Selecting and sizing process compressors

Use these guidelines and equations to better match process requirements

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Proper compressor selection and sizing requires understanding the main types of compressors and their operation, using the right mathematical models for sizing both polytropic and adiabatic compressors, and providing for surge control and compressor discharge fluid treatment.

There is no single type of compressor that can be adapted to a particular application. The operating conditions, space and weight restrictions must be reviewed before the appropriate compressor is selected. In addition, the type of driver must be selected since its operation and process conditions are interrelated.

Fig. 1 shows the different types of compressors. They can be classified into two basic types: reciprocating and centrifugal. The reciprocating compressor is well suited for high pressures and low-volume flowrates, while the centrifugal is preferred for lower pressures and high-volume flowrates. A centrifugal compressor uses the relationship between velocity and pressure to increase the gas pressure. The gas enters a rotating impeller at the eye; the vanes force the gas to the outside rim, and subsequently throw it away from the rim at a high velocity. The gas is flung into the surrounding diffuser and volute passageways with a large volume, resulting in a reduced velocity. The velocity energy is changed into pressure energy and this subsequently increases the gas pressure.

Compressor performance often varies with changes in process conditions. Sometimes performance curves supplied by the manufacturer as discharge pressure and power requirement versus an inlet volumetric flow may not be valid for variations in process conditions. Lapina[1] has provided a technique for obtaining a usable performance curve that is valid for the actual process conditions.

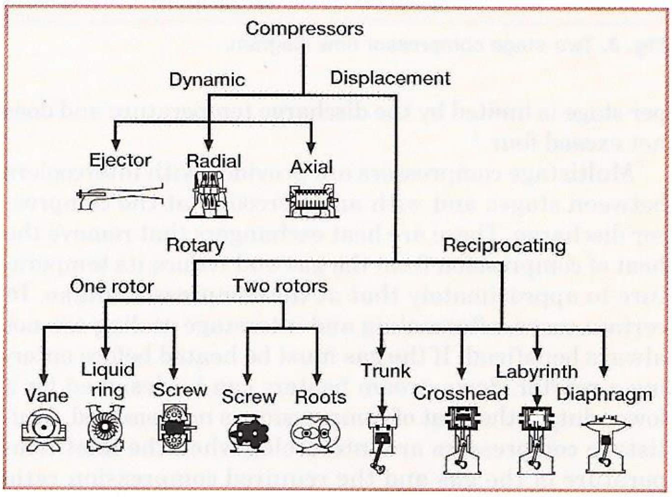

Fig. 1. Basic compressor types.

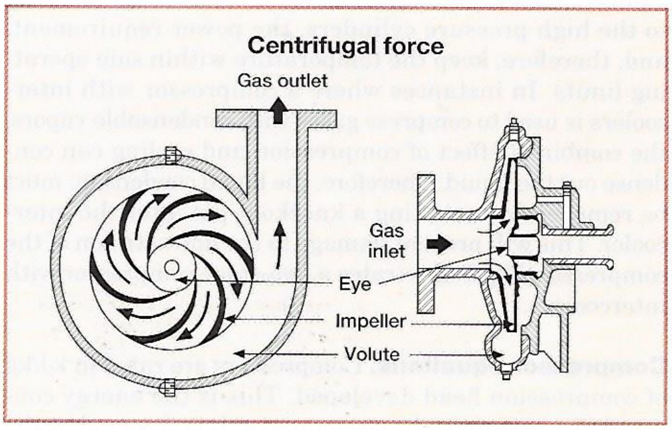

Fig. 2. Centrifugal compressor gas flow.

Centrifugal compressors. In a centrifugal compressor, at least half the driver power (e.g., an electric motor, gas or steam turbine, or a gas engine) is changed into gas velocity energy. The increased velocity can be carried forward to the next impeller for a further increase in velocity. A centrifugal compressor uses the impeller to furnish rotational pressure, which squeezes the gas outwards and closer together, resulting in some pressure increase. As the impeller is rotated faster, more energy is expended from the driver. Fig. 2 illustrates the flow of gas in a centrifugal compressor. The amount of pressure that a compressor impeller can develop depends on its speed and diameter. Increased velocity and pressure are required where there are large impeller diameters and high speed. The impeller metal will have the same centrifugal force as the gas flowing through it. Therefore, the pressure that is developed with a single impeller is limited by the strength of the impeller metal. An additional impeller is used where one impeller is incapable of providing the required pressure. The gas leaving one rim enters the next stage eye of the impeller, consequently boosting its pressure.

Reciprocating compressors. Reciprocating compressors are furnished as single or multistage with ratings from fractional to more than 15 MW per unit. The pressures range from a low vacuum at suction to 44,000 bar and higher at discharge. The number of stages depends on the overall compression ratio. The compression ratio