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# НАУЧНО-ТЕХНИЧЕСКИЙ ДИСКУРС «ИНТЕЛЛЕКТУАЛЬНЫЕ ЭНЕРГОСИСТЕМЫ»

## METHODS OF DESALINATION AT NUCLEAR POWER PLANT

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In connection with the Globe increasing population and rapid development of industrial complex the depletion of natural resources is observed. That entails the scientific research in the area of alternative sources of energy. But the problem with energy being solved by engineers and scientists is one of the solutions. However, it is necessary to bear in mind one more important natural resource – water, the source of Life on our planet. It is well-known fact that our body is composed of this liquid. It seems that there is no problem with water since it takes about 70 %. But this is a misleading vision. The vast majority of the world's oceans is salty water (99,687%). No doubt that it is a high time to stop wasting fresh water and think of some new ways of its desalination. Our research is directly focused on this problem.

Looking ahead, two main resource problems can be solved, e.g. energy and water. They are presented in the symbiosis of nuclear power plant and desalination unit. First attempts were made by soviet engineers in 1973 in the city of Shevchenko (now Aktau) where the first nuclear power reactor BN-350 with desalination plants was commissioned.

The Aktau nuclear power plant (NPP) installed electric capacity was 350 MW. At the time of its operation it was the only nuclear desalination plant in the world supplying fresh water for the city of Shevchenko in the volume of 120,000 cubic meters per day. The BN-350 fast reactor at Aktau, in Kazakhstan, successfully supplied up to 135 MWe of electric power while producing 80,000 $m^3$/day of potable water over some 27 years, about 60% of its power was used for heat and desalination.

The desalination process is carried out in several ways:

1. the multi stage flash (MSF)
2. reverse Osmosis Technology
3. the multi-stage distillation (MED).

In the MSF process, the seawater is heated to the maximum brine temperature in the brine heater and fed to another container known as a "stage", where the surrounding pressure is below the saturated vapor pressure of the brine at that temperature. The sudden lower pressure causes the brine to boil so quickly as to flash into steam. Although a small portion of this water converts into steam, the remaining water is sent through a series of additional stages, each of them having a lower pressure than the previous stage. The vapor in each stage is condensed on the outer surface of the feed stream tubes, giving its latent heat to the incoming seawater flowing inside the tubes. Thus the feed stream is heated progressively in each stage before passing through the brine heater used to feed the first stage. The hot condensate also passes

through all the stages and cools itself while flashing a portion into steam, then it is collected as final product - fresh water.

In the MED process, the seawater is boiled in the first vessel, as the boiling point of water decreases pressure decreases. After that the vapor from the first vessel is condensed in the second one and its heat is used to boil the seawater in the second evaporator, which has a lower pressure than the previous. The seawater passes to the next section and the vapor from the previous one boils it, repeating the process. Increasing the number of stages leads to the increase of water production, but also causes a higher investment, so an optimum number must be determined depending on the plant specifications.

A semipermeable membrane is located between two compartments. The membrane allows the solvent to flow through it, but does not allow the solute to move from one compartment to the other. To obtain the equilibrium, the solvent from areas of low solute concentration moves to areas of high solute concentration. Areas with low concentration become more concentrated and areas with high concentration decrease the solute concentration. This process is called osmosis. In the reverse osmosis process, a pressure commonly ranging from 55 to 68 bar, is applied to the compartment with high concentration of solute, part of the seawater 30 to 40% passes through the membrane producing freshwater. The remaining concentrated water is sent back to the sea.

The most vivid problem is sault. This problem was also solved. Technical brine contains lots of valuable chemicals widely used in industry.

When dealing with the NPP advantages with a desalination unit, it is necessary to point out its disadvantages over typical desalination plant. It is, of course, the need for a large quantity of energy resources that makes it very expensive for supplying the population with fresh water. Energy, generated at NPP is enough to supply any desalination unit.

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