and gets heated up itself as a result. The oil-air mixture, which is still hot, is passed through a separator. The oil and air are then cooled separately. The air is passed through a filter to reduce the oil content further, after which it is delivered from the compressor. The oil is re-circulated. Despite the separation and the filtration, a small quantity of oil remains in the compressed air.

The oil in a screw compressor also serves to lubricate the moving parts of the machine. For the same reason (and not for cooling), oil is used in reciprocating compressors as well. Oil is stored in the crankcase, below the piston, of a reciprocating compressor. In some compressors, the oil is simply splashed on the inner surface of the cylinder and outer surface of the piston. In others, oil is pumped on to these parts using a more elaborate system. The air and the oil are separated by tight piston rings, but in practice some oil gets carried into the compressed air stream. Thus there are traces of oil in the compressed air from both screw and reciprocating compressors.

In many applications, the compressed air must be entirely free of oil. The reason is that the compressed air comes into contact with food items, parts of the body or materials (such as cement or yarn) that are affected by oil. Examination gloves and surgical gloves made of rubber represent products that are doubly sensitive to oil: rubber is one of those substances that are affected by oil, and for obvious reasons, medical applications cannot be contaminated. But it is impossible to remove all the oil from the compressed air.

The solution is to use oil-free compressors. These are compressors in which oil is not introduced into the compressed air. Only these compressors can produce compressed air that has absolutely no oil.

Oil-free compressors are similar to their oil-lubricated counterparts, but differ in some significant ways. In the case of oil-free screw compressors, the entire circuit dealing with oil is not present because it is not necessary. The compression itself is achieved in multiple stages and not in one step. This construction is required to reduce the loss of compressed air through leakage from the airend. For the same reason, oil-free compressors also need to run at relatively high speeds. The air is cooled between the stages of compression in an oil-free screw compressor. This cooling makes the compression more efficient and reduces the energy required to produce compressed air. Oil-free screw compressors are provided with timing gears to ensure that the clearance between the rotors is maintained during operation.

Similarly, there are a number of differences between the construction of oil-free and oil-lubricated reciprocating compressors. These include a special arrangement to link the connecting rod and piston, piston rings made of polytetrafluoroethylene (PTFE), and sealed bearings at the ends of the crankshaft. There are differences in the way oil-free reciprocating compressors operate too. For instance, they draw air through the crankcase. This feature, not seen in oil-lubricated machines, serves to cool the bearings. In general, the operation of oil-free compressors is highly sensitive and requires each component to be finely tuned and matched with the other components.

Oil-free reciprocating compressors offer several advantages over oil-lubricated compressors:

- They are more environmentally friendly—there are no leakages and spillages of oil.
- Safety is improved because of reduced risks of fires associated with oil spillages near electrical cables.
- There is no oil accumulation in the air receiver as in oil-lubricated compressors.
- There are fewer parts in oil-free machines. Therefore fewer spare parts are required and their maintenance requirements are less.
- The life of the downstream equipment, including tools, is extended.
- The energy required to drive an oil-free machine is lower. This makes an oil-free compressor more economical to use.

On account of these advantages, compressor users are opting for oil-free machines. The applications range from food and beverage processing, digital printing and rice sorting to medical and railway applications. Elgi supplies oil-free reciprocating and screw compressors for all these industries and to the rubber industry.