

Basic Guide to Pipeline Compressor Stations

By Saeid Mokhtab, Greg Lamberson and Sidney Pereira dos Santos

As natural gas moves through a pipeline, the pressure decreases due to friction of the gas along the pipe wall and the gas must be recompressed to maintain the flow. Gas compressor stations are installed at optimum locations along the pipeline as the load profile changes and are sized to sufficiently boost the gas pressure and maintain flow through the pipeline. Compressor stations may be small, situated on gathering lines (Figure 1) or laterals, or large on major trunk line transmission systems. However, all are built up from the same functional blocks of equipment. Each functional element (Figure 2) plays a role in the work of the station and the design and sizing of each is essential to the efficient and safe operation of the plant.

The functional elements include gas scrubbing and liquid removal, compressor and driver

units, aftercoolers, pipes and valves. Controls — including Supervisory Control And Data Acquisition (SCADA) system, monitoring and data recording, alarms and shut down procedures, both routine and emergency — are an integral part of the station. Provision also has to be made for venting the compressor and driver housing and buildings, complete with ventilation and fire protection, and safety equipment.

The financial elements include cost-of-service calculations which include the installed cost of the equipment, fuel, maintenance and operating costs for the expected project life (typically 10 – 25 years). A risk simulated discounted-cash-flow (DCF), rate-of-return (ROR) method of investment (Santos, 2003) analysis is recommended. Fuel cost is the major item in this calculation and the projection for escalation forms an important consideration and must be included in the risk simulation analysis.

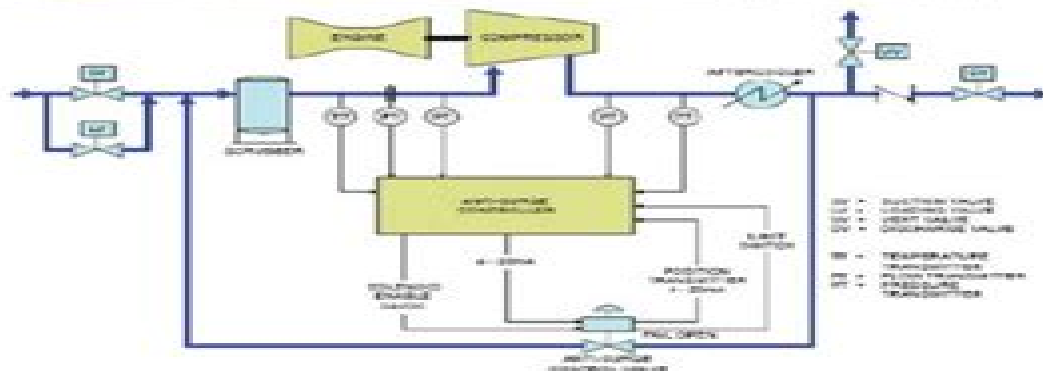
Inlet Receiving

The gas in a main transmission line is nominally clean and dry while that in gas gathering lines may contain liquids prior to processing, but in all cases there can be entrained liquids



Figure 1:
Cablunas Terminal - Onshore Gas Gathering Compressor Station. (source: PETROBRAS - Rio de Janeiro - Brazil)

Figure 2:
Typical Compressor Station P&I Diagram (Mokhtab et al., 2007).



and particulates which have to be removed before compression to maintain efficiency and integrity. Efficient and safe handling of the liquids collected from the scrubbers in a compressor station is one of the keys to a good design. Individual scrubbers (with or without standby unit) may be installed for each stage of compression for each compressor unit.

A common scrubber should be considered for multiple units on a common section line. Filter/separators may also be used to remove smaller liquid droplets and/or solid particles. In the case of reciprocating compressors being used in the transmission system a coalescer filter is of capital importance to guarantee that cylinder lubricating oil will not enter the pipeline and affect gas specification. Poor handling of these liquids can be the major source of operating and maintenance problems and have a significant impact on station economics. The section scrubber should be equipped with a mesh type mist elimination section to avoid liquid entrainment into the compressor. Scrubbers can take several forms, inertial — with or without demister pads — or the horizontal cyclonic type. The latter are commonly used on mainline transmission stations.

There are three main concerns that should be addressed in the liquid-handling design for any compressor station: safety, environmental impact, and economics. Another consideration should be operability, which includes issues like hydrate formation (when water is present in the gas composition), failure consequences, etc.

The gas compressor station's inlet receiving facilities consist of "pig" receivers and a slug catcher to remove large solid and liquid contaminants followed by filter coalescers to remove fine solids and hydrocarbon mist. A filter coalescer also cleans the gas in each fuel supply to the turbines and gas engines. Removed liquids flow to a hydrocarbon storage tank where they are separated by gravity and then transported by truck as saleable hydrocarbon liquid or disposed of as waste product.

Design Pressures

The design pressure for station gas piping should at least equal the MAMP of the pipeline. For single-stage stations, the suction and discharge piping should have the same design pressure. For multi-stage stations, the suction piping design pressure should at least equal the highest attainable suction pressure under all operating and startup modes, and the interstage and discharge piping design pressures should at least equal the maximum discharge pressure. Multi-pressure systems must be designed to ensure that each system is not over-pressured during normal operation and is protected to the appropriate pressure level during upset conditions.

It is a general rule to use design pressures to accommodate use of a standard ANSI Class rating for compressor station piping components. The cost to increase design pressure to a standard ANSI Class is minimal and will provide greater flexibility in future use of the equipment and materials.

Compression

The gas pressure in the pipelines is increased by a combination of one or more compressors connected in parallel or in series to the

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