VacAdemics
Issue 4
Applying Vacuum Technology

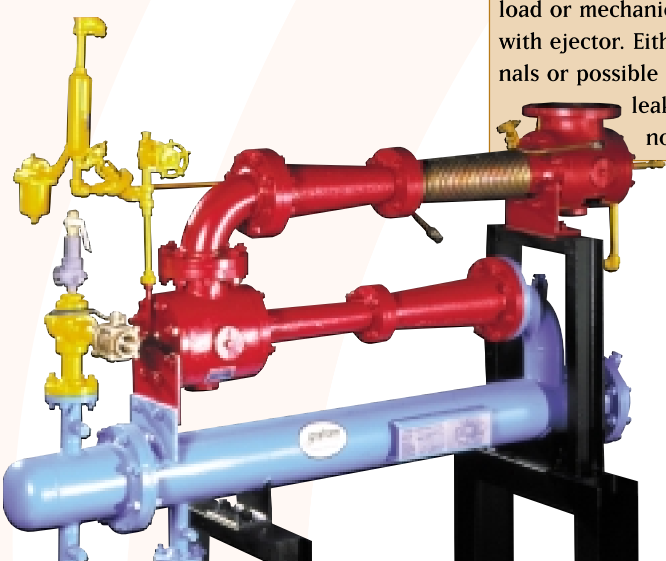
Troubleshooting Vacuum Equipment

Knowing the basics can mitigate losses from poor vacuum equipment performance

Effective and timely correction of vacuum equipment performance shortcomings is important. Knowing which variables affect performance can reduce iterative problem-solving techniques by directing you right to the cause. Often, a trial-and-error method is used, which is both time-consuming and costly. This issue of VacAdemics covers the typical causes of off-design performance for vacuum equipment. If a problem with your equipment occurs, refer to these useful guidelines and contact the equipment manufacturer. An experienced manufacturer with a full range of vacuum equipment products can quickly diagnose a problem and suggest corrective action.

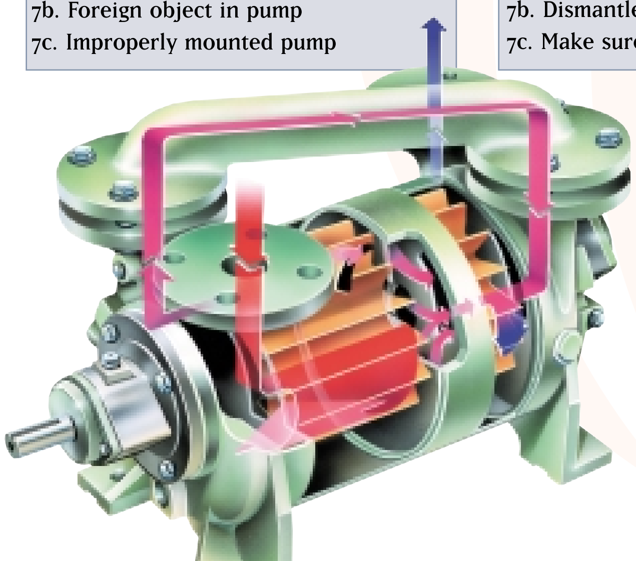
Ejectors

Observation	Problem	Corrective action
1. Poor ejector performance, unstable operation, pressure swings	1. Lower than design motive steam pressure	1a. Raise motive steam pressure to the minimum specified by the ejector manufacturer. 1b. Bore the motive nozzle to a larger diameter to permit design steam consumption. Consult with manufacturer to determine proper nozzle diameter.
2. Reduced ejector capacity and an increase in suction pressure	2a. Higher than design motive steam pressure 2b. Wasted steam consumption	2a. Reduce motive steam pressure to specified pressure. 2b. Purchase new steam nozzles with smaller diameters designed for the higher motive steam pressure.
3. Poor ejector performance, unstable operation, pressure swings	3. Higher than design steam temperature, excessive superheat	3a. Raise motive steam pressure. 3b. Bore the motive nozzle to a larger diameter to permit increased steam consumption. Consult with manufacturer to determine proper nozzle diameter.
4. Low ejector discharge temperature	4a. Reduced ejector capacity 4b. Poor ejector performance, unstable operation, pressure swings	4. The motive steam is wet and therefore the steam piping must be insulated and a moisture separator and trap added in the motive steam line just before the ejector.
5. Higher than design discharge pressure	5. Poor ejector performance, unstable operation, pressure swings	5. Look downstream for problems that could be: a. an intercondenser problem b. an ejector problem c. a restriction in the discharge piping d. noncondensable gas load is above the design rating
6. Higher than design suction pressure (assuming motive steam pressure and quality are normal and discharge pressure is equal to or less than design)	6. Greater than design process load or mechanical problems with ejector. Either worn internals or possible internal steam leak around steam nozzle threads	6a. Inspect internal dimensions and replace if necessary. 6b. Tighten steam nozzle to steam chest if necessary or seal weld nozzle to steam chest.



Liquid Ring Vacuum Pumps

Observation	Problem	Corrective action
1. Reduced capacity of pump	1a. Seal water temperature higher than design 1b. Low seal water flowrate 1c. Excessive air leakage	1a. Reduce temperature by increasing cooling water flow or check seal cooler for fouling. 1b. Adjust seal water flowrate or check centrifugal recirculation pump. 1c. Find and repair leak
2. Excessive noise	2a. Excessive or insufficient seal liquid to pump 2b. Coupling misalignment 2c. Defective bearing 2d. Cavitation	2a. Adjust seal flowrate. 2b. Realign coupling. 2c. Replace bearing. 2d. Add noncondensable gas load.
3. High power consumption	3a. Excessive seal liquid 3b. Coupling misalignment 3c. Excessive discharge pressure 3d. Defective bearing 3e. Gland ring too tight 3f. Improperly mounted pump	3a. Adjust seal flowrate. 3b. Realign coupling. 3c. Correct as necessary. 3d. Replace bearing. 3e. Loosen gland ring. 3f. Make sure mounting surface is level.
4. Overheating	4a. Excessive seal liquid temperature 4b. Insufficient seal liquid flowrate 4c. Coupling misalignment 4d. Defective bearing 4e. Gland ring too tight 4f. Improperly mounted pump	4a. Check coolant flowrate and seal cooler fouling. 4b. Increase seal liquid flowrate. 4c. Realign coupling. 4d. Replace bearing. 4e. Loosen gland ring. 4f. Make sure mounting surface is level.
5. Vibration	5a. Coupling misalignment 5b. Pump or motor not properly anchored 5c. Rotor imbalance 5d. Improperly mounted pump	5a. Realign coupling. 5b. Anchor pump or motor properly. 5c. Balance rotor. 5d. Make sure mounting surface is level.
6. Mechanical seals "squeak"	6. Insufficient lubrication	6. Check flow of coolant to seals.
7. Pump shaft is seized and will not turn	7a. Scale from hard water 7b. Foreign object in pump 7c. Improperly mounted pump	7a. Remove scale from pump. 7b. Dismantle pump and remove object. 7c. Make sure mounting surface is level.

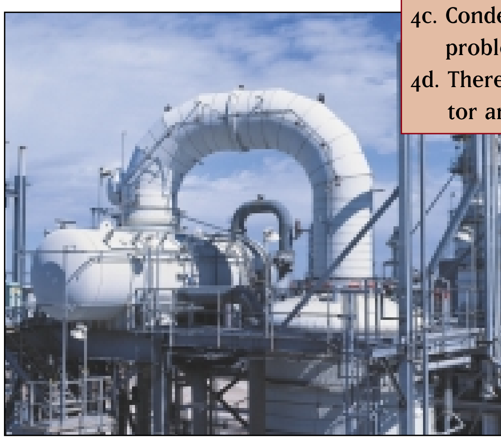


Dry Vacuum Pumps

Observation	Problem	Corrective action
1. Pump will not start	1a. Motor and/or control wiring faulty 1b. Pump seized or damaged due to product buildup	1a. Check wiring and connections for correct rotation. 1b. Remove buildup by solvent soaking or disassemble the pump to clean and repair it.
2. Poor level of vacuum	2a. Blockage in piping 2b. Faulty system valve 2c. Inlet filter element clogged 2d. Liquid in the pump 2e. Clearance opened up	2a. Clean piping and strainers. 2b. Check valve operation and settings. 2c. Check inlet filter. 2d. Pump liquid from the pump. 2e. Check clearances and the pumps for wear.
3. Excessive amperage/ power consumption	3a. Product buildup 3b. Blocked exhaust piping 3c. Liquid in pump	3a. Remove buildup by solvent soaking or disassemble the pump and clean. 3b. Clear blockage. 3c. Pump liquid from pump.
4. Loss of oil pressure	4a. Oil pressure switch faulty 4b. Low oil level 4c. Mechanical seal failure	4a. Check wiring and switch, replace as necessary. 4b. Correct oil level. 4c. Replace mechanical seals.
5. High inlet temperature	5. Process conditions are different	5. Review and correct process conditions.
6. High exhaust temperature	6a. Loss of cooling 6b. Blocked exhaust 6c. Blockage in oil cooler or cooling jackets 6d. RTD sensor faulty	6a. Check and correct cooling liquid supply. 6b. Clear blockage. 6c. Clear blockage. 6d. Check wiring and sensor, replace as necessary.
7. Low exhaust temperature	7. Liquid in pump	7. Pump liquid from pump.
8. Mechanical seal failure	8a. Pump was pneumatic tested or overpressurized at standstill 8b. Mechanical seals lost lubrication and overheated while in operation	8a. Relieve pressure and lubricate mechanical seals before operating. 8b. Replace mechanical seals.

Process Vacuum Condensers and Intercondensers

Observation	Problem	Corrective action
1. High pressure drop across process side of condenser	1a. Shellside or tubeside fouling 1b. Cooling water temperature higher than design 1c. Low cooling water flowrate 1d. Higher than design condensable organics/hydrocarbon loading	1a. Clean inside or outside surface of tubes. 1b. Reduce cooling water temperature or increase flowrate. 1c. Increase cooling water flowrate. 1d. Reduce organic/hydrocarbon loading or install larger condenser.
2. High cooling water pressure drop	2a. Waterside fouling or blockage 2b. Higher than design cooling water flowrate	2a. Clean tubing. 2b. Not a problem
3. Higher than design cooling water temperature rise	3a. Low cooling water flowrate 3b. Higher than design condensable vapor loading	3a. Increase cooling water flowrate. 3b. Increase cooling water flowrate or install larger condenser.
4. High vapor outlet temperature	4. Poor vacuum system performance	4a. Clean tubing because it is fouled. 4b. Cooling water flow is increased or inlet temperature is reduced. 4c. Condenser internals have a mechanical problem that requires repair. 4d. There is a problem with a downstream ejector and it is backstreaming.



Summary

Many variables influence vacuum system performance. They include utility supply conditions, piping upstream and downstream, equipment layout and process conditions. Routinely surveying vacuum equipment performance permits trend analysis and advanced troubleshooting, thereby avoiding major performance shortcomings. Consulting with the equipment supplier or an experienced vacuum equipment manufacturer with a complete line of vacuum equipment is recommended as soon as possible. It is not always necessary to consult the original manufacturer because in many cases, the original manufacturer is unable to support after-market service and send trained engineers to the field to correct performance limitations. Many times an experienced vacuum equipment manufacturer can step in, even when they did not supply the equipment, and quickly define the route necessary to correct the problem.

This is the fourth in a series of six educational newsletters on vacuum equipment. Watch for the next issue of VacAdemics in September.

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