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Investigation of the Working Processes in Thermocompressor Operating on Cryogenic Working Fluid

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Abstract : This article deals with research of the working process in the thermocompressor which operates on cryogenic working fluid. Thermocompressor is device suited for the conversation of heat energy directly to the potential energy of pressure. Suggested thermocompressor is suited for operation during liquid natural gas (LNG) re-gasification and is placed after evaporator. Such application of thermocompressor allows using of the LNG cold energy for rising of working fluid pressure, which then can be used for electricity generation or another purpose. Thermocompressor consists of two chambers divided by the regenerative heat exchanger. Calculation algorithm for unsteady calculation of thermocompressor working process was suggested. The results of this investigation are to change of thermocompressor's chambers temperature and pressure during the working cycle. These distributions help to find out the parameters, which significantly influence thermocompressor efficiency. These parameters include regenerative heat exchanger coefficient of the performance (COP) dead volume of the chambers, working frequency of the thermocompressor etc. Exergy analysis was performed to estimate thermocompressor efficiency. Cryogenic thermocompressor operated on nitrogen working fluid was chosen as a prototype. Calculation of the temperature and pressure change was performed with taking into account heat fluxes through regenerator and thermocompressor walls. Temperature of the cold chamber significantly differs from the results of steady calculation, which is caused by friction of the working fluid in regenerator and heat fluxes from the hot chamber. The rise of the cold chamber temperature leads to decreasing of thermocompressor delivery volume. Temperature of hot chamber differs negligibly because losses due to heat fluxes to a cold chamber are compensated by the friction of the working fluid in the regenerator. Optimal working frequency was selected. Main results of the investigation: -theoretical confirmation of thermocompressor operation capability on the cryogenic working fluid; -optimal working frequency was found; -value of the cold chamber temperature differs from the starting value much more than the temperature of the hot chamber; -main parameters which influence thermocompressor performance are regenerative heat exchanger COP and heat fluxes through regenerator and thermocompressor walls.

Keywords : cold energy, liquid natural gas, thermocompressor, regenerative heat exchanger
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