Individual homework assignment 1

"**Determination of NPP efficiency indicators in the condensation and cogeneration mode"**

Known flow and properties of nuclear power plant working fluid (Table. 1), which scheme is shown in Fig. 1.

It is necessary to calculate:

- specific steam flow in turbine d_0 and heat rate q_{my};
- turbine efficiency η_{my}, η_{my}^{a} and NPP efficiency η_c, η_c^{u};
- the annual consumption of nuclear fuel $B_г$.

Define electrical efficiency and specific heat consumption on production of electrical and thermal energy if nuclear power plant additionally supply heat Q_c to consumer (consider $Q_c = N_e$). Make conclusion about influence of heat supply on efficiency of power plant.

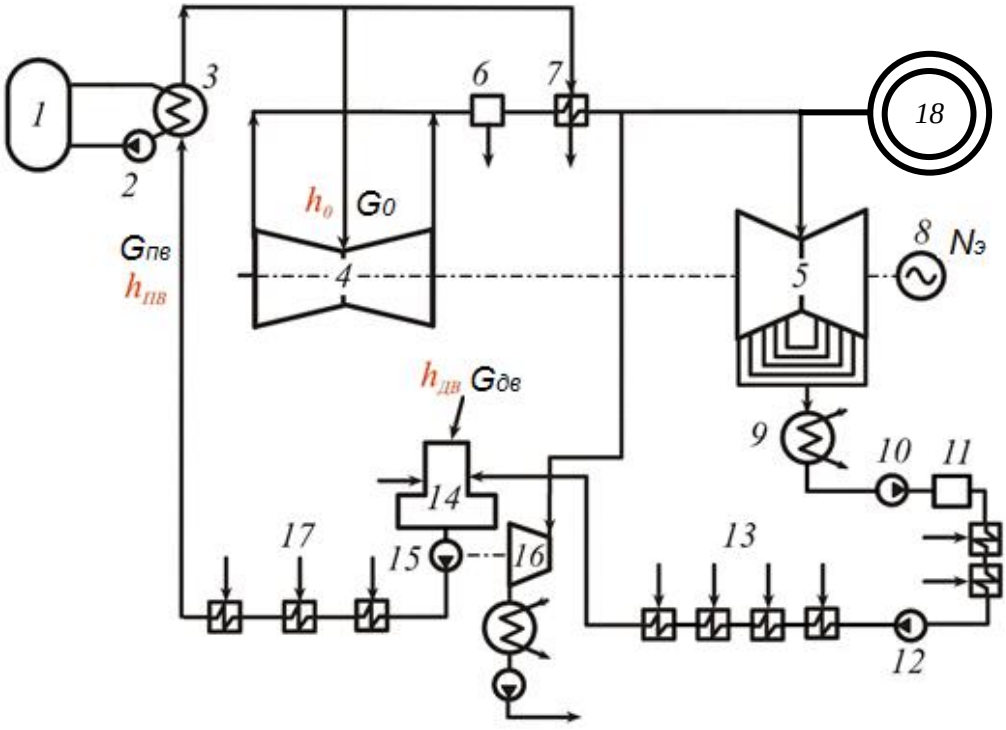

Fig. 1. A simplified diagram of the thermal power unit with cogeneration:

1 reactor; 2 main circulation pump; 3 steam generator; 4, 5 LP and HP turbines; 6 separator; 7 reheater; 8 generator; 9 condenser; 10, 12 condensate pumps of the 1st and 2nd lifting; 11 block desalting unit; 13 low-pressure heaters; 14 deaerator; 15 feed pump; 16 turbine drive feed pump; 17 high-pressure heaters; 18 heat supply unit.

Table 1. Initial data

Properies	Variant				
	1	2	3	4	5
$N_э$, MW	1000	800	750	675	1220
N_e^{mn}, MW	20,5	18	15	13	25
G_0, kg/s	1712	1369	1285	1160	2090
$G_{пв}$, kg/s	1740	1392	1305	1174	2124
$G_{дв}$, kg/s	27	21.6	25	18	33
h_0, kJ/ kg	2779	2770	2760	2780	2765
$h_{пв}$, kJ/ kg	964	960	970	980	985
$h_{дв}$, kJ/ kg	167	160	150	170	175
$\eta_{тр1}$	0,995	0,994	0,992	0,99	0,991
$\eta_{пг}$	0,985	0,983	0,984	0,98	0,981
$\eta_р$	0,99	0,99	0,99	0,99	0,99
$\eta_{тп} \cdot \eta_{пот}$	0,95	0,93	0,96	0,97	0,95
$э_{сн}$, %	6	5,9	6,1	6,2	5,7
K, MW·day/ton	$40 \cdot 10^3$	$41 \cdot 10^3$	$39 \cdot 10^3$	$38 \cdot 10^3$	$36 \cdot 10^3$
$T_{уст}$, hr/yr	6000	6200	6300	6400	6100
Properies	Variant				
	6	7	8	9	10
$N_э$, MW	900	750	600	570	500
N_e^{mn}, MW	15	17,5	12,5	19,5	20
G_0, kg/s	1620	1369	1285	1160	2090
$G_{пв}$, kg/s	1640	1392	1305	1174	2124
$G_{дв}$, kg/s	27	21.6	25	18	33
h_0, kJ/ kg	2779	2770	2760	2780	2765
$h_{пв}$, kJ/ kg	964	960	970	980	985
$h_{дв}$, kJ/ kg	167	160	150	170	175
$\eta_{тр1}$	0,995	0,994	0,993	0,990	0,992
$\eta_{пг}$	0,985	0,981	0,988	0,975	0,985
$\eta_р$	0,99	0,99	0,99	0,99	0,99
$\eta_{тп} \cdot \eta_{пот}$	0,95	0,93	0,96	0,97	0,95
$э_{сн}$, %	6	5,9	6,1	6,2	5,7
K, MW·day/ton	$40 \cdot 10^3$	$41 \cdot 10^3$	$39 \cdot 10^3$	$38 \cdot 10^3$	$36 \cdot 10^3$
$T_{уст}$, hr/yr	6000	6200	6300	6400	6100

Properies	Variant				
	11	12	13	14	15
$N_э$, MW	800	650	550	850	600
N_e^{mn}, MW	33	27	30	23	28
G_0, kg/s	1712	1369	1285	1160	2090
$G_{пв}$, kg/s	1740	1392	1305	1174	2124
$G_{дв}$, kg/s	27	21.6	25	18	33
h_0, kJ/ kg	2779	2770	2760	2780	2765
$h_{пв}$, kJ/ kg	964	960	970	980	985
$h_{дв}$, kJ/ kg	167	160	150	170	175
$\eta_{тр1}$	0,995	0,994	0,992	0,99	0,991
$\eta_{пг}$	0,985	0,983	0,984	0,98	0,981
$\eta_р$	0,99	0,99	0,99	0,99	0,99
$\eta_{тп} \cdot \eta_{пот}$	0,95	0,93	0,96	0,97	0,95
$э_{сн}$, %	5,5	5,9	6,6	6,1	6,0
K, MW·day/ton	$40 \cdot 10^3$	$41 \cdot 10^3$	$39 \cdot 10^3$	$38 \cdot 10^3$	$36 \cdot 10^3$
$T_{уст}$, hr/yr	6500	6000	6200	6300	6000
Properies	Variant				
	16				
$N_э$, MW	900				
N_e^{mn}, MW	15				
G_0, kg/s	1712				
$G_{пв}$, kg/s	1740				
$G_{дв}$, kg/s	27				
h_0, kJ/ kg	2779				
$h_{пв}$, kJ/ kg	964				
$h_{дв}$, kJ/ kg	167				
$\eta_{тр1}$	0,990				
$\eta_{пг}$	0,988				
$\eta_р$	0,99				
$\eta_{тп} \cdot \eta_{пот}$	0,95				
$э_{сн}$, %	6				
K, MW·day/ton	$40 \cdot 10^3$				
$T_{уст}$, hr/yr	6000				