

**СЕКЦИЯ 4.
ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ РАБОТЫ ТЕПЛОВЫХ
И АТОМНЫХ ЭЛЕКТРОСТАНЦИЙ**

INCREASING THE EFFICIENCY OF THE NUCLEAR POWER PLANTS

L.S. Golovina
National Research Tomsk Polytechnic University
Institute of Power Engineering, Department of Nuclear and Thermal Power Plants,
Group 5031

The main problem of turbines that are installed at RF NPPs is the necessity to keep humidity content at a low level. Therefore there is used the separator-steam re-heaters (SSR). They have one main advantage - their heating surfaces consist of modules, which can be blanked off without stopping the turbine, but the SSR also have a disadvantage. It's lateral wet steam admission. With such a drawback it's difficult to provide uniform distribution of steam among the separation modules. In the Diagram 1 you can see that the nonuniformity could be 500%. [1]

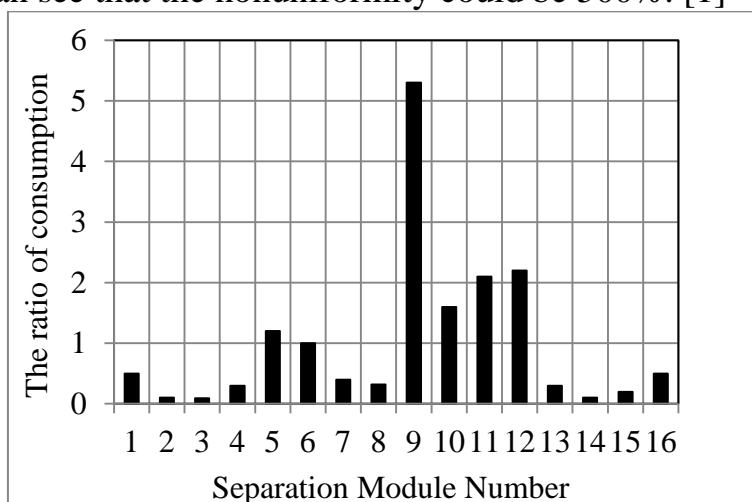


Diagram 1. Relative distribution of moisture content among the separation modules

Specialists have developed a modernization program. The main idea of the project was to replace the Russian louver plates by Powervane louver banks (Fig.1) produced by German company. [2]

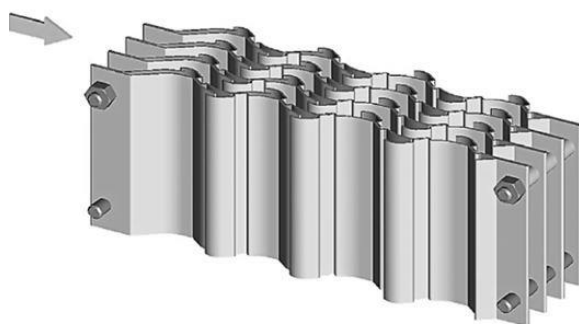


Fig.1. Powervane louvers produced by Balke-Durr

This project was realized in a four power units of Leningrad NPP. During the tests, there was determined a moisture content behind the modules. The results are shown in a Chart 1. Nonuniformity was reduced. Medium level of the relative humidity is equal to 0,6 and this value was close to the design level. [3]

Chart 1. Results the modernization

	The moisture content					
Location	Wall	E	D	B	C	Bottom C
Value (SSR-74)	0.5	0.6	0.7	0.6	0.6	0.7
Value (SSR-71)	0.6	0.6	0.6	0.6	0.6	0.6
Medium value	0.6					
Design level	0.5					

That's why we decided to understand how this modernization affects the turbine efficiency. After the above mentioned modernization the moisture content in steam is reduced. Before modernization the dryness factor X was equal to 0,985 but after this factor it equals to 0,994. If we look at the $h-s$ diagram (Fig.2) then we see that enthalpy h_k is increased.

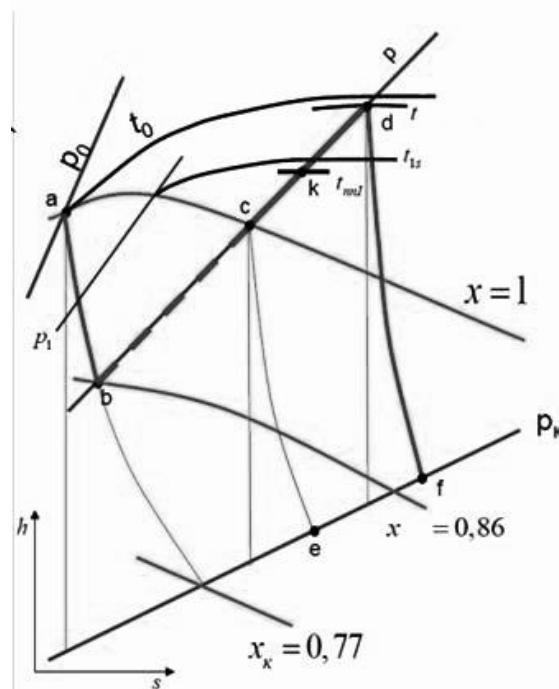


Fig.2. $h-s$ diagram

Therefore the thermal and internal efficiency has also been increased. Efficiency of generator and mechanical efficiency are constant and their multiplication is

equal to 0,985. However if we calculate the electrical efficiency via the formula (1), we will have two values: 0,363 and 0,370.

$$\eta_e = \eta_{oi} \cdot \eta_t \cdot \eta_m \cdot \eta_g \quad (1)$$

Next, it is necessary to calculate how many years should pass for the modernization to be completely paid off. Electrical power can be determined via formula (2).

$$N_e = N_o \cdot \eta_{oi} \cdot \eta_m \cdot \eta_g \quad (2)$$

The turbines K-500 are installed in the Leningrad NPP. Their rated power is equal to 500 MW. Electrical power before modernization was equal to 410 MW and after it is equal to 413 MW. 3 MW will bring an annual profit. Production and delivery of modules costs 100 million rubles. Consequently, if there is used only this power then the modernization will be repaid in 7 years.

In conclusion, it is necessary to add that the separator-steam reheaters modernization has increased the turbine efficiency and the NPP as a whole.

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Scientific advisor: S.V. Lavrinenko, assistant, Institute of Power Engineering, Department of Nuclear and Thermal Power Plants.

THE ADDITIVE TECHNOLOGIES: INNOVATIONS IN NUCLEAR ENERGY

M.A. Vergaskina

National Research Tomsk Polytechnic University

Institute of Power Engineering, Department of Nuclear and Thermal Power Plants,
5031 group

The additive industry development has began with the 3D-printers. Now plants are plan to produce metal details via additive technology.

In RF this technology is at a low level. The main problem, that has appeared after the Russian ruble fall, is the foreign additive technologies high cost. For example, the titanium powders price for the Russian consumer is about 520 euros, but in Europe it is just 230 euros.

Rosatom has offered a program to solve this problem. Now this program is being realized. It consists of the subsections: technology, raw materials, equipment and standardization. There are involved 3 institutions for the development of metal pow-