ISSN 0040-6015, Thermal Engineering, 2013, Vol. 60, No. 9, pp. 660–662. © Pleiades Publishing, Inc., 2013.
Original Russian Text © Yu.V. Parfenov, 2013, published in Teploenergetika.

NUCLEAR POWER STATIONS

The Computational-and-Experimental Investigation into the Head-Flow Characteristic of the Two-Stage Ejector for the Emergency Core Cooling System of the NPP with a Water-Moderated Water-Cooled Power Reactor

Yu. V. Parfenov

National Research University Moscow Power Engineering Institute, ul. Krasnokazarmennaya 14, Moscow, 111250 Russia

Abstract—The results of the computational-and-experimental investigation into the two-stage ejector for the emergency cooling system of the core of the water-moderated water-cooled power reactor. The results of experimental investigations performed for the ejector model at the JSC "EREC" and the result of calculations performed using the REMIX CFD code are presented.

Keywords: ejector, water-moderated water-cooled power reactor (VVER), CFD code

DOI: 10.1134/S0040601513090103

The pump–ejector aggregate, which is mounted on the pressure side of the pump, is planned to be used in the reactor core's emergency cooling system (ECCS) of the innovative projects of the NPP with water-moderated water-cooled power reactors (VVER) (AES-2006, VVER-TOI). In emergency conditions, exclusively the high-pressure pump of the ECCS will operate in a pressure range from 8 to 2 MPa. In the case of a pressure drop lower than 2 MPa, the ECCS water into contour I will also be supplied by the water-water ejector thereby increasing the total consumption, which corresponds to the operation mode of the low-pressure ECCS pump.

The pump–ejector aggregate should provide the head-flow characteristic close to the characteristic of the ECCS of the VVER NPP. The high-pressure pump, which is involved into the aggregate, is the same as the one already used at the NPP; therefore, the main problem is to find such a design of the ejector, which will provide the head-flow characteristic sufficiently close to the characteristic of the low-pressure ECCS pump. In this case, the two most important design requirements should be performed, namely, the maximal water consumption through the ejector and the pressure in contour I at which the ejector starts to operate.

The head-flow characteristic of the one-stage ejector intended for the ECCS of the innovation projects of the VVER power nuclear plants was investigated experimentally at JSC Electrogorsk Research and Engineering Center on A-plant Safety (JSC "EREC") [1]. Figure 1 represents the schematic of the flowing part of this ejector.

The experimental investigations showed that a decrease in the pressure at the output from the ejector diffuser initially causes an increase in the injection coefficient, which is determined as the ratio of the consumption of the injected water to the working water consumption. However, at a certain pressure, the limiting injection coefficient is attained, and the further decrease in the output diffuser pressure does not lead to an increase in the injection coefficient. We calculated the head-flow ejector characteristic based on the design procedure described in [2].

Calculations showed the appearance of the cavitation operational mode of the mixing chamber, which is accompanied by the so-called limiting consumption mode of the medium characteristic by a decrease in pressure after the cavitation segment, is not accompanied by an increase in the consumption. The maximal water consumption from a single-step ejector, which corresponds to the limiting injection coefficient, was approximately 570 t/h in the experiment while the maximal consumption through the ejector, which

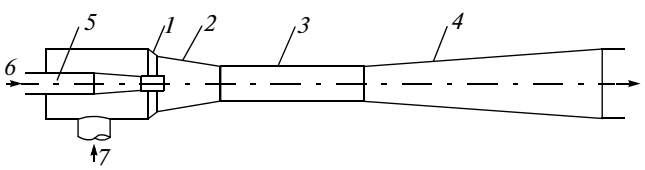

Fig. 1. Schematic of the flowing part of the one-stage ejector. (*1* and *2*) Passive nozzle, (*3*) mixing chamber, (*4*) diffuser, (*5*) working nozzle, (*6*) working water supply, and (*7*) injected water supply.