СЕКЦИЯ 1.
ЭНЕРГОСБЕРЕЖЕНИЕ И ЭНЕРГОЭФФЕКТИВНОСТЬ

DESIGN OF A POWER UNIT OF AN AUTONOMOUS NUCLEAR POWER PLANT WITH A VVER-300 REACTOR

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Introduction

The design of the two-loop Reactor Plant (RP) with VVER-300 is based on engineering solutions for the equipment of previous designs of RP with VVER.

The VVER-300 is a proposed Russian pressurized water reactor of 325-MWe generating capacity designed for remote locations. The exterior containment structure is 16 meters high and the working section, built with transportable modules, weighs 1300 tonnes. The external steam plant can have a 917 MW thermal-steam only capacity, or 325 MW steam-turbine-electrical capacity, or a mixture of capacities relating to the four primary steam loops.[1]

In particular, it has been proposed in a more powerful sister ship to the *Akademik Lomonosov* (2010) for possible use on the Russian floating nuclear power station (two reactors on a 49,000-tonne barge). The reactor could be used on a 200–500 MW barge that is expected to be completed by 2030.[1]

The reactor has been proposed for use in water desalination, district heating and/or electrical generation.[1]

The present report aimed to design VVER-300 with horizontal steam generator.

Description of the research object

The design of my research object consists of designing of three variants of steam generator. The first is horizontal steam generator, The second is vertical steam generator with economizer zone and the third, is vertical steam generator without economizer zone.

The research work containing also designing thermal scheme of NPP with High- and Low-pressure turbine with intermediate separator and Superheater and designining of Regnerative feedwater heaters of closed type.

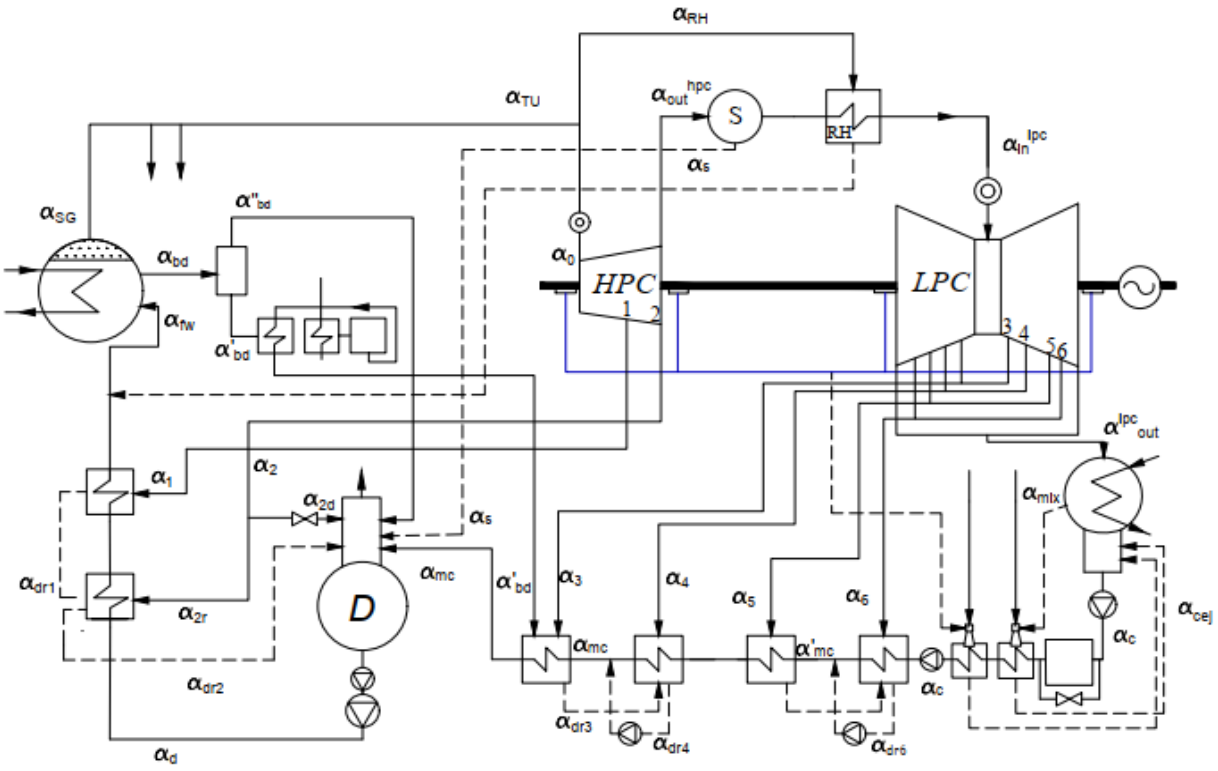

Fig. 1. NPP Scheme.

Steam generator is the most important component of the NPP. It has happened historically that the vertical type steam generators are of choice all over the world, while in Russia the horizontal steam generators are favored by the domestic nuclear industry. Both type steam generators have been operating successfully at the NPPs and adequately ensure the electric power generation. The paper outlines the efforts to elaborate various design concepts of a steam generator. One compares their parameters and characteristics, their thermal efficiency and analyzes the ways to improve the mentioned efficiency. The choice of the steam generator type is shown to involve the efforts to ensure maturity of the reactor facility design, layout, maintenance and operation within the NPP.[2]

The Results of calculation

In my project the calculation of NPP is based only on the horizontal steam generator variant and the final results are in Table 1.

Table 1. The Final results.

Thermal Power of reactor. Q_R, MW	850
Thermal loading of a steam generating unit. Q_{SG} , MW	425
Number of loops	2
Mass flow rate of steam. D_2, kg/s	227.79
Total flow rate of steam. G_{total}, kg/s	455.58
Coolant flow rate. G_1, kg/s	2537.68
Coolant pressure at the inlet to the SG. p_1, MPa	16
Coolant temperature at the inlet to the SG. t_1', °C	325
Coolant temperature at the outlet of the SG. t_1'', °C	296
Steam pressure at the SG. p_2 MPa	7

Feed water temperature. t_{fw}, °C	220
Number of SG tubes	7341
Super-heater	One stage
Final pressure P_c , kPa	5
Deaerator pressure P_d, Mpa	0.64
No. of Low RFWH	4
No. of High RFWH	2
N_e , MW	279.5
η_{npp}^{Gross} , %	32.05
η_{npp}^{net} , %	30.4
Specific flow rate of nuclear fuel (natural uranium) at nuclear power plants. b_{nf} , g/(MW · h)	$29.3 \cdot 10^{-3}$
specific flow rate of degraded fuel for the electrical supply at nuclear power plants (block). b_{Ndf} , MW	$176.35 \cdot 10^{-3}$

Conclusion

We can be concluded; all calculations are met and acceptable according to conditions. The efficiency of NPP is 32.05 % and it is acceptable of range. The finally calculations of steam generators, the horizontal variant is best choice because Steam generators of horizontal type are used on NPPs with VVER reactors from the moment of initiation of development of nuclear power generation.

LITERATURE:

1. Status report 66 - VVER-300 https://aris.iaesa.org/sites/..%5CPDF%5CVBER-300.pdf.
2. Trunov, NB (OKB Gidropress, Podol'sk (Russian Federtion)) ; Lukasevich, BI (OKB Gidropress, Podol'sk (Russian Federation)) ; Veselov, DO (OKB Gidropress, Podol'sk (Russian Federation)) ; Dragunov, Yu.G. (OAO Atomehnergoprom, Moscow (Russian Federation)).

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