8

LIQUID RING COMPRESSORS

Liquid ring compressors (Fig. 8.1) represent a subgroup of the two major compressor categories, dynamic and displacement. Since these machines use a liquid to displace gases, they are often classified as volumetric compressors with liquid displacers. Although considerably larger machines have been produced, the overwhelming majority fit in the size range where 15- to 150-kW drivers are needed to compress gases to about 100 psig, or approximately 7 bar discharge pressure (Fig. 8.2).

In general, liquid ring compressors are the functional equivalent of liquid ring pumps. The principal difference is double-lobe construction in a compressor, which balances radial forces imposed on the rotor (Figs. 8.3 and 8.4). Liquid ring compressors tolerate carryover, as incoming soft solids and liquids are cushioned by the seal liquid and washed through to discharge. Liquid ring air compressors sealed with water actually scrub out particles as small as airborne bacteria with high efficiencies.

That portion of the seal liquid that passes on through the pump is removed from the discharge stream by a separator, which the compressor manufacturer furnishes as part of the system. A continuous supply of makeup seal liquid maintains the rotating ring. Liquid from the separator is usually cooled and recirculated to provide this makeup supply.

Heat of compression raises seal liquid temperature only about 10 to 15°F during its passage from makeup to discharge, and temperatures inside a liquid ring compressor remain far below the peaks that adiabatic compression would produce. If the gas mixture is explosive, the liquid ring compressor can serve as a flame arrester when it is sealed with a nonflammable liquid such as water.

If the inlet gas mixture contains vapors that will condense at seal liquid temperature, a capacity bonus is obtained. Vapor condensation reduces the volume that the pump or compressor must handle. Condensate flows out along with discharged seal liquid, and accumulated excess liquid is then drawn out of the separator system.

A Practical Guide to Compressor Technology, Second Edition, By Heinz P. Bloch

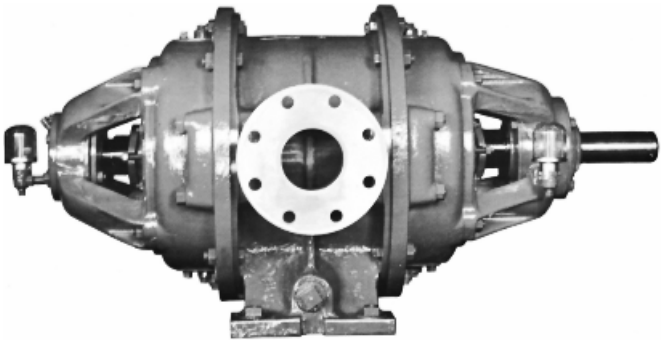


FIGURE 8.1 Liquid ring compressor. *(Nash Engineering Company, Norwalk, Conn.)*

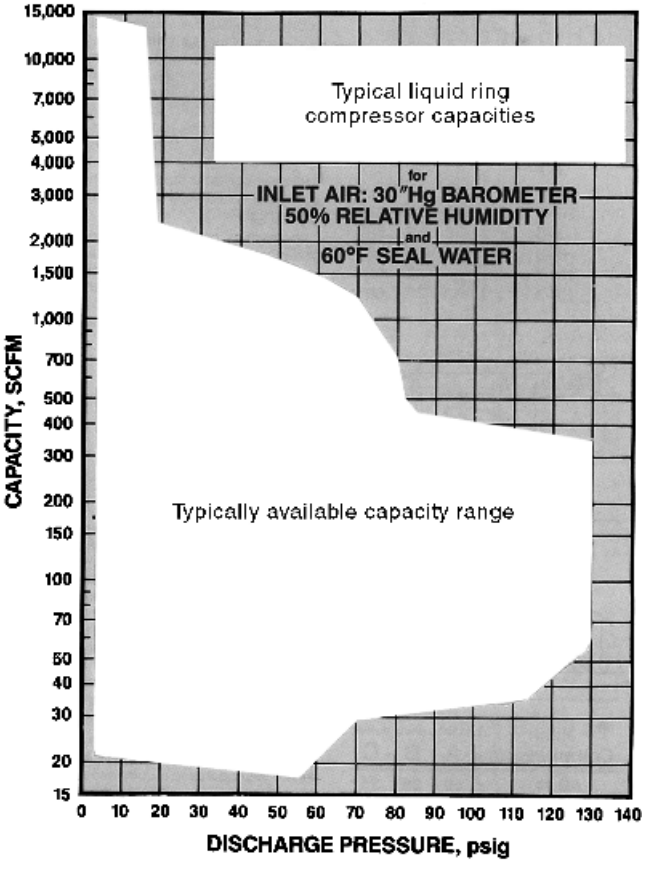


FIGURE 8.2 Typical capacity field for modern liquid ring compressors. *(Nash Engineering Company, Norwalk, Conn.)*

Water is an excellent seal liquid and is most often used for its convenience. There are many situations, though, in which some other liquid yields important advantages. Some products cannot tolerate even trace amounts of water. If condensate recovery is desired, that same liquid, or one compatible with it, may be used as the seal liquid. Sometimes, a

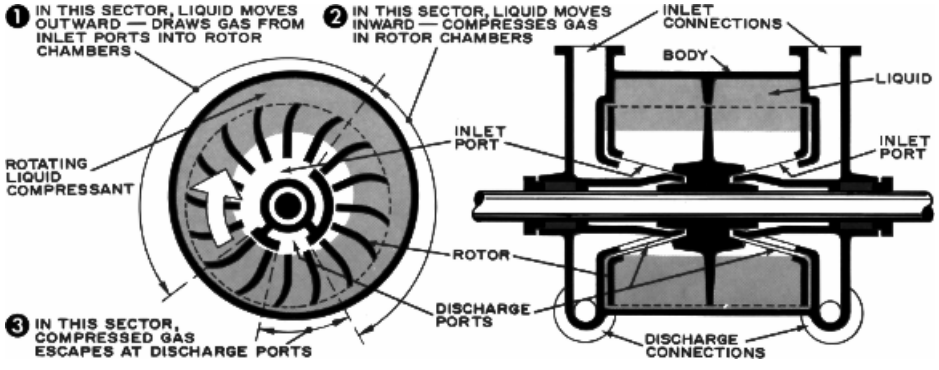
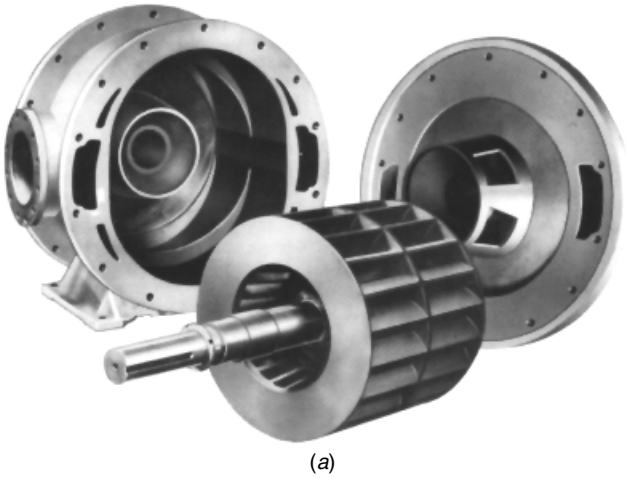


FIGURE 8.3 Functional schematic of a liquid ring compressor with a circular casing. *(Nash Engineering Company, Norwalk, Conn.)*



(*a*)

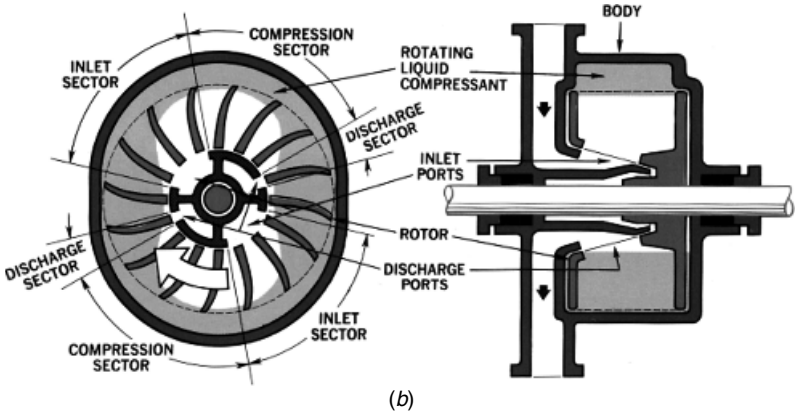


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FIGURE 8.4 (*a*) Liquid ring compressor with an elongated casing; (*b*) schematic section at the inlet and discharge sectors. *(Nash Engineering Company, Norwalk, Conn.)*

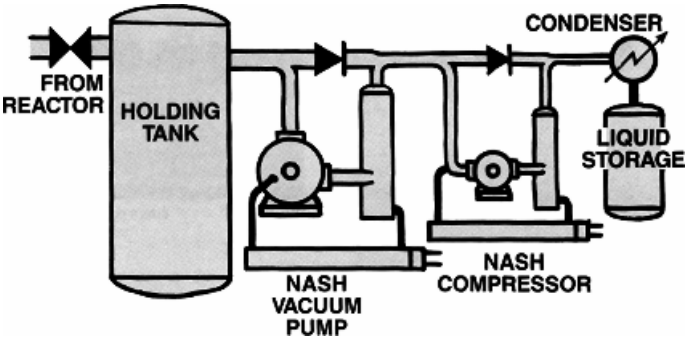

FIGURE 8.5 Vinyl chloride recovery system using liquid ring equipment. *(Nash Engineering Company, Norwalk, Conn.)*

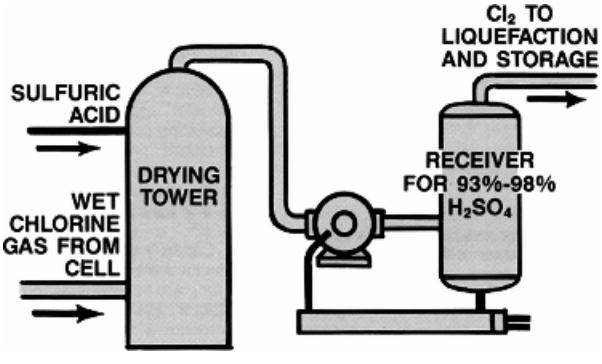

FIGURE 8.6 Corrosive gas compression system using a liquid ring compressor. *(Nash Engineering Company, Norwalk, Conn.)*

liquid that inhibits the attack of a corrosive gas mixture will improve equipment service life or make costly construction unnecessary. If low-temperature cooling is not available, the seal liquid's vapor pressure may limit the vacuum attainable. In that case, an oil seal or engineered synthetic fluid can eliminate the need for cooling water and will extend the vacuum range.

Common but greatly simplified arrangement drawings are shown in Figs. 8.5 through 8.7. Figure 8.5 represents a monomer recovery system. In one of several batch monomer recovery systems, unreacted polyvinyl chloride (PVC) is first transferred into the evacuated holding tank. A liquid ring vacuum pump scavenges gas out of the PVC and delivers it to the compressor inlet at or near atmospheric pressure. The single-stage compressor then compresses the gas for condensation and storage as a pressurized liquid.

A corrosive gas compression system is depicted in Fig. 8.6. This layout and equipment choice minimizes the attack of corrosive gases on compressors and vacuum pumps, often without resorting to the use of expensive construction materials. Selecting appropriate seal liquids plays a part in this success. As one of many examples, concentrated sulfuric acid is used as the seal liquid in many liquid ring compressors handling chlorine gas. Another approach is used with dry hydrogen chloride gas, which is compressed with an oil seal. Water is used to seal stainless steel compressors handling carbon dioxide, sulfur dioxide, or hydrogen sulfide.

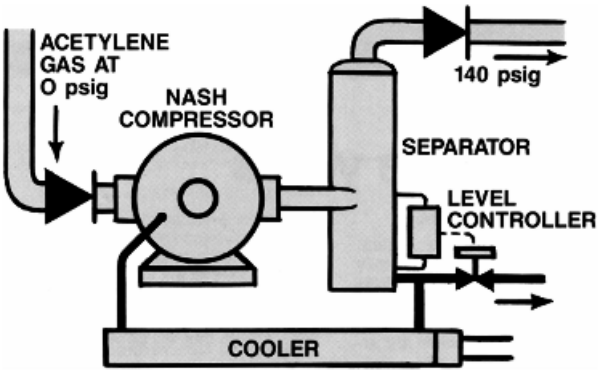

FIGURE 8.7 Explosive gas compression system using a liquid ring compressor accommodates a 10 : 1 compression ratio in a single stage. *(Nash Engineering Company, Norwalk, Conn.)*

Typical of arrangements for handling dangerously explosive gases, the compressor system shown in Fig. 8.7 keeps acetylene cool and saturated with water, which is used as the seal liquid. Tests with intentionally propagated explosions both upstream and downstream of liquid ring compressors confirm that they can function effectively as flame arresters. A single-stage liquid ring compressor can handle a discharge pressure as high as 140 psig (9.5 bar). It should be noted that multistage compression is available for higher discharge pressures.