STEAM TURBINES

Options for modernizing aging turbines

BY JASON MATTISON AND CHRIS MAHON

Steam turbines have been a staple of industrial facilities for more than a century. They enable production processes across a range of industries, including oil and gas, real estate heating, ventilation, and air conditioning (HVAC) chillers, food and beverage, chemical processing, and power generation.

Despite their continued relevance, many facilities operate steam turbines that are in need of modernization. Some units were installed 50 or 60 years ago with heat rates and reliability levels well below what current models can achieve. This may be attributable to a CAPEX-constrained environment, as well as concerns about downtime associated with installing new units. As a result, some opt for low cost partial modernizations or short-term repairs. However, this is not always optimal for improving the turbine's long-term performance and reliability.

One alternative is a footprint solution. The turbine and all components are modernized, but the dimensions and the positioning of the flanges are not changed. This is essentially a replacement machine that requires only slight changes to the existing base frame or foundation. The current oil system, the driven machine, and/or the gear can be adapted according to new operating parameters. In some cases, no changes are required. The replacement machine's outer casing can be tailored for the process, including using a more modern and robust material of construction. Additionally, all stationary components are replaced to ensure optimal interaction with the turbine rotor, including the blading. This option is often advisable when modifications must be made for new operating data or when the service life of highly stressed components has been exhausted. Investment is typically about 70% of the cost of a new unit. Little or no change is required to connections and associated turbine systems, thereby reducing downtime.

A phosphoric acid production plant operator for example, used this approach to increase plant capacity by 25%. The objective was to modernize the existing steam turbine (installed in 2006) at a new steam condition set to accommodate a revamped blower. The operator also sought to improve turbine reliability traced to first-stage blading issues.

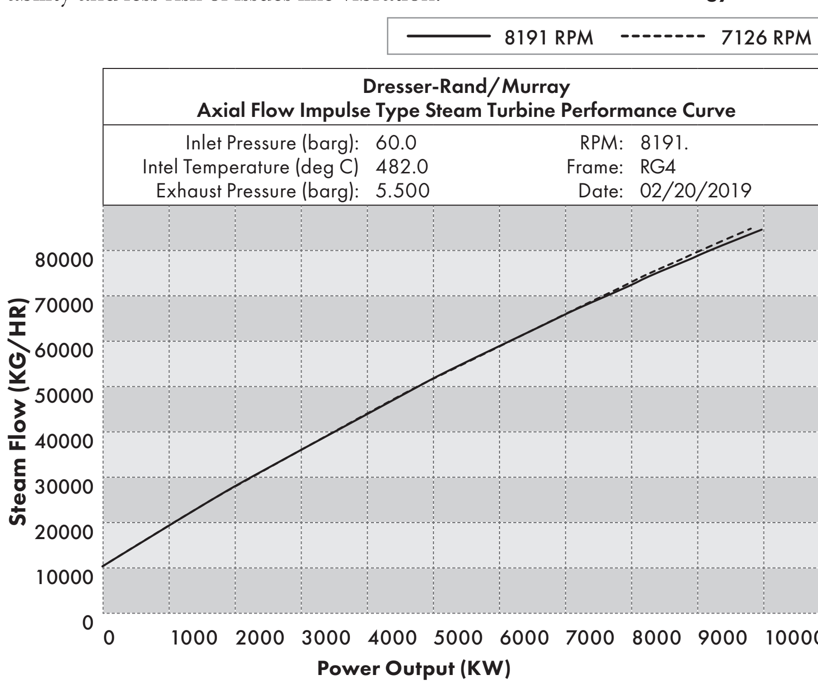
A Murray footprint replacement turbine was installed with a revamped steam path and new first stage blading. The attachment between the blades and the wheel was changed from a t-root style to a fir-tree style with greater strength and load-carrying capability. The replacement unit was built to match all existing interfaces, including the foundation and original steam connections (inlet, exhaust, supports, and coupling). The project took four weeks from shutdown to start-up.

Murray steam turbine footprint solution with a modified steam path. Similar upgrade options are available for other turbine nameplates (e.g., Dresser-Rand, Worthington, Westinghouse, Delaval, Turbodyne, Terry, Ingersoll-Rand, Coppus). Courtesy of Siemens Energy.

OTHER OPTIONS

In addition to footprint turbines, other modernization options include:

Blading and seal retrofits: With modern thermodynamic and mechanical design software, it is possible in some instances to pass more flow through a turbine and increase its rated output by changing the design of the first stage blades and the nozzle plate. 3D modeling software enables OEMs to implement new designs with greater predictability and less risk of issues like vibration.



Design changes for high exhaust wetness: Waste incineration and biomass plants often operate with relatively low live-steam parameters to protect the boiler against high-temperature corrosion. The result is high exhaust wetness conditions for the turbine, which increases erosion of the low-pressure (LP) portion, including the end-stage blades. This problem can be addressed by implementing more resistant materials and changing end-stage blade geometry to increase erosion protection. Hollow guide vanes to suction away excess moisture from the exhaust steam are also available for certain types of blades.

Redesign of low-pressure (LP parts): For operators of condensing steam turbines, it may become uneconomical to produce electricity due to market changes. A reduction in power output or an increase in process steam are ways to restore profitability. Options range from cutting back/optimizing the quantity of low-pressure steam to complete conversion of a condensing turbine into a back-pressure turbine. In other cases, it may be necessary to modify turbine generator sets to be flexible enough to respond to changes in loads on the power grid.

Retrofitting control systems: Many steam turbines still use mechanical-hydraulic or older electronic controls. Wear and tear on components, and an uncertain supply of spare parts can impair smooth operation. It is possible to modernize turbine controls to ensure API conformity. In many cases, remote diagnostic services (RDS) can be implemented to enable capabilities such as early warning of failures, root cause analyses (RCA), and remote troubleshooting.

For any steam turbine upgrade project, an analysis of the condition of the turbine and the entire system is required to determine the optimal approach. A look at the current and future requirements will reveal which systems, components, and parts can still be used and which will have to be adapted and replaced. After a preliminary evaluation, a feasibility analysis can be conducted, which allows the operator to evaluate the costs of retrofits or upgrades for the existing turbine(s) and system. ■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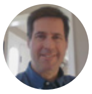
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