How to Increase the Vacuum of a Liquid Ring Pump

By Joe Aliasso

The degree of vacuum a Liquid Ring Pump can produce depends on the vapor pressure of the sealant fluid. To increase vacuum level, an atmospheric air motivated ejector can be installed in front of the pump.

This ejector operates by taking advantage of the pressure energy of the 14.7 psia motive atmospheric air, compressing it to a higher absolute pressure. The pressure energy of the motive air is converted to velocity energy as it expands from atmosphere to process pressure while flowing through the ejector nozzle. This high velocity motive air is mixed with the process load in the suction chamber.

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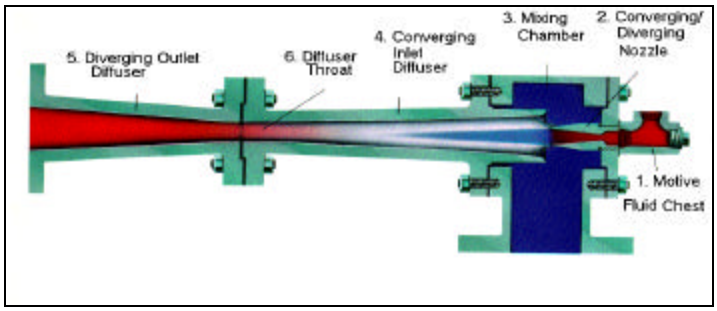
For an ejector with a compression ratio greater than 2:1, a shock wave is set-up in the ejector diffuser. Here the velocity energy is slowed down and converted back to pressure energy. The outlet pressure at the discharge diffuser, in absolute terms, is higher than the inlet pressure. This is how the ejector compresses the load. The "atmospheric air motivated ejector" principal of operation is the same as a steam motivated ejector, except the one major difference is the atmospheric air ejector cannot discharge against an atmosphere backpressure because the motive energy (pressure) needs to be higher than



Ejector operation illustrated

the discharge pressure of the ejector. This means that the atmospheric air ejector can be used as a booster only, and that a backing pump, normally a Liquid Ring Pump, is required. When an atmospheric air ejector is coupled with a Liquid Ring Pump, the pump is first turned on to start producing a vacuum. Once the pump is up to speed, the atmospheric air motive valve can be opened to allow the atmospheric air ejector to operate. For applications with evacuation requirements, the atmospheric air ejector should be bypassed and operated only when the design interstage pressure is achieved. Benefits of an atmospheric air ejector are:

1. Simple design with no moving parts, practically no wear and negligible erosion.
2. Increased vacuum levels from the air ejector are possible when used with a Liquid Ring Pump. For a Liquid Ring Pump using 60°F water as the sealant, 25 mmHgA can be obtained. But when an atmospheric air ejector is used with this pump, 5 mmHgA can be obtained.
3. Ejector can be manufactured in a wide variety of materials, including 316SS, titanium, and FRP.
4. Ejector protects the Liquid Ring Pump from cavitating, even when warm water is used as the sealant. The atmospheric air ejector boosts the operating pressure of the Liquid Ring Pump to keep it out of the range of cavitation.
5. When the ejector is used as part of a Rotary Lobe Blower-Atmospheric Air Ejector-Liquid Ring Pump System, it eliminates the need for an intercooler (gas cooler). The atmospheric air ejector mixes ambient air (motive) with the process load. The resulting mixture temperature of the gas leaving the ejector is cooler than the inlet load temperature. Therefore, an intercooler is not required after a rotary lobe blower.
6. Minimal space requirements: ejector is normally flanged directly to the Liquid Ring Pump suction connection. Because no utility piping is required, it can also be easily installed into existing systems.
7. To eliminate additional air load into the process stream (from the motive air), the discharge gas stream from the Liquid Ring Pump can be used as the motive supply for the air ejector.
8. If sized properly, ejector can eliminate the need for a vacuum relief valve or the vacuum breaker normally required for Liquid Ring Pumps operating at low absolute pressures. The atmospheric air ejector, when operating constantly, adds air load to the backing pump. Even when the process load goes to zero, the air ejector will keep the Liquid Ring Pump from operating deadheaded with no process load, preventing cavitation.
9. Ejector is economical to manufacture when compared to other vacuum producing equipment. No additional piping or utilities are required for operation.

A disadvantage of the atmospheric air ejector is the necessity to handle motive air as an additional load on the Liquid

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Ring Pump. Even though the interstage pressure is increased (suction pressure of the Liquid Ring Pump), the resulting ACFM to be handled is increased slightly. This normally results in a larger Liquid Ring Pump. This disadvantage often is clearly outweighed by all the advantages of the air ejector. If your process requires better improved vacuum than is achievable by a Liquid Ring Pump, or your water temperature is too hot and causing your pump to cavitate, then an atmospheric air ejector is the simplest and most cost effective solution to the problem.

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