Compression for the Petrochemical Midstream Market

Compressors in natural gas production, gathering, processing and transmission are fundamentally of two types: Positive displacement- and centrifugal or turbo-compressors. Displacement compressors are reciprocating and rotary screw machines. Displacement compressors are designed to move relatively small quantities of gas at high pressure differentials whereas turbo-compressors convey gas in large quantities with a relatively low pressure rise. Smaller and medium sized reciprocating compressors, and for smaller gas flows, lately rotary screw compressors, are applied in gas production, gathering and storage where high-pressure differentials are required. Larger size turbo-compressors or "pipeliners" have been mostly utilized in long distance transmission service. See also Figure 1.

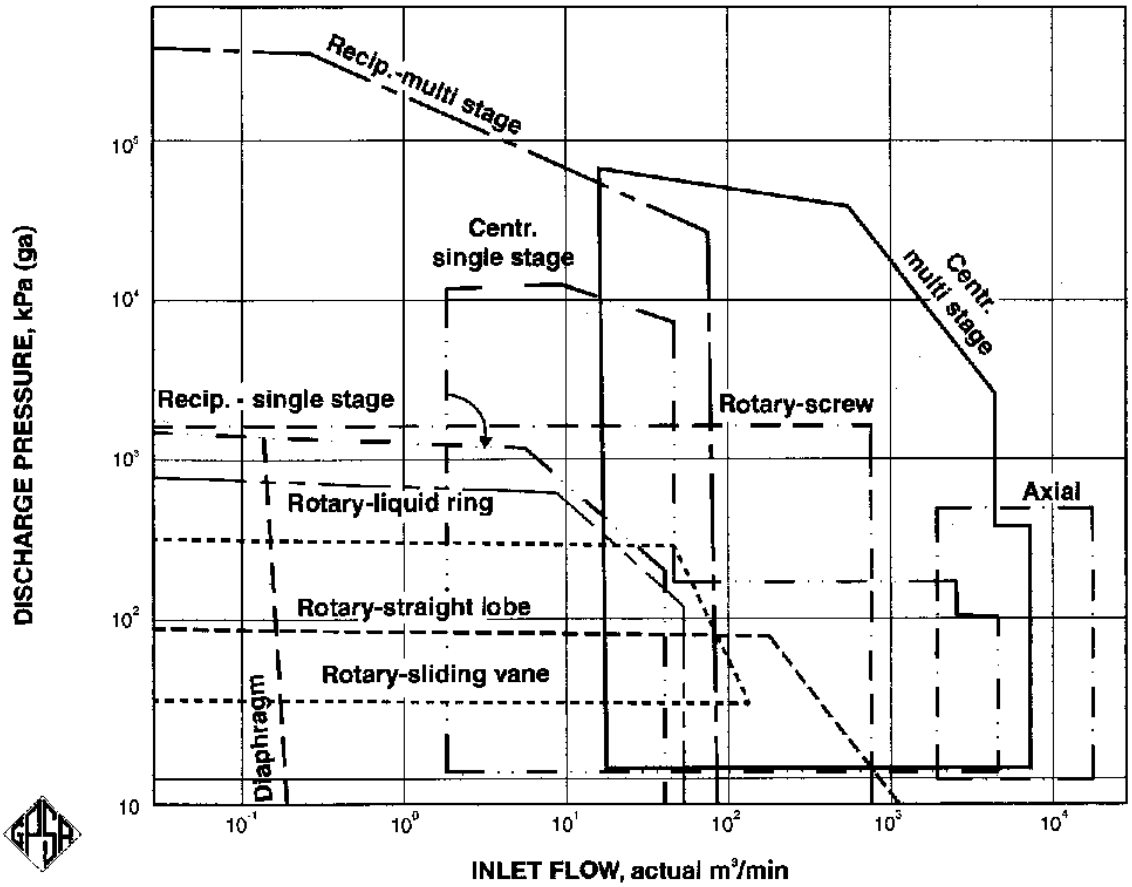

Figure 1. Compressor application ranges.[1]

Reciprocating Compressors. Balanced opposed reciprocating piston compressors are designed in many different frame sizes with a number of cranks varying from 2 to 10

[1] Source: Gas Processors Supplier Association

to cover all applications. They can be driven by electric motors, internal combustion engines, steam or gas turbines, depending on economics dictated by the individual services. Most manufacturers design a variety of standardized components so that proven reliability is built into the machines, yet each unit is custom designed for its specific service. Reciprocating compressors in gas production, gathering and storage range in size from below ~ 100 bhp (75 KW) to around 6700 bhp (5000 kW) with a median size from about 1300 bhp (1000 kW) to approximately 2600 bhp (2000 kW). Reciprocating compressor speeds range between 200 and 1500 rpm. API Standard 618, *Reciprocating Compressors for Petroleum, Chemical and Gas Industry Services*, tends to make speeds above 500 rpm or in general compressors with piston speeds[2] up to 700 ft/min or 3.5 m/sec. a borderline case. The majority of reciprocating compressors in the midstream market fall therefore, into the category of high-speed machines.[3] The standard is somewhat vague and leaves it to the users to set their own standards. Higher piston speeds allow a reduction of the compressor's footprint. They are therefore, easier to package, complete with their drivers and appurtenances such as heat exchangers, pulsation drums and oil piping. Thus, they also become portable units that can be moved from field to field as required.

Screw Compressors. In these rotary positive displacement machines, usually two rotors run within close tolerance to each other without contacting each other or the rotor case. This is achieved by hardened and ground helical timing gears. Therefore, no lubrication is necessary and compression is 100% oil free.

However, oil or other liquid-flooded screw compressors are also frequently used in gas processing service. Practically all gases can be compressed for instance: ammonia, argon, ethylene, acetylene, butadiene, chlorine, hydrochloric, natural, torch, blast furnace, marsh, helium, lime-kiln, coke oven, carbon monoxide, all hydrocarbon combinations, town gas, methane, propane, propylene, flue gas, crude gas, sulphur dioxide, oxide of nitrogen, nitrogen, styrene, vinyl chloride and hydrogen gas. Screw compressors used in the midstream market exhibit approximately the same size ranges as reciprocating compressors in that business.[4] They operate at median speeds of about 1500 rpm.

Traditionally, reciprocating and rotary compressors make use of direct coupled reciprocating gas or diesel engines as driver of choice for locations where remote access and absence of electrical utilities dictates the use of self-contained units. This has led to the packaging concept in gas production, gathering and storage with packages mounted on trailers for high mobility.

Centrifugal Compressors. These multi-stage, single-shaft turbocompressors are generally made up of standardized components. There are two principal casing types: Horizontally split casing and vertically split casing or barrel-type compressor designs. Nozzle configurations can be selected over a wide range.

To date many machines have been built for intake volumes between 500 and 200,000 m^3/h (294 - 117,000 cfm) at discharge pressures up to 160 bar (2,352 psi). With regard to the volume and compression ratio, and in the selection of the materials for the casing, impellers and other components,

[2] Average piston speed (ft./min. or m/sec.) is calculated as 2 x stroke (in ft.) x rpm or 2 x stroke (in ft.) x rpm.

[3] Example: ARIEL product line – www.arielcorp.com

[4] Modern screw compressors have been produced in excess of 13,500 bhp (10,000 kW) for other industries. They have a MAWP limit of around 1500 psig (100 bar) with a pressure ratio of about 15 – reciprocating compressors have considerably higher MAWPs. Example: www.aerzen usa.

centrifugal compressor design is extremely flexible. Consequently, centrifugal compressors can be used for practically every gas. Compressors for gas pipeline transmission stations are usually single barrel type machines with in-line nozzle arrangements, i.e. so-called pipe liners.[5] Drive is usually provided directly from a gas turbine but can also be accomplished by an electric motor through speed increasing gears.

Meeting the following objectives dictates the choice of compression equipment in the midstream market:

1. Suitability/Fit for purpose
2. Optimization of foot print and power-to-weight ratio
3. Minimization of capital or first costs
4. Minimization of operating and maintenance costs
5. Maximizing efficiency and minimizing power requirement
6. Optimization of operational flexibility, such as maximizing speed range and load variability but also mobility through packaging concepts
7. Meeting environmental targets such as resistance to ingestion of entrained liquids or solids and freedom from vibration and noise as well as reliable shaft sealing systems
8. Minimizing Life Cycle Costs (LCC)

References:

1. Bloch, H.P. & Geitner, F.K., *COMPRESSORS – How to Achieve High Reliability & Availability*, 2012 The McGraw-Hill Companies, email: bulksales@mcgraw-hill.com, New York, NY and other global cities, 268 pages.
2. H.P. Bloch, *A Practical Guide to Compressor Technology,* 2nd Edition, 2006 John Wiley and Sons, Inc., ISBN-13: 978-0471727934, ISBN-10: 9780471727934

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[5] www.solargasturbines