active decay products (Mo, REE, etc.), and structural materials left over after the first extraction cycle [2].

Gas-discharge plasma offers a single-stage, high-speed method of obtaining oxide compounds from SNF PW's distributed water solutions. Nevertheless, the only processing of water solutions in plasma necessitates high energy consumption (up to 4 kW•h/kg) and does not offer the chemical synthesis of oxide compounds in air plasma with the necessary composition without further hydrogen reduction [1].

Following the extraction cycle, reprocessing of spent nuclear fuel results in reprocessing waste (RW SNF), which is an aqueous nitrate solution (raffinate) with the following composition: [1]: HNO_3, 0.07 percent Fe, 0.11 percent Nd, 0.10 percent Mo, 0.06 percent Y, 0.058 % Zr, 0.04 percent Na, 0.039 percent Ce, 0.036 % Cs, 0.031 % Co, 0.026 % Sr, and remaining H_2O comprise 18,00 % [2].

Figure 1 illustrates the impact on Tad for aqueous organic nitrate solutions based on ethanol (a) and acetone (b) of spent nuclear fuel content (RW SNF) and organic compounds from reactor waste.

Optimization of system operation modes "HF generator-VHF plasma torch" are shown in Fig. 2.

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IMPROVING THE ENERGY EFFICIENCY OF THE NATURAL GAS LIQUEFACTION PROCESS IN ARCTIC CONDITIONS

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The process of liquefying natural gas is an economically and energetically costly process, due to the use of heat exchangers of elaborate designs and heavy loads on refrigerant compressors. For upside projects in the Arctic belt, a critical task is to choose the most energy-efficient solution for conducting the natural gas liquefaction process in order to minimize economic costs. This problem is a complex and multifactorial task requiring a comprehensive solution, which can be obtained using pinch analysis and selection of optimal process parameters, taking into account the thermodynamic features of the process.

As part of the work for large-scale production in Arctic conditions, technologies were chosen for research that allow integrating climatic conditions into the process of liquefaction of natural gas. Energy efficiency analysis was carried out for the C3MR (mixed refrigerant technology with pre-propane cooling) and DMR (dual mixed refrigerant technology) processes. These technologies use plate-ribbed and spiral heat exchangers with a large heat exchange surface area and high-power compressors for compressing refrigerant vapor [1].

For the study, industrial data on the composition of the prepared natural gas supplied for liquefaction and the productivity of the processing line were obtained. After analyzing the composition and properties of natural gas from an upside field, thermobaric conditions were determined, taking into account the behavior of the phase state and the quantity of heat with a decrease in temperature, according to which technological modeling of the selected processes in the Hysys software was carried out. Figure 1 shows a model of the DMR process.

To carry out the pinch analysis, a numerical image of the heat exchange system of the studied liquefaction processes was compiled, according to which the dependences of temperature changes in the system of cold and hot technological flows were constructed when their total flow enthalpy changed (composite curves). The specific heat capacity of natural gas and mixed refrigerants changes non-linearly with a linear decrease in temperature due to partial condensation of the components [2]. To account for large local changes in the specific heat capacity of flows, it is necessary to identify temperature ranges at which the specific heat capacity will change by no more than ten percent. In this regard, the method of multidimensional nonlinear regression was applied to segmentation of flows.

At the next stage, a technical and economic analysis of thermal energy integration options was performed in order to optimize the obtained composite curves, which are the basis for choosing technological and structural parameters of the process.

The reduction in the specific energy consumption of the studied processes was carried out by reducing the power consumption of gas-driven compressors. As a result of the analysis of the effect of refrigerant costs, optimal ratios have been obtained, at which the total power consumed by compressors is minimal.

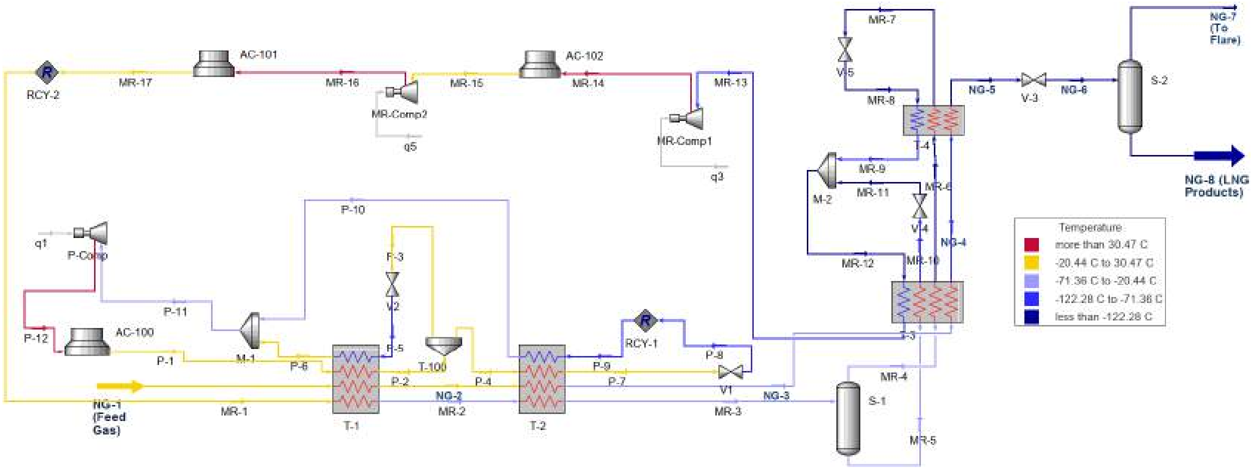

Fig. 1. *Model of the natural gas liquefaction process using a double mixed refrigerant in Hysys software*

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