GAS SAVINGS

Combined cycle with Turboden ORC technology

COMBINED CYCLE BASED ON ORC TECHNOLOGY FOR HEAT RECOVERY APPLICATIONS HAS CONSIDERABLE POTENTIAL FOR BOOSTING ENERGY EFFICIENCY AND INCREASING GAS SAVINGS AT O&G FACILITIES. CONSIDERING INNOVATIVE NATURE OF THIS TECHNOLOGY, THERE IS AN ESTABLISHED PRACTICE OF COOPERATION BETWEEN TURBODEN AND LEADING INTERNATIONAL O&G COMPANIES, UNDER WHICH TURBODEN ENGINEERS CONDUCT THE ANALYSIS OF EXISTING AND PLANNED FACILITIES AND ISSUE RECOMMENDATIONS FOR ENERGY EFFICIENCY INCREASE, USEFUL FOR PERSPECTIVE PLANNING.

KEY WORDS: *tilization of waste heat, combined cycle on the basis of the ORC, conversion of thermal energy, gas savings, energy efficiency.*

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Similar to traditional combined cycles based on steam, combined cycle application employing Organic Rankine cycle (ORC) technology foresees the recovery of energy contained in exhaust gas in dedicated heat exchanger, and "heat recovery" turbine for conversion of heat to electric power. At the same time, unlike typical steam solution, ORC unit uses organic working fluid in closed loop. It allows upgrading simple cycle gas turbines when combined cycles with traditional steam turbines are not suitable due to various issues – for example, in case of considerable load fluctuations, water absence, installations in remote locations and difficult on-site operation.

Thanks to the use of high-molecular-mass working fluids instead of water, which guarantees dry vapour expansion in every operating conditions and no corrosion and erosion of the turbogenerator components, ORC technology has advantages for medium scale power systems (1-20 MW). Minimum operation and maintenance costs with no major overhaul required during lifecycle, absence of water consumption, high availability, full island mode capability and no need of dedicated personnel are some of the features that make ORC technology appealing for various industrial sectors. Another important factor is the flexibility, which allows automatic adjustment to the available heat volume with a high-efficiency operation in the range from 10% to 110% of the nominal load.

The track record gained since 1980 has allowed Turboden, a Mitsubishi Heavy industries group company, to become the worldwide leader in tailoring ORC solutions with more than 300 plants in operation for the so called "Green Energy" production. In the area of heat recovery applications, 3 plants are today acquired references in gas compressor stations, 1 in a flare gas exploitation system, 5 plants in cement and refractory fields, 7 in metallurgy, 2 in glass and many others in waste to energy, biomass and geothermal applications.

From a heat recovery potential point of view, compressor stations represent one of the biggest energy deposits. This is especially important for the specific areas where there is the difference between export and domestic gas price, lack of electricity or grid coverage, remote locations with the necessity of several independent power sources etc.

The main reason why the turbines are open cycles is the advantage of the design, which reduces warm up time, size and simplicity, load fluctuation and auxiliary requirements (no water or cooling needed). Disadvantages are instead fuel consumption and associated fuel costs. Following these aspects in 2011 Turboden successfully installed and put in commercial operation 1 MW ORC unit bottoming 1 Solar Centaur 40 in a gas compressor station in Canada. The ORC was a retrofit installation on an existing station. It has been demonstrating until now an overall availability exceeding 98% with more than 28,000 working hours of operation. The ORC allowed a comparable fuel saving between 15 and 20% and its associated cost, without adding major operating and maintenance costs.

It should be noted here that this direction also draws the attention of various international development institutions. With the participation of World Bank, two heat recovery projects at compressor plants in Uzbekistan were developed and financed. The first one will start

operations in existing gas compressor station of SC "Uztransgas" where the ORC unit will recover waste heat from 3 GE LM1600 gas turbines. The solution will allow to produce 1 additional MW as "free" additional electric power to cover the self-consumptions of the station, regardless which gas compressor unit is in operation. The second project will recover the heat from 1 GE LM2500 gas turbine with an electric power production of 5.5 MW at SC "Uzneftegazdobycha". Both projects have been driven by the key advantages of the ORC technology such as no water consumption and low maintenance requirements compatible with gas turbine maintenance program, fully integration and automatic operating mode in each gas compressor station load, no affection of the gas turbines operations as well as no operator needed on-site.

Apart from ORC turbogenerator and organic loop, the projects foresee the modification of GT exhaust ducting according to Turboden design. Particularly, waste heat recovery exchangers are installed on the gas turbine exhaust lines with the aim to cool the exhaust gas and re-utilize the recovered energy, otherwise lost in the atmosphere. The heat exchangers supplied by Turboden are optimized to distribute properly flue gas and provide minimum gas turbine back pressure, acceptable by OEM; and are also equipped with air sealed divertors and by-pass lines to ensure uninterruptable gas pumping unit operation.

When the plant layout is complicated and congested, especially at existing facilities, a heat carrier loop is typically interposed between the hot source and the ORC, usually represented by thermal oil. It allows flexibility and easier decoupling from the primary heat source with distances up to 250-300 m and more, and minimizing the influence on the existing engineering lines. Alternatively, in greenfield projects and/or when the plant layout is not congested, Turboden developed an innovative direct exchange solution where the organic fluid is directly evaporated by the exhaust gas in a specifically designed heat recovery exchanger. This solution already employed by Turboden in heat recovery projects from diesel engines will also be employed in the 5.5 MWe project under development in Uzbekistan.

In order to condensate working fluid, air cooled condensers are installed, maximizing the electrical efficiency of the ORC plant. Instead, for some other projects, including 5.6 MW ORC unit at wood processing plant in Torzhok which was put in operation February 2017, water cooling is used with hot water cogeneration.

Therefore, combined cycle based on ORC technology for heat recovery applications has considerable potential for boosting energy efficiency and increasing gas savings at O&G facilities.