J-T Expander Bypass

Application Discussion
AD122
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In the production of natural gas products, turboexpanders are sometimes used in the recovery of Natural Gas Liquids (NGL). A turboexpander consists of alternate sets of nozzles and rotating blades through which vapor or gas flows in a steady-state expansion process. The use of turboexpanders is a large capital investment, but can offer significant power savings. Along with the need for power, these devices are typically used in processes with high feed gas pressures (greater than 400 psig), compact plant layout, varying feed products and where a large amount (greater than 30%) of ethane recovery is desired.

Turboexpanders are used to recover cryogenic liquids from lean natural gas or to convert the energy of a gas stream into mechanical work as the gas or vapor expands through the expander. These liquids are what are commonly referred to as NGL such as propane, butane and ethane. Many times, the objective of the turboexpander is to conserve energy and the mechanical work produced is often considered a byproduct.

When a gas or vapor passes through a turboexpander, the gas expands as it flows across the turbine blades and cools through the isentropic (constant Entropy) gas expansion process. Through the cooling process, hydrocarbon gas temperatures drop through the respective dew points of many of the constituents. As the temperatures of the gases drop below the dew point, they condense out as liquid and can be recovered. As these gases have a higher BTU content than methane, this can yield a higher selling price depending on demand. At this point, the lean gas is used to cool the incoming gas through several heat exchangers and is then recompressed and sent back to the pipeline for transport. Figure 1 shows a cross section of this process where the mechanical work created by the expander is used to the drive the lean gas compressor.

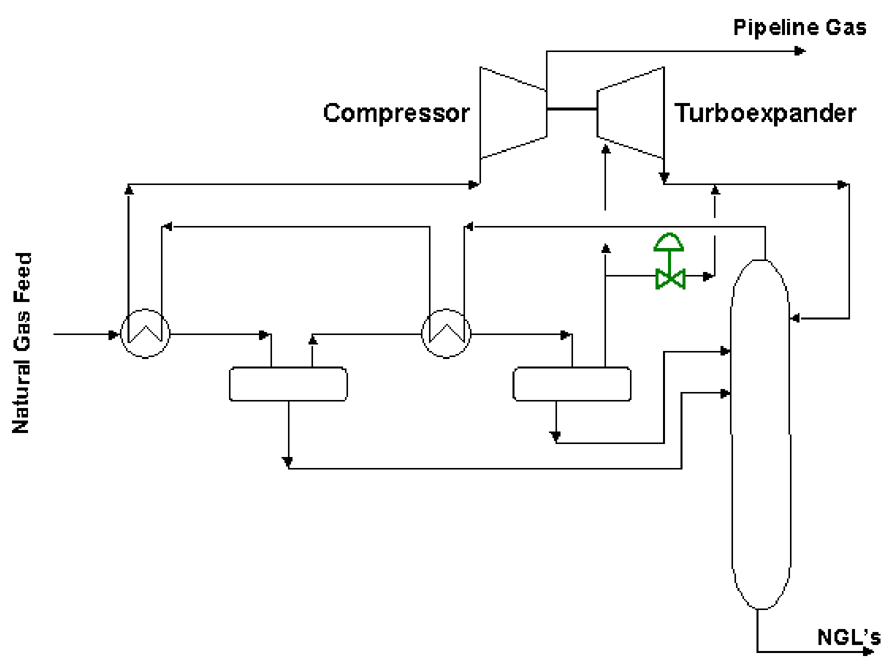

Figure 1: Natural Gas Process Including Turboexpander and Expander Bypass Valve

The turboexpander replaces the Joule-Thompson expansion valve used in a conventional refrigeration system. The expansion valve is isenthalpic (constant Enthalpy, no work or heat transfer) while the turboexpander takes work out of the system making it isentropic. Isentropic expansion allows for a lower temperature of the expanded gases at the same pressure reduction than that of isenthalpic expansion.

The use of turboexpanders, however, does not eliminate the need for the Joule Thompson valve. This is typically referred to as the expander bypass valve (See Figure 1), but operates under the Joule Thompson effect. The valve is used to enable a more efficient startup and shutdown of the turboexpander. It is also used to continue the process should the expander go offline or if flow increases beyond the full speed capacity of the turboexpander.

There are many factors that must be taken into account when selecting the proper valve for this application. As inlet pressures vary between 700 and 1500 psig and outlet pressures vary between 200 and 700 psig, the effects of damaging noise and vibration need to be addressed. Another concern is that at the low temperatures (-150F) experienced, proper body and trim material selection is important. In order to protect the expander in the event of a system upset, the valve must open quickly. Ideally, the valve will possess the same capacity and characteristic as the expander to provide a seamless transition between the devices. The final concern is tight shutoff. As previously stated, the turboexpander is a much more efficient device than the valve so energy could be lost through the valve if shutoff is not maintained.

The main concern when looking at product selection in this application is to ensure that the materials selected are compatible with the cryogenic temperatures and that the valve trim selection addresses issues with noise that are common at these pressure drops. Also of concern is the accessory package that control stroking speed.

Another concern that must be explored is the possibility of hydrate formation in the line. Hydrates are solid compounds formed by the chemical combination of gas and water under pressure and can cause deposits to form in the pipe and valve trim. Most facilities utilize dehydration units to prevent hydrate formation and the expanders are usually installed at the end of the process. However, this should be explored when selecting the expander bypass valve. If hydrates are present trims with small passages can plug and render the valve useless.

For many applications, the Fisher Ebody with 316 SST body and trim materials can be used. In applications where the temperature can reach as low as –325F, Fisher developed the Cryogenic Ebody. It should also be noted that an extension type bonnet is recommended at these temperatures to protect frosting on the stem and instruments. Depending upon the pressure drop, noise abatement trim such as the Whisper I, Whisper III or WhisperFlo solutions in 316 SST materials may be required. In low pressure drop applications, standard trim can be used. These solutions can also be designed to match the control characteristic of the expander providing a smooth transition between the two devices. The accessories necessary to obtain fast stroking speeds will include volume boosters and quick exhaust valves.