

LAMPIRAN

Tabel A2. Berbagai ekuivalen berdimensi

Panjang	$1 \text{ m} = 3,2808 \text{ ft} = 39,37 \text{ in}$ $1 \text{ cm} = 10^{-2} \text{ m} = 0,394 \text{ in} = 0,0328 \text{ ft}$ $1 \text{ mm} = 10^{-3} \text{ m}$ $1 \text{ pm} = 10^{-6} \text{ m}$ $1 \text{ \AA} = 10^{-10} \text{ m}$ $1 \text{ km} = 0,621 \text{ mil}$ $1 \text{ mi} = 5280 \text{ ft}$
Luas	$1 \text{ m}^2 = 10,76 \text{ ft}^2$ $1 \text{ cm}^2 = 10^{-4} \text{ m}^2 = 0,155 \text{ in}^2$
Volum	$1 \text{ gal} = 0,13368 \text{ ft}^3 = 3,785 \text{ liter}$ $1 \text{ liter} = 10^{-3} \text{ m}^3$
Waktu	$1 \text{ h} = 3600 \text{ s} = 60 \text{ min}$ $1 \text{ ms} = 10^{-3} \text{ s}$ $1 \text{ Ps} = 10^6 \text{ s}$ $1 \text{ ns} = 10^{-9} \text{ s}$
Massa	$1 \text{ kg} = 1000 \text{ g} = 2,2046 \text{ lbm} = 6,8521 \times 10^{-2} \text{ slug}$ $1 \text{ slug} = 1 \text{ lbf} \cdot \text{s}^2 / \text{ft} = 32,174 \text{ lbm}$
Kakas	$1 \text{ N} = 1 \text{ kg} \cdot \text{m} / \text{s}^2$ $1 \text{ dyn} = 1 \text{ g} \cdot \text{cm} / \text{s}^2$ $1 \text{ lbf} = 4,448 \times 10^5 \text{ dyn} = 4,448 \text{ N}$
Energi	$1 \text{ J} = 1 \text{ kg} \cdot \text{m}^2 / \text{s}^2$ $1 \text{ Btu} = 778,16 \text{ ft} \cdot \text{lbf} = 1,055 \times 10^{10} \text{ ergs} = 252 \text{ kal} = 1055,0 \text{ J}$ $1 \text{ kal} = 4,186 \text{ J}$ $1 \text{ kkal} = 4186 \text{ J} = 1000 \text{ kal}$ $1 \text{ erg} = 1 \text{ g} \cdot \text{cm}^2 / \text{s}^2 = 10^{-7} \text{ J}$ $1 \text{ eV} = 1,602 \times 10^{-19} \text{ J}$ $1 \text{ Q} = 10^{19} \text{ Btu} = 1,055 \times 10^{21} \text{ J}$ $1 \text{ Quad} = 10^{15} \text{ Btu}$ $1 \text{ kJ} = 0,947813 \text{ Btu} = 0,23884 \text{ kkal}$
Daya	$1 \text{ W} = 1 \text{ kg} \cdot \text{m}^2 / \text{s}^3 = 1 \text{ Js}$ $1 \text{ hp} = 550 \text{ ft} \cdot \text{lbf} / \text{s}$ $1 \text{ hp} = 2545 \text{ Btu} / \text{h} = 746 \text{ W}$ $1 \text{ kW} = 1000 \text{ W} = 3412 \text{ Btu} / \text{h}$
Tekanan	$1 \text{ atm} = 14,696 \text{ lbf} / \text{in}^2 = 760 \text{ torr} = 101325 \text{ N} / \text{m}^2$ $1 \text{ mm Hg} = 0,01934 \text{ lbf} / \text{in}^2 = 1 \text{ torr}$ $1 \text{ dyn} / \text{cm}^2 = 145,7 \times 10^{-7} \text{ lbf} / \text{in}^2$ $1 \text{ bar} = 10^5 \text{ N} / \text{m}^2 = 14,504 \text{ lbf} / \text{in}^2 = 10^6 \text{ dyn} / \text{cm}^2$ $1 \mu = 10^{-6} \text{ m Hg} = 10^{-3} \text{ mm Hg}$ $1 \text{ Pa} = 1 \text{ N} / \text{m}^2 = 1,4504 \times 10^{-4} \text{ lbf} / \text{in}^2$ $1 \text{ in Hg} = 3376,8 \text{ N} / \text{m}^2$ $1 \text{ in H}_2\text{O} = 248,8 \text{ N} / \text{m}^2$
Daya persatuan luas	$1 \text{ W} / \text{m}^2 = 0,3170 \text{ Btu} / (\text{jam} \cdot \text{ft}^2) = 0,85984 \text{ kkal} / (\text{jam} \cdot \text{m}^2)$
Koefisien perpindahan kalor	$1 \text{ W} / (\text{m}^2 \cdot ^\circ\text{C}) = 0,1761 \text{ Btu} / (\text{jam} \cdot \text{ft}^2 \cdot ^\circ\text{F}) = 0,85984 \text{ kkal} / (\text{jam} \cdot \text{m}^2 \cdot ^\circ\text{C})$
Energi persatuan massa	$1 \text{ kJ} / \text{kg} = 0,4299 \text{ Btu} / \text{lbm} = 0,23884 \text{ kkal} / \text{kg}$
Kalor jenis	$1 \text{ kJ} / (\text{kg} \cdot ^\circ\text{C}) = 0,23884 \text{ Btu} / (\text{lbm} \cdot ^\circ\text{F}) = 0,23884 \text{ kkal} / (\text{kg} \cdot ^\circ\text{C})$
Konduktivitas termal	$1 \text{ W} / (\text{m} \cdot ^\circ\text{C}) = 0,5778 \text{ Btu} / (\text{jam} \cdot \text{ft} \cdot ^\circ\text{F}) = 0,85984 \text{ kkal} / (\text{jam} \cdot \text{m} \cdot ^\circ\text{C})$

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

$T, ^\circ\text{C}$	$\rho, \text{kg/m}^3$	$c_p, \text{J}/(\text{kg}\cdot\text{K})$	$\nu, \text{m}^2/\text{s}$	$k, \text{W}/(\text{m}\cdot\text{K})$	$\alpha, \text{m}^2/\text{s}$	Pr	β, K^{-1}
<i>Air, H₂O</i>							
0	1,002,28	4,2178 × 10 ³	1,788 × 10 ⁻⁶	0,552	1,308 × 10 ⁻⁷	13,6	0,18 × 10 ⁻³
20	1,000,52	4,1818	1,006	0,597	1,430	7,02	
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)	Specific Pressure, p (bars) ^b		Specific Volume (m ³ /kg)		Heat of Vaporization, h_g (kJ/kg)		Specific 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 Coef., $\beta \cdot 10^6$ (K ⁻¹)		Temperature, T (K)
	$v_f \cdot 10^3$	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	$\sigma \cdot 10^3$	$\beta \cdot 10^6$							
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 (O₂) (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), $M = 18.02$ 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)									
		ρ (kg/m ³)	c_p (J/kg · K)	k (W/m · K)	$\alpha \cdot 10^6$ (m ² /s)	k (W/m · K)/ c_p (J/kg · K)									
						100	200	400	600	800	1000	1200	1500	2000	2500
Titanium	1953	4500	522	21.9	9.32	30.5	24.5	20.4	19.4	19.7	20.7	22.0	24.5		
Tungsten	3660	19300	132	174	68.3	300	465	551	591	633	675	620	686		
Uranium	1406	19070	116	27.6	12.5	21.7	25.1	29.6	34.0	38.8	43.9	49.0			
Vanadium	2192	6100	489	30.7	10.3	35.8	31.3	31.3	33.3	35.7	38.2	40.8	44.6	50.9	
Zinc	693	7140	389	116	41.8	117	118	111	103	540	563	597	645	714	867
Zirconium	2125	6570	278	22.7	12.4	33.2	25.2	21.6	20.7	21.6	23.7	26.0	28.8	33.0	
						205	264	300	322	342	362	344	344	344	

NO	NAMA MATERIAL	<i>Rho</i>	<i>Cv</i>	<i>k</i>
		kg/m ³	J/kg°C	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 ₄ C) (dense)	2400,00	920,50	28,45
114	boron carbide (B ₄ C) (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 ₂ O ₃ 2) (perp p)	2100,00	795,00	28,87
119	boron nitride (BN 97, BN ₂ O ₃ 2) (prs ax)	2100,00	795,00	15,06
120	boron silicide (B ₄ Si)	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 ₂ O 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°C
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.

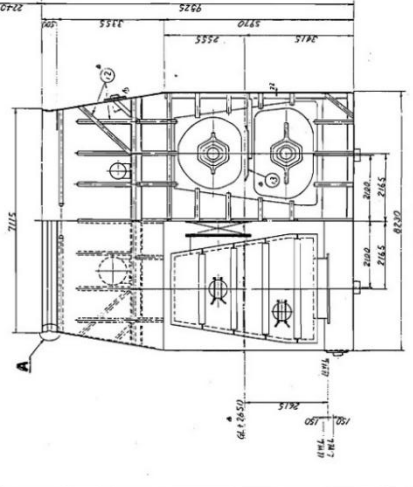
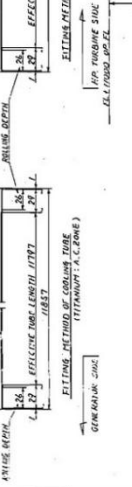
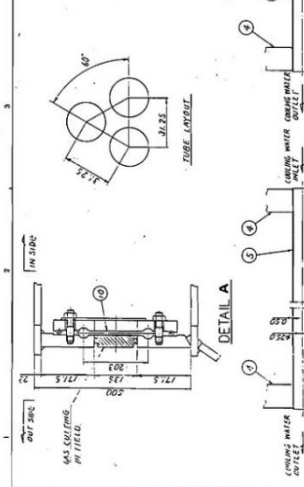
Materials of all components are carefully selected in order to minimize damage due to corrosion and erosion.

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.

NO	DATE	REVISION
1	11/11/55	ASSEMBLY DRAWING
2	11/11/55	REVISION
3	11/11/55	REVISION
4	11/11/55	REVISION
5	11/11/55	REVISION
6	11/11/55	REVISION
7	11/11/55	REVISION
8	11/11/55	REVISION
9	11/11/55	REVISION
10	11/11/55	REVISION
11	11/11/55	REVISION
12	11/11/55	REVISION
13	11/11/55	REVISION
14	11/11/55	REVISION
15	11/11/55	REVISION
16	11/11/55	REVISION
17	11/11/55	REVISION
18	11/11/55	REVISION
19	11/11/55	REVISION
20	11/11/55	REVISION

MATERIAL		PARTICULAR	
1	6061 ALUMINUM SHEET	1	CONDUIT
2	3/4" DIA. STAINLESS STEEL PIPE	2	CONDUIT
3	3/4" DIA. STAINLESS STEEL PIPE	3	CONDUIT
4	3/4" DIA. STAINLESS STEEL PIPE	4	CONDUIT
5	3/4" DIA. STAINLESS STEEL PIPE	5	CONDUIT
6	3/4" DIA. STAINLESS STEEL PIPE	6	CONDUIT
7	3/4" DIA. STAINLESS STEEL PIPE	7	CONDUIT
8	3/4" DIA. STAINLESS STEEL PIPE	8	CONDUIT
9	3/4" DIA. STAINLESS STEEL PIPE	9	CONDUIT
10	3/4" DIA. STAINLESS STEEL PIPE	10	CONDUIT
11	3/4" DIA. STAINLESS STEEL PIPE	11	CONDUIT
12	3/4" DIA. STAINLESS STEEL PIPE	12	CONDUIT
13	3/4" DIA. STAINLESS STEEL PIPE	13	CONDUIT
14	3/4" DIA. STAINLESS STEEL PIPE	14	CONDUIT
15	3/4" DIA. STAINLESS STEEL PIPE	15	CONDUIT
16	3/4" DIA. STAINLESS STEEL PIPE	16	CONDUIT
17	3/4" DIA. STAINLESS STEEL PIPE	17	CONDUIT
18	3/4" DIA. STAINLESS STEEL PIPE	18	CONDUIT
19	3/4" DIA. STAINLESS STEEL PIPE	19	CONDUIT
20	3/4" DIA. STAINLESS STEEL PIPE	20	CONDUIT

MATERIAL		PARTICULAR	
1	6061 ALUMINUM SHEET	1	CONDUIT
2	3/4" DIA. STAINLESS STEEL PIPE	2	CONDUIT
3	3/4" DIA. STAINLESS STEEL PIPE	3	CONDUIT
4	3/4" DIA. STAINLESS STEEL PIPE	4	CONDUIT
5	3/4" DIA. STAINLESS STEEL PIPE	5	CONDUIT
6	3/4" DIA. STAINLESS STEEL PIPE	6	CONDUIT
7	3/4" DIA. STAINLESS STEEL PIPE	7	CONDUIT
8	3/4" DIA. STAINLESS STEEL PIPE	8	CONDUIT
9	3/4" DIA. STAINLESS STEEL PIPE	9	CONDUIT
10	3/4" DIA. STAINLESS STEEL PIPE	10	CONDUIT
11	3/4" DIA. STAINLESS STEEL PIPE	11	CONDUIT
12	3/4" DIA. STAINLESS STEEL PIPE	12	CONDUIT
13	3/4" DIA. STAINLESS STEEL PIPE	13	CONDUIT
14	3/4" DIA. STAINLESS STEEL PIPE	14	CONDUIT
15	3/4" DIA. STAINLESS STEEL PIPE	15	CONDUIT
16	3/4" DIA. STAINLESS STEEL PIPE	16	CONDUIT
17	3/4" DIA. STAINLESS STEEL PIPE	17	CONDUIT
18	3/4" DIA. STAINLESS STEEL PIPE	18	CONDUIT
19	3/4" DIA. STAINLESS STEEL PIPE	19	CONDUIT
20	3/4" DIA. STAINLESS STEEL PIPE	20	CONDUIT



NOTES:
 1. WATER PUMP AND WATER RES. CAPACITY NOT SHOWN.
 2. CONNECTION LIST IS SHOWN ON CONDENSER DRAWING SHEET NO. 32-26913 R-5.
 3. EXTERNAL WTS. TO BE INSTALLED AT EVERY 2 BAYS.

PERUSAHAAN UNIM LISTRIK NEGARA
 PT. PALM OIL & CO. LTD.
 GREEN COMBINED CYCLE POWER PLANT
 PAKSI KELAPA BANGSAL
 PERAK
 MALAYSIA

CONDENSER
 SECTIONAL ASSEMBLY 32-26913 R-5
 J. MITSUBISHI HEAVY INDUSTRIES, LTD.
 2-2-1, YAMAGUCHI-KU, KOBAYASHI-KU, TOKYO, JAPAN