WEIGHING MODERNIZATION OPTIONS FOR LEGACY TURBOCOMPRESSORS

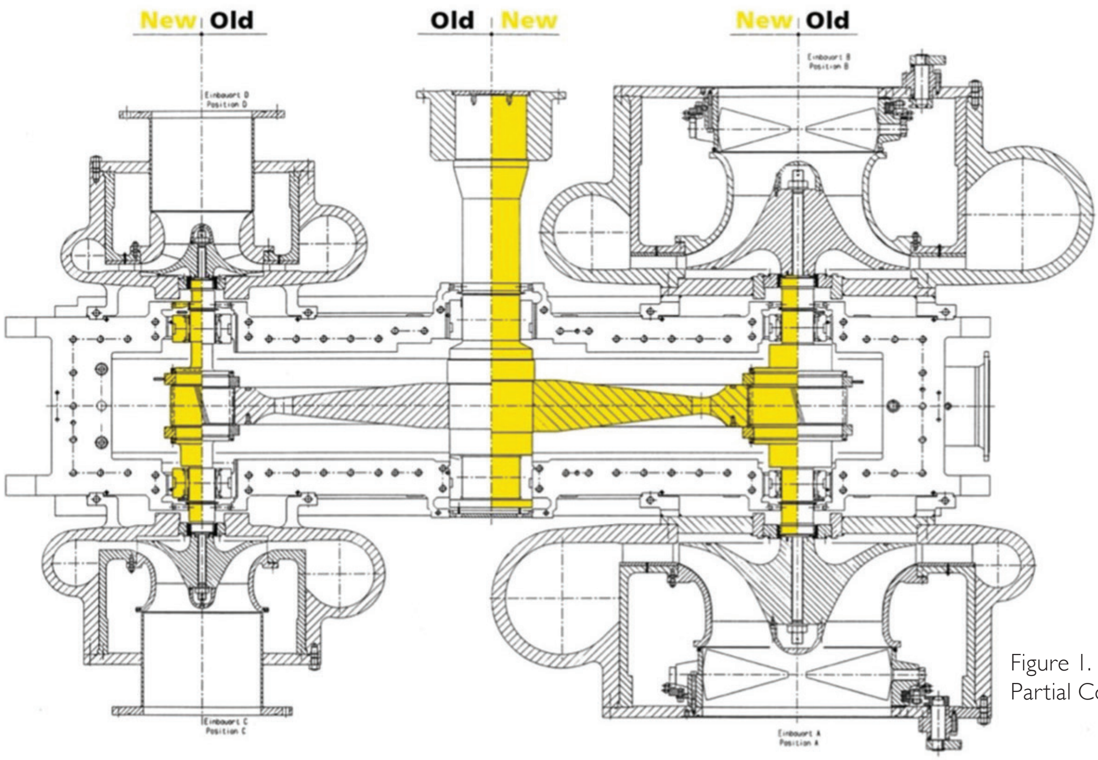

Figure 1. Depiction Of Partial Compressor Re-Aero

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Process conditions at oil and gas facilities evolve over time. In certain cases, the conditions may have changed to such a degree that the equipment originally installed when the plant was commissioned is operating at or outside the limits of its design envelope. With turbocompressors, this can result in several undesirable consequences, including low plant efficiency, high power consumption and associated emissions, and potential production bottlenecks. In other cases, the compressor may be performing well, but applicable environmental regulations have tightened, which necessitate changes to maintain compliance.

While there are cases where the installation of a new compressor package and foundation, piping, ancillary systems, etc. is unavoidable, it may be possible for operators to save significant capital expenditures (capex) and associated downtime by modifying or upgrading the existing unit. Here are some common upgrade and modernization options that should be considered before deciding to purchase a new turbocompressor.

COMPRESSOR REVAMP

Compressor revamps are applicable when process conditions have changed sufficiently such that the original compressor aero design is no longer appropriate (i.e., the unit is operating at or near its boundary conditions).

A revamp can include a complete re-aero of the compressor internals and conversion of the gearset without changes to the casing, external process connections and given footprint. Using some internal stationary and/or rotor components, while combining them with new rotating and/or static parts, is also possible.

Siemens Energy has conducted successful revamps for both onshore and offshore oil and gas customers. In one case, an integrally geared-type carbon dioxide (CO_2) compressor being used for recycle was unable to meet future flow requirements at a process facility due to an increase in production. Siemens Energy's revamp solution included:

- 2x new bull gears, 5x new pinion shafts
- 10x new impellers & contour rings
- 10x new carbon ring seals
- 1x new inlet guide vane (IGV), 1x new set of bearings, new coupling

The revamp resulted in a 40% increase in flow. The increased efficiency also proved beneficial, as it allowed the operator to keep the existing electric motor drive.

DRIVER EXCHANGE AND ELECTRIFICATION

A driver exchange is applicable when new plant operating conditions require additional power or when there is insufficient steam production to drive the steam turbine. In facilities that use gas turbines, there may be constraints around emissions, particularly if the turbine is required to operate at part-load. In both cases, conversion to an electric motor drive can provide several advantages. Electrifying production also brings benefits to the environment.

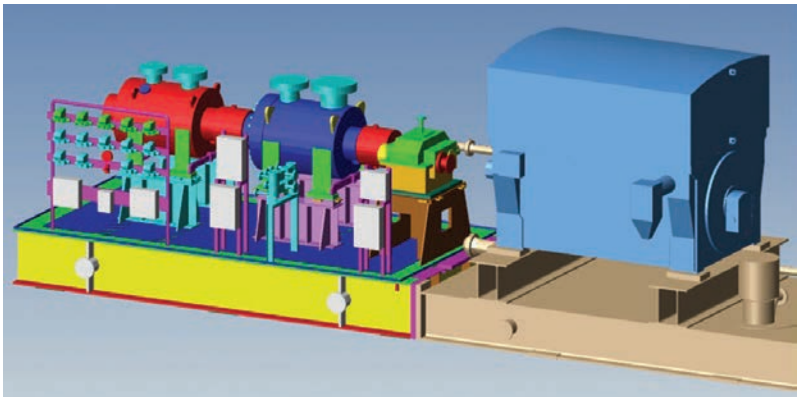

Figure 2. Illustration Of Electric Motor Drive Installation, While Maintaining The Existing Turbocompressor

In 2019, Siemens Energy conducted a driver exchange for a compression train at a station originally commissioned in 1962. The modernization project replaced the existing gas turbine with a 14,000-hp (10,444-kW) electric drive package and a speed-increasing gearbox.

Modifications were also made to the compressor to accommodate new flow conditions and enhance operability. This included new rotor and aerodynamic stationaries that feature modern, high-efficiency flow paths. The original casing, head, bearing housing, and seal system components were all reused to minimize impact to the piping layout.

The revamp was a success, as it reduced the load on a separate train that was frequently overloaded. With the revamped compressor train running, the overloaded unit is now more centrally located in the efficient part of its compressor performance map, improving overall station efficiency and lowering CO_2 emissions.

In certain cases, a hybrid/dual drive (i.e., electric motor or motor-generator in combination with a steam or gas turbine) may be advantageous. Hybrid drives feature a single compressor with separate drivers at opposite ends of the shaft. This gives the operator optionality to meet compression duties using both grid electricity and mechanical power from a gas or steam turbine, whichever is more advantageous at the time. If a motor-generator is utilized, there is the added option to self-generate onsite power using available horsepower after compression duties are met.

Facilities in locations where large seasonal/temperature changes affect the efficiency of the gas turbine or where there is not sufficient stability in the grid to rely solely on an electric drive are two examples where a hybrid drive can be beneficial. Siemens Energy has successfully implemented hybrid drives in liquefied natural gas (LNG), pipeline, and chemical applications.

DRY GAS SEAL RETROFIT AND ELIMINATION OF SEAL GAS BOOSTER COMPRESSOR

Methane leakage across primary compressor seals has historically been accepted as a normal part of compressor operation. However, regulatory agencies worldwide are proposing new limits on fugitive emissions.

Fugitive emissions rates from wet seal systems typically range from 40 to 200 standard cubic feet per minute (SCFM). Leakage rates with dry gas seal (DGS) systems are substantially lower. Siemens Energy has developed dual tandem seal systems that can guarantee as low as 2 SCFM of leakage. A dual-pressurized, zero-emissions DGS option is also an option where a clean and pressurized barrier gas is available (N_2). Other benefits of a DGS retrofit include a reduction in parasitic power losses and the elimination of oil ingress into the process gas.

To address issues frequently encountered with DGS booster compressors, Siemens Energy has developed a unique seal design made from polytetrafluoroethylene (PTFE) that sits between the DGS and process seal labyrinth (PSL). The leak tight seal serves as an alternative to boosters and protects the DGS from process gas contamination at slow compressor speeds or when then the unit is stopped in a pressurized standby condition. It can be installed as part of a DGS retrofit and provides lower maintenance and reduced capex.

OTHER UPGRADE OPTIONS

Upgrades can also be made to specific sub-systems or components of the compressor package. For example, control system upgrades are applicable when the compressor itself is performing well but the existing hardware, including programmable logic controllers (PLCs) have become obsolete. Modernizing the controls can be a cost-effective way to improve compressor availability and reliability. It can also enable energy savings through load-sharing or surge line control optimization.

A change in materials of one or more components, such as O-rings (upgrade to polymer or Teflon) or labyrinth seals (from aluminum to PEEK/PEK) is also common. These types of modifications typically result in minimal compressor downtime and can contribute to reduced maintenance, extended life, and higher efficiency.

CONCLUSION: NO TWO PROJECTS ARE ALIKE

The decision to modernize and/or upgrade an existing turbocompressor ultimately depends on end-user objectives and facility constraints. Operators can benefit by engaging with the compressor original equipment manufacturer (OEM) early on to weigh the cost savings and other benefits of equipment modernization.

To aid the process, Siemens Energy developed myAdvisor, an online service that provides digital support for modernization and upgrade options. By inputting key machine information such as 'Machine Type', 'Industry', 'Operational Profile', and 'Year of Installation', myAdvisor identifies and displays potential improvements specific to the user's compressor package. This information can serve as a starting point from which the operator can converse with the OEM and internal stakeholders to sign off on an upgrade project.

ABOUT THE AUTHORS

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