Table 1. Final results

Name	Symbol	Value
Electrical power	N_e MW	1000
Initial pressure	p_0, MPa	6,27
Initial temperature	t_0, °C	t_{sat0}
Feed water temperature	t_{fw}, °C	220
Thermal power of SG	Q_{sg}, MW	754,9
Coolant temperature at the inlet to the SG	t_1', °C	321,0
Coolant temperature at the outlet of the SG	t_1'', °C	291,0
Coolant flow	G_1, kg/s	4455
Number stages of Superheater	-	1
Steam temperature at the outlet of the SG	t_{st}°C	281,7
Final pressure	p_c, kPa	3,5
Deaerator pressure	p_d , Mpa	0,62
n HPH	2	Number of high-pressure heaters
n MLPH	4	Number of low pressure heater
Steam flow rate for a turbine	$G_0, \frac{kg}{s}$	1507
Thermal loading of turbine	Q_{TS}, Mpa	2974

Efficiency of heat transport

$$\eta_{pipe}{}^{II} = \frac{Q_{TS}}{Q_{SG}} = \frac{2974}{3006} = 989 = 98{,}9\% .$$

NPP Efficiency:

$$\eta_{NPP} = \eta_{rs} \cdot \eta_{pipe}{}^{II} \cdot \eta_{pipe}{}^{I} \cdot \eta_{SG} \cdot \eta_{e}.$$

The calculation is acceptable according to conditions. NPP efficiency is 32,28% and it's in the range.

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DESIGN OF A POWER UNIT WITH VVER FOR A NPP WITH ELECTRIC CAPACITY OF 870 MW

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Introduction

The most widely used kind of reactor in the world is VVER, the VVER uses water as both a coolant and a moderator. Water-based energy reactor VVER.

Heat from the reactor core is transferred to the secondary circuit via the primary coolant [1].

A well-regulated chain reaction powers nuclear reactor, while the majority of reactors produce electricity. Fission heat is used in power reactors to create steam, which powers turbines to provide electricity [1].

The fuel assembly, control rods, coolant, pressure vessel, containment structure, and an external cooling facility are all common parts of nuclear reactors.

A reactor, a pressurizer, and four circulation loops, each of which has a steam generator and a reactor coolant pump, make up the reactor coolant system [2].

Object

Design NPP with an electrical power of 870 MW:

- Design and calculation thermal diagram of NPP;
- Turbine condenser Design ;
- Design Calculation of a Saturated Steam Generator;
- Calculation of WWER NPR;
- Passive safety systems from modern VVER reactorsю

The main task of the work

This task's goal is to determine what relative flow rate calculations for each part and determine steam flow at the turbine and verify of efficiency of turbine installation and efficiency power plant and to choose of suitable equipment for the water -steam circuit.

Through the Calculation I find out number of low-pressure heaters it will be 4 LPH, and calculate the real temperature rises after each heater it would be $\Delta t_{LPH} = 27{,}5$ °C.

Using the optimal value of feedwater temperature $t_{fwp} = 210$ ℃, I find out number of high-pressure heaters it will be 2 HPH, and the Real temperature rises after each heater $\Delta t_{HPH} =$ 25,1 °C [3].

Table 1. The main parameters and features of NPP

Electrical power	N_e MW	870
Initial pressure	p_0, MPa	6,5
Pressure of condenser	p_c, kPa	4
Pressure of deaerator	p_d , MPa	0,6
Stage of reheat	N_{stage}	Double

Calculation of processes in Turbine

For Low Pressure Cylinder I calculated the Isentropic process of extractions from LPC with absolute internal efficiency $\eta_{0i}^{LPC} = 0{,}80$.

So, I find out that the Exhaust steam quality from LPC,$x^{LPC} = 0{,}885$.

For High Pressure Cylinder the Isentropic process of extractions from LPC with absolute internal efficiency $\eta_{0i}^{HPC} = 0{,}83$ [3].

Thermal diagram shows the main components of secondary circuit/

After getting the values of relative flowrates I determined steam flow to a turbine $G_0 = 1287$ kg/s ; the find Values of flow rate at all the part of NPP.

Table 2. The main results of Calculation of indicators of thermal efficiency

SG Thermal capacity	Q_{SG}, kW	$2622 \cdot 10^3$
Thermal loading of turbine	Q_T, kW	$2589 \cdot 10^3$
Turbine Plant efficiency	η_e, %	33.6
NPP Gross efficiency	η_{npp}^{Gross}, %	32.3

Steam Generator

According to project calculation based on the type of horizontal steam generator. One of the basic and essential components of equipments in the NPP is the steam generator.

The "Horizontal steam generator" concept, which related to heat exchange technology, can be applied to nuclear power plant steam producing facilities [2].

A horizontal steam generator's vessel is a massive, thick-walled vessel. It has a bottom, two side shells, and a middle shell. Welding is used to join every component to the other components[4].

Horizontal steam generators are preferred in the Russian nuclear sector. In Russia, steam generator tubes are constructed of steel of such 08H18N10T type.

The calculation of the thermal part of the SG To evaluate the primary dimensions of the heat exchange surface, a steam generator's thermal calculation is performed.

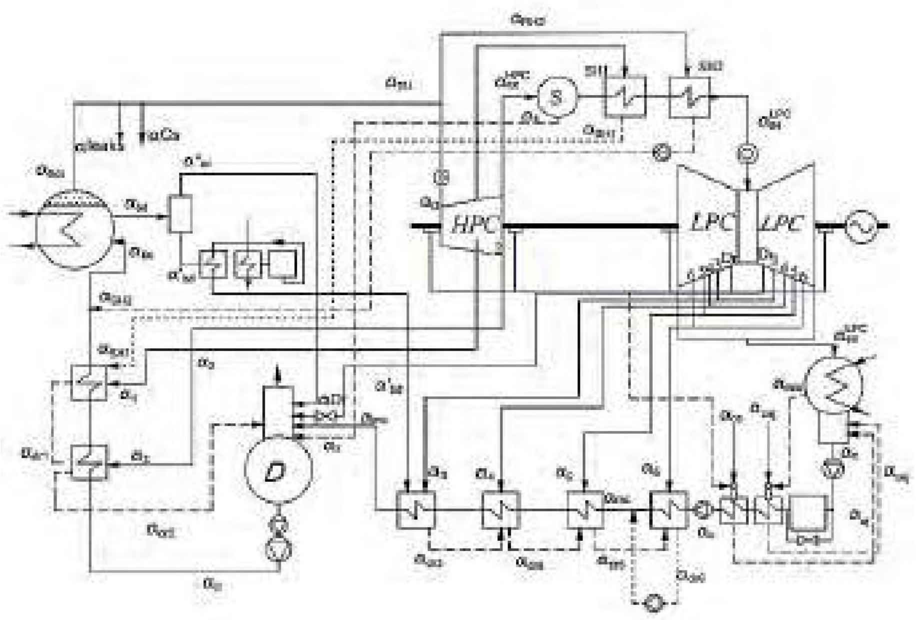

Fig. 1. NPP Thermal diagram

As the Calculation of mechanical part of Horizontal SG of Saturated Vapor with U-Shaped Tubes, the results of mechanical analysis is to evaluate static strength and the wall thickness of these components [4].

Table 3. The Final results calculation of SG

Thermal Power of reactor.	Q_R, MW	2729
Number of loops	Z_{loop}	4
Mass flow rate of steam.	D_2, kg/s	351,4
Coolant flow	G_1, kg/s	2703
The inlet pressure of Coolant to SG	P_1, MPa	16,56
Feed water temperature.	t_{fw}, °C	210
Number of SG tubes	N_{tube}, pcs	8813

Conclusion

The calculations show a design for a nuclear power plant VVER with 4 loops of a horizontal steam generator and an electric power of 870 MW.

Through cancelations of the work I find that all results is in the acceptable rang according to the standards, the efficiency of NPP is 32,3%.

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