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PhD Thesis Summary:

„ Analysis of gas turbine application in process industry"

The PhD thesis comprises systems in which the Gas Turbine (GT) exhaust gases are directly utilized at industrial scale, as: preheated air in industrial furnace, heat source for direct drying and heat source for absorption chillers. Mentioned industrial processes were described, including review of documented reference projects, as well as experience of main GT manufacturers. Researched solutions allowed to reduce specific energy consumption and consequently the CO2 emission in the range from 7% to 20% and reduce the cost of energy by 15-30 %. Deep utilization of exhaust gas from GT allowed to achieve the total efficiency of cogeneration plant even above 90%.

The scope of PhD thesis includes the feasibility study on implementation of researched solutions in Polish industry. Based on reference projects, the power range of analyzed GT was defined between 5 and 35 MW. Various GT types were investigated: Small Industrial, Heavy Duties and Aeroderivative. GT selection was based also on the exhaust gas data, exhaust gas emissions and the capabilities to burn alternative gas fuels available currently in Poland (High Nitrogen Natural Gas, Coke Oven Gas and Hydrogen) and gas fuels that will be available in future (Syngas from coal gasification). Performed analysis includes the effect of ambient conditions, load profile, as well as aging impact on the key GT parameters in investigated applications based on the GT operating data. Possibilities of exhaust gas temperature and flow control by means of GT auxiliaries and control systems are explored.

Mass and heat balance models for GT integrated with industrial processes were developed. Modification in GT control philosophy for auxiliaries and control systems, that allows to regulate exhaust gas temperature and flow at constant GT power, is proposed. The direct and indirect GT exhaust gas measurement methods are described.

Modern GTs produced by Baker Hughes ($\eta \geq 36\%$) enable the reduction of specific energy consumption and cost of energy in described applications. Recommended GT architecture is two shaft Industrial GT equipped with Variable Nozzle Guide Vanes, that allows to increase efficiency in part load, as well as extend the window for exhaust gas temperature and flow control. Most advantageous system for each studied GT type is defined based on comparison between the control capabilities and the variations of main GT parameters.

Keywords: absorption chillers, alternative fuels, auxiliaries' systems, cogeneration, cycle simulation, drying, emission, gas turbine, heat recovery, hydrogen, industrial furnaces, regulation systems, specific energy consumption, trigeneration.

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PhD Student Signature