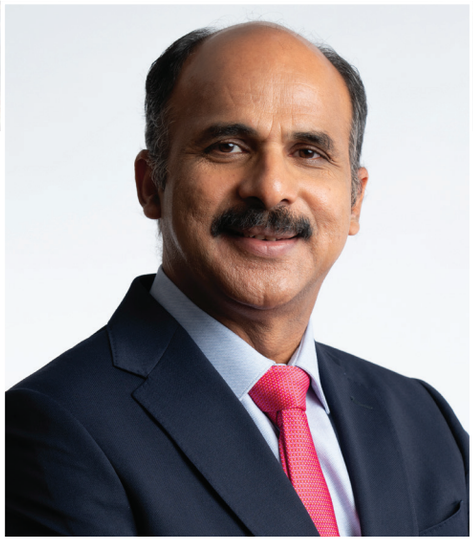

Steam Turbines for Petroleum Refining Industry

S. NARAYANA PRASAD
CEO, Triveni Turbines

Triveni Turbines has established a reputation for delivering benchmark efficiencies to EPCs building new oil and gas plants or modernizing existing oil and gas plants worldwide through its steam turbine products in the API segment. **S. Narayana Prasad, CEO, Triveni Turbines,** throws more light on the role of steam turbines in petroleum refining industry.

GUEST COLUMN

The petroleum refining industry has experienced steady growth in recent years due to robust demand, high refinery margins, and the establishment of new refineries[1] in the Middle East, the U.S., and China. Oil supply is projected to increase to 102.9 million barrels per day[2] in 2024, after considering Organization of the Petroleum Exporting Countries (OPEC) production cuts. Onshore oil inventories in various countries are expected to be lower in 2024 compared to pre-COVID-19 levels due to disruptions in shipping routes and increased offshore inventories.

The chemical and petroleum industries together contribute approximately 7 per cent and 2.5 per cent to global GDP[4,5] respectively. Both industries require extensive process heating, with the petroleum refining sector[6] utilizing nearly 90 per cent of onsite fuel for this purpose, around 25 per cent of which is for generating steam used in process heating.

Refinery Industry for Net Zero Emissions 2050 scenario – Innovations & Policy Framework

The petroleum refining sector has the highest process heating energy demand among all manufacturing sectors and, consequently, is the largest source of onsite greenhouse gas (GHG) emissions from combustion. A significant portion of the electricity used in the refining industry is generated offsite, with approximately 30 per cent produced onsite[6] through cogeneration / combined heat and power (CHP) applications. Onsite energy production through CHP is roughly twice as efficient as energy supplied through the grid.

In the pursuit of Net Zero Emissions by 2050 (NZE 2050), the refinery industry is expected to play a crucial role in reducing Scope 1 emissions, which include direct energy and process emissions. According to an International Energy Agency (IEA) report[7], approximately $450 billion is invested annually worldwide in energy efficiency improvements and other end-use applications. Energy efficiency is central to the path towards a low-carbon future; it is the lowest-cost option and is often referred to as the 'first fuel' — the resource to be utilized before all other energy options. Enhancing energy efficiency not only reduces emissions but also improves energy security, relieves pressure on national budgets, boosts competitiveness, and enhances operational efficiency. Energy efficiency measures are characterized by high technological maturity and commercial-scale deployment.

Countries are working towards the NZE 2050 goal. For example, a major Middle Eastern nation has developed standards and procedures for energy efficiency at the Front End Engineering Design (FEED) stage, which are advisory in nature and have made third-party energy efficiency audits mandatory. They have also incentivized project managers and Engineering, Procurement, and Construction (EPC) contractors to meet long-term performance metrics for facilities. National oil exploration and refining companies are increasingly forming partnerships with oil, gas, and petrochemical companies to build new facilities aimed at enhancing plant efficiencies.

API 612 - 1.5 MW installed at the customer site

API 612 - 2.7 MW installed at the customer site

In India, the government is also supporting the petroleum industry through the new Petroleum, Chemicals and Petrochemical Investment Regions (PCPIR) 2020-35 policy, which includes provisions for 100 per cent Foreign Direct Investment (FDI) and 20 per cent Viability Gap Funding (VGF). This policy aims to expedite the establishment of refinery facilities to meet energy demands and build efficient energy ecosystems. Additionally, initiatives by the Bureau of Energy Efficiency (BEE) to collaborate with EPC contractors and Energy Service Companies (ESCOs) are expected to enhance and promote the country's energy efficiency.

Driven by the goals of NZE 2050 and Nationally Determined Contributions (NDCs), the petroleum refinery industry is increasingly emphasizing the importance of energy efficiency and equipment reliability. This trend presents new challenges for Original Equipment Manufacturers (OEMs) of steam turbines and gas turbines, pushing them to meet higher standards of performance and efficiency.

Petroleum Refining & Steam Turbines

Refining industry converts crude into more than 2,500 refined products and feedstocks for the petrochemical industry. Petroleum refining consists of four primary processes:

- Distillation (~600°C) for separation of fuels
- Petroleum conversion (cracking, reforming, coking, etc. at ~400°C)
- Petroleum treating (desulphurization and hydrotreating) and
- Feedstock handling (storage and blending)

For the primary processes, process heat requirements are met through fuel burning and electric heaters. Steam in refinery processes is used for heating petroleum products in heat exchangers, for steam stripping in distillation towers for enhancing separation efficiency and also as a medium for producing vacuum (vacuum distillation towers) through steam ejectors.

The petroleum refinery industry is one of the largest adopters of Cogeneration / Combined Heat and Power (CHP) systems. A significant reason for the widespread adoption of CHP in petroleum refining is the availability of large quantities of by-product, the waste gas.

Steam turbines used in refinery applications can be backpressure or condensing types, with or without extraction, depending on the plant cycle design. Steam turbines can be used for mechanical drive pumps and compressors within refineries, and also for power generation by coupling with alternator. CHP systems incorporating steam turbines and gas turbines can be configured to operate as either electrical load matching or thermal load matching systems.

CASE STUDY

Triveni API (Refinery) Product Portfolio

Triveni Turbines has a substantial installed base of turbines in refineries worldwide and maintains a strong project pipeline for API steam turbines under 100 MW, with installations planned over the next several years.

Case Study 1: Project is driven by Triveni Turbines' 1.5 MW (4 No's) and 2.7 MW (4 No's) back pressure Steam Turbine Generators (STG) for drive applications in Kuwait

API 612 - 3.6 MW during dispatch from Peenya factory

Project Description: Triveni Turbines Limited has successfully executed a contract from a national oil company and a leading petroleum refining company in Kuwait to design, supply, and commission an API 612 steam turbine for use in fan drive applications and as per Shell Design Engineering Practices (DEP) plus AMEC FW project variations. Each steam turbine powers four combustion air blowers and flue gas fans respectively for the world's largest reformer package.

Challenge: These special purpose steam turbines are designed, manufactured and tested as per the project specifications which includes design for outdoor installation, ensuring a minimum design metal temperature suitable for -30°C, and they must meet the classification for electrical hazard area zone 1, IIC, and T3.

Solution: The supplied steam turbines have a design life of 30-year service life and six years of continuous operation. The supply scope also encompassed gear units, lube oil systems, unit control panels, and gland steam condensers. The project was commissioned successfully to meet the specifications.

Case Study 2: Project is driven by Triveni Turbines' 3.6 MW back pressure steam turbine generators (STG) for drive applications in India

Project Description: Triveni Turbines Limited has executed a contract from a national oil company and a leading petroleum refining company in India to design, supply, and commission an API 612 steam turbine for use in compressor drive applications.

Challenge: The steam turbines are designed to meet the project specifications, featuring instrumentation appropriate for electrical hazard areas and high-humidity environments. The steam turbines, clutch, coupling and driven equipment are mounted on a common base frame that complies with applicable standards.

Solutions: The steam turbines were successfully mounted on a common base frame in compliance with API RP 686 standards. They were supplied to the customer with advanced governing and control systems (including the Woodward FT 5009 TMR Governor and MOOG Hydraulic actuator) to drive an induction generator/motor and compressor. Additionally, they feature instrumentation suitable for Zone 1, IIC, T3, and high-humidity environments. ■

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