



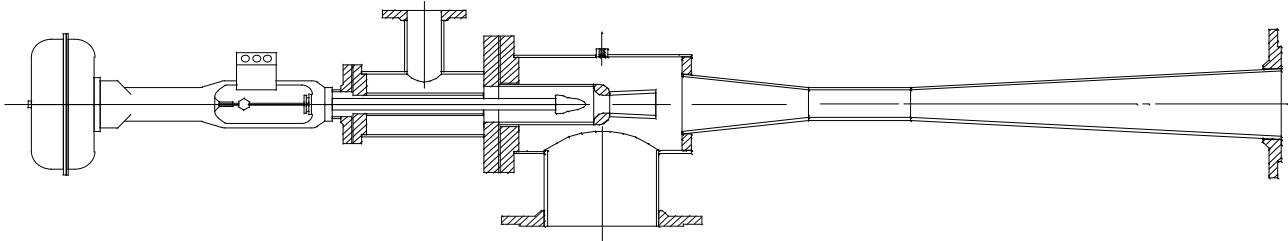
CROLL-REYNOLDS CO., INC.

Westfield, NJ (908) 232-4200 FAX (908) 232-2146

INSTALLATION, OPERATING, AND MAINTENANCE INSTRUCTIONS

STEAM-JET SPINDLE-OPERATED
THERMOCOMPRESSORS

FORM V-146-A Rev. 2/2/96



General Configuration of Spindle-Thermocompressor

DESCRIPTION

Steam-Jet Thermocompressors are pumping devices used, in general, to recompress low pressure gases to a usable pressure. A simple example is the recovery of low pressure steam: higher pressure motive steam is used to entrain and recompress water vapor to an intermediate pressure for use elsewhere in the process. The theory behind the steam-jet thermocompressor involves converting high pressure motive steam into a high velocity jet in a converging-diverging nozzle. Gas and vapor molecules surrounding the high velocity jet are entrained, or swept up, under the principle of viscous drag. This continuous entrainment of molecules near the nozzle tip is what drives the pumping effect. After the molecules are swept up by the jet, the two constituents (motive steam and entrained load) are mixed violently in the converging section of the venturi throat and then compressed to a higher pressure in the straight and diverging sections. When the mixture is finally discharged, the stream is at an intermediate pressure - higher than the inlet "suction" pressure but lower than the motive steam pressure - and traveling at a velocity much lower than that of the jet.

Thermocompressors normally operate in a compression range up to 2:1 (discharge pressure:suction pressure). Such a low ratio provides flexibility through capacity control: motive pressure can be throttled to effectively control capacity over certain ranges. The result is a family of curves showing performance over a given range for varying motive and discharge pressures. The Spindle Thermocompressor incorporates the throttling action in its design. The user needs only to provide design steam pressure to the nozzle and the required signal to the spindle actuator (refer to the performance curve for more information).

INSTALLATION

Orientation - The thermocompressor is much like a pipe fitting and can be installed in any convenient location or orientation between the compression points. Consult the drawings supplied with the system for component listings and locations. The spindle does not require independent support. If space limitations prevent direct-coupling of equipment, try to avoid long lengths of interconnecting piping to minimize pressure losses. The thermocompressor should also be independently supported. Using the unit to support interconnecting piping,

especially with larger units, can impose excessive loads and moments on the throat sections and lead to misalignment.

Suction and discharge piping - Suction piping must be independently supported and made full size to match the thermocompressor suction line. Avoid filters, valves or other pressure drops in the suction line that were not accounted for in the specification and design phases, or a loss in compression and capacity will result. Avoid low points or loops that might accumulate condensate or process solids or, if unavoidable, install condensate drains and clean-out connections. Discharge piping from the thermocompressor can be directed to any number of places, as long as the backpressure does not exceed anything more than a few inches of water above the operating discharge pressure for that range (consult the performance curve). Heating units, piping headers, aftercondensers and silencers are all suitable for normal operation.

Steam Quality and Supply - The absolute pressure at the thermocompressor suction may be less than that of the vapor pressure of water at 32°F, so any moisture in the motive steam will freeze the instant it discharges from the nozzle (consult the performance curve and datasheet). The ice particles will coat the internal surfaces of the venturi section and seriously interfere with the performance of the system. To ensure that the steam supply is as dry as possible, separators with traps must be installed in the steam lines as close to the motive connections as possible. Valves should be installed to shut off the steam to the unit in any location convenient for operation, and unions or flanged connections should be incorporated to allow for easy nozzle assembly removal.

Instrumentation - Steam gauges with 1/4 turn ball valves and syphon loops are recommended, whether installed in the main steam line leading to the thermocompressor or on the steam chest itself. Vacuum or pressure gauges with isolating valves and test hose connections are also recommended for the suction and discharge lines.

When measuring the pressure at any point in the system, care should be taken that the taps be properly located. Taps are provided on the nozzle assemblies (for steam pressure) and on the suction heads. Taps in the interconnecting and process lines can be located anywhere except directly opposite the discharge. Vacuum gauges reading inches of mercury may be used, but be sure to correct for atmospheric pressure (absolute



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pressure = current barometer reading - vacuum gauge reading). Bourdon tube gauges are not recommended. Contact the factory or a local representative for help in selecting the proper instrumentation.

Commissioning - Before final connections are made, be sure to blow out the steam and any water lines thoroughly. New pipe contains dirt and scale which can be carried over into the thermocompressor and clog the nozzles.

After installation, check the system thoroughly for leaks with a 15 psig hydrotest. As a final check, use the following test procedures for a vacuum leak test:

1. Isolate the thermocompressor from the process with a slip blind.
2. Using only the thermocompressor, operate the system in the dead-head condition and check suction pressure. Consult the performance curve or data sheet for dead-head suction pressure.
3. Determine the source of the leak and correct. Continue on until all leaks have been corrected.

OPERATION

Whether or not the unit should be started with an open line to the process depends on the application and is at the discretion of the operator. The following procedures assume for the most part that the unit can be isolated for testing but open to the process during start-up. The procedures can also be easily applied to dead-head testing.

Before opening any steam valves, turn on the water to any intercondensers and establish the proper flow. Never open the steam valves without the water running to intercondensers. Damage may occur to the equipment. Condensate pumps should be tested prior to start-up. Also check the system datasheet for the correct cooling water temperature.

With proper cooling water flow established, turn the steam on to the thermocompressor. Check the datasheet for correct steam pressure. Priming down to operating range may take a while, depending on the volume of the system. For this reason larger hogging stages are sometimes used to prime the system down quickly. A hogger will prime down much quicker than a stage designed for the operating condition. Regardless, the unit may operate in the broken mode - characterized by a "whoosh" or chugging sound - until the load comes down into the thermocompressor's stable range.

The spindle can be adjusted through its range of motion by providing the correct signal to the actuator, allowing the unit's capacity and range to be regulated according to design conditions (consult the factory test performance curve). Motive pressure should be maintained at the full design pressure corresponding to the rated capacity and compression range. A reasonably higher motive pressure will have no harmful effects on thermocompressor performance at partial load other than wasting motive steam. Capacity may fall off rapidly, however,

making control difficult and possibly causing the unit to fall into an unsteady mode of operation.

System performance can be checked at any time with partial or no load tests and the performance curve. If the desired operating pressures are not obtained, it is probably due to one of the following causes:

1. Low Steam Pressure - An ejector will operate with a higher than specified steam pressure, but not with a lower pressure. Excessive superheat will have the same effect as low pressure.
2. Wet Steam - Wet steam will cause a noticeable loss in vacuum. Steam with a quality of 98% or less is considered wet. Check the steam separator and trap. Check insulation.
3. High Back Pressure - If a thermocompressor has a higher back pressure than it was designed for (see the system datasheet), a loss in capacity or compression will result. Check for restrictions or obstructions in the exhaust lines, such as accumulating condensate. Also check water flow and temperatures in downstream condensers. If a discharge pot is being used, make sure that is designed large enough to pass the volume of vapor being handled.
4. Excessive Air Leakage - Inspect the assembly for openings, split pipes, missing gaskets, leaky valves, etc. Hydrotest with water to locate leaks. An air leak will tend to overload downstream condensers, creating a high back pressure condition.
5. Clogged Steam Nozzles - With a new installation, pipe scale or dirt from the steam lines can clog the steam nozzles, even when a strainer is used. Remove the nozzles for inspection and clean thoroughly with emery cloth, particularly the orifices. Note that additives to the boiler water have been known to clog nozzles. The deposits collect on the nozzle walls, and can be easily missed during inspection.
6. Worn Parts - Particularly the motive nozzles and venturi throat, will cause a loss in compression and should be replaced. Deterioration will generally show up as pitting or wire drawing as a result of corrosion or particle impingement, rather than a smooth and even enlargement.

MAINTENANCE

Thermocompressor maintenance is relatively straight forward, but can vastly improve reliability and performance if approached systematically. Some users get by with swapping out parts in periods of dire emergency: performance slowly erodes over a period of time and nothing is done until the unit ceases to effectively operate altogether. At that point spare



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parts are installed to correct the problem (if the problem is in fact known and the correct spare parts are in the plant's inventory), and the unit is returned to service. The period of degraded performance leading up to failure and the downtime itself, however, can result in higher operating costs from longer cycle times, increased steam usage and production outages. For this reason a systematic preventative maintenance (PM) program is highly recommended.

An effective PM program begins with documentation. Serial numbers, parts lists, performance curves, operating histories and maintenance procedures should be kept up to date by the maintenance or engineering departments for quick reference. Croll-Reynolds equipment components all bear nameplates with the equipment serial numbers and model numbers. Should the plant's documentation lack a performance curve or drawing, one phone call will connect plant personnel to over seventy five years of design and performance records for every piece of equipment ever sold by Croll-Reynolds, each referenced by individual serial numbers and safely stored in a fire-proof vault at our Westfield, NJ offices.

An effective PM program also includes periodic inspection and tests. Yearly shut downs are perfect opportunities to perform such tests. A typical PM procedure should include the following:

- Disassemble and inspect gaskets for evidence of leaks
- Check for and document regions of corrosion and wear
- Check nozzle bores and throat diameters against original specifications
- Clean all internal surfaces (nozzles, heads, throats, diffusers) thoroughly
- Check for evidence of wet steam (grooves in nozzle bore and diffuser) and correct
- Reassemble with new gaskets and required spare parts, avoiding misalignment of the components

- Blow down steam strainers and inspect separators and traps
- Record what spare parts were taken from inventory and order replacements
- Inspect the condensers for evidence of fouling and clean thoroughly.
- Calibrate the vacuum, pressure and temperature gauges and replace if necessary
- Test the unit in-line against the performance curve with either a blanked suction or orifice meter

A properly stocked inventory of spare parts is necessary regardless of the extent of the PM program. At least one nozzle (or set of nozzles for multi-nozzle units) for each unit should be kept in stock. Relaying process, boiler chemical, steam quality and water hardness information to the engineers at Croll-Reynolds will also aid in the proper selection of spare parts.

WARNING

Steam Jet Ejector systems are mechanically designed for 15 psig and full vacuum at 450° F on the process side, unless otherwise specified by the customer. Pressure relief devices are necessary on ejector systems where the potential exists for the pressure and/or temperature to exceed the design of any of the system components. These protective devices shall be supplied by and are the responsibility of the customer. Mechanical failure and possible injury to personnel may result if these precautions are not taken.

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