ORC UNIT FOR HEAT RECOVERY FROM THE COMPRESSED AIR INDUSTRY

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ABSTRACT

The use of waste heat in industry is becoming a particularly important aspect in the current state of climate change and the growing demand for electricity by individual consumers and by industry. The stability and the availability of such energy plays an important role in the case of electricity production from secondary heat applications. Production of process gases, e.g. compressed air, is an unstable source of waste heat, dependent on production cycle and actual load. This work presents the design of an ORC unit that is dedicated to work in such conditions with secondary heat from the compressed air industry.

Oil is the source of heat in the compressors, which acts as a lubricating, sealing and cooling medium for the compression module. The presented ORC plant is intended to cooperate with two screw compressors; 110 kWe power each. The total amount of heat available from two units is on the level of 120 kW. The devices need to stay separated and the oil from two machines cannot be mixed, therefore an intermediate water loop with two exchangers was incorporated. After a series of analyses of several variants of the power plant and operating fluids, a variant without regeneration was proposed. The working medium chosen to operate in the ORC system is a new generation refrigerant R1233zd characterized by very low environmental impact (ODP = 0, GWP = 1).

The entire system together with the single-stage axial turbine was made as a hermetic design. There is a high-speed three-phase generator with a capacity of 10 kWe on one shaft with a turbine. Due to the regime of work in changing conditions and the need for a quick start and stop a super-precision rolling bearing system with a self-regulating bearing tension mechanism was used. At the nominal point the turbine operates at a rotational speed of 24,000 RPM and a mass flow of 0.5 kg/s. In addition, the design of the turbine blade system has been optimized in order to maximize efficiency and find the optimal variant to work in the whole range of changing working conditions.