Individual homework assignment 2

"**Determination of the optimal pressure in the condenser of an NPP"**

Condenser of steam turbine plant (Fig. 1) provides pressure behind turbine p_c with the following initial parameters: cooling water input temperature t_{w1}, cooling water flow G_w, steam flow to the condenser D_c.

Material and dimensions $d_o \times \delta_{wall}$ of tubes, number of strokes z for cooling water are known.

Task:

- determine heat exchange surface area F and the main dimensions of the condenser n_{tubes}, L (number and length of tubes).
- with reference to designed condenser determine how the pressure in the condenser changes if the actual flow rate of cooling water is reduced and becomes equal to G'_w.
- Build $t - Q$ - diagram of condenser.

Notes:

- take into account the dependence of the rate w'_w of cooling water in the tubes on the flow rate G'_w;
- cooling water density is assumed to be equal ρ_w=1000 kg/m³;
- average heat capacity of the cooling water equals c_w=4,186 kJ/kg;
- coefficient of contamination of tubes equals a_0=0,65…0,85.

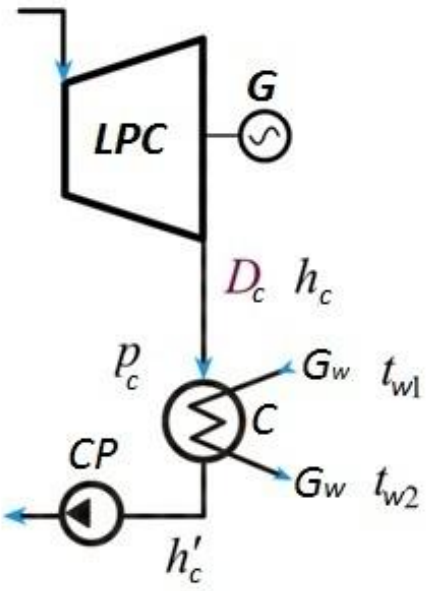

Fig. 1. Simple condensing unit:
LPC – low pressure turbine cylinder; G – generator; C – condenser; CP – condensate pump

Table 1. Source data

Value	Variant							
	1	2	3	4	5	6	7	8
p_c, MPa	0,004	0,0045	0,0043	0,0035	0,003	0,005	0,006	0,004
t_{w1}, ºC	12	13	12	10	6	10	12	8
G_w, kg/s	$5\cdot10^{-3}$	$6\cdot10^{-3}$	$5\cdot10^{-3}$	$6\cdot10^{-3}$	$6\cdot10^{-3}$	$5\cdot10^{-3}$	$4\cdot10^{-3}$	$5\cdot10^{-3}$
D_c, kg/s	120	130	100	100	130	120	105	110
w_w, м/s	1,6	1,7	1,8	1,9	2	1,6	2,2	1,5
d_o, mm	26	25	26	25	27	26	25	32
δ_{wall}, mm	1	1	1	1	1	1	1	1
z	4	6	8	10	8	6	4	6
Material of tubes	brass		stainless steel		titanium		brass	
G'_w, kg/s	$1,2\cdot G_w$		$0,75\cdot G_w$		$0,8\cdot G_w$		$0,6\cdot G_w$	
Value	Variant							
	9	10	11	12	13	14	15	
p_c, MPa	0,003	0,0035	0,004	0,0045	0,005	0,0055	0,006	
t_{w1}, ºC	8	9	10	11	12	13	14	
G_w, kg/s	$5\cdot10^{-3}$	$6\cdot10^{-3}$	$5\cdot10^{-3}$	$6\cdot10^{-3}$	$6\cdot10^{-3}$	$5\cdot10^{-3}$	$6\cdot10^{-3}$	
D_c, kg/s	120	130	100	100	130	120	130	
w_w, м/s	1,5	1,6	1,7	1,8	1,9	2,0	1,9	
d_o, mm	26	25	27	25	28	25	26	
δ_{wall}, mm	1,0	1,2	1,1	1,0	1,2	1,1	1,2	
z	9	10	11	12	13	14	15	
Material of tubes	titan		stainless steel		titan		stainless steel	
G'_w, kg/s	$1,1\cdot G_в$		$0,95\cdot G_в$		$1,15\cdot G_в$		$0,85\cdot G_в$	