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Environmental, legislative and technological aspects of the methodology for selecting non-aqueous working fluids for power plants

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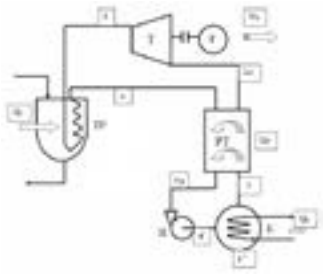
The article is devoted to the solution of the task of choosing the working fluid for the heat-power circuit of power plants on non-aqueous working substances. The authors formulated number of technical proposals for the introduction of fluorocarbon working substances in the heat and power circuit of fast-neutron nuclear facilities with a liquid metal heat transfer phenomena. In the article, based on the analysis of the material balances of the presence of ozone-hazardous or greenhouse substances in the Earth's atmosphere and taking into account industrial and natural emissions over certain periods of time, shows the groundlessness (and, consequently, the invalid pattern) of the provisions on which international agreements on prohibition are based and the restriction of the use of a number of substances. Based on processing of mass balances according to IPCC-94 and IPCC-2013 the conclusions are made about the overestimate in IPCC-94 lifetime assessment for the most stable fluorocarbon CF_4, which gives grounds for removing restrictions on the use of fluorocarbons on the basis of the greenhouse hazard and creates the conditions for studying the technological properties of fluorocarbons. Study of the thermal stability of fluorocarbon compounds (C_3F_8, C_4F_{10}) under constant and cyclic heating in the presence of structural materials containing catalysts has been done. Under these conditions, the temperature of the beginning of the thermal decomposition of octafluoropropane is 630°C, decafluorobutane is 600°C. We also studied the impact of radiation on fluorocarbon working fluids (under α- and β-radiation). As calculations have shown, when using fluorocarbons, the required level of thermodynamic efficiency is reached at a pressure of 6 to 10 MPa (for water up to 24 MPa), which positively affects the safety of the reactor plant without reducing the efficiency. In the indicated range of pressures and temperatures up to 550°C there is an optimum pressure value at which the cycle efficiency is maximal.



Schematic diagram of the NPP on fast neutrons. TP-reactor heat exchanger thermal capacity Q0; T-turbine; G-generator to produce electrical power Ne; PT-regenerative heat exchanger thermal capacity Qp; K-condenser thermal capacity Qk; H-the pump

Biography

Andrey A Sukhikh is a Doctor of Technical Sciences, a Professor at the Department of Theoretical Foundations of Heat Technology of Federal State Budgetary Educational Institution of higher education National Research University MPEI, Moscow, is a specialist in the field of experimental physics. He is a leading Teacher on the basic discipline of engineering thermodynamics. He got Laureate of the Government Prize in the field of Science and Technology in 2008 for the work development and introduction of a set of precision data on thermophysical properties of working substances and cryogenic refrigeration and heat pumps.

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