Energy Recovery from Natural Gas Letdown Stations

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Every industrial process creates at least some waste heat or secondary energy sources. A rational solution is to recycle this industrial waste energy in the actual manufacturing process - regenerative usage. Likewise, this waste energy can be used as a secondary energy source, which consists of three main groups: gas overpressure, waste heat and combustible waste.

The main sources of waste heat are technological devices, which are typically energetically inefficient.

One potential secondary energy source is the overpressure that results from lowering natural-gas pressure to meet consumer specifications. In order to be transported through pipelines, natural gas has to have a very high pressure. At this level of pressure, however, it cannot be used by consumers, which means that it has to be forcibly lowered. This creates energy losses. Natural gas pressure is reduced in two steps. First, it is lowered at a gas-regulating station, where the pressure goes from a range of 3,5 – 7,5 MPa to a range of 0,3 – 1,2 MPa. Then, at gas control points, it is reduced to a range of 0,005 – 0,6 MPa. Water steam is treated similarly. Many industrial boilers produce steam with a pressure range of about 1,3 MPa. To make it usable, it needs to be at 0,3 – 0,6 MPa. The pressure has to be reduced through a throttling process.

Secondary energy sources can be recovered by using machines that convert energy streams into a more valuable energy form. Most frequently, the most useful forms are electrical and mechanical energy, due to their widespread use and the need for high exergy value. Low-grade thermal energy does not satisfy modern requirements. Frequently, the secondary energy sources produced by manufacturers significantly exceed their needs for low-temperature heat.

For this purpose, different types of machines can be applied: turbines, piston engines, screw engines, etc. Each year, turbines are getting more popular in small-energy production. This is due to certain advantages, such as the direct transfer of torque to the electric generator, the small number of moving parts, etc.

Turbines with a large capacity (several megawatts) are nowadays applied in industrial systems with large and continuous streams of secondary energy sources. In order to increase the number of possible sources of energy recovery, it is necessary to create low-power machines that can recover small amounts of energy streams with low-potential parameters.

This is made possible by microturbines, which expand the range of objects that allow secondary energy recovery. Existing steam and gas turbines have some disadvantages. It is necessary to improve microturbine designs to make them viable energy recovery machines, while simultaneously increasing the efficiency of the transformations.

The new type of microturbine is developed by the specialists of "Scientific and Technological Park of the BNTU "Polytechnic" is called TurboSphere. It simultaneously combines several units, such as a turbine, a heat exchanger, and a power generator. TurboSphere has only one blade wheel, and its multistage gas-flow expansion is performed by heating gas between stages.

The electrical power of the turbines ranges from 5 kW to 500kW, depending on the characteristics of the energy sources. The TurboSphere is a compact machine, with only one moving part - a blade wheel with a diameter from 300 mm to 700 mm. This blade wheel's rotational velocity can reach 3000 rpm or more. It requires neither a high-velocity electric generator nor a reduction gear. Its dimensions allow for the TurboSphere to be placed indoors or outdoors.

The turbine's original design and concept allow for earlier implementation of complicated power cycles. Allowing the use of any type of steam or gas as a working fluid, this process creates a wide spectrum of input and output characteristics, including flow rate, pressure, and temperature.

This innovative turbine performs the following tasks:

1 Power generation from waste heat using the Organic Rankine Cycle (ORC);

2 Electricity production from low-potential fuel, such as trash and wood;

3 Recovery of natural gas overpressure at gas stations;

4 Conversion of steam overpressure energy into electricity during steam throttling, minimizing energy loss.

It is possible to integrate the TurboSphere into sources of alternative energy, such as geothermal and solar energy.

The energy market requires small, cheap, and highly efficient micro turbines for the recovery of secondary energy sources. In addition to having these traits, the versatile TurboSphere will be compatible with a wide range of energy sources and their necessary parameters.