LAMPIRAN

Tabel A2. Berbagai ekuivalen berdimensi

Panjang	1 m = 3,2808 ft = 39,37 in
	1 cm = 10^{-2} m = 0.394 in = 0,0328 ft
	1mm = 10^{-3}m
	1 pm = 10^{-6} m
	1A = 10^{-10}m
	1 km =0,621 mil
	1 mi = 5280 ft
Luas	1 m^2 = 10,76 ft^2
	1 cm^2 = 10^{-4} m^2 = 0,155 in^2
Volum	1 gal = 0,13368 ft^3 = 3,785 liter
	1 liter = 10^{-3} m^3
Waktu	1 h=3600 s=60min
	1ms = 10^{-3}s
	1 Ps = 10^{-6} s
	1 ns = 10^{-9} s
Massa	1 kg =1000 g = 2,2046 lbm = 6,8521 x 10^{-2} slug
	1 slug = 1 lbf•s^2/ft = 32,174 lbm
Kakas	1 N = 1 kg•m/s^2
	1 dyn=- 1 g•cm/s^2
	1 lbf = 4,448 x 10^5 dyn = 4,448 N
Energi	1 J= 1 kg-M^2/S^2
	1 Btu= 778,16 ft •lbf = 1,055 x 10^{10} ergs = 252 kal = 1055,0 J
	1 kal = 4,186 J
	1 kkal= 4186 J = 1000 kal
	1 erg = 1 g•cm^2/s^2 = 10^{-7} J
	1eV=1,602x10^{-19}J
	1 Q = 10^{18} Btu = 1,055 x 10^{21} J
	1 Quad = 10^{15} Btu
	1 kJ = 0,947813 Btu = 0,23884 kkal
Daya	1 W= 1 kg•m^2/s^3 = 1 Js
	1 hp- 550 ft • lbf/s
	1 hp = 2545 Btu/h = 746 W
	1kW-1000W=3412 Btu/h
Tekanan	1 atm =14,696 lbf/in^2 = 760 torr = 101325 N/m^2
	1 mm Hg = 0,01934 1bf/in^2 = 1 torr
	1 dyn/cm^2 = 145,(Tx 10^{-1} lbf/in^2
	1 bar = 10^5 N/m^2 = 14,504 lbf/in^2 = 10^6 dyn/cm^2
	1µ=10^{-6}m Hg = 10^{-3} mm Hg
	1 Pa= 1 N/m^2 = 1,4504 x 10^{-4} lbf/in^2
	1 in Hg = 3376,8 N/m^2
	1 in H_20 = 248,8 N/m^2
Daya persatuan luas	1 W/m^2 = 0,3170 Btu/(jam•ft^2)= 0,85984 kkal/(jam•m^2)
Koefisien perpindahan kalor	1 W/(m^2• °C) = 0,1761 Btu/(jam·ft^2 •°F) = 0,85984 kkal/(jam·m^2 •°C)
Energi persatuan massa	1 kJ/kg = 0,4299 Btu/lbm = 0,23884 kkal/kg
Kalor jenis	1 kJ/(kg•°C) = 0,23884 Btu/(lbm• F) = 0,23884 kkal/(kg•°C)
Konduktivitas termal	1 W/(m•°C) = 0,5778 Btu/jam-ft-°F) = 0,85984 kkal/(jam•m•°C)

Tabel C.3 Sifat-sifat cairan jenuh (satuan-satuan SI)

T, °C	ρ, kg/m^3	c_p, J/(kg·K)	ν, m^2/s	k, W/(m·K)	α, m^2/s	Pr	β, K^{-1}
Air, H_2O							
0	1.002,28	4,2178 × 10^3	1,788 × 10^{-6}	0,552	1,308 × 10^{-7}	13,6	
20	1.000,52	4,1818	1,006	0,597	1,430	7,02	0,18 × 10^{-3}
40	994,59	4,1784	0,658	0,628	1,512	4,34	
60	985,46	4,1843	0,478	0,651	1,554	3,02	
80	974,08	4,1964	0,364	0,668	1,636	2,22	
100	960,63	4,2161	0,294	0,680	1,680	1,74	
120	945,25	4,250	0,247	0,685	1,708	1,446	
140	928,27	4,283	0,214	0,684	1,724	1,241	
160	909,69	4,342	0,190	0,680	1,729	1,099	
180	889,03	4,417	0,173	0,675	1,724	1,004	
200	866,76	4,505	0,160	0,665	1,706	0,937	
220	842,41	4,610	0,150	0,652	1,680	0,891	
240	815,66	4,756	0,143	0,635	1,639	0,871	
260	785,87	4,949	0,137	0,611	1,577	0,874	
280	752,55	5,208	0,135	0,580	1,481	0,910	
300	714,26	5,728	0,135	0,540	1,324	1,019	

TABLE A.6 Thermophysical Properties of Saturated Water[a]

Temperature, T (K)	Pressure, p (bars)[b]	Specic Volume (m^3/kg)		Heat of Vaporization, h_g (kJ/kg)	Specic Heat (kJ/kg · K)		Viscosity (N · s/m^2)		Thermal Conductivity (W/m · K)		Prandtl Number		Surface Tension, $\sigma \cdot 10^3$ (N/m)	Expansion Coefficient, $\beta \cdot 10^6$ (K^{-1})	Temperature, T (K)
		$v \cdot 10^3$	v_g		c_p,	$c_{p,g}$	$\mu \cdot 10^6$	$\mu_g \cdot 10^6$	$k \cdot 10^3$	$k_g \cdot 10^3$	Pr	Pr_g			
273.15	0.00611	1.000	206.3	2502	4.217	1.854	1750	8.02	569	18.2	12.99	0.815	75.5	−68.05	273.15
275	0.00697	1.000	181.7	2497	4.211	1.855	1652	8.09	574	18.3	12.22	0.817	75.3	−32.74	275
280	0.00990	1.000	130.4	2485	4.198	1.858	1422	8.29	582	18.6	10.26	0.825	74.8	46.04	280
285	0.01387	1.000	99.4	2473	4.189	1.861	1225	8.49	590	18.9	8.81	0.833	74.3	114.1	285
290	0.01917	1.001	69.7	2461	4.184	1.864	1080	8.69	598	19.3	7.56	0.841	73.7	174.0	290
295	0.02617	1.002	51.94	2449	4.181	1.868	959	8.89	606	19.5	6.62	0.849	72.7	227.5	295
300	0.03531	1.003	39.13	2438	4.179	1.872	855	9.09	613	19.6	5.83	0.857	71.7	276.1	300
305	0.04712	1.005	29.74	2426	4.178	1.877	769	9.29	620	20.1	5.20	0.865	70.9	320.6	305
310	0.06221	1.007	22.93	2414	4.178	1.882	695	9.49	628	20.4	4.62	0.873	70.0	361.9	310
315	0.08132	1.009	17.82	2402	4.179	1.888	631	9.69	634	20.7	4.16	0.883	69.2	400.4	315
320	0.1053	1.011	13.98	2390	4.180	1.895	577	9.89	640	21.0	3.77	0.894	68.3	436.7	320
325	0.1351	1.013	11.06	2378	4.182	1.903	528	10.09	645	21.3	3.42	0.901	67.5	471.2	325
330	0.1719	1.016	8.82	2366	4.184	1.911	489	10.29	650	21.7	3.15	0.908	66.6	504.0	330
335	0.2167	1.018	7.09	2354	4.186	1.920	453	10.49	656	22.0	2.88	0.916	65.8	535.5	335
340	0.2713	1.021	5.74	2342	4.188	1.930	420	10.69	660	22.3	2.66	0.925	64.9	566.0	340
345	0.3372	1.024	4.683	2329	4.191	1.941	389	10.89	664	22.6	2.45	0.933	64.1	595.4	345
350	0.4163	1.027	3.846	2317	4.195	1.954	365	11.09	668	23.0	2.29	0.942	63.2	624.2	350
355	0.5100	1.030	3.180	2304	4.199	1.968	343	11.29	671	23.3	2.14	0.951	62.3	652.3	355
360	0.6209	1.034	2.645	2291	4.203	1.983	324	11.49	674	23.7	2.02	0.960	61.4	697.9	360
365	0.7514	1.038	2.212	2278	4.209	1.999	306	11.69	677	24.1	1.91	0.969	60.5	707.1	365

T (K)	ρ (kg/m^3)	c_p (kJ/kg·K)	$\mu \cdot 10^7$ (N·s/m^2)	$\nu \cdot 10^6$ (m^2/s)	$k \cdot 10^3$ (W/m·K)	$\alpha \cdot 10^6$ (m^2/s)	Pr
Oxygen (O_2) *(continued)*							
350	1.100	0.929	233.5	21.23	29.6	29.0	0.733
400	0.9620	0.942	258.2	26.84	33.0	36.4	0.737
450	0.8554	0.956	281.4	32.90	36.3	44.4	0.741
500	0.7698	0.972	303.3	39.40	41.2	55.1	0.716
550	0.6998	0.988	324.0	46.30	44.1	63.8	0.726
600	0.6414	1.003	343.7	53.59	47.3	73.5	0.729
700	0.5498	1.031	380.8	69.26	52.8	93.1	0.744
800	0.4810	1.054	415.2	86.32	58.9	116	0.743
900	0.4275	1.074	447.2	104.6	64.9	141	0.740
1000	0.3848	1.090	477.0	124.0	71.0	169	0.733
1100	0.3498	1.103	505.5	144.5	75.8	196	0.736
1200	0.3206	1.115	532.5	166.1	81.9	229	0.725
1300	0.2960	1.125	588.4	188.6	87.1	262	0.721
Water Vapor (Steam), $\mathcal{M} = 18.02$ kg/kmol							
380	0.5863	2.060	127.1	21.68	24.6	20.4	1.06
400	0.5542	2.014	134.4	24.25	26.1	23.4	1.04
450	0.4902	1.980	152.5	31.11	29.9	30.8	1.01
500	0.4405	1.985	170.4	38.68	33.9	38.8	0.998
550	0.4005	1.997	188.4	47.04	37.9	47.4	0.993
600	0.3652	2.026	206.7	56.60	42.2	57.0	0.993
650	0.3380	2.056	224.7	66.48	46.4	66.8	0.996
700	0.3140	2.085	242.6	77.26	50.5	77.1	1.00
750	0.2931	2.119	260.4	88.84	54.9	88.4	1.00
800	0.2739	2.152	278.6	101.7	59.2	100	1.01
850	0.2579	2.186	296.9	115.1	63.7	113	1.02

TABLE A.1 *Continued*

Composition	Melting Point (K)	Properties at 300 K				Properties at Various Temperatures (K)									
						k (W/m · K)/c_p (J/kg · K)									
		ρ (kg/m^3)	c_p (J/kg · K)	k (W/m · K)	$\alpha \cdot 10^6$ (m^2/s)	100	200	400	600	800	1000	1200	1500	2000	2500
Titanium	1953	4500	522	21.9	9.32	30.5 300	24.5 465	20.4 551	19.4 591	19.7 633	20.7 675	22.0 620	24.5 686		
Tungsten	3660	19300	132	174	68.3	208 87	186 122	159 137	137 142	125 145	118 148	113 152	107 157	100 167	95 176
Uranium	1406	19070	116	27.6	12.5	21.7 94	25.1 108	29.6 125	34.0 146	38.8 176	43.9 180	49.0 161			
Vanadium	2192	6100	489	30.7	10.3	35.8 258	31.3 430	31.3 515	33.3 540	35.7 563	38.2 597	40.8 645	44.6 714	50.9 867	
Zinc	693	7140	389	116	41.8	117 297	118 367	111 402	103 436						
Zirconium	2125	6570	278	22.7	12.4	33.2 205	25.2 264	21.6 300	20.7 322	21.6 342	23.7 362	26.0 344	28.8 344	33.0 344	

NO	NAMA MATERIAL	*Rho* kg/m*3	*Cv* J/kg°C	*k* J/sec m°C
111	borolite 101 cermet (ZrB_2 93-96, b 4-7)	5300,00	460,20	27,61
112	boron	2500,00	1130,00	2,09
113	boron carbide (B_4C) (dense)	2400,00	920,50	28,45
114	boron carbide (B_4C) (porous)	2000,00	920,50	17,15
115	boron nitride (BN) (perp pr axis, 95 d)	2100,00	795,00	32,84
116	boron nitride. (BN) (prs axis, 94 d)	2100,00	795,00	20,92
117	boron nitride (BN 80, c 20) (prs axis)	1620,00	795,00	19,04
118	boron nitride (BN 97, BN_2O_3 2) (perp p)	2100,00	795,00	28,87
119	boron nitride (BN 97, BN_2O_3 2) (prs ax)	2100,00	795,00	15,06
120	boron silicide (B_4Si)	2460,00	1046,00	9,83
121	brass, aluminum (Cu76, Zn22, Al2)	8600,00	376,60	100,42
122	brass, cartridge (Cu70, Zn30)	8570,00	418,40	100,42
123	brass, leaded	8500,00	376,60	117,15
124	brass, muntz metal	8400,00	376,60	125,52
125	brass, red, cast (Cu85, Zn5, Pb5, Sn3)	8750,00	376,60	71,97
126	brass, red, wrought (Cu85, Zn 15)	8750,00	376,60	146,44
127	brass, tin (naval and admiralty)	8460,00	376,60	112,97
128	brass, yellow (Cu65, Zrl35)	8470,00	376,60	117,15
129	brick, dirome (Cr_2O_3 32)	3200,00	627,60	1,17
130	brick, chrome magnesite (see ref 47)	3000,00	753,10	2,09
131	brick, diatomaceous earth (accr strata)	440,00	795,00	0,09
132	brick, diatomaceous earth (high burn)	590,00	795,00	0,23
133	brick, diatomaceous earth (molded, frd)	610,00	795,00	0,24

1 Technical Specification

Condenser

(1) Special Data

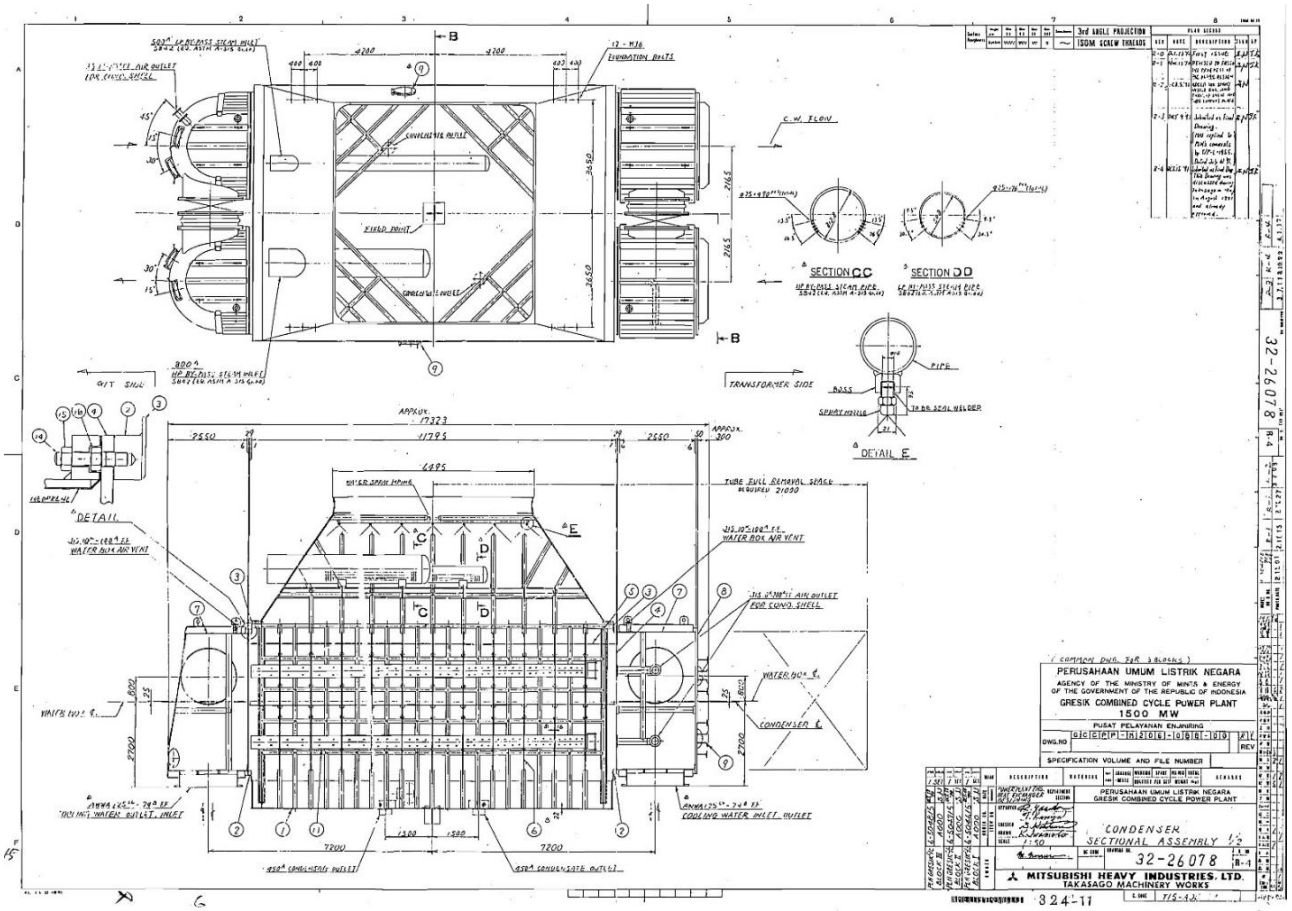
Quantity	1
Type	Radial flow surface cooling
cooling surface area	14,150 m^2
Cooling water flow	46,070 m^3/hr
Inlet cooling water temperature	30℃
Vacuum	697 mmHg
Number of passes	1
Cooling water velocity in tubes	2.1 m/s
Tubes:	
Diameter	25.0 mm
Thickness	1.25 mm/0.5 mm
Number	14,636/636
Effective length	11,797 mm
Material	Aluminum brass (Air cooling zone: Titanium)
Dissolved oxygen content in the condensate	less than 0.01 cm^3/litre

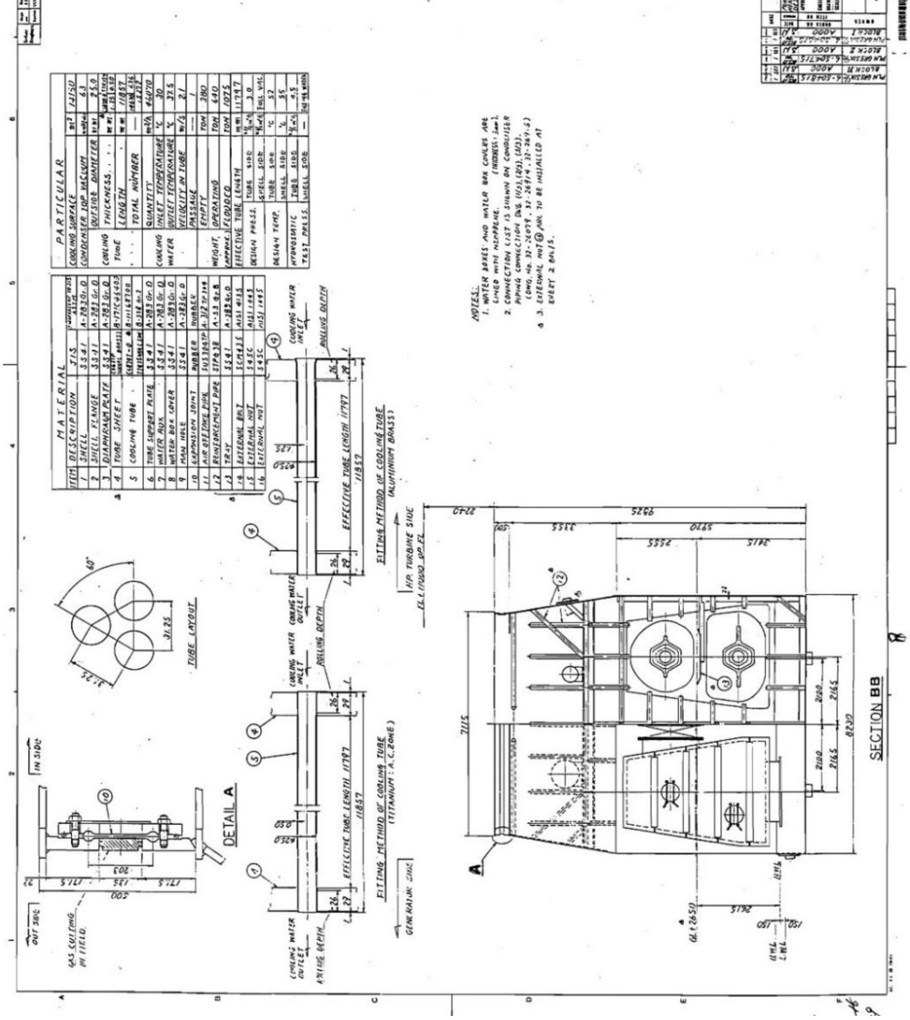
(2) Design Considerations

The condenser has been designed in accordance with the standards of the Heat Exchange Institute with a cleanliness factor of 0.85.

Materials of all components are carefully selected in order to minimize damage due to corrosion and erosion.

The condenser has been designed to accept 730 t/hr of steam from a HP turbine by-pass system and 136.5 t/hr of steam from a LP turbine by-pass system.


SECTION CC
SECTION DD
DETAIL
DETAIL E
TRANSFORMER SIDE
GIT SIDE
PERUSAHAAN UMUM LISTRIK NEGARA
GRESIK COMBINED CYCLE POWER PLANT
1500 MW
CONDENSER
SECTIONAL ASSEMBLY 1/2
32-26078
MITSUBISHI HEAVY INDUSTRIES, LTD.
TAKASAGO MACHINERY WORKS


PERUSAHAAN UMUM LISTRIK NEGARA
GRESIK COMBINED CYCLE POWER PLANT
1500 MW
CONDENSER
SECTIONAL ASSEMBLY 2/2
32-26913
MITSUBISHI HEAVY INDUSTRIES, LTD.
TAKASAGO MACHINERY WORKS
3.2.4-12
MATERIAL
PARTICULAR
NOTES:
DETAIL A
TUBE LAYOUT
SECTION BB