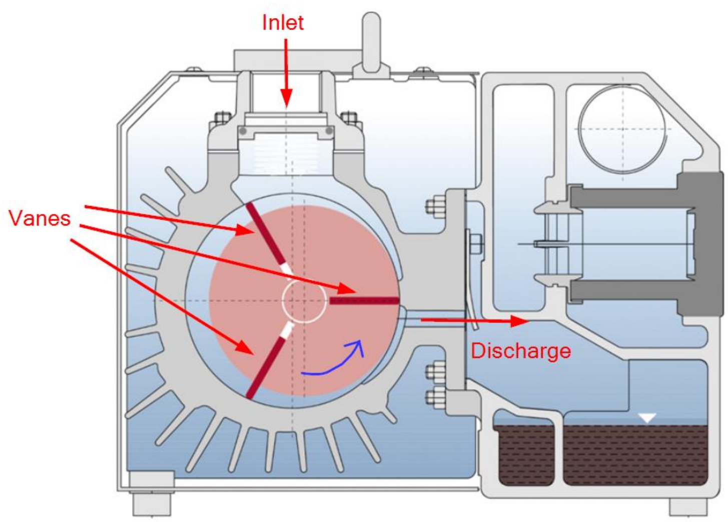
Happy New Year!

A few months back, I wrote an article on tricks I've learned to optimize an oil lubricated rotary vane vacuum pump. Since then, I have run into quite a few applications where our Elmo Rietschle rotary vane pumps, claw pumps, regen blowers, and Nash dry screw pumps have all encountered their common enemy: heat. So, I thought I would share with you their individual relationships with heat. As always, please feel free to tell me to stop with these emails if you don't find value in them.

Rotary Vane Pump

A rotary vane pump is designed with a cylindrical casing, in which a rotor is positioned eccentrically so that it is almost touching the cylinder. Rotor blades, or vanes, are positioned inside the rotor slots. When the rotor starts running, due to centrifugal force the blades are thrown out and slide against the internal surface of the cylinder. A cell is formed between two blades with a volume that changes constantly during rotary. Air enters the inlet port into a cell, then compressed as the cell rotates away from the inlet and toward the exit port. The pumps are easy to operate and maintain, and relatively economical vacuum solutions.

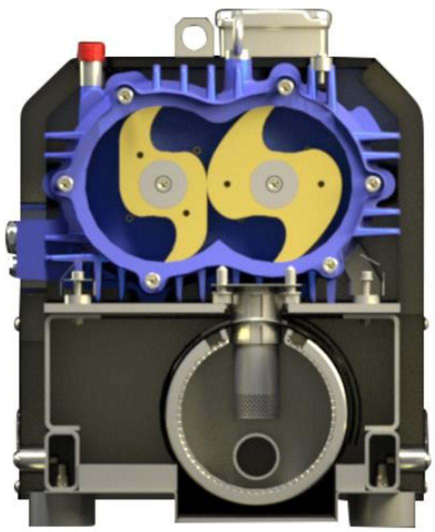


In an oil lubricated rotary vane pump, oil is circulated to lubricate the vanes and the rotor assembly, then the oil-air mixture is discharged and separated. In my earlier article, I have already discussed the damaging emulsion that can result from condensing water vapor mixing with oil inside the pump. Another easily missed failure mode is allowing the vacuum pump to run open to atmosphere for extended period. A typical oil lubricated rotary vane needs to see at least 15 in-Hg at the suction port in order to circulate the oil inside the pump. When running open to atmosphere, the pump can be at too weak of vacuum, not allowing oil to circulate, causing overheat and start spewing oil mist out of the exhaust port.

A dry vane pump can be more susceptible to heat from various causes. Incoming high temperature process gas can kill the carbon vanes' life quickly. Many dry vane pumps' max vacuum depth is limited to 24 to 25 in-Hg, but I've seen a few units' vacuum relief valve having been misadjusted in operation, which allowed the pump to go deeper in vacuum. This would certainly raise the heat level inside the pump due to excessive compression and kill the vanes even faster. If the pump discharge is piped to a scrubber that may be creating back pressure, which will raise the pump temperature further, and wearing the vanes more. Particulate is the biggest killer of carbon vanes in a dry vane pump, not heat. Any powder that get past the inlet filtration into the pump will act like sandpaper to wear down the vanes at an exponential rate. Once a vane is broken, it will quickly crash the other vanes in the pump.

Claw Pump

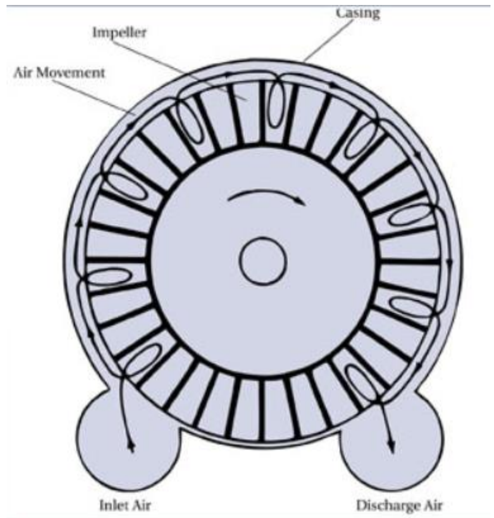
A claw pump consists of two rotors that turn in opposite directions in a compressor housing, without contacting each other. They are synchronized via a precision gear. As the claw moves over the suction connection, gas is sucked into the compression chamber. As the rotors revolve, the gas is compressed between the rotors until the lower rotor uncovers the discharge channel. More than 60% of differential pressure efficiency can be expected from this internal compression.



To remove the heat generated by the compression process, cooling air is sucked in between the compression housing and the silencing cover before it leaves the pump. Even with this cooling mechanism, a claw pump can still have high discharge temperature. This can serve as an advantage for reduced condensation of carry-over vapors, but this can pose an auto-ignition risk when flammable gases are present. Polymerization of process vapors can also build up on running components, requiring additional maintenance. Uncontrolled build-up of heat can result in excessive internal component expansion, closing the tight tolerance and crashing the pump.

Regen Blower (Side Channel Blower)

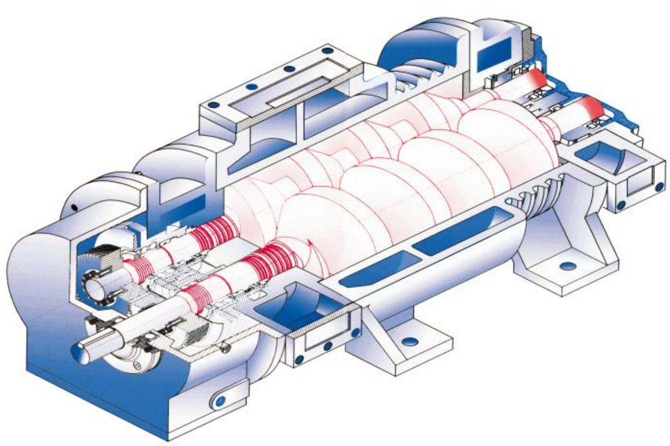
In a regen blower, air is drawn in and trapped between two impeller blades as it spins from inlet to the discharge. During this rotation, the trapped air is compressed inward and outward via centrifugal force.



Because of this continuous movement of air and resulting friction, regen blowers can add considerable heat. The air movement within the blower itself becomes the main cooling solution. Like most dry pumps, solid or liquid ingestions can be catastrophic, but fine particulates can be especially more problematic for a regen blower. They can clog up inlet filter, reduce air flow into the blower, causing insufficient heat removal, allowing rotor and impeller to expand until touching the casting, and crashing the blower. Clogging up the discharge filter can also create excess back pressure, slowing down air movement inside the unit, and crashing the blower.

Dry screw Pump

A dry screw pump uses two parallel screw rotors, with a profile comprising of plurality of curves. The dual pitch screw design compresses the gasses and transports them to the exhaust port where the final compression is done by both the exhaust gas and volumetric reduction. The two screws rotate freely and make no contact with each other or the wall of the casing. The pumping chamber is oil-free so no oil mixes with the process gas.



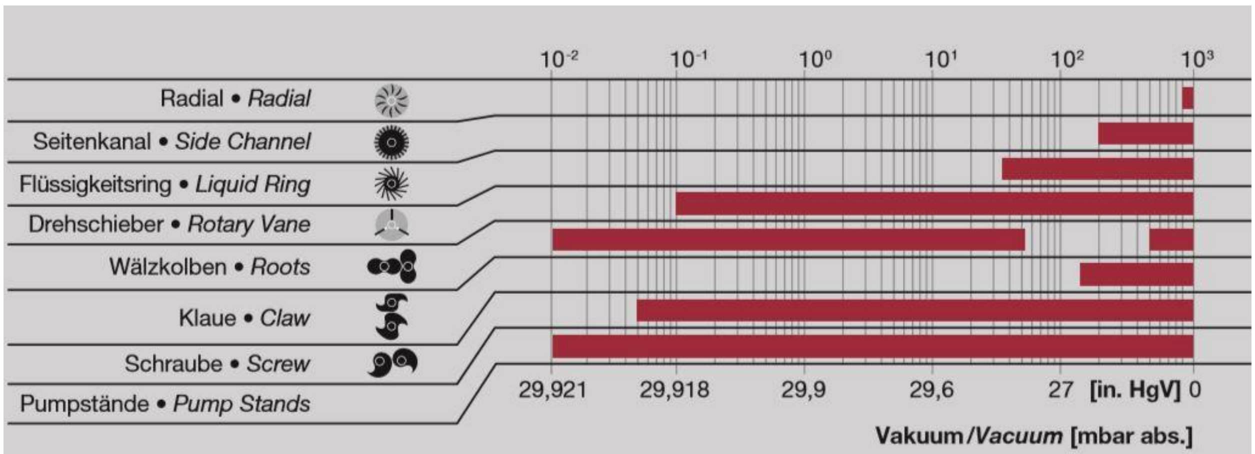
These pumps can be a great problem solver for many chemical and pharmaceutical applications, but due to the extensive compression of the process gas and no oil cooling, it can generate a lot of heat. Water cooled jacket around the housing is often used to control the heat, which can present a challenge of its own: cooling too much can result in vapor condensing inside the pump. These pumps are often used to handle corrosive vapors with the goal of avoiding condensation. Cooling the pump too much before startup or after shutdown can condense these vapors and damage internals of the pump. Cooling the exterior of the screw pump still does not address the heat generated by the screw, which can only be dissipated through conduction via shaft and gear assembly.

Liquid Ring Vacuum Pump

Since I've discussed liquid ring vacuum pumps' relationship with heat in numerous previous articles, I'll just to quickly touch on this: excessive heat can result in loss of suction capacity, limited vacuum depth, increased cavitation risks, and even expansion of rotor assembly and crashing the pump in the worst case.

Don't be scare!

I don't want to scare you off from using any of these vacuum pumps in your application. Each of these vacuum technologies has its own strengths and serves a range of needs. Below is a vacuum depth capability comparison chart from Elmo Rietschle.



There are also many unique designs, engineered solutions, and new development within these technologies that can overcome the issues I've mentioned above. For example:

- There are oxygen service rate rotary vane, claw and screw pumps that can handle higher than normal oxygen concentration to remove explosion risks.
- Elmo Rietschle is coming out with a new specialty coated claw pump to handle corrosive carry-over vapors and liquids.
- Engineered inlet condensation/filtration/separation solutions can lower incoming gas temperature and remove contaminates.
- Nash is coming out with a new dry screw pump design that cools down the screw shafts internally.

I hope you find value in this long email. Have a wonderful 2020!