BAB X
PENUTUP

10.1 Kesimpulan

Dari hasil perancangan mesin kapal Container 288 TEUs didapatkan hasil sebagai berikut :

- Panjang Seluruhnya Loa : 95,90 m
- Pajang Antara Garis Air Lwl : 91,64 m
- Panjang Garis Tegak Lpp : 89,00 m
- Lebar Kapal B : 15,20 m
- Tinggi Kapal H : 7,20 m
- Sarat Air Kapal T : 5,65 m
- Kecepatan Dinas : 12 Knot
- Jarak pelayaran : 1140 mil laut

Motor penggerak utama dipilih mesin diesel empat langkah sebagai berikut :

- Merk : MAN B&W
- Tipe : S26MC6
- Daya : 2720 HP / 2000 KW
- Putara Mesin : 250 RPM
- SFOC : 181 gr/HP/jam
- Cylinders : 9

Motor bantu

- Merk : Yanmar
- Tipe : 6 HCHL-HTNA
- Daya motor : 250 KW
- Cylinder : 130 mm x 165 mm
- RPM : 1200 rpm
- Jumlah : 2 unit

1. Dalam perancangan kamar mesin tidak lepas dari adanya nilai-nilai asumsi yang digunakan untuk mempermudah perhitungan perancangangan mesin dengan tidak melupakan peraturan peraturan standar dari kaidah perhintungan mesin kapal. Sehingga di dapatkan nilai yang mendekati keadaan yang sebenarnya.
2. Dari penentuan mesin kapal didapat kesimpulan bahwa pemilihan motor induk haruslah sangat spesifik dikarenakan adanya pemikiran untuk peletakan mesin dan juga untuk kebutuhan perhitungan sistem pelayanan induk.
3. Dalam perancangan mesin kapal, didapatkan bahwa perhitungan sistem pelayanan motor induk harus memperhatikan kebutuhan motor induk tersebut. Sehingga mendapatkan keefektifan dalam penggunaan listrik dan bahan bakar.

10.2 Saran

Setelah mengerjakan tugas perancangan mesin kapal ini banyak pengalaman dan pelajaran yang didapat dan dapat dijadikan pelajaran agar nantinya dapat melakukan perancangan lebih efektif yakni :

1. Perlunya disesuaiakan antara mata kuliah dengan perancangan dan yang nanti akan digunakan di dunia kerja kelak karena selama ini yang didapatkan selama perkuliahan hanya bagian kecilnya saja belum menyeluruh secara garis besarnya, sehingga ini menyulitkan dalam perancangan.
2. Agar mahasiswa dibekali dengan pengetahuan umum tentang perancangan selama masa kuliah agar nantinya bisa menjadi pondasi ketika sudah memulai tugas perancangan.
3. Mahasiswa agar disediakan panduan dan regulasi yang jelas untuk tugas perancangan apa yang harus dan tidak dikerjakan, hal ini untuk mempermudah dalam perancangan dan agar serupa dan tidak terjadi ketidak sesuaian satu dengan yang lainnya.
4. Perlu adanya kedekatan yang lebih antara mahasiswa dengan dosen pembimbing untuk pengarahan perhitungan mesin kapal ini.

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DAFTAR NOTASI

Tabulasi berikut menunjukkan simbol yang digunakan pada tugas merancang kapal ini. Karena huruf terbatas, kadang kala huruf yang sama digunakan untuk menyatakan lebih dari satu konsep.

a	: Jumlah maksimum block diantara Davit Guide roller dan WinchHead.
A	: Luas pandangan samping lambung kapal (m^2), luas daun kemudi.
α	: Sudut putar daun kemudi.
a_o	: Jarak gading – gading (mm).
A_{rudder}	: Luas daun kemudi (m^2).
Am	: Luas penampang melintang tengah kapal (m^2).
Awl	: Luas bidang garis air (m^2).
b	: Lebar daun kemudi (m).
B	: Lebar kapal, lebar tangki (m).
BHP	: Brake Horse Power (HP).
B/T	: Perbadingan lebar dan sarat kapal.
Bp	: Koefisien baling-baling dengan diagram Bp-δ.
c	: Lebar daun kemudi dalam (m), jumlah minimum block.
C_A	: Koefisien penambahan hambatan untuk korelasi model - kapal.
C_{AA}	: Koefisien hambatan udara.
C_{AS}	: Koefisien hambatan kemudi.
Cb	: Koefisien blok.
C_F	: Koefisien hambatan gesek.
C_{fwc}	: Kebutuhan air tawar untuk pendinginan motor induk.
C_{fwd}	: Kebutuhan air tawar untuk makan dan minum.
C_{fww}	: Kebutuhan air tawar untuk cuci dan mandi.
C_m	: Koefisien tengah kapal.
C_P	: Koefisien prismatik memanjang.
C_R	: Koefisien hambatan sisa; Gaya pada daun kemudi.
C_T	: Koefisien hambatan total.
Cw	: Koefisien garis air kapal.
C_1	: Faktor untuk kapal.
C_2	: Faktor untuk kemudi.
C_3	: Faktor untuk profile kemudi.
C_4	: Faktor untuk perencanaan kemudi.

V_a	: Kecepatan maju baling-baling (knot).
V_b	: Kecepatan aliran masuk ke pompa.
V_{ca}	: Kandungan CO_2 tiap m^3 udara luar yang masuk ruangan.
$V_{do\ AE}$	: Volume bahan bakar motor bantu (m^3).
V_{db}	: Volume total tangki ballast (m^3).
Ve	: Kecepatan air masuk ke baling – baling (m/dtk).
V_{fo}	: Volume bahan bakar motor induk (m^3).
V_h	:Volume langkah torak tiap – tiap silinder (dm^3), volume tangki Hydrophore (m^3)
V_{lo}	: Volume tangki minyak lumas (m^3).
V_o	: Volume fluida sisa (m^3).
V_r	:Kandungan maksimum CO_2 yang dihasilkan dari ruangan (lt/m^3), kecepatan penurunan sekoci.
V_{rc}	: Volume CO_2 yang dihasilkan tiap – tiap m^3 dari ruangan (lt/m^3).
Vs	: Kecepatan kapal (knot, m/dt), kecepatan aliran dalam pipa.
V_{setl}	: Volume tangki settling (m^3).
V_{serv}	: Volume tangki service (m^3).
∇_{Displ}	: Volume Displacement dalam (m^3).
V_w	: Kecepatan tarik capstan (m/s).
w	: Faktor arus ikut Taylor.
W_{fo}	: Berat bahan bakar (ton).
W_{fw}	: Berat air tawar (ton).
W_{fwc}	: Berat air untuk pendinginan motor (ton).
W_{fwd}	: Berat air tawar untuk makan dan minum (ton).
W_{fww}	: Berat air tawar untuk cuci dan mandi (ton).
W_{lo}	: Berat minyak pelumas (ton).
W_{fwd}	: Kebutuhan air tawar untuk makan dan minum (ton).
Z	: Angka petunjuk untuk jangkar, jumlah daun baling-baling, jumlah silinder motor induk.
Z_c	: Jumlah ABK.

Q	: Kapasitas kompresor, beban tambahan akibat tenaga kinetic.
Q_b	:Berat penuh rigged boat, kapasitas pompa bilga, kapasitas pompa ballast.
Q_{displ}	: Koefisien Prismatic displacement.
Q_r	: Momen torsi motor penggerak/daun kemudi.
Q_p	: Berat total penumpang.
Q_{pk}	: Kapasitas pompa pemadam kebakaran.
Q_u	: Kapasitas udara kamar mesin.
R	: Jari-jari propeller, radius pelayaran.
R_{AA}	: Hambatan udara (kg).
R_{br}	: Tegangan putus tali (kg/m^2).
R_F	: Hambatan gesek (kg).
Re	: Angka Reynolds (Aliran laminar).
ρ	: Massa density 104,49 kg S^2/m^3.
ρ_u	: Massa density udara.
R_m	: Kekuatan tarik material (N/mm^2).
R_n	: Reynolds number.
R_r	: Hambatan sisa (kg).
R_T	: Hambatan total (kg).
S	: Luas permukaan basah badan kapal (m^2).
S^l	: Permukaan basah badan dan anggota badan kapal sepanjang garis air (m^2).
SFC	: Spesific fuel oil consumption (g/kW.h).
SHP	: Shaft Horse Power (HP).
σ_v	: Angka kavitasi.
$\sigma_{0,7}$	: Konstanta kavitasi (0,7 R).
T	:Sarat kapal, lambung timbul untuk tropical load line (m), gaya dorong(kg).
t	:Tebal pelat dalam (mm), faktor pengisapan Taylor, lamanya pelayaran.
τ	: koefisien gaya dorong.
T_{cl}	: Gaya tarik pada cable lifter.
T_{max}	: Tegangan maksimum dari winch head.
T_{min}	: Tegangan minimum dari winch head.
T_W	: Tegangan putus tali.

F	: Faktor untuk instalasi propulsi (Disk Area of Screw).
F_{disk}	:Area of the screw (m^2), letak lambung timbul untuk fresh water, loadline.
F_a	: Developed blade area (m^2).
F_a/F	: Blade area ratio propeller.
Fn	: Angka froude
F_P	: Fore perpendicular (garis tegak haluan).
F_p	: Projected area of the blades (m^2).
g	: Gaya gravitasi 9,81 m/dt^2.
G_a	: Berat jangkar (kg).
γ	: Berat jenis air laut 1,025 t/m^3.
γ_{fo}	: Berat jenis bahan bakar 0,9 ton/m^3.
H	: Jarak ordinat (Lpp/station), tinggi bangunan atas, tinggi centre girder, tinggi efektif diukur dari garis muat sampai puncak teratas rumah geladak dalam (m), deck load (beban geladak) kN/m^2.
H	: Tinggi kapal (m).
H_a	: Head statis total (m).
H_{lf}	: Head loss karena pipa hisap (m).
H_{li}	: Head loss karena peralatan pipa hisap (m).
H_{rudder}	: Tinggi daun kemudi (m).
H_t	: Head total.
Ho/D	: Pitch ratio baling-baling.
i_a	: Ratio mekanisme gigi.
i_{bw}	: Perbandingan putaran motor dan putaran winch head.
J	: Kapasitas total bejana (dm^3).
k	: Faktor tipe dari poros.
k_r	: Faktor bahan tergantung dari kekuatan tarik.
k_{re}	: Jumlah penggantian udara supply/exhaust.
k_t	: Koefisien tergantung daya dorong.
k_1	: Koefisien luas daun kemudi.
k_2	: Koefisien profile / model kemudi.
k_3	: Koefisien letak daun kemudi.
L	: Jarak memanjang tangki, panjang ruangan (m), berat barang bawaan (kg).

d	: Diameter poros dalam (m), diameter rantai (inch).
D	: Displasemen kapal (ton), volume rata-rata pemakaian air, diameter silinder mesin.
d_b	: Diameter pipa ballast.
D_{cl}	: Diameter efektif cable lifter (mm).
D_{BT}	: Diameter Bow Trushter.
D_h	: Diameter pipa utama (mm), diameter winch head.
Do	: Diameter optimum baling-baling (m).
D_{prop}	: Diameter baling-baling (m).
D_t	: Diameter tongkat kemudi (mm).
D_T	: Diameter Tentativ.
d_w	: Diameter tali tambat (mm).
D_{we}	: Diameter penggerak tali.
d_z	: Diameter pipa cabang (mm).
Δ	: Displasemen kapal (ton).
Δ_p	: Head perbedaan tekanan (bar).
δ_K	: Koreksi Advance Coefficient
EHP	: Efektif Horse Power (HP).
η_a	: Efisiensi mekanis dengan spin gear.
η_{bw}	: Efisiensi boat winch.
η_{cl}	: Efisiensi cable lifter.
η_f	: Efisiensi alat penurunan sekoci.
η_g	: Efisiensi generator.
η_H	: Efisiensi badan kapal (1 - t) / (1 - w).
η_o	: Efisiensi baling-baling dari percobaan model.
η_p	: Efisiensi baling-baling.
η_r	: Efisiensi untuk davit guide roller.
η_{rr}	: Efisiensi rotary relatif.
η_s	: Efisiensi untuk snatch block.
η_{sg}	: Efisiensi untuk electric steering gear.
η_w	: Efisiensi dari sistem transmisi.
ε	:Koefisien yang tergantung pada perbandingan diameter block dengan diameter penjatuh tackle.

L_a	: Panjang rantai jangkar yang menggantung (m).
λ	: Koefisien gesek pipa.
LCB	: Jarak/letak titik tekan memanjang dari tengah kapal (m).
LOA	: Length over all (panjang keseluruhan) (m).
LPP	: Length between perpendicular (panjang antara garis tegak) (m).
LWL	: Length water line (panjang garis air dalam) (m).
$L/\nabla^{1/3}$	: Rasio panjang - displasemen.
$\dot{m}$	: Jumlah total block pada alat penurunan sekoci.
M_{cl}	: Momen putar pada cable lifter (kg.m).
M_m	: Momen putar pada poros motor (kg.cm), torsi pada penggulung.
M_{mb}	: Torsi pada motor listrik.
M_h	: Torsi pada poros winch head.
n	: Jumlah station, putaran baling-baling per detik (rps).
n_m	: Putaran motor untuk electric windlass.
n_h	: Putaran pada winch head.
N_k	: Koreksi Putaran baling-baling (rpm).
N_e	: Daya efektif windlass/Capstan (HP).
N_{eu}	: Daya pada sistem supply/exhaust.
N_m	: Daya motor penggerak (HP).
N_{rs}	: Putaran motor penggerak.
N_W	: Putaran poros penggulung tali (rpm).
P_o - e	: Tekanan statik pada sumbu baling-baling (lbs/sg.ft).
P	: Berat rata-rata ABK (kg), tekanan discharge.
P_a	: Berat rantai jangkar pada saat bergerak (kg/mm).
P_B	: Brake Horse Power (HP).
P_C	: Propulsive coefisient.
P_m	: Tekanan maksimum dalam tangki (m^3/jam).
P_{maks}	: Daya maksimum dari pemakaian beban (kW).
P_{me}	: Tekanan kerja effektif silinder (bar).
P_n	: Gaya yang bekerja pada daun kemudi (kg).
P_o	: Tekanan minimum dalam tangki (kg/m^3).
P_S	: Shaft Horse Power (HP).
P_W	: Tenaga winch yang dibutuhkan tegangan tali.
φ_h	: Head factor.

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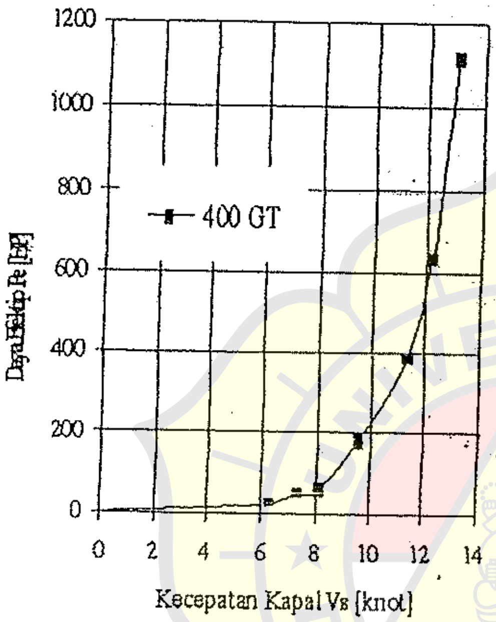
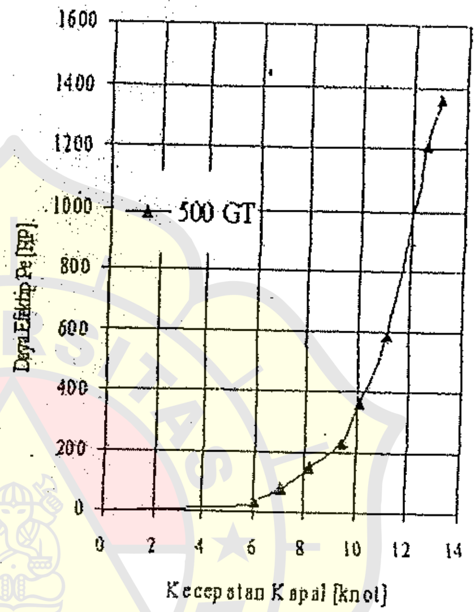
Tabel-8.4 Hasil *Resistance Test* Kapal *Ferry* Ro-Ro 500 G/T (September 1990)[4]

Run no.	v_M [m/dt]	Fr	V_s [m/dt]	V_s [knot]	R_{TM} [N]	C_{TM} x10^{-3}	C_{TS} x10^{-3}	R_{TS} [kN]	*Effective Power* P_E [HP]
1	0.6949	0,1554	3,1078	6,0416	1,6520	4,8690	2,6181	7,2931	30,8254
2	0,8165	0,1825	3,6514	7,0984	2,8347	6,0526	3,8944	14,9751	74,3654
3	0,9421	0,2106	4,2133	8,1907	4,4490	7,1346	5,0545	25,8780	148,2844
4	1,0781	0,2410	4,8215	9,3729	5,9271	7,2585	5,2484	35,1875	230,7311
5	1,1567	0,2586	5,1729	10,0562	8,0898	8,6065	6,6317	51,1806	360,0663
6	1,2796	0,2861	5,7225	11,1245	11,3947	9,9060	7,9804	75,3698	586,5702
7	1,4404	0,3220	6,4416	12,5225	19,5207	13,3927	11,5228	137,8955	1208,0451
8	1,4944	0,3341	6,6833	12,9923	21,0922	13,4431	11,5901	149,3042	1357,0697



Gb.8.3b Kurva P_E – Vs *Ferry* Ro-Ro prototipe 400 GT



Gb.8.3c Kurva P_E – Vs *Ferry* Ro-Ro prototipe 500 GT

Dari teori Propulsi diketahui, daya yang dibutuhkan masing-2 poros baling-2 *Shaft Horse Power* SHP [HP] atau *Shaft Power* P [kW] terkait dengan daya efektip P_E untuk suatu kecepatan kapal Vs adalah sbb.:

- kapal berbaling-baling tunggal (*single screw*) : $P = P_E \cdot (P.C)^{-1}$
- kapal berbaling-baling ganda (*twin screw*) : $P = ½\ P_E \cdot (P.C)^{-1}$

dimana :

P.C = *propulsive coefficient* (= *total propulsive efficiency*) dari kapal ;

Dalam praktek biasanya diberikan tambahan yakni *service allowance* atau juga disebut *load fraction* = *x* , sehingga formulasi menjadi sbb.: :

- kapal *single screw* : $P = P_E\,(1 + x)\,.\,(P.C)^{-1}$
- kapal *twin screw* : $P = ½\ P_E\,(1 + x)\,.\,(P.C)^{-1}$

Adapun daya yang diberikan kepada baling-2 yakni *Delivered Shaft Horse Power* disingkat *Delivered Horse Power* DHP [HP] atau P_D [kW] , rumusannya adalah sbb. :

- kapal berbaling-baling tunggal (*single screw*) : $P_D = P_E \cdot (\eta_D)^{-1}$
- kapal berbaling-baling ganda (*twin screw*) : $P_D = ½\ P_E \cdot (\eta_D)^{-1}$

dimana :

η_D = *propulsive efficiency* (= *quasi propulsive coefficient* = QPC) dari kapal ;

Adapun harga P.C didapatkan dari formulasi :

$$P.C = \eta_H \cdot \eta_O \cdot \eta_{RR} = \eta_H \cdot \eta_P$$

dimana :

η_H = efisiensi badan kapal (*hull efficiency*) = (1 – w) / (1 – t)
w = fraksi arus ikut (*wake fraction*)
t = faktor deduksi gaya dorong (*thrust deduction factor*)
η_P = efisiensi baling-2 pada kondisi berada di buritan kapal (*propeller efficiency in behind condition*)
η_O = efisiensi baling-2 yang diperoleh dari percobaan model '*open water test*' (*propeller efficiency in open condition*)
η_{RR} = faktor koreksi η_O menjadi η_P (*relative rotative efficiency*)

Untuk keperluan praktis harga P.C ≈ η_D

Dengan rumus pendekatan Taylor harga-2 w dan t dapat dihitung sbb. :

- kapal *single screw* : $w = -0{,}05 + 0{,}50\ Cb$
  $t = k \cdot w$
  dimana Cb = *block coefficient* dan
  koefisien $k = 0{,}55 \sim 0{,}70$, yakni : $k = 0{,}55$ untuk kapal dengan daun kemudi tipis ;
  $k = 0{,}70$ untuk kapal dengan daun kemudi tebal.
- kapal *twin screw* : $w = -0{,}20 + 0{,}55\ Cb$
  $t \approx w$

Bila harga-2 w dan t telah didapatkan dengan rumus diatas, maka besarnya η_H dapat dihitung. Sedangkan harga η_O *propeller efficiency in open condition* η_O dapat diasumsikan 0,50 ~ 065 , sedangkan *relative rotative efficiency* η_{RR} dapat dipakai harga rata-2 [14] :

- kapal *single screw* : $\eta_{RR} = 1{,}00 \sim 1{,}07 \approx \pm 1{,}02$
- kapal *twin screw* : $\eta_{RR} < 1{,}00 \approx \pm 0{,}985$

sehingga harga P.C dari kapal ybs. dapat kapal dihitung.

Formulasi pendekatan *propulsive efficiency* η_D (= QPC) bila diketahui besarnya rpm poros baling-2 = N (untuk baling-2 berdaun 4) dan panjang Lpp kapal sbb. [17] :

$$\eta_D = 0{,}885 - 0{,}00012 \cdot N \cdot \sqrt{Lpp}$$

Sebagai gambaran, kapal LPG contoh didepan : Lpp = 208 m dan N = 120 rpm

$$\eta_D = 0{,}885 - 0{,}00012 \cdot 120 \cdot \sqrt{208} = 0{,}68$$

$$P.C \approx \eta_D = 0{,}68 = 68\%$$

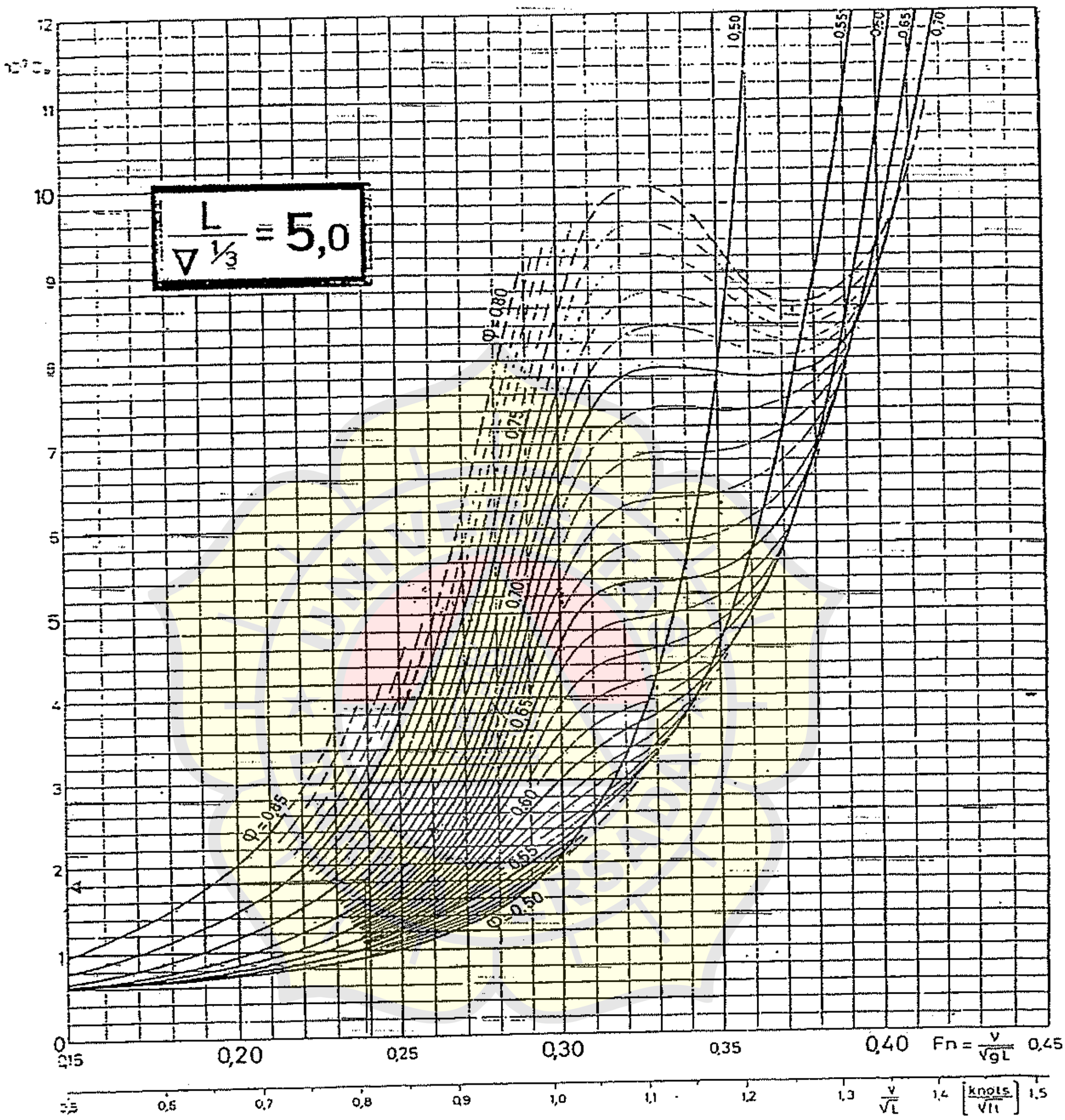
Karena harga P_E untuk kecepatan yang diminta Vs dapat dibaca dari kurva P_E *vs* Vs hasil *Resistance Test* (lihat Gb.8.3a~3.c), maka harga daya yang diperlukan oleh masing-2 poros baling-2 P dapat dihitung.

Dalam praktek pembuatan estimasi daya yang diperlukan mesin induk yang digunakan sebagai penggerak kapal (*propelling engine*) $P_{M/E}$, biasanya diambil ketentuan kerugian daya karena adanya gesekan-2 poros dengan bantalan-2 sebesar 3% untuk kapal dengan kamar mesin terletak di belakang dan 5% untuk kamar mesin berada di tengah kapal. Sedangkan kerugian daya karena adanya gigi reduksi (*gear box*) adalah 0% bila mesin induk kapal tidak memakai *gear box* dan bila ada gigi reduksi dengan *gear ratio* tinggi maka kerugian daya dapat mencapai 3%.

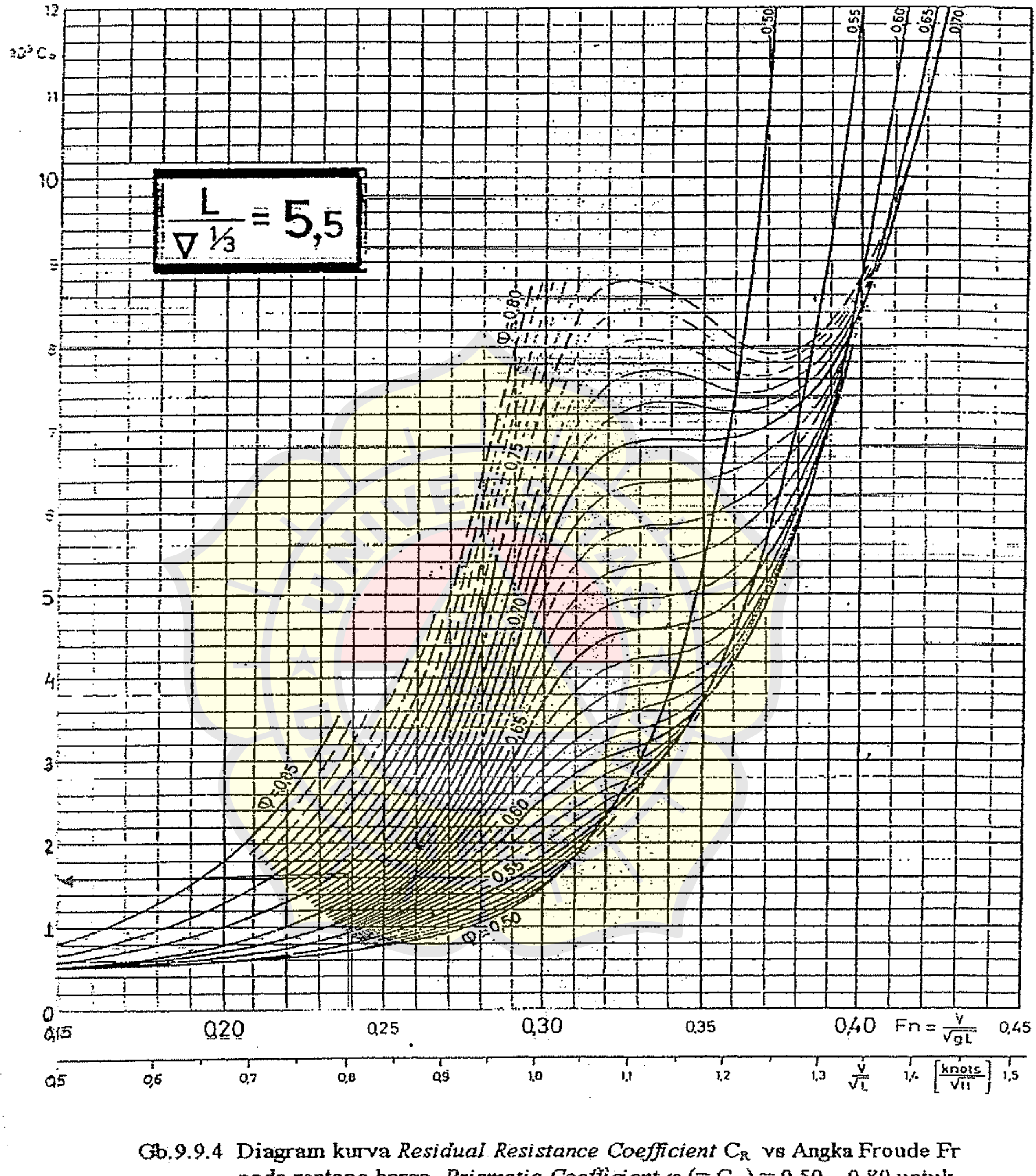
Selain hal-2 tersebut diperlukan tambahan yakni sebagai *service allowance* atau biasa disebut *sea margin* sebesar 10% ~ 20% tergantung dari daerah pelayarannya.

Dengan demikian besarnya $P_{M/E}$ dapat diestimasi sbb. :

$$P_{M/E} = \{100\% + (\underset{\uparrow\ (gear\ box)}{0\% \sim 3\%}) + (\underset{\uparrow\ (lokasi\ Km.\ Mesin)}{3\% \sim 5\%}) + (\underset{\uparrow\ (sea\ margin)}{10\% \sim 20\%})\}\ P$$



Gb.9.9.3 Diagram kurva *Residual Resistance Coefficient* C_R vs Angka Froude Fr pada rentang harga *Prismatic Coefficient* φ (= C_p) = 0,50 ~ 0,80 untuk *Volumetric Coefficient* C_∇(= L / $\nabla^{1/3}$) = 5,0 (8)



Gb.9.9.4 Diagram kurva *Residual Resistance Coefficient* C_R vs Angka Froude Fr pada rentang harga *Prismatic Coefficient* φ (= C_P) = 0,50 – 0,80 untuk *Volumetric Coefficient* C_∇(= L / $\nabla^{1/3}$) = 5,5 (8)

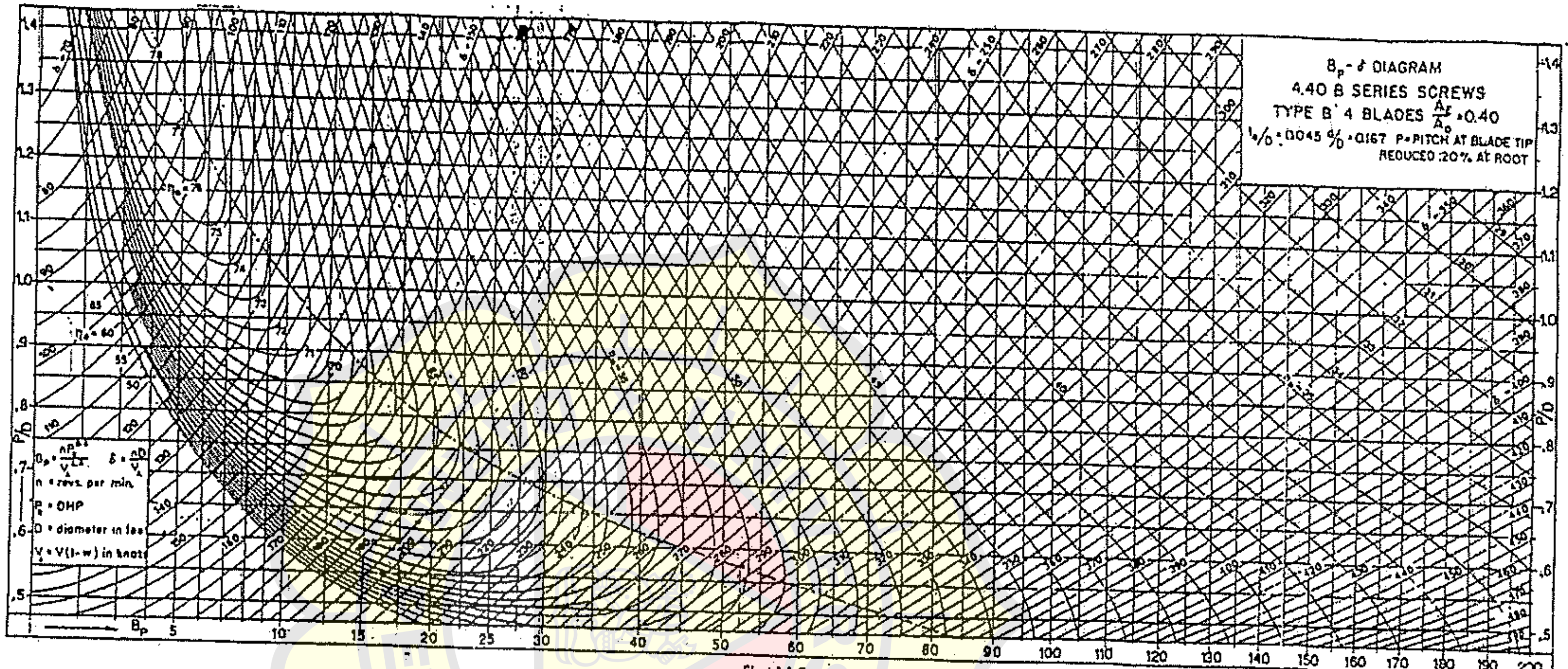
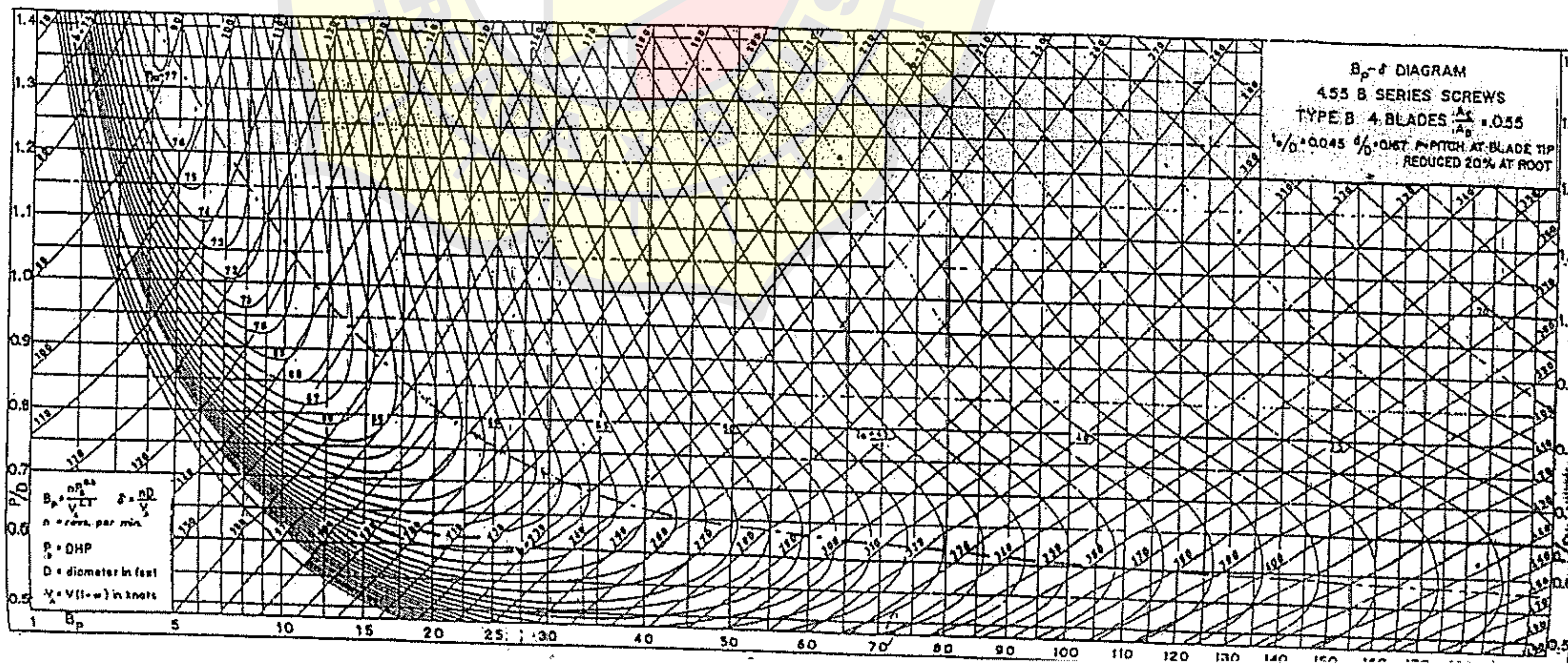
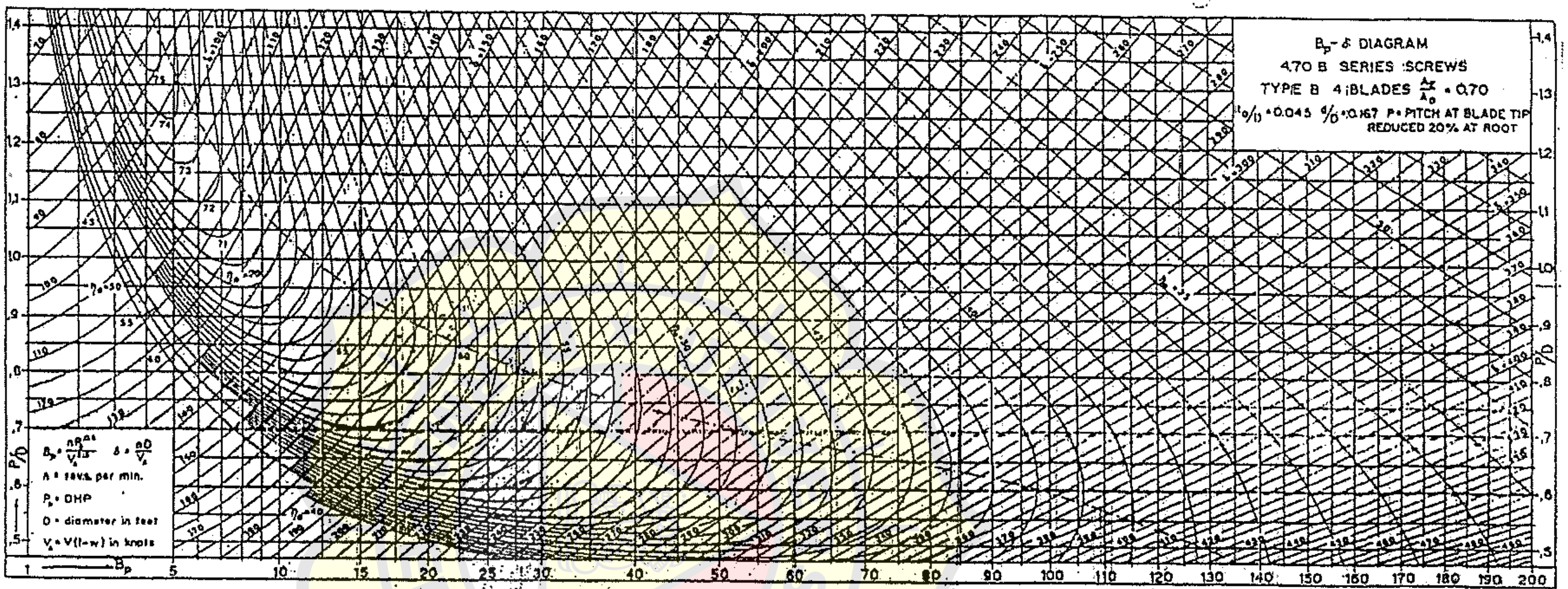

Bp - δ DIAGRAM
4.40 B SERIES SCREWS
TYPE B 4 BLADES $\frac{A_E}{A_O}$ = 0.40
t/D = 0.045 a/D = 0.167 P = PITCH AT BLADE TIP REDUCED 20% AT ROOT
$B_P = \frac{nP^{0.5}}{V_A^{2.5}}$ $\delta = \frac{nD}{V_A}$
n = revs. per min.
$P = DHP$
D = diameter in feet
$V_A = V(1-w)$ in knots
P/D
Bp

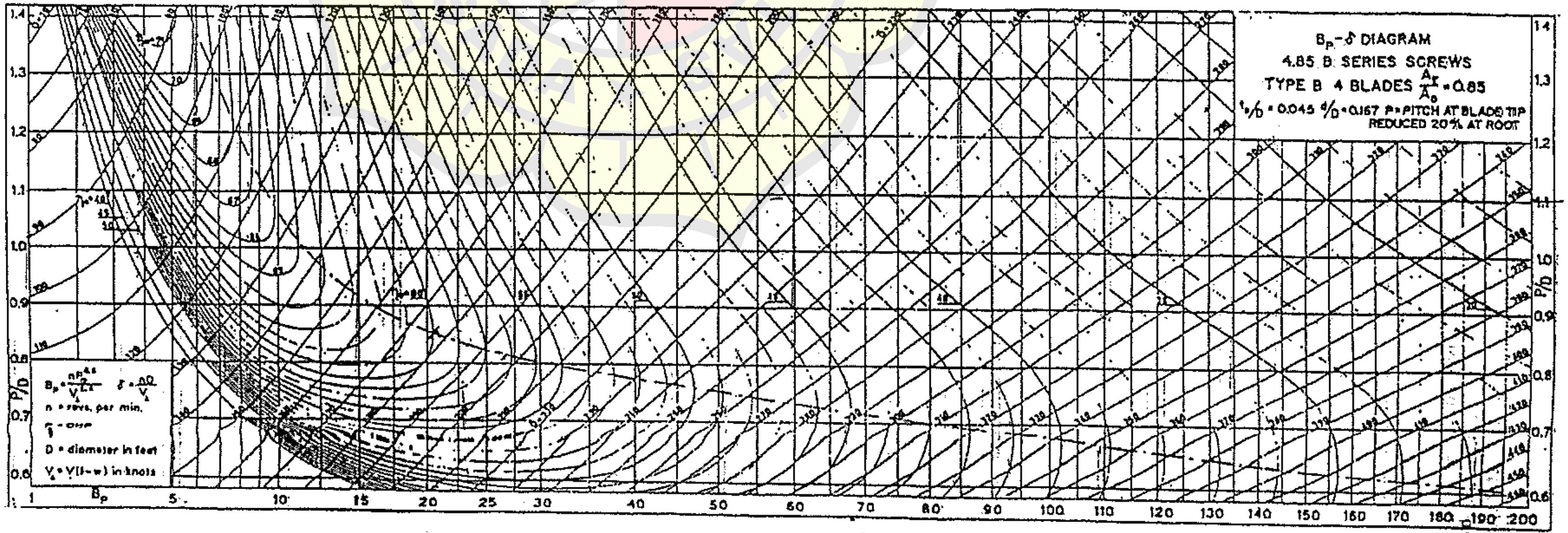
Fig. 115


Bp - δ DIAGRAM
4.55 B SERIES SCREWS
TYPE B 4 BLADES $\frac{A_E}{A_O}$ = 0.55
t/D = 0.045 a/D = 0.167 P = PITCH AT BLADE TIP REDUCED 20% AT ROOT
$B_P = \frac{nP^{0.5}}{V_A^{2.5}}$ $\delta = \frac{nD}{V_A}$
n = revs. per min.
$P = DHP$
D = diameter in feet
$V_A = V(1-w)$ in knots
P/D
Bp



$B_p - \delta$ DIAGRAM
4.70 B SERIES SCREWS
TYPE B 4 BLADES $\frac{A_r}{A_o} = 0.70$
$t_o/D = 0.045$ $a/D = 0.167$ P = PITCH AT BLADE TIP REDUCED 20% AT ROOT
$B_p = \frac{nP^{0.5}}{V_a^{2.5}}$ $\delta = \frac{nD}{V_a}$
n = revs. per min.
P_s = DHP
D = diameter in feet
$V_a = V(1-w)$ in knots
P/D
B_p

Fig. 117



$B_p - \delta$ DIAGRAM
4.85 B SERIES SCREWS
TYPE B 4 BLADES $\frac{A_r}{A_o} = 0.85$
$t_o/D = 0.045$ $a/D = 0.167$ P = PITCH AT BLADE TIP REDUCED 20% AT ROOT
$B_p = \frac{nP^{0.5}}{V_a^{2.5}}$ $\delta = \frac{nD}{V_a}$
n = revs. per min.
P = DHP
D = diameter in feet
$V_a = V(1-w)$ in knots
P/D
B_p

Lampiran – 1

Tabel-L1.1 Viskositas kinematis air tawar ν dalam satuan centiStokes [cST = 10^{-6} m²/dt.] pada suhu dalam satuan °C

°C	0,0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9
0	1,7867	1,7806	1,7745	1,7685	1,7625	1,7565	1,7505	1,7446	1,7387	1,7329
1	1,7270	1,7212	1,7155	1,7097	1,7040	1,6984	1,6927	1,6871	1,6815	1,6759
2	1,6704	1,6649	1,6594	1,6540	1,6486	1,6432	1,6378	1,6325	1,6272	1,6219
3	1,6167	1,6114	1,6062	1,6011	1,5959	1,5908	1,5857	1,5806	1,5756	1,5706
4	1,5656	1,5606	1,5557	1,5507	1,5459	1,5410	1,5361	1,5313	1,5265	1,5217
5	1,5170	1,5123	1,5075	1,5029	1,4982	1,4936	1,4890	1,4844	1,4798	1,4752
6	1,4707	1,4662	1,4617	1,4573	1,4529	1,4484	1,4441	1,4397	1,4353	1,4310
7	1,4267	1,4224	1,4181	1,4139	1,4096	1,4054	1,4013	1,3971	1,3929	1,3888
8	1,3847	1,3806	1,3766	1,3725	1,3685	1,3645	1,3605	1,3565	1,3525	1,3486
9	1,3446	1,3407	1,3368	1,3330	1,3291	1,3253	1,3215	1,3177	1,3139	1,3102
10	1,3064	1,3027	1,2990	1,2953	1,2916	1,2879	1,2843	1,2807	1,2771	1,2735
11	1,2699	1,2663	1,2628	1,2592	1,2557	1,2522	1,2487	1,2453	1,2418	1,2384
12	1,2350	1,2315	1,2282	1,2248	1,2214	1,2181	1,2148	1,2115	1,2082	1,2049
13	1,2016	1,1983	1,1951	1,1918	1,1886	1,1854	1,1823	1,1791	1,1759	1,1728
14	1,1696	1,1665	1,1634	1,1603	1,1572	1,1541	1,1511	1,1481	1,1450	1,1420
15	1,1390	1,1360	1,1330	1,1301	1,1271	1,1242	1,1212	1,1183	1,1154	1,1125
16	1,1097	1,1068	1,1040	1,1011	1,0983	1,0955	1,0927	1,0899	1,0871	1,0843
17	1,0816	1,0788	1,0761	1,0733	1,0706	1,0679	1,0652	1,0625	1,0599	1,0572
18	1,0546	1,0519	1,0493	1,0467	1,0441	1,0415	1,0389	1,0363	1,0338	1,0312
19	1,0287	1,0261	1,0236	1,0211	1,0186	1,0161	1,0136	1,0111	1,0866	1,0062
20	1,0037	1,0013	0,9989	0,9965	0,9941	0,9917	0,9893	0,9869	0,9845	0,9822
21	0,9798	0,9775	0,9752	0,9729	0,9705	0,9682	0,9659	0,9636	0,9614	0,9591
22	0,9568	0,9546	0,9523	0,9501	0,9479	0,9457	0,9435	0,9413	0,9391	0,9369
23	0,9347	0,9326	0,9304	0,9263	0,9261	0,9240	0,9218	0,9197	0,9176	0,9155
24	0,9134	0,9113	0,9092	0,9072	0,9051	0,9031	0,9010	0,8990	0,8960	0,8949
25	0,8929	0,8909	0,8889	0,8869	0,8849	0,8829	0,8809	0,8790	0,8770	0,8751
26	0,8731	0,8712	0,8693	0,8673	0,8654	0,8635	0,8616	0,8597	0,8578	0,8560
27	0,8541	0,8522	0,8504	0,8485	0,8467	0,8448	0,8430	0,8412	0,8393	0,8375
28	0,8357	0,8339	0,8321	0,8303	0,8286	0,8268	0,8250	0,8232	0,8215	0,8197
29	0,8180	0,8163	0,8145	0,8128	0,8111	0,8094	0,8077	0,8060	0,8043	0,8026
30	0,8009	0,7992	0,7976	0,7959	0,7942	0,7926	0,7909	0,7892	0,7876	0,7859

Contoh :

Air di tangki percobaan Laboratorium Hidrodinamika ITS pada saat *resistance test* tgl.1 Juni 1994 dilaksanakan : suhu 27,0° C, sehingga :

$$\nu_{\text{air tawar}} = 0{,}8541 \ \text{cST} \ \ (= 0{,}8451.10^{-6} \ \text{m}^2/\text{dt.})$$

Tabel-L1.2 Viskositas kinematis air laut (air dengan kadar garam 3,5%) [cST][10^{-6} m²/dt.] pada suhu dalam satuan °C

°C	0,0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9
0	1,3284	1,8224	1,8163	1,8103	1,8044	1,7984	1,7925	1,7866	1,7808	1,7749
1	1,7692	1,7634	1,7577	1,7520	1,7463	1,7407	1,7351	1,7296	1,7240	1,7185
2	1,7131	1,7076	1,7022	1,6968	1,6915	1,6861	1,6808	1,6755	1,6703	1,6651
3	1,6599	1,6547	1,6496	1,6445	1,6394	1,6343	1,6293	1,6243	1,6193	1,6143
4	1,6094	1,6045	1,5996	1,5948	1,5899	1,5851	1,5803	1,5756	1,5708	1,5661
5	1,5614	1,5568	1,5521	1,5475	1,5429	1,5384	1,5338	1,5293	1,5248	1,5203
6	1,5158	1,5114	1,5070	1,5026	1,4982	1,4939	1,4896	1,4853	1,4810	1,4767
7	1,4724	1,4681	1,4640	1,4598	1,4556	1,4515	1,44474	1,4433	1,4392	1,4351
8	1,4310	1,4270	1,4230	1,4190	1,4150	1,4110	1,4071	1,4032	1,3993	1,3954
9	1,3915	1,3877	1,3839	1,3800	1,3762	1,3725	1,3687	1,33650	1,3612	1,3575
10	1,3538	1,3501	1,3465	1,3428	1,3392	1,3356	1,3320	1,3284	1,3248	1,3213
11	1,3177	1,3142	1,3107	1,3072	1,3038	1,3003	1,2969	1,2934	1,2900	1,2866
12	1,2832	1,2799	1,2765	1,2732	1,2699	1,2666	1,2633	1,2600	1,2568	1,2535
13	1,2503	1,2471	1,2438	1,2406	1,2375	1,2343	1,2311	1,22280	1,2248	1,2217
14	1,2186	1,2155	1,2124	1,2094	1,2063	1,2033	1,2003	1,1973	1,1943	1,1913
15	1,1883	1,1853	1,1824	1,1794	1,1765	1,1736	1,1707	1,1678	1,1649	1,1620
16	1,1592	1,1563	1,1535	1,1507	1,1479	1,1451	1,1423	1,1395	1,1367	1,1340
17	1,1313	1,1285	1,1258	1,1231	1,1204	1,1177	1,1150	1,1123	1,1097	1,1070
18	1,1044	1,1018	1,0991	1,0965	1,0939	1,0914	1,0888	1,0862	1,0836	1,0811
19	1,0785	1,0760	1,0735	1,0710	1,0685	1,0660	1,0635	1,0611	1,0586	1,0562
20	1,0537	1,0513	1,0489	1,0465	1,0441	1,0417	1,0393	1,0369	1,0345	1,0322
21	1,0298	1,0275	1,0251	1,0228	1,0205	1,0182	1,0159	1,0136	1,0113	1,0090
22	1,0068	1,0045	1,0023	1,00003	0,9978	0,9956	0,9934	0,9912	0,9890	0,9868
23	0,9846	0,9824	0,9802	0,9781	0,9759	0,9738	0,9716	0,9695	0,9674	0,9653
24	0,9632	0,9611	0,9590	0,9569	0,9550	0,9527	0,9507	0,9486	0,9466	0,9446
25	0,9425	0,9405	0,9385	0,9365	0,9345	0,9325	0,9305	0,9285	0,9265	0,9245
26	0,9226	0,9206	0,9187	0,9167	0,9148	0,9129	0,9109	0,9090	0,9071	0,9052
27	0,9333	0,9014	0,8995	0,8977	0,8958	0,8939	0,8921	0,8902	0,8884	0,8865
28	0,8847	0,8829	0,8811	0,8792	0,8774	0,8756	0,8738	0,8721	0,8703	0,8685
29	0,8667	0,8649	0,8632	0,8614	0,8597	0,8579	0,8562	0,8545	0,8527	0,8510
30	0,84931	0,8476	0,8459	0,8442	0,8425	0,8408	0,8391	0,8374	0,8357	0,8340

<u>Contoh</u> :

Tangki percobaan Laboratorium Hidrodinamika ITS saat melaksanakan *model test / resistance test* untuk kapal *tanker* 1500DWT dalam bulan Juni 1994 mengambil asumsi suhu air laut dimana kapal akan dioperasikan = 28,0° C, sehingga :

$$\nu'_{air\ laut} = 0,8847 \text{ cST } (= 0,8847.10^{-6} \text{ m}^2/\text{dt.})$$

Tabel-L1.3 Massa jenis udara (kering)

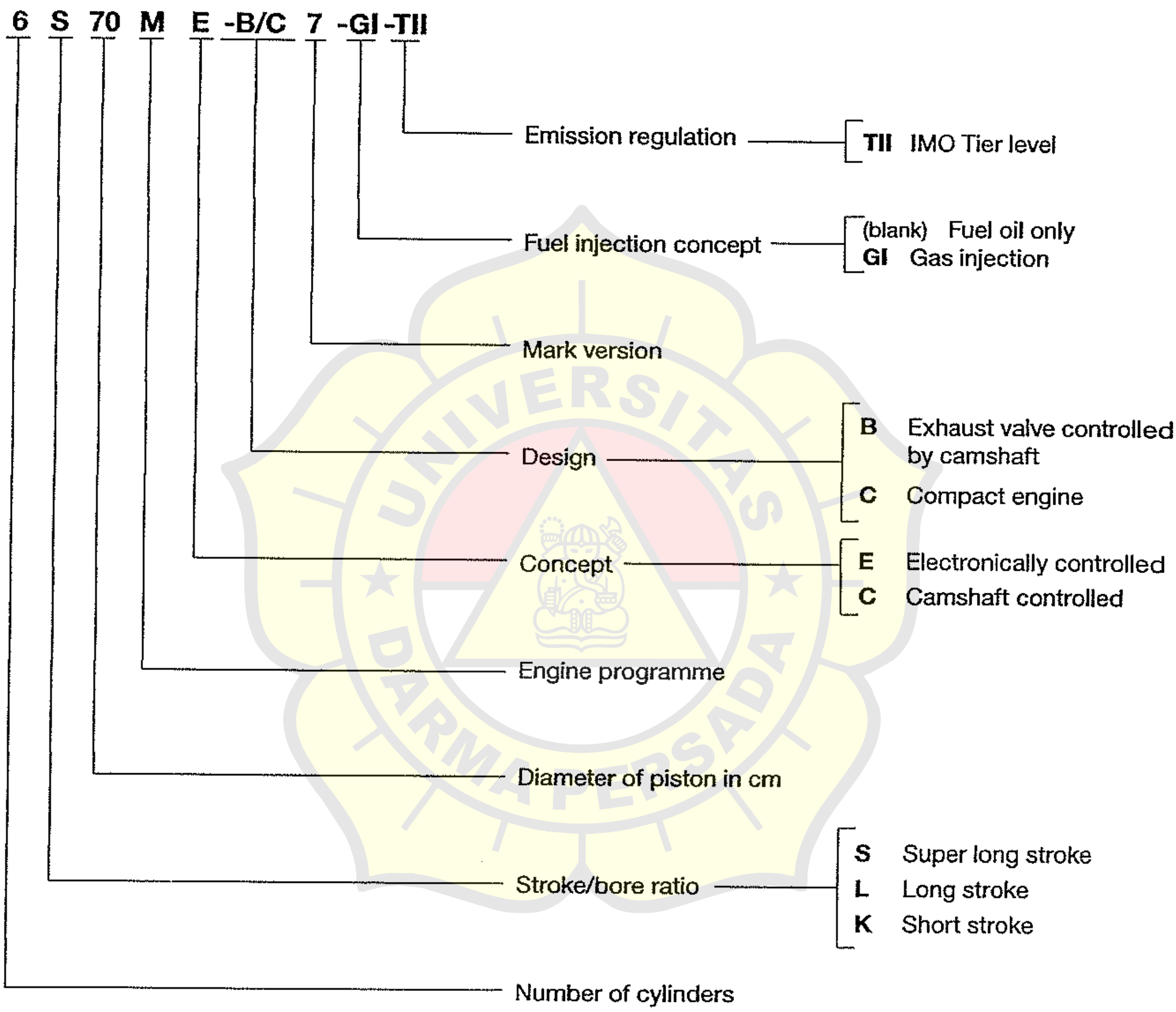
Suhu [°C]	γ_{udara} [kg/m3]
0	1,293
5	1,270
10	1,247
15	1,226
20	1,184
25	1,184
30	1,165

Lampiran – 2

Tabel konversi satuan menjadi S I

Kuantitas	Satuan Inggris / Amerika atau MKS	Satuan S I
Panjang	1 fathom........................	1,8288 m
	1 ft.	0,3048 m
	1 in.	25,400 mm
Luas	1 ft ^{2}	9,2903.10 $^{-2}$ m ^{2}
	1 in ^{2}	6,4516.10 ^{2} mm ^{2}
Volume	1 ft ^{3}	2,8317. 10 $^{-2}$ m ^{3}
	1 in ^{3}	1,6387. 10 ^{4} mm ^{3}
	1 gallon (*liquid*)..........	3,7854. 10 $^{-3}$ m ^{3}
Massa	1 lb	0,4536 kg
	1 ton (*long*)	1,0160. 10 ^{3} kg
	1 ton (*metric*)	1,0000. 10 ^{3} kg
Gaya	1 lb	4,4482 N
	1 kg	9,8067 N
	1 ton (*long*)	9,9640 kN
	1 ton (*metric*)	9,8067 kN
Enersi, Usaha	1 Btu	1,0551. 10 ^{3} J
	1 ft.lb	1,3558 J
	1 in.lb.	1,1298.10 $^{-1}$ J
	1 kcal............................	4,1868.10 ^{3} J
	1 kg.m	9,8067 J
Daya	1 HP (*British*) .... = 76 kg.m/dt	7,4570.10 ^{2} W
	1 HP (*metric*)............. = 75 kg.m/dt	7,3560.10 ^{2} W
Tekanan, Tegangan	1 psi	6,8948.10 ^{3} N/m ^{2} (=Pa)
		6,8948. 10 ^{3} bar
	1 kg/cm ^{2}	9,8067.10 ^{4} N/m ^{2} (=Pa)
	1 kg/ mm ^{2}	9,8067.10 ^{6} N/m ^{2} (=Pa)
Kecepatan	1 knot	0,5144 m/dt
Torsi	1 lb.in	0,11298 N.m
	1 kg.m	9,80665 N.m
Sudut (datar)	1 derajad (=*degree*).....	π / 180 radian

Engine Type Designation



Engine Cross Section of S26MC6

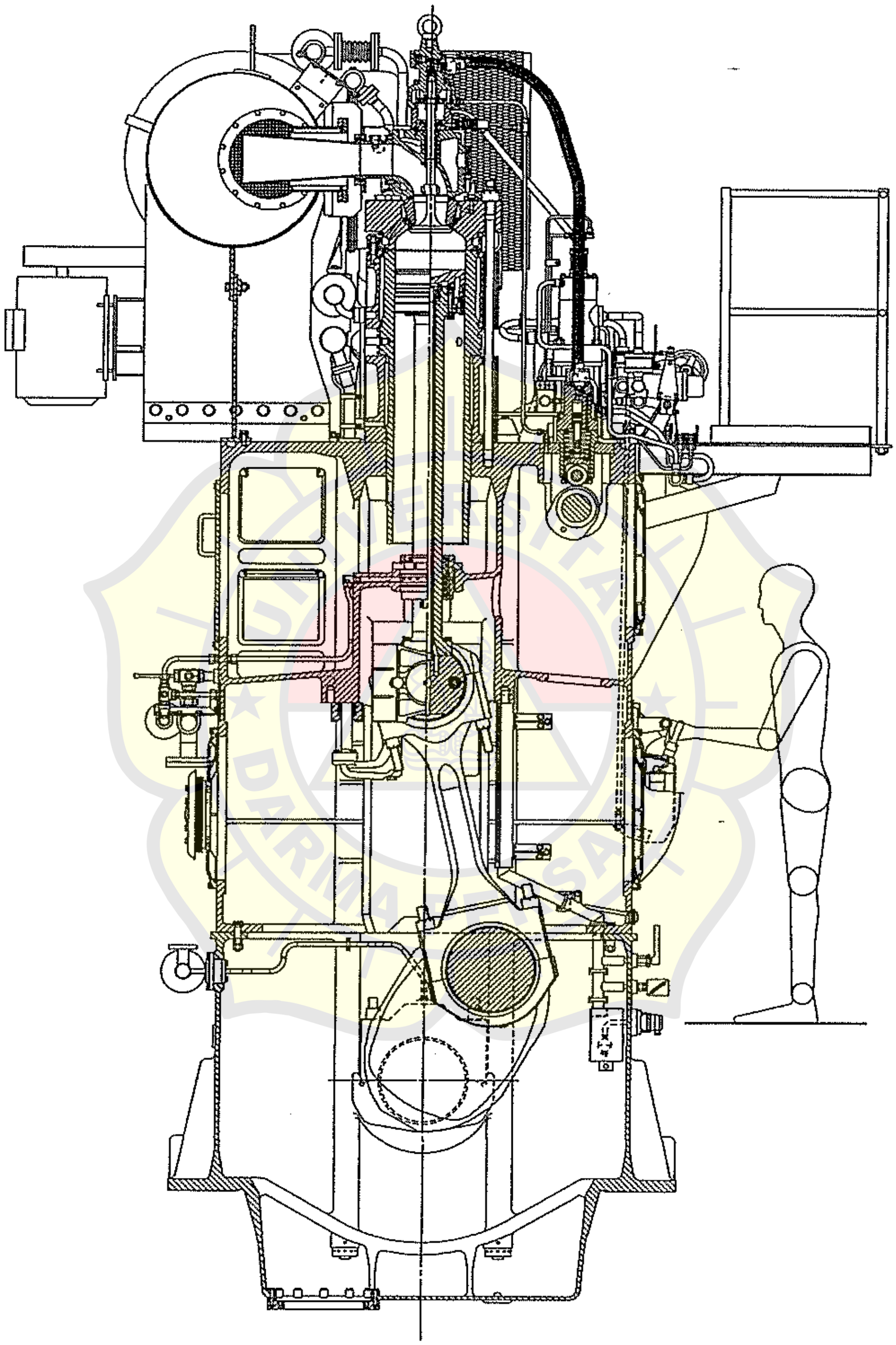


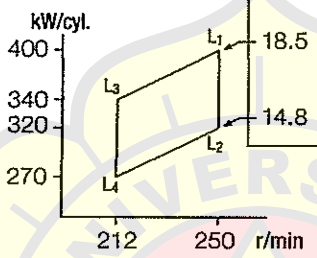
Fig.: 1.07.01: Engine cross section

Power, Speed and Lubricating Oil

MAN B&W S26MC6-TII

Power and Speed

	Cyl.	L_1 kW
Stroke: 980 mm	5	2,000
	6	2,400
	7	2,800
	8	3,200
	9	3,600
	10	4,000
	11	4,400
	12	4,800



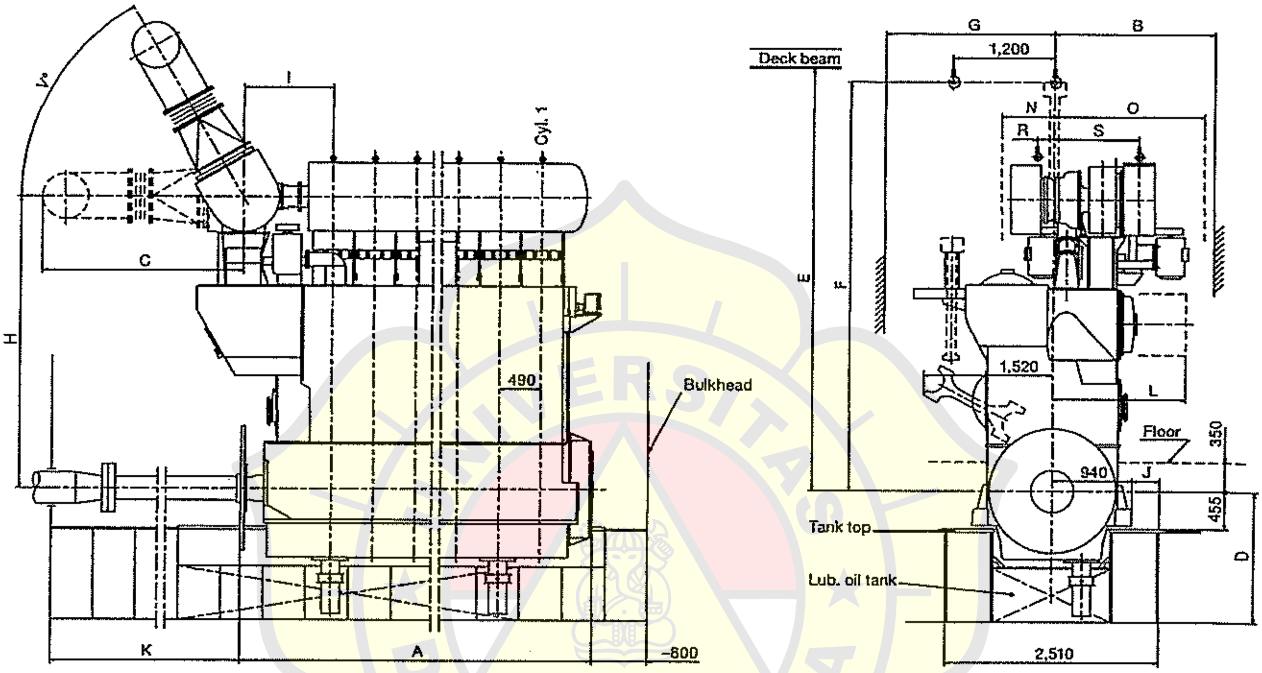
MEP bar	SFOC g/kWh	
	MCR	Minimum at Part Load
18.5	181	179
14.8	177	175

Fuel and lubricating oil consumption

At load Layout point	Specific fuel oil consumption g/kWH		Lubricating oil consumption	
	With conventional turbocharger		System oil Approximate g/kWH	MAN B&W Alpha cylinder lubricator
	100%	80%		
L_1 and L_2	181	179	0.1	0.7
L_3 and L_4	177	175		

Fig 1.03.01: Power, speed, fuel and lubrication oil

Space Requirement



Normal/minimum centre line distance for twin engine installation: 3,450/2,800 mm (2,800 mm for common gallery for starboard and port design engines).

The dimensions are given in mm, and are for guidance only. If the dimensions cannot be fulfilled, please contact MAN Diesel or our local representative.

Fig. 5.02.01a: Space requirement for the engine, turbocharger on aft end (4 59 121)

Cyl. No.		5	6	7	8	9	10	11	12		
A	min.	3,637	4,127	4,617	5,107	5,597	6,577	7,067	7,557	Fore end: A minimum shows basic engine A maximum shows engine with built-on tuning wheel For PTO: See corresponding space requirement	
A	max.	3,732	4,222	4,712	5,202	5,692	6,672	7,162	7,652		
B		1,880								MAN Diesel, ABB and Mitsubishi turbochargers	The required space to the engine room casing includes top bracing
C		2,107	-	-	2,470	2,756	2,520	-	-	MAN Diesel TCA	Dimension according to turbocharger choice at nominal MCR
		-	-	2,239	2,376	2,514	-	-	-	ABB TPL	
		-	-	2,186	2,323	2,461	-	-	-	Mitsubishi MET	
D		1,590	1,590	1,600	1,630	1,650	1,650	1,650	1,650	The dimension includes a cofferdam of 600 mm and must fulfil minimum height to tank top according to classification rules	
E		4,600								Electrical crane	The distance from crankshaft centre line to lower edge of deck beam, when using MAN B&W Double Jib Crane
		4,525								Manual crane	
F		4,850								Minimum overhaul height, normal lifting procedure	
		4,750								Minimum overhaul height, reduced height lifting procedure	
G		1,990								See 'Engine Top Bracing', if top bracing fitted on camshaft side	
H		3,520								See 'Engine outline'	
I		-	-	-	-	-	-	-	-	MAN Diesel TCA	Dimension according to turbocharger choice at nominal MCR
		-	-	-	-	-	-	-	-	ABB TPL	
		-	-	1,020	1,020	1,020	-	-	-	Mitsubishi MET	
J		319								Space for tightening control of holding down bolts	
K		See text								K must be equal to or larger than the propeller shaft, if the propeller shaft is to be drawn into the engine room	
L		1,690								Space for air cooler element overhaul	
N		1,126								The distances cover required space and hook travelling width for turbocharger TCR22	
O		1,466									
R		782									
S		814									
V		0°, 15°, 30°, 45°, 60°, 75°, 90°								Maximum 15° when engine room has minimum headroom above the turbocharger	

Fig. 5.02.01b: Space requirement for the engine

Fuel considerations

When the engine is stopped, the circulating pump will continue to circulate heated heavy fuel through the fuel oil system on the engine, thereby keeping the fuel pumps heated and the fuel valves deaerated. This automatic circulation of preheated fuel during engine standstill is the background for our recommendation:

Constant operation on heavy fuel

In addition, if this recommendation was not followed, there would be a latent risk of diesel oil and heavy fuels of marginal quality forming incompatible blends during fuel change over or when operating in areas with restrictions on sulpher content in fuel oil due to exhaust gas emission control.

In special circumstances a change-over to diesel oil may become necessary – and this can be performed at any time, even when the engine is not running. Such a change-over may become necessary if, for instance, the vessel is expected to be inactive for a prolonged period with cold engine e.g. due to:

- docking
- stop for more than five days
- major repairs of the fuel system, etc.

Heating of fuel drain pipe

Owing to the relatively high viscosity of the heavy fuel oil, it is recommended that the drain pipe and the fuel oil drain tank are heated to min. 50 °C, but max. 100 °C.

Fuel flow velocity and viscosity

For external pipe connections, we prescribe the following maximum flow velocities:

Marine diesel oil .... 1.0 m/s
Heavy fuel oil .... 0.6 m/s

The fuel viscosity is influenced by factors such as emulsification of water into the fuel for reducing the NO_x emission. This is further described in Section 7.06.

An emulsification arrangement for the main engine is described in our publication:

Exhaust Gas Emission Control Today and Tomorrow

Further information about fuel oil specifications is available in our publication:

Guidelines for Fuels and Lubes Purchasing

The publications are available at: www.mandiesel.com under 'Quicklinks' → 'Technical Papers'.

Components for Fuel Oil System

Fuel oil centrifuges

The manual cleaning type of centrifuges are not to be recommended, neither for attended machinery spaces (AMS) nor for unattended machinery spaces (UMS). Centrifuges must be self-cleaning, either with total discharge or with partial discharge.

Distinction must be made between installations for:

- Specific gravities < 0.991 (corresponding to ISO 8217 and British Standard 6843 from RMA to RMH, and CIMAC from A to H-grades
- Specific gravities > 0.991 and (corresponding to CIMAC K-grades).

For the latter specific gravities, the manufacturers have developed special types of centrifuges, e.g.:

Alfa Laval .... Alcap
Westfalia .... Unitrol
Mitsubishi .... E-Hidens II

The centrifuge should be able to treat approximately the following quantity of oil:

0.23 litres/kWh

This figure includes a margin for:

- Water content in fuel oil
- Possible sludge, ash and other impurities in the fuel oil
- Increased fuel oil consumption, in connection with other conditions than ISO standard condition
- Purifier service for cleaning and maintenance.

The size of the centrifuge has to be chosen according to the supplier's table valid for the selected viscosity of the Heavy Fuel Oil. Normally, two centrifuges are installed for Heavy Fuel Oil (HFO), each with adequate capacity to comply with the above recommendation.

A centrifuge for Marine Diesel Oil (MDO) is not a must. However, MAN Diesel recommends that at least one of the HFO purifiers can also treat MDO.

If it is decided after all to install an individual purifier for MDO on board, the capacity should be based on the above recommendation, or it should be a centrifuge of the same size as that for HFO.

The *Nominal MCR* is used to determine the total installed capacity. Any derating can be taken into consideration in border-line cases where the centrifuge that is one step smaller is able to cover *Specified MCR*.

Fuel oil supply pump

This is to be of the screw or gear wheel type.

Fuel oil viscosity, specified.... up to 700 cSt at 50 °C
Fuel oil viscosity maximum .... 1000 cSt
Pump head .... 4 bar
Fuel oil flow .... see 'List of Capacities'
Delivery pressure .... 4 bar
Working temperature .... 100 °C
Minimum temperature .... 50 °C

The capacity stated in 'List of Capacities' is to be fulfilled with a tolerance of: ÷0% to +15% and shall also be able to cover the back-flushing, see 'Fuel oil filter'.

Fuel oil circulating pump

This is to be of the screw or gear wheel type.

Fuel oil viscosity, specified.... up to 700 cSt at 50 °C
Fuel oil viscosity normal .... 20 cSt
Fuel oil viscosity maximum .... 1000 cSt
Fuel oil flow .... see 'List of Capacities'
Pump head .... 6 bar
Delivery pressure .... 10 bar
Working temperature .... 150 °C

The capacity stated in 'List of Capacities' is to be fulfilled with a tolerance of: ÷0% to +15% and shall also be able to cover the back-flushing, see 'Fuel oil filter'.

Pump head is based on a total pressure drop in filter and preheater of maximum 1.5 bar.

Lubricating and Cooling Oil System

The lubricating oil is pumped from a bottom tank by means of the main lubricating oil pump to the lubricating oil cooler, a thermostatic valve and, through a full-flow filter, to the engine inlet RU, Fig. 8.01.01.

RU lubricates main bearings, thrust bearing, axial vibration damper, crankpin bearings, piston cooling, crosshead, camshaft and turbocharger bearings.

The main lube oil system is common to the camshaft as well. The major part of the oil is divided between piston cooling and crosshead lubrication.

From the engine, the oil collects in the oil pan, from where it is drained off to the bottom tank, see Fig. 8.06.01a and b 'Lubricating oil tank, with cofferdam'. By class demand, a cofferdam must be placed underneath the lubricating oil tank.

The engine crankcase is vented through 'AR' by a pipe which extends directly to the deck. This pipe has a drain arrangement so that oil condensed in the pipe can be led to a drain tank, see details in Fig. 8.07.01.

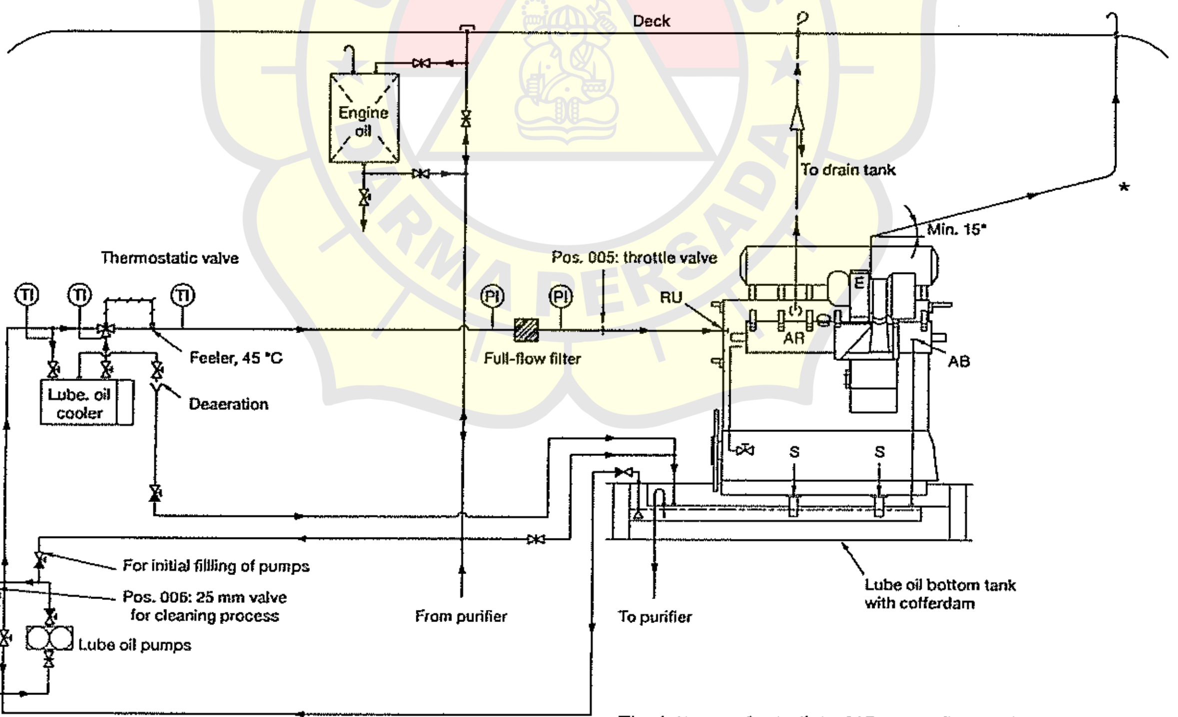
Drains from the engine bedplate 'AE' are fitted on both sides, see Fig. 8.07.02 'Bedplate drain pipes'.

For external pipe connections, we prescribe a maximum oil velocity of 1.8 m/s.

Lubrication of turbochargers

Turbochargers with slide bearings are normally lubricated from the main engine system. AB is outlet from the turbocharger, see Figs. 8.03.01 to 8.03.03, which are shown with sensors for UMS.

Figs. 8.03.01 to 8.03.03 show the lube oil pipe arrangements for different turbocharger makes.



The letters refer to list of 'Counterflanges'

* Venting for MAN Diesel or Mitsubishi turbochargers only

178 57 55-2.2

Fig. 8.01.01 Lubricating and cooling oil system

Components for Lubricating Oil System

Lubricating oil pump

The lubricating oil pump can be of the displacement wheel, or the centrifugal type:

Lubricating oil viscosity, specified...75 cSt at 50 °C
Lubricating oil viscosity........... maximum 400 cSt *
Lubricating oil flow..............see 'List of capacities'
Design pump head..4.0 bar
Delivery pressure ....4.0 bar
Max. working temperature............................. 70 °C

* *400 cSt is specified, as it is normal practice when starting on cold oil, to partly open the bypass valves of the lubricating oil pumps, so as to reduce the electric power requirements for the pumps.*

The flow capacity must be within a range from 100 to 112% of the capacity stated.

The pump head is based on a total pressure drop across cooler and filter of maximum 1 bar.

Referring to Fig. 8.01.01, the bypass valve shown between the main lubricating oil pumps may be omitted in cases where the pumps have a built-in bypass or if centrifugal pumps are used.

If centrifugal pumps are used, it is recommended to install a throttle valve at position '005' to prevent an excessive oil level in the oil pan if the centrifugal pump is supplying too much oil to the engine.

During trials, the valve should be adjusted by means of a device which permits the valve to be closed only to the extent that the minimum flow area through the valve gives the specified lubricating oil pressure at the inlet to the engine at full normal load conditions. It should be possible to fully open the valve, e.g. when starting the engine with cold oil.

It is recommended to install a 25 mm valve (pos. 006), with a hose connection after the main lubricating oil pumps, for checking the cleanliness of the lubricating oil system during the flushing procedure. The valve is to be located on the underside of a horizontal pipe just after the discharge from the lubricating oil pumps.

Lubricating oil cooler

The lubricating oil cooler must be of the shell and tube type made of seawater resistant material, or a plate type heat exchanger with plate material of titanium, unless freshwater is used in a central cooling water system.

Lubricating oil viscosity, specified...75 cSt at 50 °C
Lubricating oil flow..............see 'List of capacities'
Heat dissipation ....see 'List of capacities'
Lubricating oil temperature, outlet cooler...... 45 °C
Working pressure on oil side.........................4.0 bar
Pressure drop on oil side ....maximum 0.5 bar
Cooling water flow...............see 'List of capacities'
Cooling water temperature at inlet:
seawater..32 °C
freshwater..36 °C
Pressure drop on water side.......maximum 0.2 bar

The lubricating oil flow capacity must be within a range from 100 to 112% of the capacity stated.

The cooling water flow capacity must be within a range from 100 to 112% of the capacity stated.

To ensure the correct functioning of the lubricating oil cooler, we recommend that the seawater temperature is regulated so that it will not be lower than 10 °C.

The pressure drop may be larger, depending on the actual cooler design.

Lubricating oil temperature control valve

The temperature control system can, by means of a three-way valve unit, by-pass the cooler totally or partly.

Lubricating oil viscosity, specified....75 cSt at 50 °C
Lubricating oil flow..............see 'List of capacities'
Temperature range, inlet to engine.........40 - 47 °C

Lubricating oil full flow filter

Lubricating oil flow .... see 'List of capacities'
Working pressure .... 4.0 bar
Test pressure...................... according to class rules
Absolute fineness .... 40 μm*
Working temperature .... approximately 45 °C
Oil viscosity at working temp. .... 90 - 100 cSt
Pressure drop with clean filter .... maximum 0.2 bar
Filter to be cleaned
at a pressure drop .... maximum 0.5 bar

* *The absolute fineness corresponds to a nominal fineness of approximately 25 μm at a retaining rate of 90%.*

The flow capacity must be within a range from 100 to 112% of the capacity stated.

The full-flow filter should be located as close as possible to the main engine.

If a double filter (duplex) is installed, it should have sufficient capacity to allow the specified full amount of oil to flow through each side of the filter at a given working temperature with a pressure drop across the filter of maximum 0.2 bar (clean filter).

If a filter with a back-flushing arrangement is installed, the following should be noted:

- The required oil flow, specified in the 'List of capacities', should be increased by the amount of oil used for the back-flushing, so that the lubricating oil pressure at the inlet to the main engine can be maintained during cleaning.
- If an automatically cleaned filter is installed, it should be noted that in order to activate the cleaning process, certain makes of filter require a higher oil pressure at the inlet to the filter than the pump pressure specified. Therefore, the pump capacity should be adequate for this purpose, too.

Flushing of lube oil system

Before starting the engine for the first time, the lubricating oil system on board has to be cleaned in accordance with MAN Diesel's recommendations: 'Flushing of Main Lubricating Oil System', which is available on request.

Central Cooling Water System

The central cooling water system is characterised by having only one heat exchanger cooled by seawater, and by the other coolers, including the jacket water cooler, being cooled by central cooling water.

In order to prevent too high a scavenge air temperature, the cooling water design temperature in the central cooling water system is normally 36 °C, corresponding to a maximum seawater temperature of 32 °C.

Our recommendation of keeping the cooling water inlet temperature to the main engine scavenge air cooler as low as possible also applies to the central cooling system. This means that the temperature control valve in the central cooling water circuit is to be set to minimum 10 °C, whereby the temperature follows the outboard seawater temperature when central cooling water temperature exceeds 10 °C.

For external pipe connections, we prescribe the following maximum water velocities:

Jacket water .... 3.0 m/s
Central cooling water .... 3.0 m/s
Seawater .... 3.0 m/s

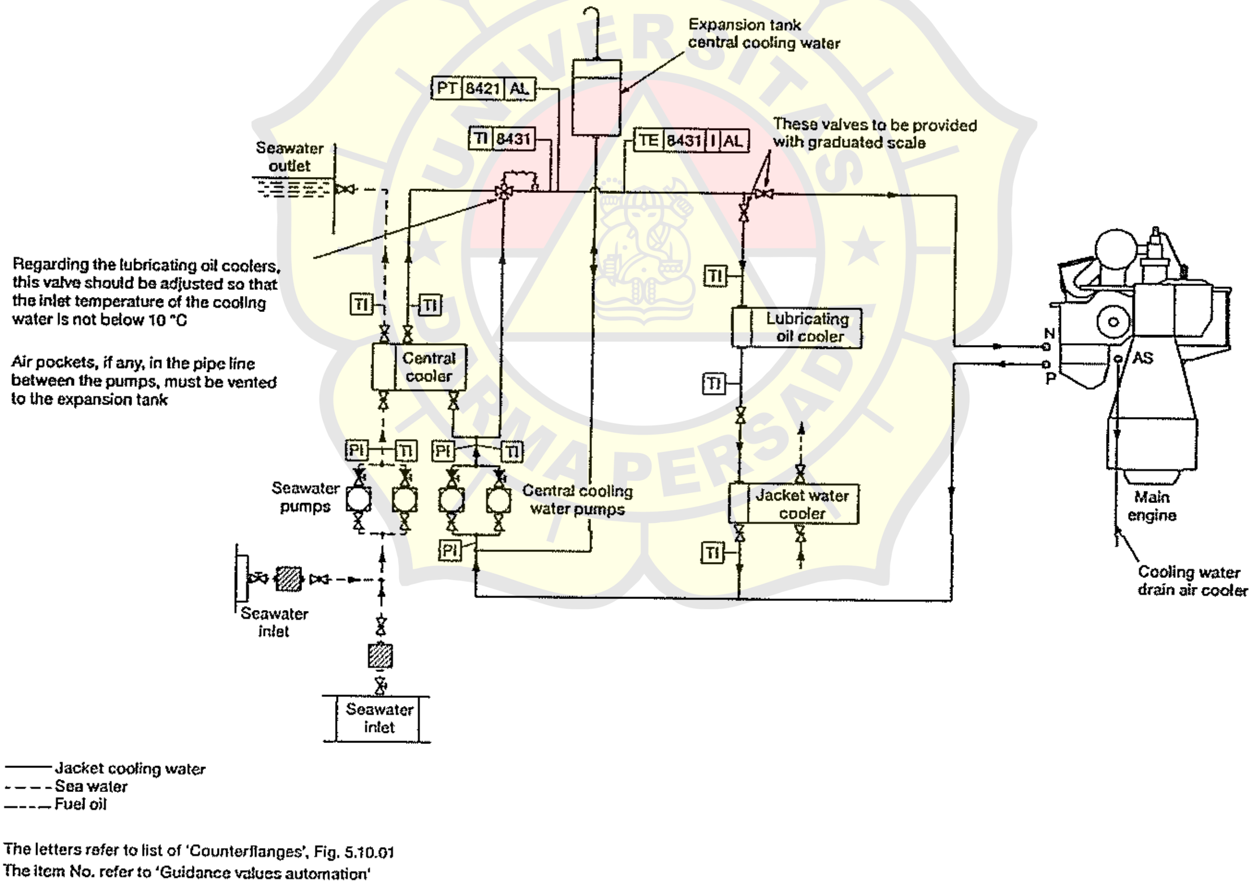


Fig. 11.02.01: Central cooling water system

Components for Central Cooling Water System

Seawater cooling pumps

The pumps are to be of the centrifugal type.

Seawater flow .... see 'List of Capacities'
Pump head ....2.5 bar
Test pressure ....according to class rules
Working temperature, normal ....0-32 °C
Working temperature .... maximum 50 °C

The flow capacity must be within a range from 100 to 110% of the capacity stated.

The differential pressure of the pumps is to be determined on the basis of the total actual pressure drop across the cooling water system.

Central cooler

The cooler is to be of the shell and tube or plate heat exchanger type, made of seawater resistant material.

Heat dissipation .... see 'List of Capacities'
Central cooling water flow ..... see 'List of Capacities'
Central cooling water temperature, outlet......... 36 °C
Pressure drop on central cooling side .....max. 0.2 bar
Seawater flow .... see 'List of Capacities'
Seawater temperature, inlet .... 32 °C
Pressure drop on
seawater side .... maximum 0.2 bar

The pressure drop may be larger, depending on the actual cooler design.

The heat dissipation and the seawater flow figures are based on MCR output at tropical conditions, i.e. a seawater temperature of 32 °C and an ambient air temperature of 45 °C.

Overload running at tropical conditions will slightly increase the temperature level in the cooling system, and will also slightly influence the engine performance.

Central cooling water pumps

The pumps are to be of the centrifugal type.

Central cooling water flow... see 'List of Capacities'
Pump head ....2.5 bar
Delivery pressure ....depends on location of expansion tank
Test pressure ....according to class rules
Working temperature ....80 °C
Design temperature..................................... 100 °C

The flow capacity must be within a range from 100 to 110% of the capacity stated.

The 'List of Capacities' covers the main engine only. The differential pressure provided by the pumps is to be determined on the basis of the total actual pressure drop across the cooling water system.

Central cooling water thermostatic valve

The low temperature cooling system is to be equipped with a three-way valve, mounted as a mixing valve, which by-passes all or part of the fresh water around the central cooler.

The sensor is to be located at the outlet pipe from the thermostatic valve and is set so as to keep a temperature level of minimum 10 °C.

Components for Starting Air System

Starting air compressors

The starting air compressors are to be of the water-cooled, two-stage type with intercooling.

More than two compressors may be installed to supply the total capacity stated.

Air intake quantity:
Reversible engine,
for 12 starts .... see 'List of capacities'
Non-reversible engine,
for 6 starts .... see 'List of capacities'
Delivery pressure .... 30 bar

Starting air receivers

The starting air receivers shall be provided with man holes and flanges for pipe connections.

The volume of the two receivers is:
Reversible engine,
for 12 starts .... see 'List of capacities' *
Non-reversible engine,
for 6 starts .... see 'List of capacities' *
Working pressure .... 30 bar
Test pressure .... according to class rule

* The volume stated is at 25 °C and 1,000 mbar

Reduction station for control and safety air

In normal operating, each of the two lines supplies one engine inlet. During maintenance, three isolating valves in the reduction station allow one of the two lines to be shut down while the other line supplies both engine inlets, see Fig. 13.01.01.

Reduction .... from 30-10 bar to 7 bar
(Tolerance ±10%)

Flow rate, free air .... 750 Normal liters/min
equal to 0.013 m^3/s
Filter, fineness .... 40 μm

Reduction valve for turbocharger cleaning etc

Reduction .... from 30-10 bar to 7 bar
(Tolerance ±10%)

Flow rate, free air .... 2,600 Normal liters/min
equal to 0.043 m^3/s

The consumption of compressed air for control air, exhaust valve air springs and safety air as well as air for turbocharger cleaning and fuel valve testing is covered by the capacities stated for air receivers and compressors in the list of capacities.

Starting and control air pipes

The piping delivered with and fitted onto the main engine is shown in the following figures in Section 13.03:

Fig. 13.03.01 Starting air pipes
Fig. 13.03.02 Air spring pipes, exhaust valves

Turning gear

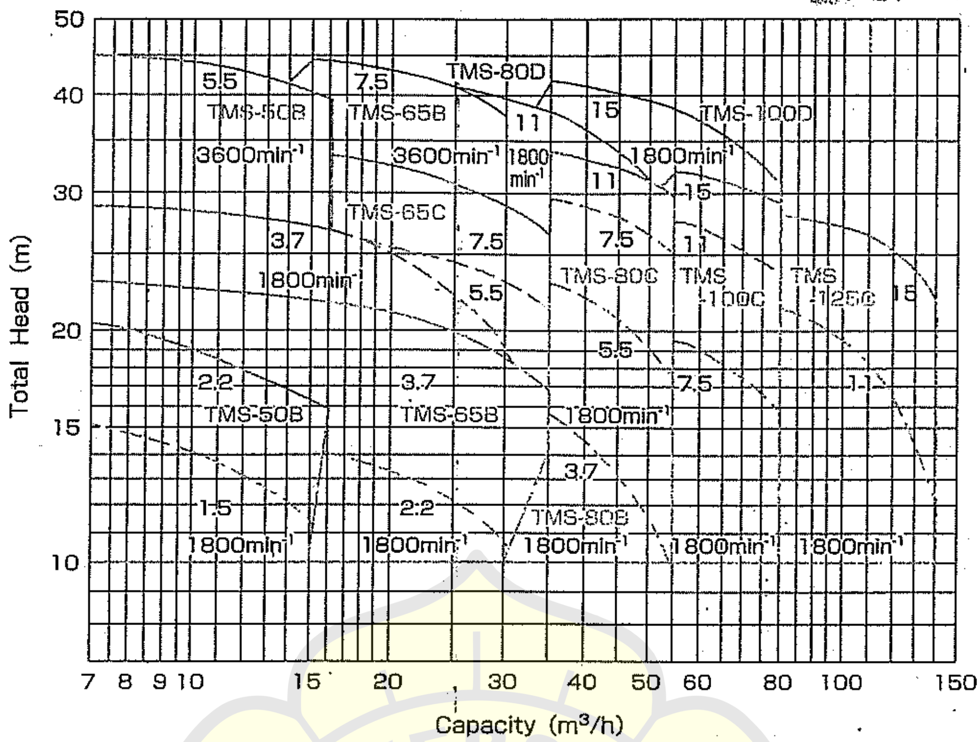
The turning wheel has cylindrical teeth and is fitted to the thrust shaft. The turning wheel is driven by a pinion on the terminal shaft of the turning gear, which is mounted on the bedplate.

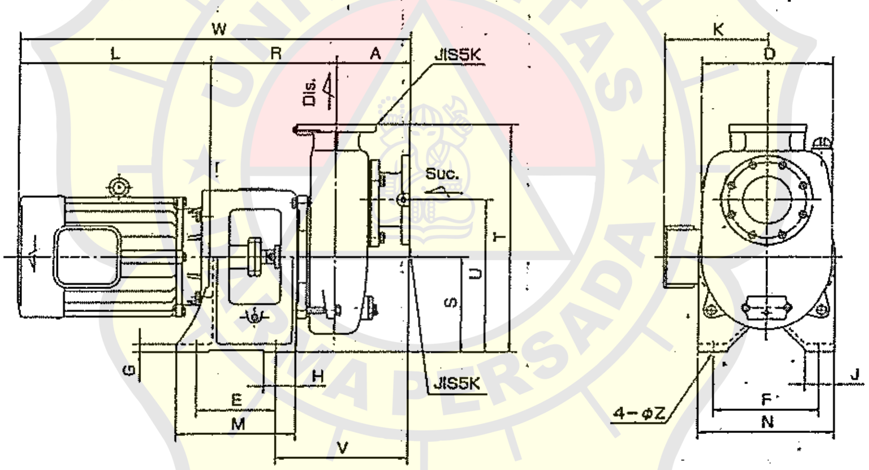
Engagement and disengagement of the turning gear is effected by displacing the pinion and terminal shaft axially. To prevent the main engine from starting when the turning gear is engaged, the turning gear is equipped with a safety arrangement which interlocks with the starting air system.

The turning gear is driven by an electric motor with a built-in gear and brake. Key specifications of the electric motor and brake are stated in Section 13.04.

CENTRIFUGAL PUMP

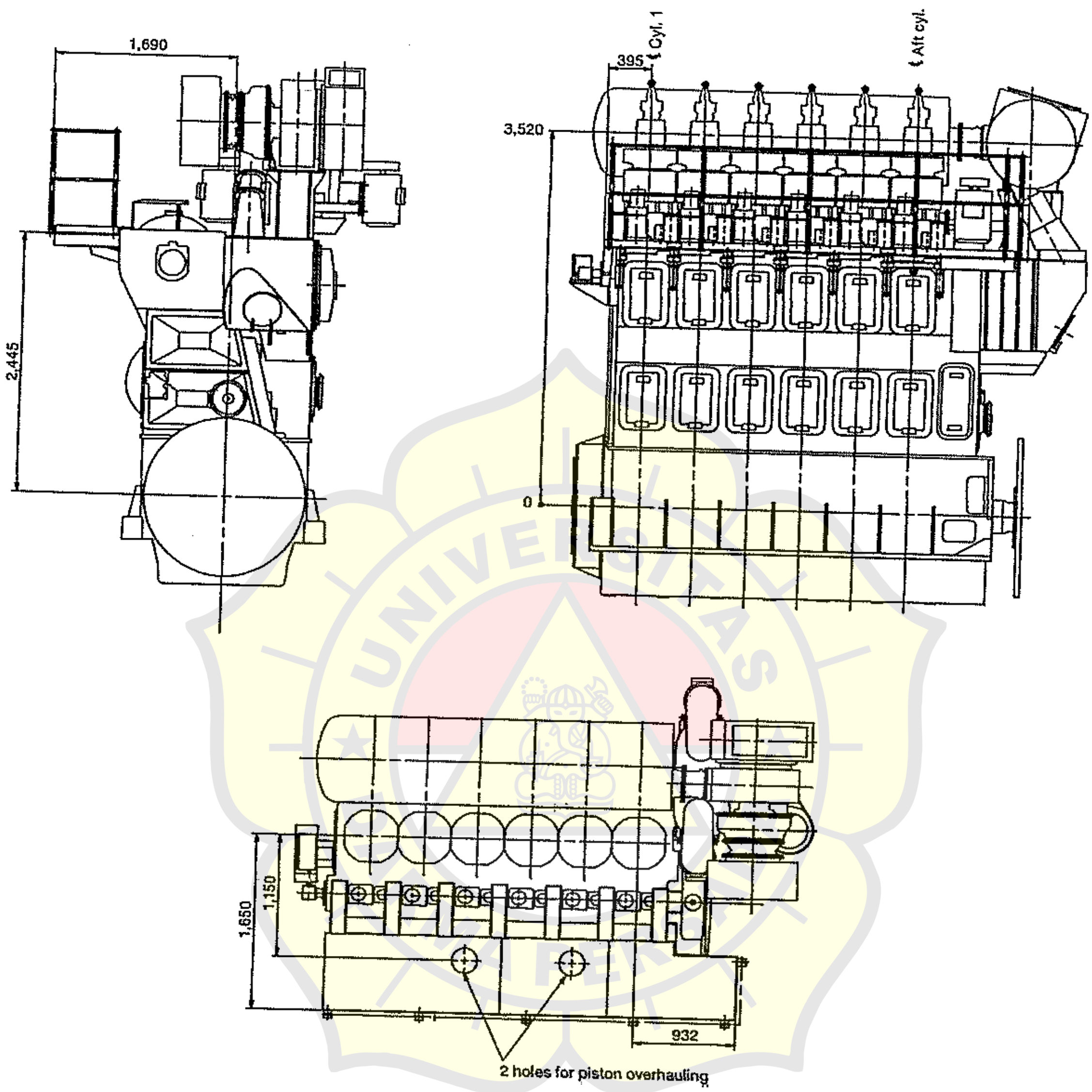
Performance





Model No.	Motor kW	Motor min⁻¹	Bore Suc.	Bore Dis.	A	D	E	F	G	H	J	K	L	M	N	R	S	T	U	V	W	Z
TMS-50B	1.5	1800	50	50	150	270	150	220	15	80	65	195	300	250	280	240	190	455	315	280	690	15
	2.2						180		18			205	330	280		250					730	
	5.5	3600					200	270				265	400	300	330	270	210	475	335		820	
TMS-65B	2.2	1800	65	65	150	275	180	220	18	80	65	205	330	280	280	260	190	455	315	230	740	15
	3.7											215	355								765	
	7.5	3600					200	270				265	400	300	330	280	210	475	335		830	
TMS-65C	3.7	1800	65	65	150	325	180	220	18	80	65	215	355	280	280	260	190	480	330	290	765	15
	5.5						200	270				265	400	300	330	280	210	500	350		830	
	7.5																					
TMS-80B	3.7	1800	80	80	165	305	180	220	18	80	65	215	355	280	280	270	190	480	315	315	790	15
TMS-80C	5.5	1800	80	80	165	340	200	270	18	80	75	265	400	300	350	290	250	600	400	315	855	19
	7.5																					
	11								20			285	485			320					970	
TMS-80D	11	1800	80	80	165	480	200	270	20	80	75	285	485	300	350	335	250	625	425	330	985	19
TMS-100C	7.5	1800	100	100	185	340	200	270	18	80	75	265	400	300	350	290	250	600	400	335	875	19
	11								20			285	485			320					990	
	15												525								1030	
TMS-100D	15	1800	100	100	165	480	200	270	20	80	75	285	525	300	350	335	250	625	425	330	1025	19
TMS-125C	11	1800	125	125	210	385	200	270	20	80	75	285	485	300	350	335	250	625	425	375	1030	19
	15												525								1070	

Dimension (mm): columns A to Z.



182 64 35-9.2.0

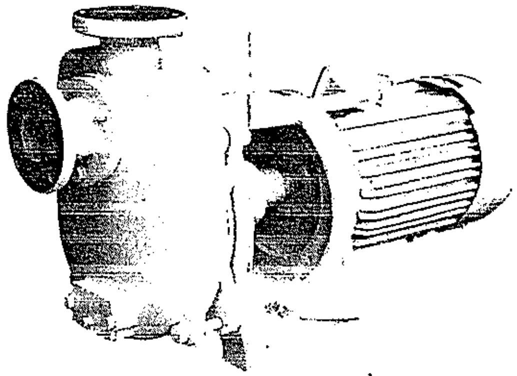
Please note that the latest version of the dimensioned drawing is available for download at www.mandiesel.com under 'Marine' → 'Low Speed' → 'Installation Drawings'. First choose engine series, then engine type and select 'Outline drawing' for the actual number of cylinders and type of turbocharger installation in the list of drawings available for download.

Fig. 5.06.01c: Gallery outline, 6S26MC6 with turbocharger on aft end

TAIKO

CENTRIFUGAL PUMP

TMS



Application

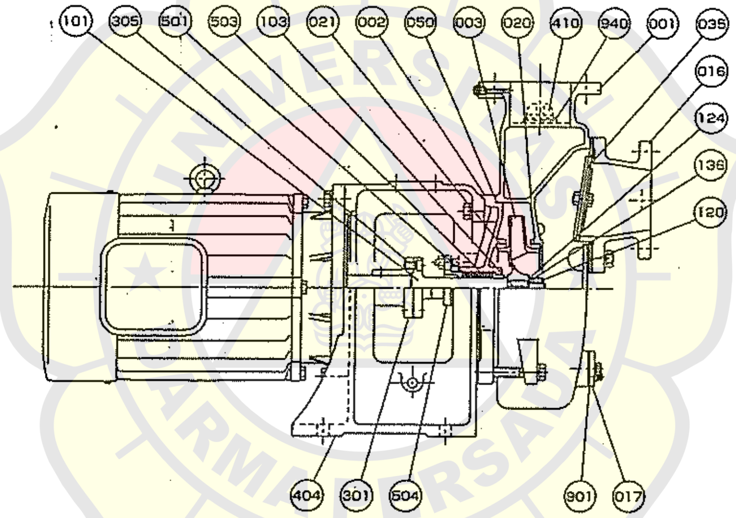
Fire & G.S. Pump
Bilge & Ballast Pump

Feature

Horizontal Single-stage Single-suction
Self-priming Closed Coupling Type

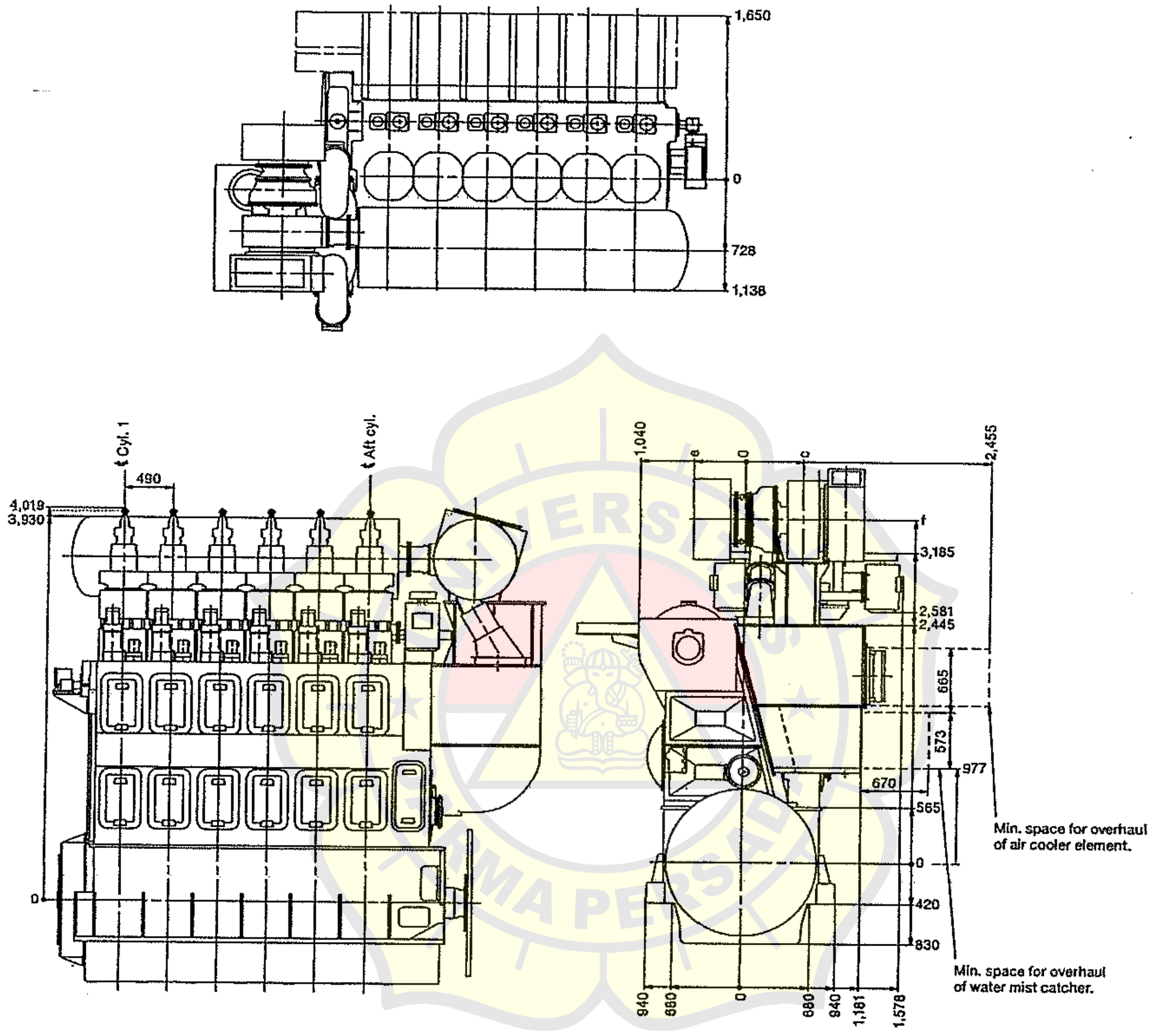
2-4

Structure & Material



Part No.	Name	Req. No.	Sea Water Material	Sea Water JIS	Fresh Water Material	Fresh Water JIS
001	CASING	1	BRONZE	CAC402	CAST IRON	FC200
002	CASING COVER	1	BRONZE	CAC402	CAST IRON	FC200
003	IMPELLER	1	PHOSPHOR BRONZE	CAC502A	PHOSPHOR BRONZE	CAC502A
016	SUCTION COVER	1	BRONZE	FC200	CAST IRON	FC200
017	DRAIN COVER	1	BRONZE	FC200	CAST IRON	FC200
020	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
021	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
035	CHECK VALVE	1	RUBBER /BRONZE	NBR /CAC402	RUBBER /BRONZE	NBR /CAC402
050	O-RING	1	RUBBER	NBR	RUBBER	NBR
101	SHAFT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
103	IMPELLER KEY	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
120	IMPELLER NUT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304

Part No.	Name	Req. No.	Sea Water Material	Sea Water JIS	Fresh Water Material	Fresh Water JIS
124	IMPELLER WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
136	SPRING WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
301	COUPLING	1	MILD STEEL	SS400	MILD STEEL	SS400
305	COUPLING BOLT	4	Cr-Mo STEEL	SCM435	Cr-Mo STEEL	SCM435
404	PUMP FRAME	1	CAST IRON	FC200	CAST IRON	FC200
410	PRIMING CAP	1	BRONZE	CAC402	BRONZE	CAC402
501	GLAND PACKING	4	CARBONIZED FIBER	–	CARBONIZED FIBER	–
503	LANTERN RING	1	BRONZE	CAC402	BRONZE	CAC402
504	GLAND	1	BRONZE	CAC402	BRONZE	CAC402
901	GASKET	1	RUBBER	NBR	RUBBER	NBR
940	GASKET	1	RUBBER	NBR	RUBBER	NBR



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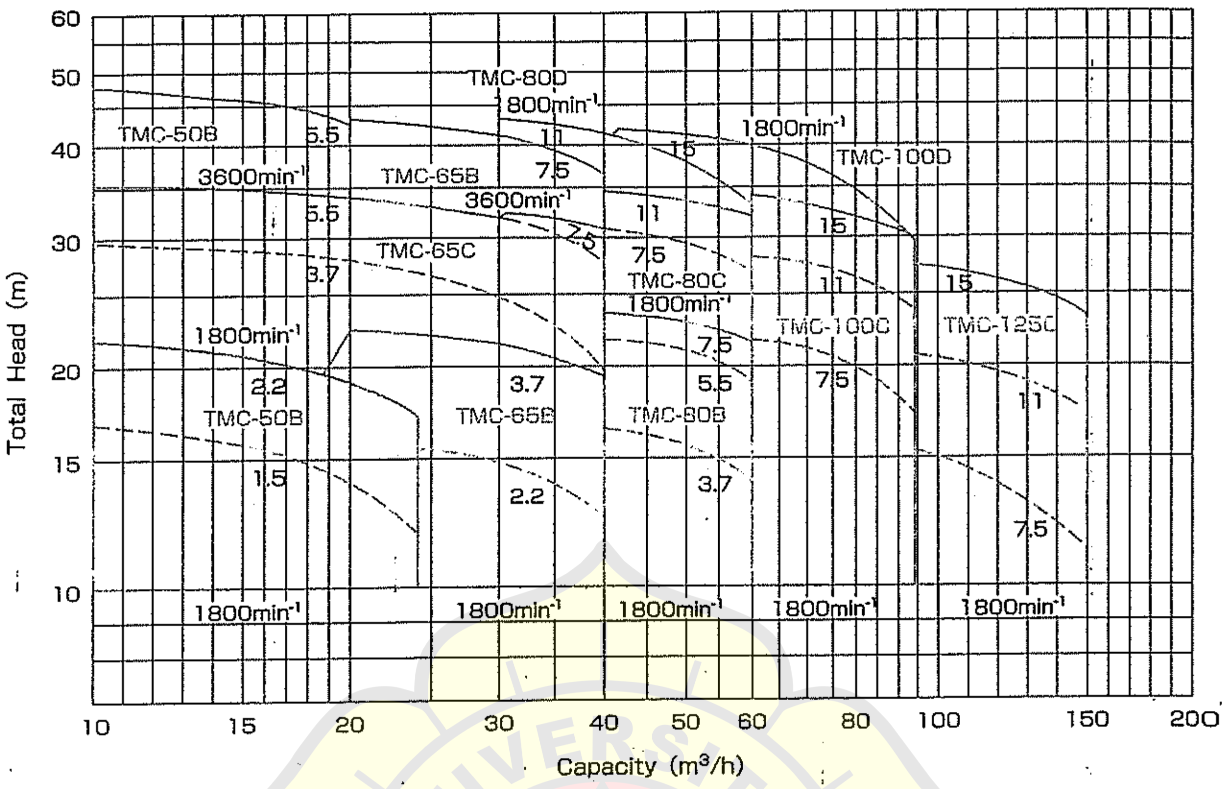
Please note that the latest version of the dimensioned drawing is available for download at www.mandiesel.com under 'Marine' → 'Low Speed' → 'Installation Drawings'. First choose engine series, then engine type and select 'Outline drawing' for the actual number of cylinders and type of turbocharger installation in the list of drawings available for download.

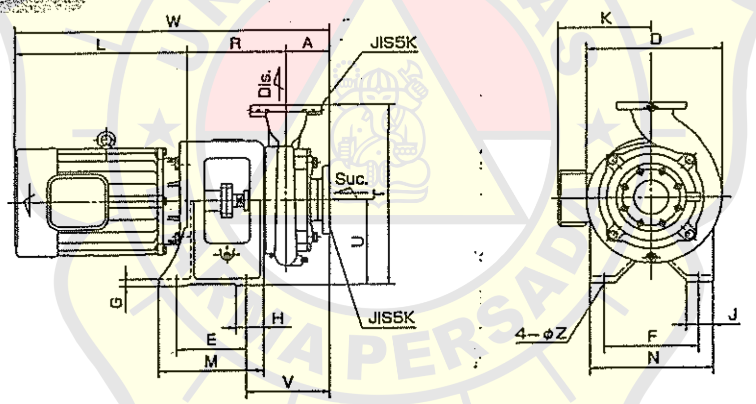
For platform dimensions, see 'Gallery Outline'.

Fig. 5.06.01b: Engine outline, 6S26MC6 with turbocharger on aft end

CENTRIFUGAL PUMP

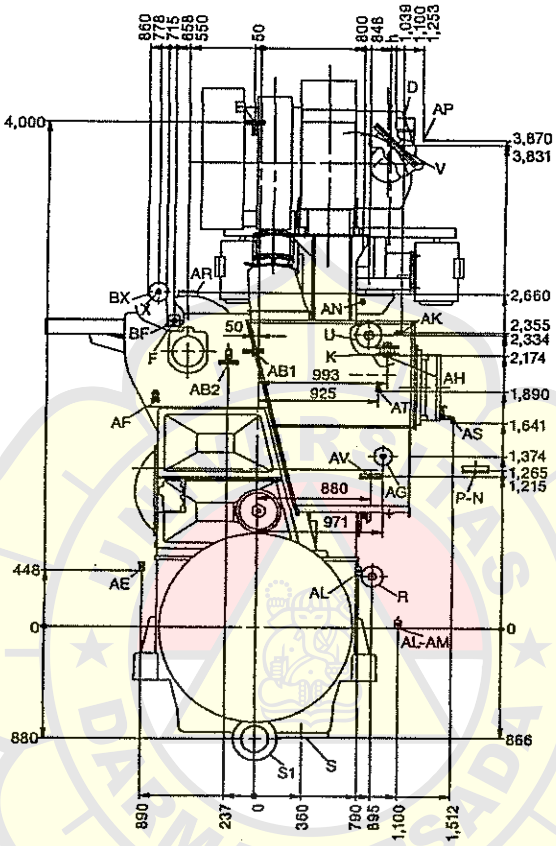
Performance





Model No.	Motor kW	Motor min⁻¹	Bore Suc.	Bore Dis.	A	D	E	F	G	H	J	K	L	M	N	R	T	U	V	W	Z
TMC-50B	1.5	1800	50	50	100	265	150	220	15	80	65	195	300	250	280	215	370	190	205	615	15
	2.2						180		18			205	330	280		225				655	
	5.5	3600					200	270				265	400	300	330	245	390	210		745	
TMC-65B	2.2	1800	65	65	100	285	180	220	18	80	65	206	330	280	280	227	390	190	207	657	15
	3.7											215	355							682	
	7.5	3600					200	270				265	400	300	330	247	410	210		747	
TMC-65C	3.7	1800	65	65	100	335	180	220	18	80	65	215	355	280	280	227	415	190	207	682	15
	5.5						200	270				265	400	300	330	247	435	210		747	
	7.5																				
TMC-80B	3.7	1800	80	80	100	325	180	220	18	80	65	215	355	280	280	232	415	190	212	687	16
	5.5						200	270				265	400	300	330	252	435	210		752	
	7.5																				
TMC-80C	7.5	1800	80	80	100	365	200	270	18	80	75	265	400	300	350	252	500	250	212	752	19
	11								20			285	485			282				867	
TMC-80D	11	1800	80	80	125	405	200	270	20	80	75	285	485	300	350	290	530	250	245	900	19
TMC-100C	7.5	1800	100	100	125	385	200	270	18	80	75	265	400	300	350	253	530	250	238	778	19
	11								20			285	485			283				893	
	15												525							933	
TMC-100D	15	1800	100	100	125	405	200	270	20	80	75	285	525	300	350	290	565	250	245	940	19
TMC-125C	7.5	1800	125	125	140	420	200	270	18	80	75	265	400	300	350	265	530	250	265	805	19
	11								20			285	485			295				920	
	15												525							960	

Dimension (mm)



111 17 25-5.2.0

The letters refer to list of 'Counterflanges', fig. 5.10.01

Fig. 5.09.01b: Engine pipe connections, 6S26MC6 with turbocharger on aft end

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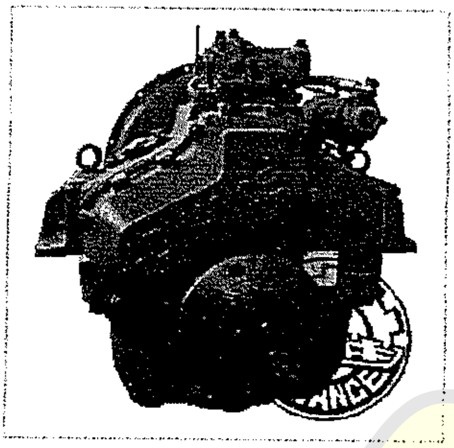

Marine Gearbox (135A)

Marine Gearbox (135A)

Price: Get Latest Price

Min. order: 1 Pieces

Trade Terms: FOB

Payment Terms: T/T, D/P

Price Valid Time: From Oct 06, 2013 To Jan 06, 2014

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Other Prod This Co

06/16A Gear

Marine Gear 120

HC400 Seri Gear

800 Series

GW Series

Basic Info.

Model NO.: 135A

Type: Circular Gear

Manufacturing Method: Cast Gear

Toothed Portion Shape: Spur Gear

Color: as Shown in Figure

Export Markets: Global

Additional Info.

Trademark: ADVANCE

Packing: Wooden Cases or According to Your Requirements

Standard: INTERNATIONAL

Origin: China

HS Code: 84834090

Production Capacity: 1000 PCS/ Year

Product Description

1.135A Marine Gearbox.

2. Specification: Long X Length X High(mm): 578 X 744 X 830.

3. Rated Rev(r/min): 1000-2000.

4. Bell Housing: SAE1

5. Flange: SAE14

6. Center Distance(mm): 225

7. Thrust(kN): 29.4

8. Net Weight(kg): 470

9. Control Mode: Push-Pull Cable, Electronic Control.

10. Matched Engine: 6135Ca h615 NT-855-M240; CAT 3406

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REFERENSI BAB III

Section 9

Framing System

A. Transverse Framing

1. General

1.1 Frame spacing

Forward of the collision bulkhead and aft of the after peak bulkhead, the frame spacing shall in general not exceed 600 mm.

1.2 Definitions

k = material factor according to Section 2, B.2.

ℓ = unsupported span [m] according to Section 3, C., see also Fig. 9.1

ℓ_{min} = 2,0 m

ℓ_{Ku}, ℓ_{Ko} = length of lower/upper bracket connection of main frames within the length ℓ [m], see Fig. 9.1

m_a = $0{,}204\ \frac{a}{\ell}\left[4-\left(\frac{a}{\ell}\right)^2\right]$, where $\frac{a}{\ell} \le 1$

e = spacing of web frames [m]

p = p_s or p_e as the case may be

p_s = load on ship's sides [kN/m²] according to Section 4, B.2.1

p_e = load on bow structures [kN/m²] according to Section 4, B.2.2 or stern structures according to Section 4, B.2.3 as the case may be

p_L = 'tween deck load [kN/m²] according to Section.4, C.1.

p_1, p_2 = pressure [kN/m²] according to Section 4, D.1.

H_u = depth up to the lowest deck [m]

c_r = factor for curved frames

= $1{,}0 - 2\ \frac{s}{\ell}$

c_{rmin} = 0,75

s = max. height of curve.

2. Main frames

2.1 Scantlings

2.1.1 The section modulus W_R and shear area A_R of the main frames including end attachments are not to be less than:

$$W_R = n \cdot c \cdot a \cdot \ell^2 \cdot p \cdot c_r \cdot k \quad [cm^3]$$

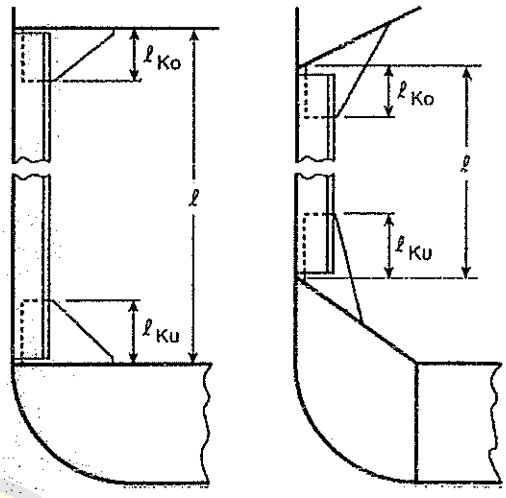


Fig. 9.1 Unsupported span of transverse frames

upper end shear area :

$$A_{RO} = \left(1 - 0{,}817 \cdot m_a\right) 0{,}04 \cdot a \cdot \ell \cdot p \cdot k \quad [cm^2]$$

lower end shear area :

$$A_{RU} = \left(1 - 0{,}817 \cdot m_a\right) 0{,}07 \cdot a \cdot \ell \cdot p \cdot k \quad [cm^2]$$

n = $0{,}9 - 0{,}0035 \cdot L$ for $L < 100$ m

= 0,55 for $L \ge 100$ m

c = $1{,}0 - \left(\frac{\ell_{Ku}}{\ell} + 0{,}4 \cdot \frac{\ell_{Ko}}{\ell}\right)$

c_{min} = 0,6

Within the lower bracket connection the section modulus is not to be less than the value obtained for c = 1,0.

2.1.2 In ships with more than 3 decks the main frames are to extend at least to the deck above the lowest deck.

2.1.3 The scantlings of the main frames are not to be less than those of the 'tween deck frames above.

2.1.4 Where the scantlings of the main frames are determined by strength calculations, the following permissible stresses are to be observed:

bending stress: $\sigma_b = \frac{150}{k}$ [N/mm²]

shear stress: $\tau = \frac{100}{k}$ [N/mm²]

Section 11

Watertight Bulkheads

A. General

1. Watertight subdivision

1.1 All ships are to have a collision bulkhead, a stern tube bulkhead and one watertight bulkhead at each end of the engine room. In ships with machinery aft, the stern tube bulkhead may substitute the aft engine room bulkhead.

1.2 For ships without longitudinal bulkheads in the cargo hold area the number of watertight transverse bulkheads should, in general, not be less than given in Table 11.1.

Table 11.1 Number of watertight transverse bulkheads

L [m]	Arrangement of machinery space	
	aft	elsewhere
L ≤ 65	3	4
65 < L ≤ 85	4	4
85 < L ≤ 105	4	5
105 < L ≤ 125	5	6
125 < L ≤ 145	6	7
145 < L ≤ 165	7	8
165 < L ≤ 185	8	9
L > 185	to be special considered	

1.3 One or more of the watertight bulkheads required by 1.2, may be dispensed with where the transverse strength of the ship is adequate. The number of watertight bulkheads will be entered into the Register.

1.4 Number and location of transverse bulkheads fitted in addition to those specified in 1.1 are to be so selected as to ensure sufficient transverse strength of the hull.

1.5 For ships which require proof of survival capability in damaged conditions, the watertight sub-division will be determined by damage stability calculations. For oil tankers see Section 24, A.2., for passenger vessels see Section 29-I, C., for special purpose ships see Section 29-II, C., for cargo ships of more than 100 m in length see Section 36 and for supply vessels see Section 34, A.2. For liquefied gas tankers see Rules for Ships Carrying Liquefied Gases in Bulk, Volume IX, Section 2, for chemical tankers see Rules for Ships Carrying Dangerous Chemicals in Bulk, Volume X, Section 2.

2. Arrangement of watertight bulkheads

2.1 Collision bulkhead

2.1.1 A collision bulkhead shall be located at a distance from the forward perpendicular of not less than 0,05 L_c or 10 m, whichever is the less, and, except as may be permitted by the Administration, not more than 0,08 L_c or 0,05 L_c + 3 m, whichever is the greater

2.1.2 Where any part of the ship below the waterline extends forward of the forward perpendicular, e.g., a bulbous bow, the distance x shall be measured from a point either:

- at the mid-length of such extension, i.e. x = 0,5 • a
- at a distance 0,015 Lc forward of the forward perpendicular, i.e. x = 0,015 • L_c, or
- at a distance 3 m forward of the forward perpendicular, i.e. x = 3,0 m

whichever gives the smallest measurement.

The length L_c and the distance a are to be specified in the approval documents.

2.1.3 If 2.1.2 is applicable, the required distances specified in 2.1.1 are to be measured from a reference point located at a distance x forward of the F.P.

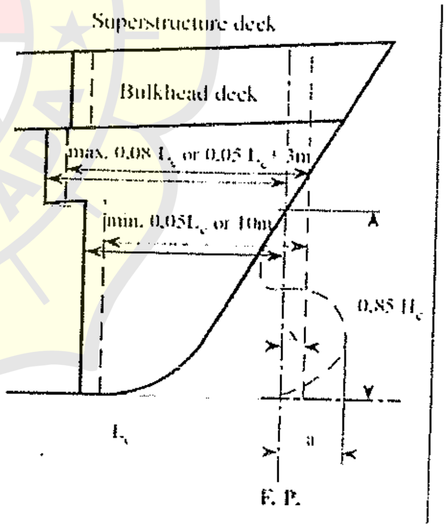


Fig.11.1 Location of collision bulkhead

2.1.4 The collision bulkhead shall extend watertight up to the bulkhead deck. The bulkhead may have steps or recesses provided they are within the limits prescribed in 2.1.1.

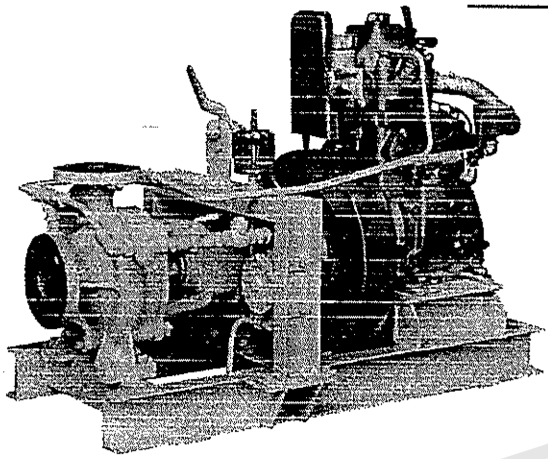
2.1.5 No doors, manholes, access openings, or ventilation ducts are permitted in the collision bulkhead below the bulkhead deck.

REFERENSI BAB IV DAN BAB V

TAIKO

CENTRIFUGAL PUMP

EHCV



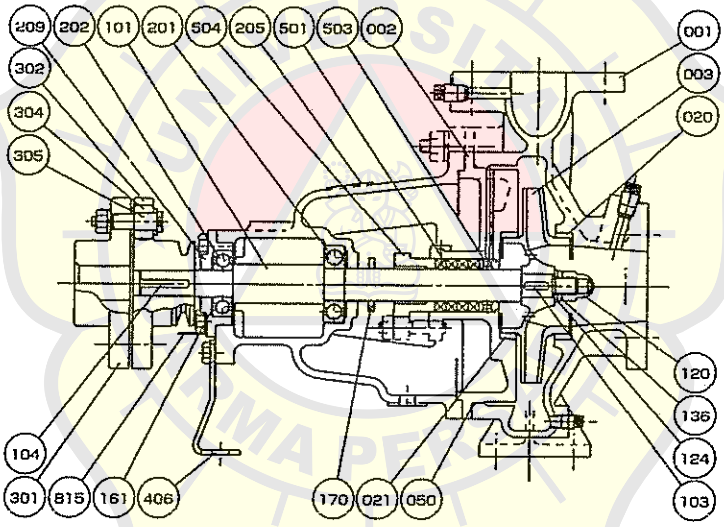
Application

Emergency Fire Pump

Feature

Horizontal Single-stage Single-suction
Self-priming Type (Diesel Engine Driven)

Structure & Material

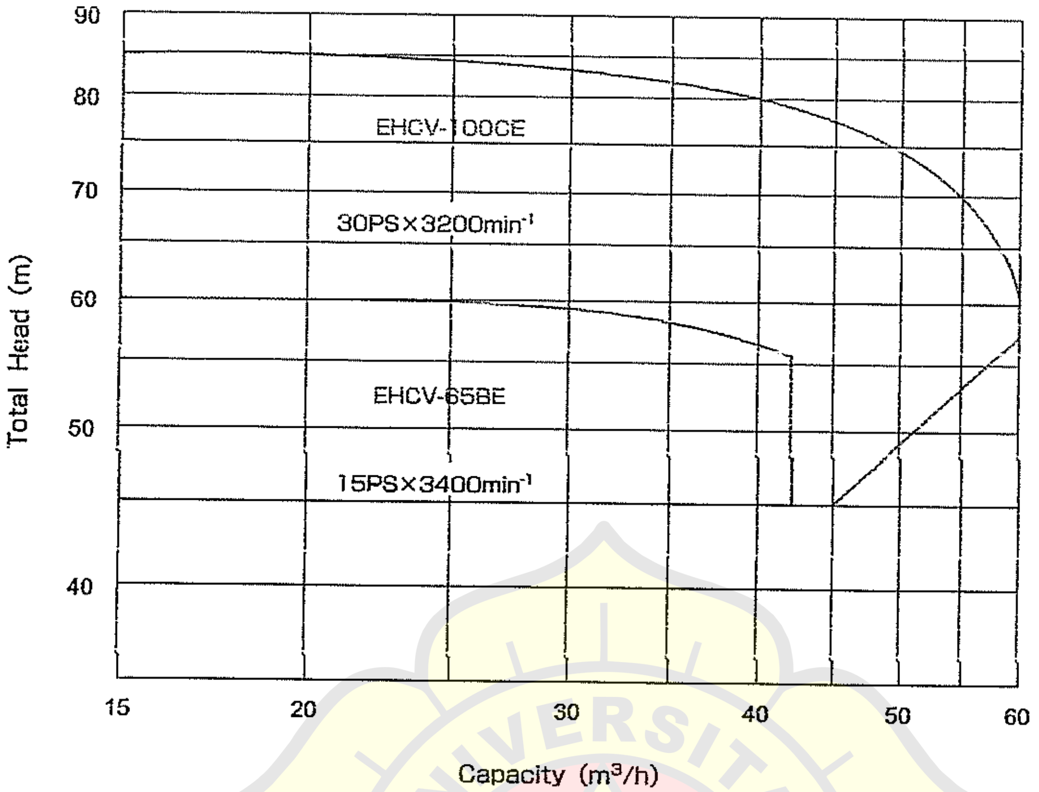


Part No.	Name	Req. No.	Sea Water		Fresh Water	
			Material	JIS	Material	JIS
001	CASING	1	BRONZE	CAC402	CAST IRON	FC200
002	CASING COVER	1	BRONZE	CAC402	CAST IRON	FC200
003	IMPELLER	1	PHOSPHOR BRONZE	CAC502A	PHOSPHOR BRONZE	CAC502A
020	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
021	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
050	O-RING	1	RUBBER	NBR	RUBBER	NBR
101	SHAFT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
103	KEY	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
104	KEY	1	CARBON STEEL	S45C	CARBON STEEL	S45C
120	IMPELLER NUT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
124	IMPELLER WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
136	SPRING WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
161	RETAINING RING	1	SPRING STEEL	SUP6	SPRING STEEL	SUP6
170	FLINGER	1	RUBBER	NBR	RUBBER	NBR

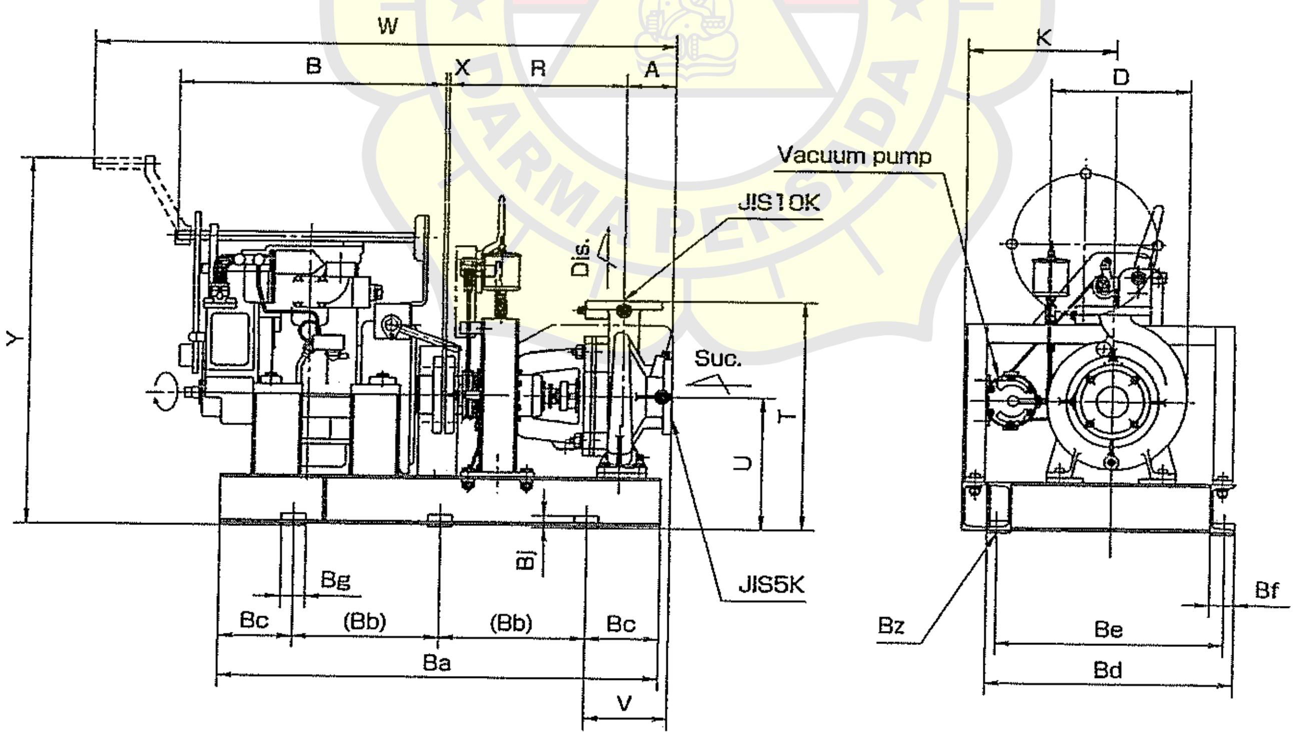
Part No.	Name	Req. No.	Sea Water		Fresh Water	
			Material	JIS	Material	JIS
201	BALL BEARING	1	BEARING STEEL	SUJ2	BEARING STEEL	SUJ2
202	BALL BEARING	1	BEARING STEEL	SUJ2	BEARING STEEL	SUJ2
205	BEARING HOUSING	1	CAST IRON	FC200	CAST IRON	FC200
209	BEARING COVER	1	CAST IRON	FC200	CAST IRON	FC200
301	COUPLING	1	CAST IRON	FC200	CAST IRON	FC200
302	COUPLING	1	CAST IRON	FC200	CAST IRON	FC200
304	COUPLING RING	8	RUBBER	NBR	RUBBER	NBR
305	COUPLING BOLT & NUT	8	MILD STEEL	SS400	MILD STEEL	SS400
406	SUPPORT	1	MILD STEEL	SS400	MILD STEEL	SS400
501	GLAND PACKING	4	CARBONIZED FIBER	–	CARBONIZED FIBER	–
503	LANTERN RING	1	BRONZE	CAC402	BRONZE	CAC402
504	GLAND	1	BRONZE	CAC402	BRONZE	CAC402
815	PLATE	1	MILD STEEL	SS400	MILD STEEL	SS400

CENTRIFUGAL PUMP

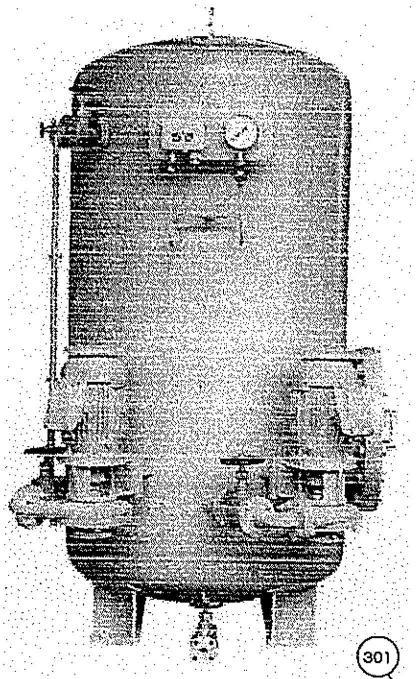
Performance



Dimension



Model No.	Engine		Bore		Dimension (mm)																			
	PS	min^{-1}	Suc.	Dis.	A	B	D	K	R	T	U	V	W	X	Y	Ba	Bb	Bc	Bd	Be	Bf	Bg	Bj	Bz
EHCV-65BE	15	3400	65	50	100	547	266	305	366	475	275	170	1190	3	766	900	600	150	510	470	50	50	25	4-φ15
EHCV-100CE	30	3200	100	80	125	667	390	315	470	629	345	185	1525	3	989	1200	450	150	530	490	50	50	30	6-φ19



HYDROPHORE TANK UNIT

UH

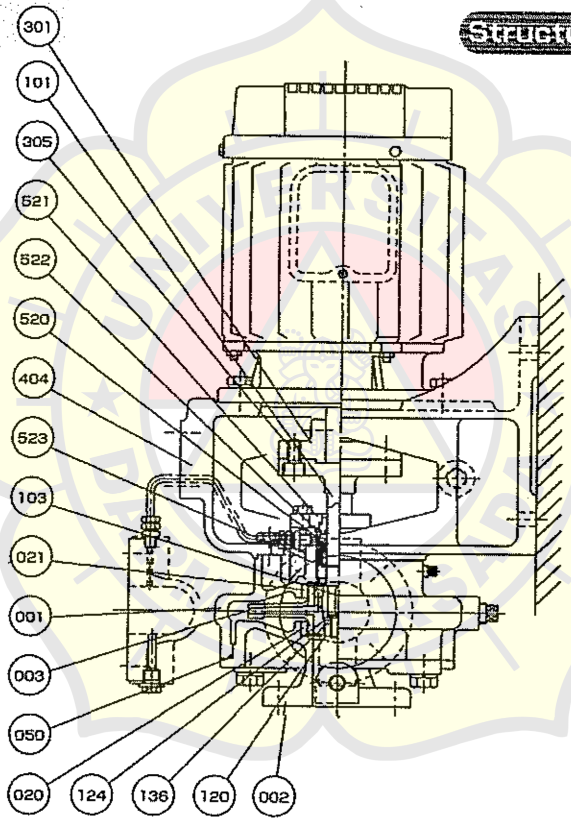
Application

Fresh Water
Sanitary Water
Drinking Water

Feature

F.W. & Sanitary

Structure & Material



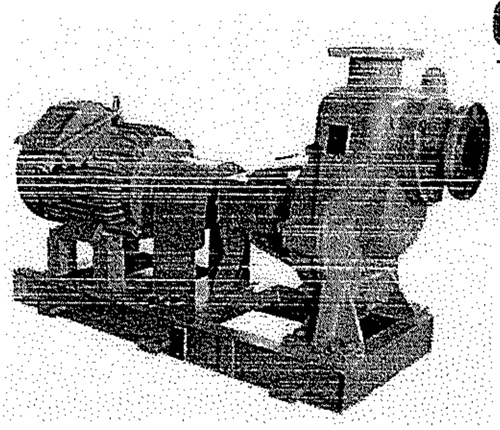
TMV-OOMT TYPE

Part No.	Name	Req. No.	Sea Water		Fresh Water	
			Material	JIS	Material	JIS
001	CASING	1	BRONZE	CAC402	CAST IRON	FC200
002	CASING COVER	1	BRONZE	CAC402	CAST IRON	FC200
003	IMPELLER	1	PHOSPHOR BRONZE	CAC502A	PHOSPHOR BRONZE	CAC502A
020	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
021	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
050	O-RING	1	RUBBER	NBR	RUBBER	NBR
101	SHAFT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
103	KEY	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
120	IMPELLER NUT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304

Part No.	Name	Req. No.	Sea Water		Fresh Water	
			Material	JIS	Material	JIS
124	IMPELLER WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
136	SPRING WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
301	COUPLING	1	MILD STEEL	SS400	MILD STEEL	SS400
305	COUPLING BOLT	4	Cr-Mo STEEL	SCM435	Cr-Mo STEEL	SCM435
404	PUMP FRAME	1	CAST IRON	FC200	CAST IRON	FC200
520	MECHANICAL SEAL	1	SiC & CARBON	—	SiC & CARBON	—
521	MECH. SEAL COVER	1	BRONZE	CAC402	BRONZE	CAC402
522	O-RING	1	RUBBER	NBR	RUBBER	NBR
523	RETAINING RING	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304

CENTRIFUGAL PUMP

EHS



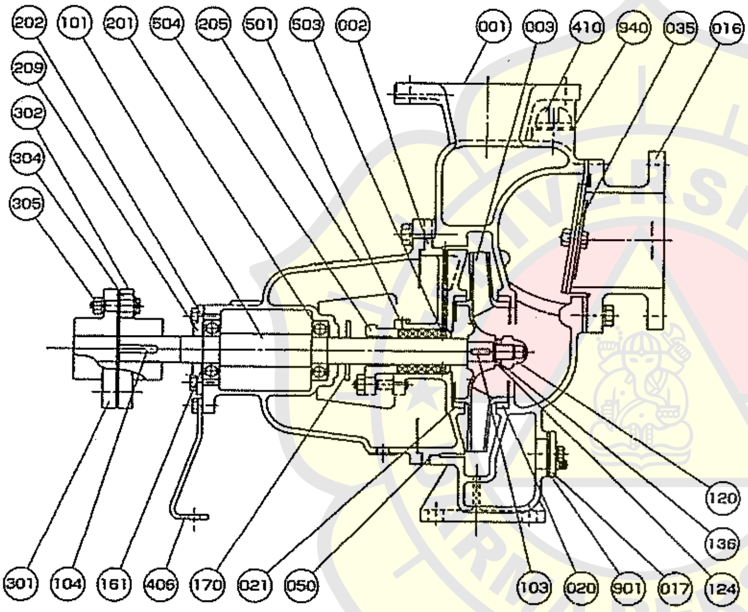
Application

Fire & G.S. Pump
Bilge & Ballast Pump

Feature

Horizontal Single-stage Single-suction
Self-priming Type

Structure & Material

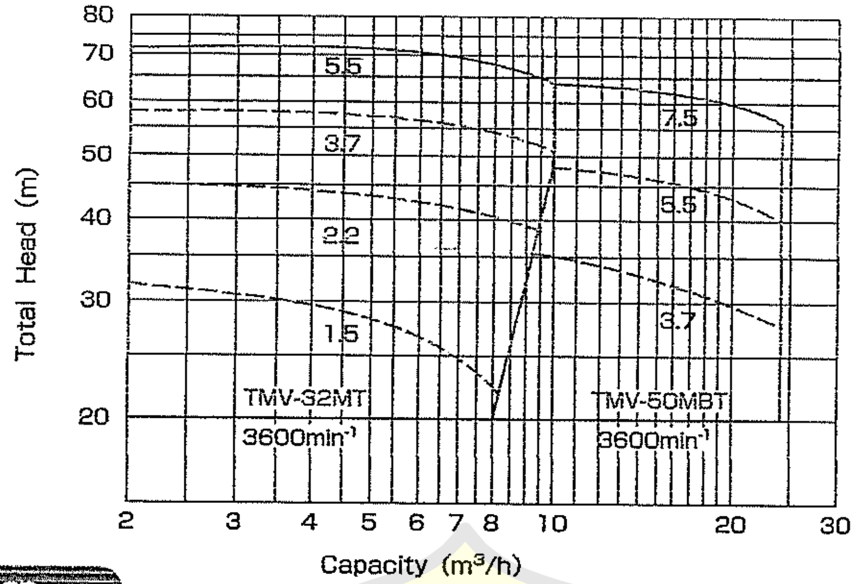


Part No.	Name	Req. No.	Sea Water Material	Sea Water JIS	Fresh Water Material	Fresh Water JIS
001	CASING	1	BRONZE	CAC402	CAST IRON	FC200
002	CASING COVER	1	BRONZE	CAC402	CAST IRON	FC200
003	IMPELLER	1	PHOSPHOR BRONZE	CAC502A	PHOSPHOR BRONZE	CAC502A
016	SUCTION COVER	1	BRONZE	CAC402	CAST IRON	FC200
017	DRAIN COVER	1	BRONZE	CAC402	CAST IRON	FC200
020	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
021	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
035	CHECK VALVE	1	RUBBER /BRONZE	NBR /CAC402	RUBBER /BRONZE	NBR /CAC402
050	O-RING	1	RUBBER	NBR	RUBBER	NBR
101	SHAFT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
103	KEY	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
104	KEY	1	CARBON STEEL	S45C	CARBON STEEL	S45C
120	IMPELLER NUT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
124	IMPELLER WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
136	SPRING WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
161	RETAINING RING	1	SPRING STEEL	SUP6	SPRING STEEL	SUP6

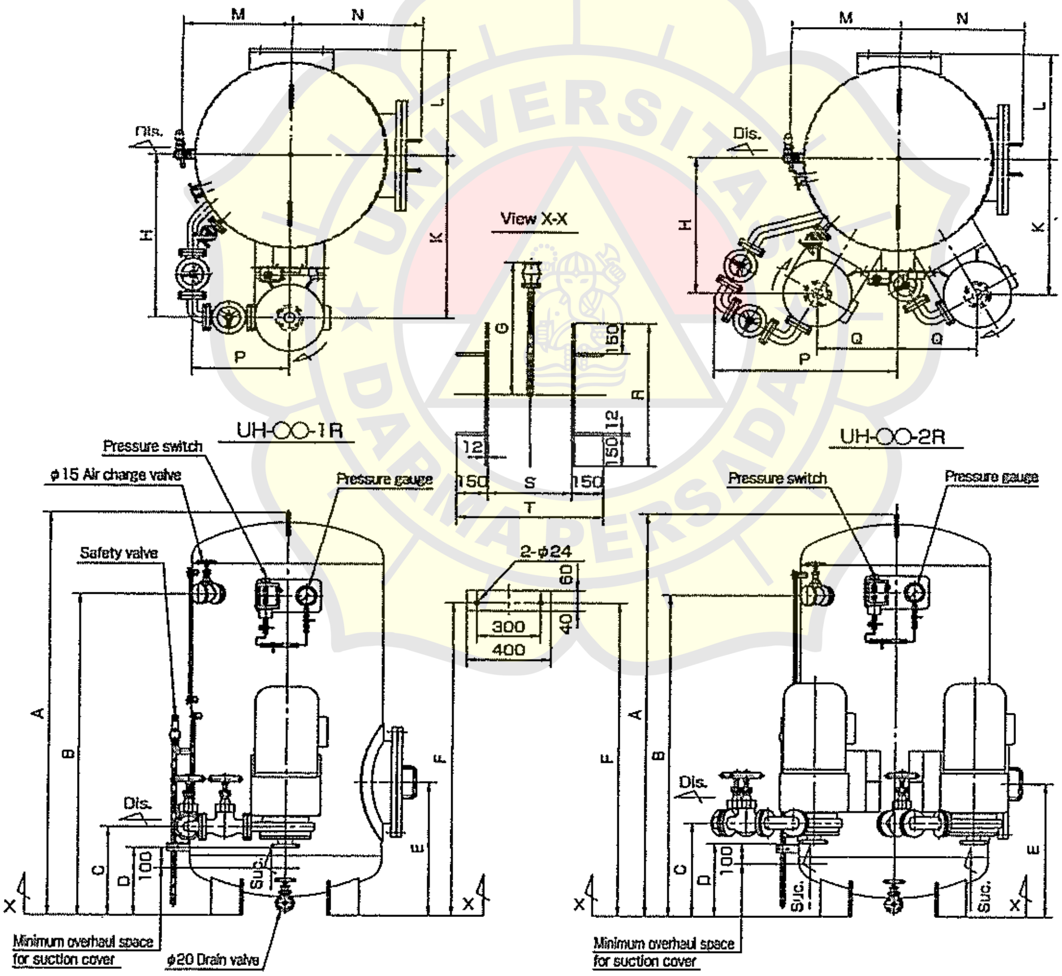
Part No.	Name	Req. No.	Sea Water Material	Sea Water JIS	Fresh Water Material	Fresh Water JIS
170	FLINGER	1	RUBBER	NBR	RUBBER	NBR
201	BALL BEARING	1	BEARING STEEL	SUJ2	BEARING STEEL	SUJ2
202	BALL BEARING	1	BEARING STEEL	SUJ2	BEARING STEEL	SUJ2
205	BEARING HOUSING	1	CAST IRON	FC200	CAST IRON	FC200
209	BEARING COVER	1	CAST IRON	FC200	CAST IRON	FC200
301	COUPLING	1	CAST IRON	FC200	CAST IRON	FC200
302	COUPLING	1	CAST IRON	FC200	CAST IRON	FC200
304	COUPLING RING	8	RUBBER	NBR	RUBBER	NBR
305	COUPLING BOLT&NUT	8	MILD STEEL	SS400	MILD STEEL	SS400
406	SUPPORT	1	MILD STEEL	SS400	MILD STEEL	SS400
410	PRIMING CAP	1	BRONZE	CAC402	BRONZE	CAC402
501	GLAND PACKING	4	CARBONIZED FIBER	—	CARBONIZED FIBER	—
503	LANTERN RING	1	BRONZE	CAC402	BRONZE	CAC402
504	GLAND	1	BRONZE	CAC402	BRONZE	CAC402
901	GASKET	1	RUBBER	NBR	RUBBER	NBR
940	GASKET	1	RUBBER	NBR	RUBBER	NBR

HYDROPHORE TANK UNIT

Performance



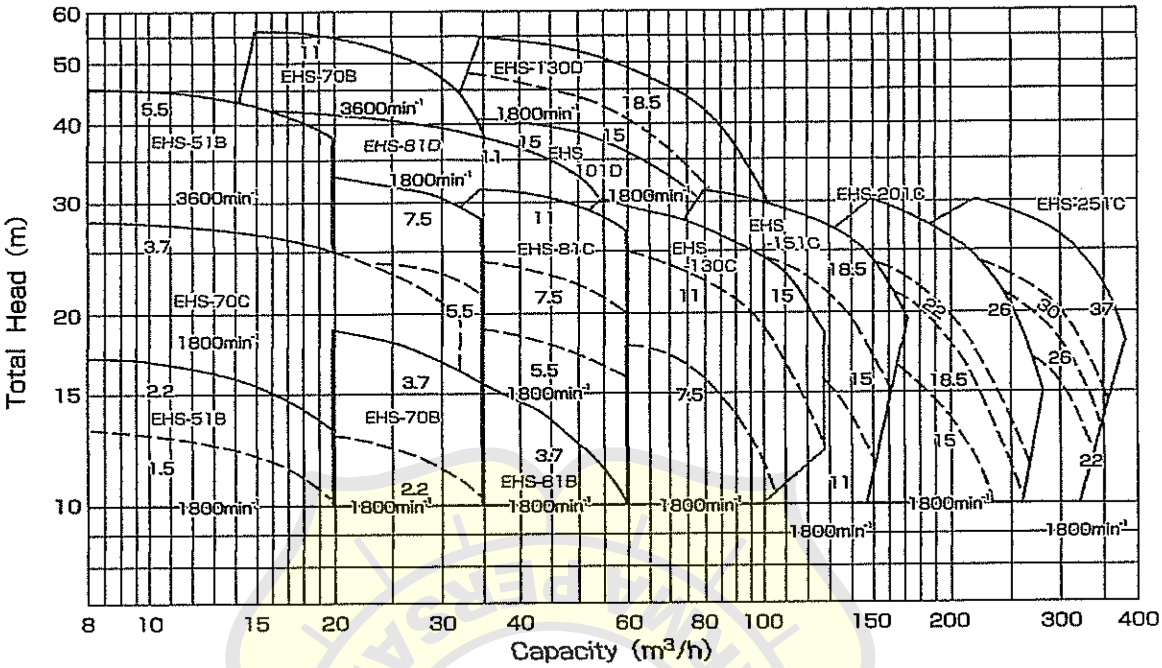
Dimension



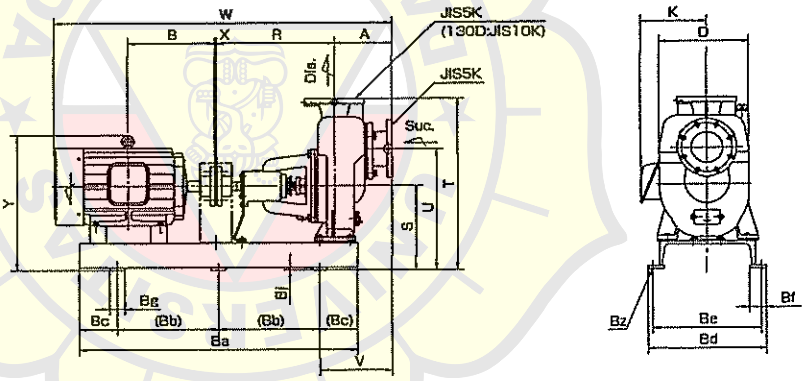
※mark is based on the bore size of attached pump.

Model No.	Bore		Tank Volume (L)	Dimension (mm)																
	Suc.	Dis.		A	B	C	D	E	F	G	H	K	L	M	N	P	Q	R	S	T
UH-0.5-1R	※	50	500	1198	805	450	350	600	795	625	680	680	495	520	595	260	–	700	400	700
UH-0.5-2R	※	50	500	1198	880	450	350	600	795	625	589	589	495	520	595	560	340	700	400	700
UH-1.0-1R	※	50	1000	1967	1570	450	350	650	1620	650	720	720	520	520	620	240	–	700	400	700
UH-1.0-2R	※	50	1000	1967	1570	450	350	650	1620	650	624	624	520	520	620	580	360	700	400	700
UH-1.5-1R	※	50	1500	1956	1530	450	350	700	1620	750	820	820	620	650	715	240	–	800	500	800
UH-1.5-2R	※	50	1500	1956	1530	450	350	700	1520	750	710	710	620	650	715	630	410	800	.500	800
UH-2.0-1R	※	50	2000	2170	1700	450	350	750	1690	800	960	960	670	700	785	280	–	900	600	900
UH-2.0-2R	※	50	2000	2170	1700	450	350	750	1690	800	830	830	670	700	785	734	480	900	600	900

Performance



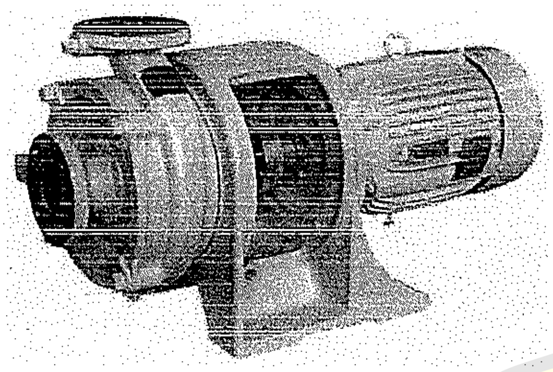
Dimension



Model No.	Motor		Bore		Dimension (mm)																				
	kW	min⁻¹	Suc.	Dis.	A	B	D	K	R	S	T	U	V	W	X	Y	Ba	Bb	Bc	Bd	Be	Bf	Bg	Bj	Bz
EHS-51B	1.5	1800	50	50	178	168.5	254	188	355	270	538	380	238	867	3	365	700	450	125	325	290	55	50	12	4-φ15
	2.2					193		197						914		375									
	5.5	3600				239		245						990		428	800	500	150			50			
EHS-70B	2.2	1800	65	65	188	193	262	197	355	270	538	380	248	924	3	375	700	450	125	325	290	55	50	12	4-φ15
	3.7					200		212						944		416	800	500	150			50			
	11	3600				323		285						1154		500	1000	700		390	350	65	60		4-φ19
EHS-70C	3.7	1800	65	65	188	200	313	212	355	290	585	430	248	944	3	436	800	500	150	390	350	65	60	12	4-φ15
	5.5					239		245						1000											
	7.5					258							273	1039			900	550	175						4-φ19
EHS-81B	3.7	1800	80	80	230	200	276	212	365	290	585	400	300	996	3	436	800	500	150	390	350	65	60	12	4-φ15
EHS-81C	5.5	1800	80	80	205	239	337	245	470	320	670	470	265	1132	3	478	1000	350	150	470	430	65	60	12	6-φ19
	7.5					258								1171											
	11					323		285						1286		550	1100	400							
EHS-81D	11	1800	80	80	215	323	384	285	470	345	720	520	275	1296	3	575	1100	400	150	470	430	65	60	12	6-φ19
EHS-101D	15	1800	100	100	225	345	400	285	470	370	745	545	285	1348	3	600	1100	400	150	470	430	65	60	12	6-φ19
EHS-130C	7.5	1800	125	125	225	258	358	245	470	345	700	495	285	1191	3	503	1000	350	150	470	430	65	60	12	6-φ19
	11					323		285						1306		575	1100	400							
	15					345								1348											
EHS-130D	15	1800	125	100	280	345	416	285	575	370	770	545	340	1508	3	600	1200	450	150	470	430	65	60	12	6-φ19
	18.5					351.5		330						1520		630									
EHS-151C	11	1800	150	150	285	323	353	285	470	345	720	520	345	1366	3	575	1100	400	150	470	430	65	60	12	6-φ19
	15					345								1408											
	18.5					351.5		330						1420		605									
EHS-201C	15	1800	200	200	325	345	400	285	470	370	810	570	385	1448	3	600	1100	400	150	470	430	65	60	12	6-φ19
	18.5					351.5		330						1460		630									
	22																								
	26					370.5								1499			1200	450							
EHS-251C	22	1800	250	250	335	351.5	500	330	530	430	960	660	365	1530	3	690	1200	450	150	550	500	65	60	25	6-φ19
	26					370.5								1569											
	30																								
	37					425.5		345						1650	4	705	1300	500							

CENTRIFUGAL PUMP

TMC



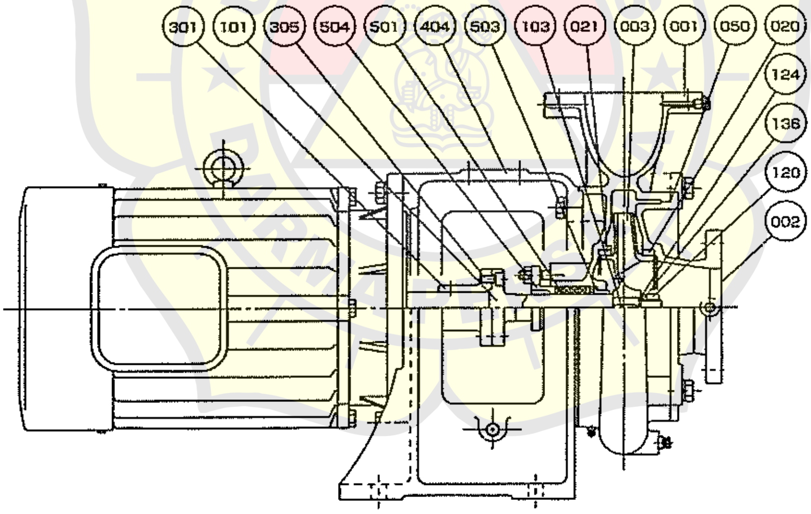
Application

Cooling Fresh Water
Cooling Sea Water
Sea Water Service

Feature

Horizontal Single-stage Single-suction
Closed Coupling Type

Structure & Material

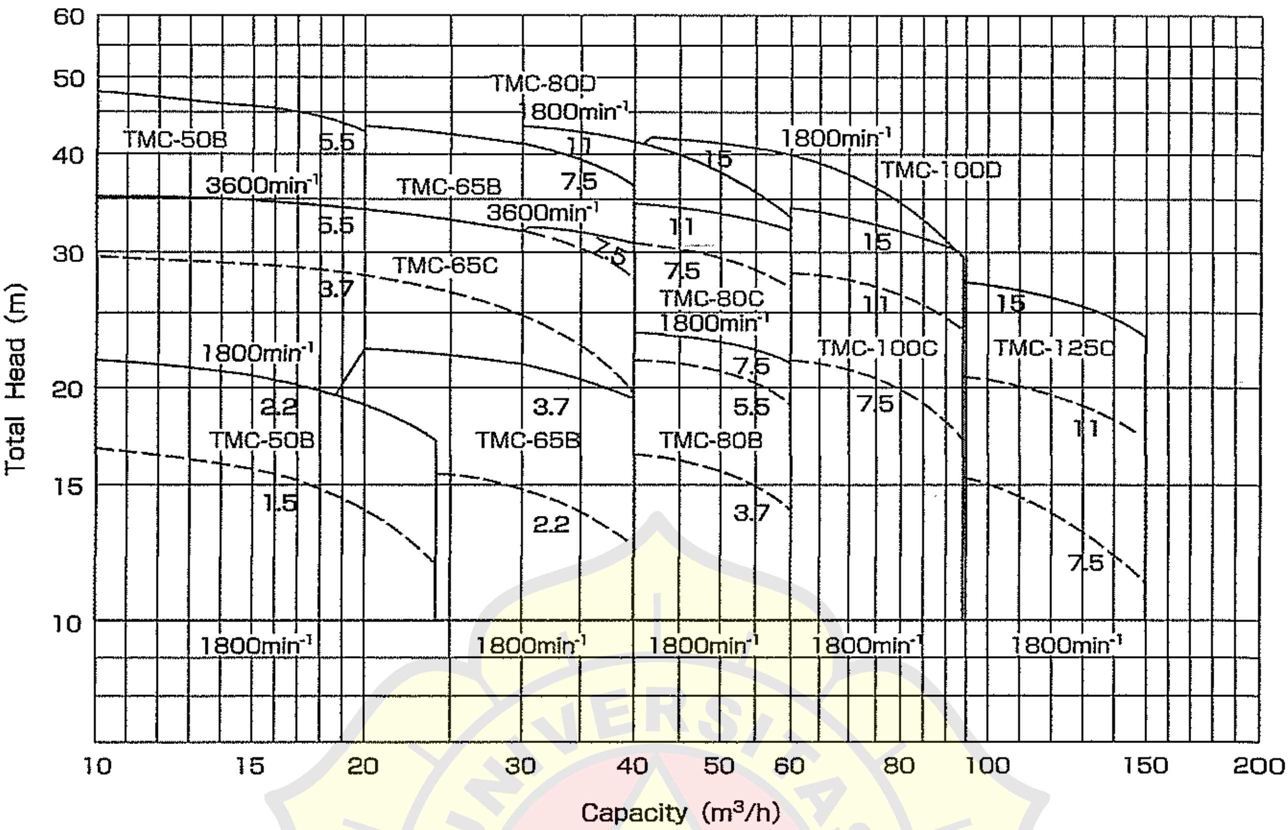


Part No.	Name	Req. No.	Sea Water Material	Sea Water JIS	Fresh Water Material	Fresh Water JIS
001	CASING	1	BRONZE	CAC402	CAST IRON	FC200
002	CASING COVER	1	BRONZE	CAC402	CAST IRON	FC200
003	IMPELLER	1	PHOSPHOR BRONZE	CAC502A	PHOSPHOR BRONZE	CAC502A
020	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
021	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
050	O-RING	1	RUBBER	NBR	RUBBER	NBR
101	SHAFT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
103	IMPELLER KEY	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
120	IMPELLER NUT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304

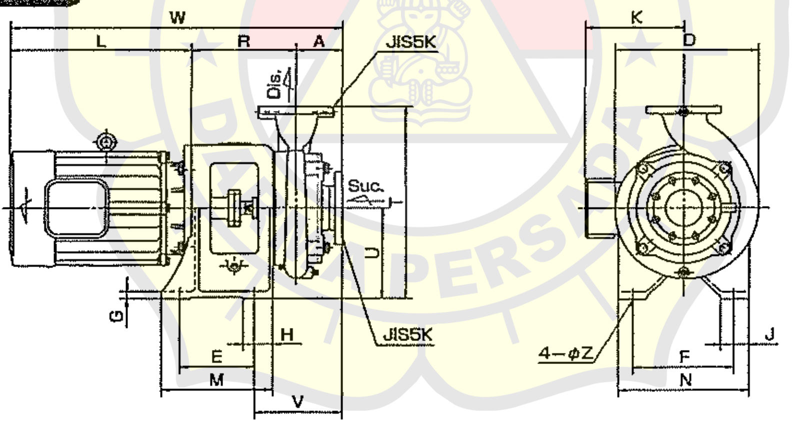
Part No.	Name	Req. No.	Sea Water Material	Sea Water JIS	Fresh Water Material	Fresh Water JIS
124	IMPELLER WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
136	SPRING WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
301	COUPLING	1	MILD STEEL	SS400	MILD STEEL	SS400
305	COUPLING BOLT	4	Cr-Mo STEEL	SCM435	Cr-Mo STEEL	SCM435
404	FRAME	1	CAST IRON	FC200	CAST IRON	FC200
501	GLAND PACKING	4	CARBONIZED FIBER	–	CARBONIZED FIBER	–
503	LANTERN RING	1	BRONZE	CAC402	BRONZE	CAC402
504	GLAND	1	BRONZE	CAC402	BRONZE	CAC402

CENTRIFUGAL PUMP

Performance



Dimension



Model No.	Motor		Bore		Dimension (mm)																
	kW	min⁻¹	Suc.	Dis.	A	D	E	F	G	H	J	K	L	M	N	R	T	U	V	W	Z
TMC-50B	1.5	1800	50	50	100	265	150	220	15	80	65	195	300	250	280	215	370	190	205	615	15
	2.2						180		18			205	330	280		225				655	
	5.5	3600					200	270				265	400	300	330	245	390	210		745	
TMC-65B	2.2	1800	65	65	100	285	180	220	18	80	65	205	330	280	280	227	390	190	207	657	15
	3.7											215	355							682	
	7.5	3600					200	270				265	400	300	330	247	410	210		747	
TMC-65C	3.7	1800	65	65	100	335	180	220	18	80	65	215	355	280	280	227	415	190	207	682	15
	5.5						200	270				265	400	300	330	247	435	210		747	
	7.5																				
TMC-80B	3.7	1800	80	80	100	325	180	220	18	80	65	215	355	280	280	232	415	190	212	687	15
	5.5						200	270				265	400	300	330	252	435	210		752	
	7.5																				
TMC-80C	7.5	1800	80	80	100	365	200	270	18	80	75	265	400	300	350	252	500	250	212	752	19
	11								20			285	485			282				867	
TMC-80D	11	1800	80	80	125	405	200	270	20	80	75	285	485	300	350	290	530	250	245	900	19
TMC-100C	7.5	1800	100	100	125	385	200	270	18	80	75	265	400	300	350	253	530	250	238	778	19
	11								20			285	485			283				893	
	15												525							933	
TMC-100D	15	1800	100	100	125	405	200	270	20	80	75	285	525	300	350	290	565	250	245	940	19
TMC-125C	7.5	1800	125	125	140	420	200	270	18	80	75	265	400	300	350	265	530	250	265	805	19
	11								20			285	485			295				920	
	15												525							960	

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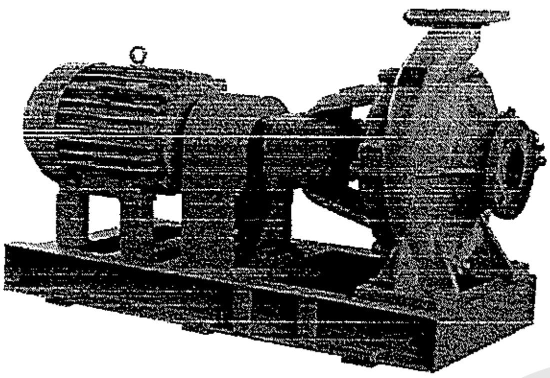
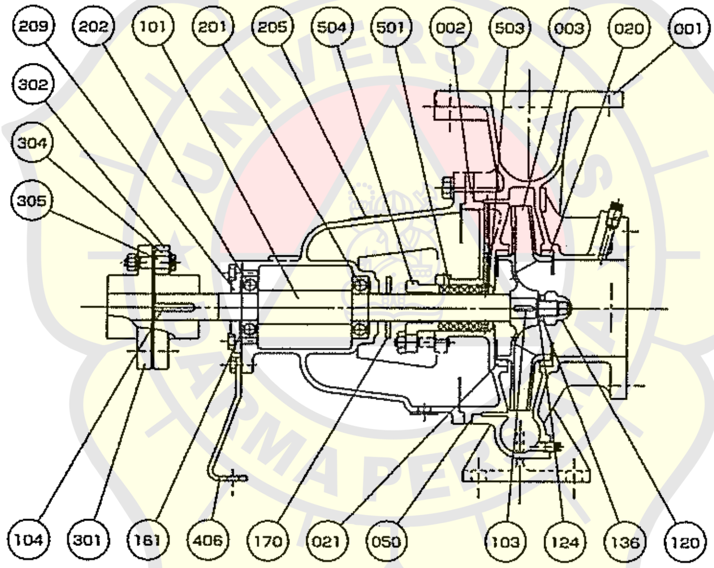
CENTRIFUGAL PUMP
EHC



Application
Cooling Fresh Water
Cooling Sea Water
Sea Water Service

Feature
Horizontal Single-stage Single-suction

Structure & Material

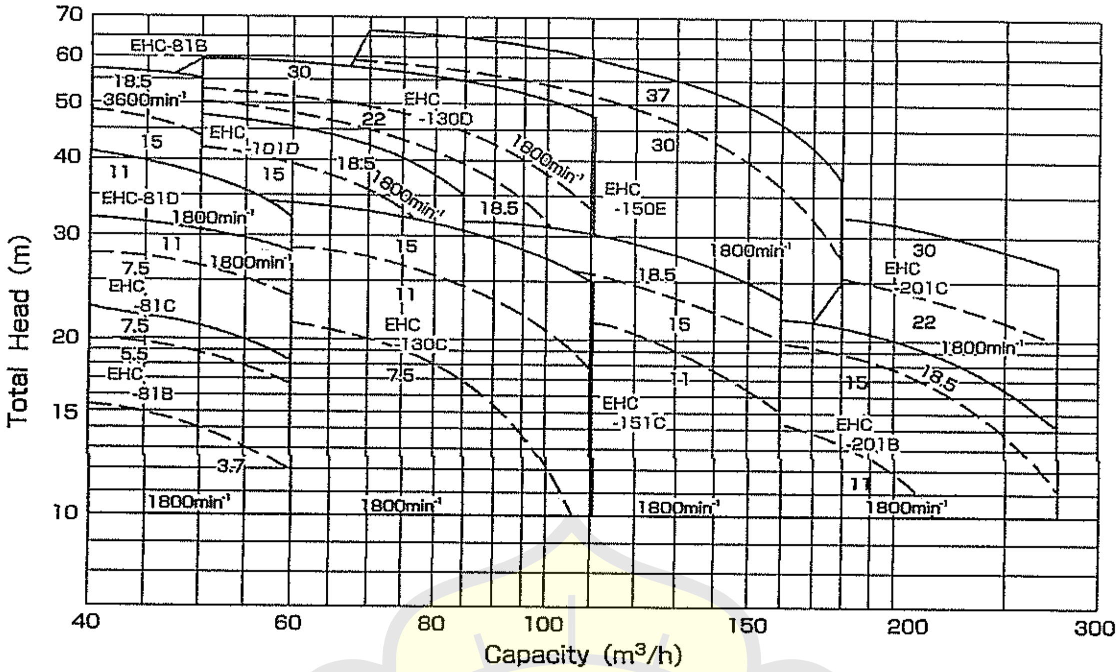


Part No.	Name	Req. No.	Sea Water Material	Sea Water JIS	Fresh Water Material	Fresh Water JIS
001	CASING	1	BRONZE	CAC402	CAST IRON	FC200
002	CASING COVER	1	BRONZE	CAC402	CAST IRON	FC200
003	IMPELLER	1	PHOSPHOR BRONZE	CAC502A	PHOSPHOR BRONZE	CAC502A
020	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
021	CASING RING	1	BRONZE	CAC402	BRONZE	CAC402
050	O-RING	1	RUBBER	NBR	RUBBER	NBR
101	SHAFT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
103	IMPELLER KEY	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
104	COUPLING KEY	1	CARBON STEEL	S45C	CARBON STEEL	S45C
120	IMPELLER NUT	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
124	IMPELLER WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
136	SPRING WASHER	1	STAINLESS STEEL	SUS304	STAINLESS STEEL	SUS304
161	RETAINING RING	1	SPRING STEEL	SUP6	SPRING STEEL	SUP6

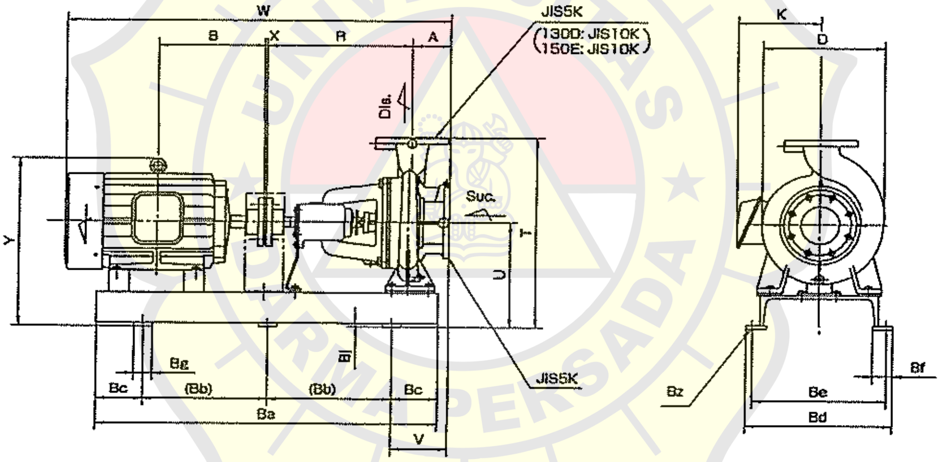
Part No.	Name	Req. No.	Sea Water Material	Sea Water JIS	Fresh Water Material	Fresh Water JIS
170	FLINGER	1	RUBBER	NBR	RUBBER	NBR
201	BALL BEARING	1	BEARING STEEL	SUJ2	BEARING STEEL	SUJ2
202	BALL BEARING	1	BEARING STEEL	SUJ2	BEARING STEEL	SUJ2
205	BEARING HOUSING	1	CAST IRON	FC200	CAST IRON	FC200
209	BEARING COVER	1	CAST IRON	FC200	CAST IRON	FC200
301	COUPLING	1	CAST IRON	FC200	CAST IRON	FC200
302	COUPLING	1	CAST IRON	FC200	CAST IRON	FC200
304	COUPLING RING	8	RUBBER	NBR	RUBBER	NBR
305	COUPLING BOLT & NUT	8	MILD STEEL	SS400	MILD STEEL	SS400
406	SUPPORT	1	MILD STEEL	SS400	MILD STEEL	SS400
501	GLAND PACKING	4	CARBONIZED FIBER	–	CARBONIZED FIBER	–
503	LANTERN RING	1	BRONZE	CAC402	BRONZE	CAC402
504	GLAND	4	BRONZE	CAC402	BRONZE	CAC402

CENTRIFUGAL PUMP

Performance



Dimension



Model No.	Motor		Bore		Dimension (mm)																			
	kW	min⁻¹	Suc.	Dis.	A	B	D	K	R	T	U	V	W	X	Y	Ba	Bb	Bc	Bd	Be	Bf	Bg	Bj	Bz
EHC-81B	3.7	1800	80	60	100	200	326	212	360	515	290	165	861	3	436	800	500	150	390	350	65	60	12	4-φ15
	5.5					239		245					917		448									
	7.5					258						190	956			900	550	175						
	15	3600				323		285				165	1071		520	1000	700	150						4-φ19
	18.5					345							1113											
EHC-81C	7.5	1800	80	80	100	258	364	245	470	570	320	160	1066	3	478	1000	350	150	470	430	65	60	12	6-φ19
	11					323		285					1181		550	1100	400							
EHC-81D	11	1800	80	80	125	323	413	285	470	625	345	185	1206	3	575	1100	400	150	470	430	65	60	12	6-φ19
EHC-101D	15	1800	100	100	125	345	413	285	470	685	370	185	1248	3	600	1100	400	150	470	430	65	60	12	6-φ19
	18.5					351.5		330					1260		630									
EHC-130C	7.5	1800	125	125	125	258	390	245	470	625	345	185	1091	3	503	1000	350	150	470	430	65	60	12	6-φ19
	11					323		285					1206		575	1100	400							
	15					345							1248											
EHC-130D	18.5	1800	125	100	140	351.5	440	330	575	685	370	200	1380	3	630	1200	450	150	470	430	65	60	12	6-φ19
	22																							
	30					370.5							1419											
EHC-151C	11	1800	150	150	140	323	427	285	470	625	345	200	1221	3	575	1100	400	150	470	430	65	60	12	6-φ19
	15					345							1263											
	18.5					351.5		330					1275		605									
EHC-150E	30	1800	150	125	140	370.5	576	330	530	865	465	170	1374	3	725	1300	500	150	550	500	65	60	12	6-φ24
	37					425.5		345					1455	4	345									
EHC-201B	11	1800	200	200	140	323	450	285	470	685	370	200	1221	3	600	1100	400	150	470	430	65	60	12	6-φ19
	15					345							1263											
	18.5					351.5		330					1275		630									
EHC-201C	22	1800	200	200	140	351.5	475	330	470	725	370	200	1275	3	630	1100	400	150	470	430	65	60	12	6-φ19
	30					370.5							1314			1200	450							

ClassNK ISO 9001 JAB CM 005

ClassNK ISO 9001

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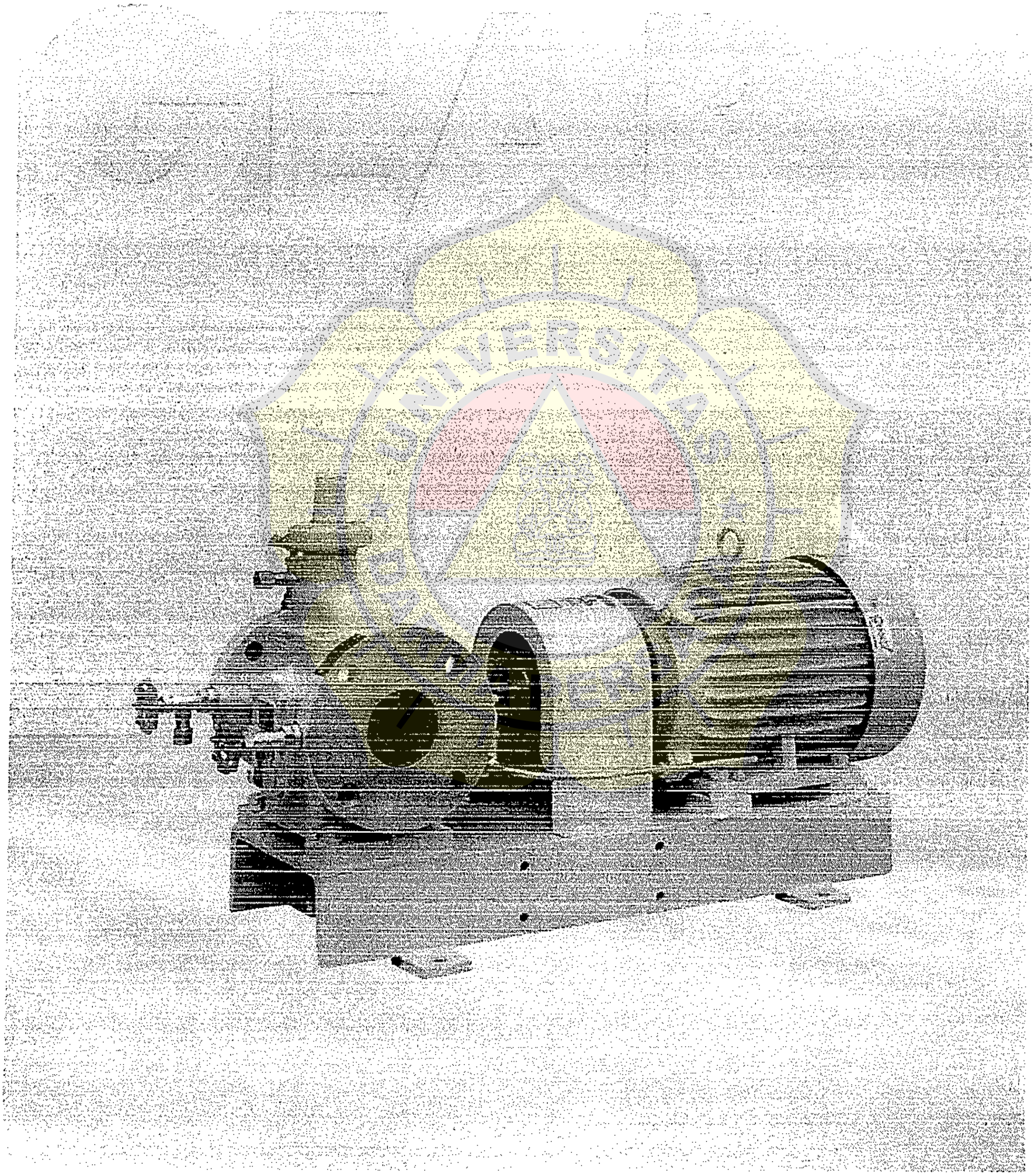
GEAR PUMP

NHG



大晃機械工業株式会社

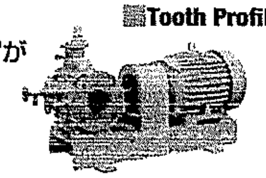
TAIKO KIKAI INDUSTRIES CO., LTD.

特長 Feature

NHGシリーズは、一般電動横形低圧・内装軸受式歯車ポンプです。

NHG series is motor driven horizontal low pressure internal bearing type gear pumps.

温　度：世界にさきがけて考案された、一点連続接触歯車"欠円ギヤー"が標準です。



Tooth Profile: To be the first in the world to design a one-point-contact-gear called "Segmental Gear" as our standard model.

仕様 Specification

歯　形：取扱い油温は、最高80℃です。

Temperature: Maximum handling oil temperature is 80℃.

軸　受：内装軸受式で揚液による自己潤滑方式のため、潤滑性を有する液に適します。

Bearing: Internal bearing is self-lubricated by pumping liquid which is suitable to serve lubricant fluids.

軸　封：グランドパッキン式が標準です。ご要望に応じて、メカニカルシール式又はオイルシール式を製作します。

Shaft Seal: The conventional gland packing is our standard; however, the mechanical seal type is also available.

フランジ：吸込み、吐出し共JIS10Kです。

Flange: Both suction and discharge are JIS10K.

軸　心：ポンプと電動機との軸継手の芯の振れの許容範囲は、回転速度2000～500min⁻¹において、軸継手側面で0.1mm以下、軸継手端面で0.1mm以下です。

Centering: If connecting the pump with the motor, the standard allowable alignment value at the rate of 2000 to 500min^{-1} at the shaft coupling side surface should be under 0.1mm and at the shaft coupling end surface should be under 0.1mm.

水圧試験：計画仕様圧力の2倍が標準です。最高1.20MPaです。

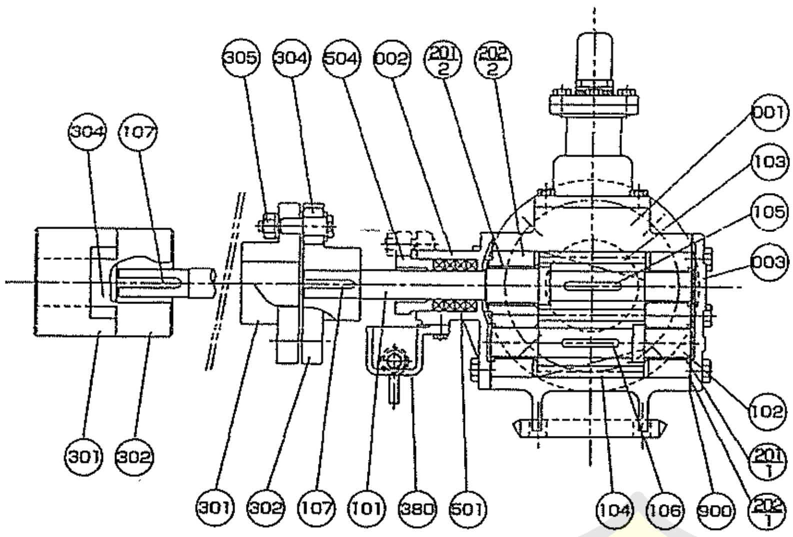
Hydraulic Test: Twice the value of the designed specification pressure with a maximum value of 1.20MPa.

吐出し量：吐出し量は、吐出圧力0.60MPa、粘度25.8mm²/sにおける量です。許容吸込圧力範囲は、ポンプ入口において、－0.05～0.20MPaです。

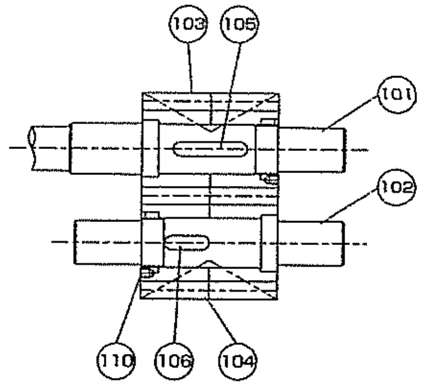
Capacity: The following capacity shows at viscosity of 25.8mm^2/s with discharge pressure of 0.60MPa. The allowable suction pressure range is −0.05 to 0.20MPa at the pump suction.

形番 Model No.	口径 Bore (mm) 吸込み×吐出し Suc.×Dis.	吐出し量 Capacity (m^3/h) 60Hz 1200min^{-1}	60Hz 1800min^{-1}	50Hz 1000min^{-1}	50Hz 1500min^{-1}
NHG-0.3	32×25	0.3	0.45	0.25	0.37
NHG-0.5		0.5	0.75	0.41	0.62
NHG-1		1	1.5	0.8	1.2
NHG-1.5	40×32	1.5	2.2	1.2	1.8
NHG-2		2	3	1.6	2.5
NHG-2.5	50×40	2.5	3.7	2	3
NHG-3		3	4.5	2.5	3.7
NHG-4	65×50	4	6	3.3	5
NHG-5		5	7.5	4	6
NHG-6		6	9	5	7.5
NHG-7.5	80×65	7.5	11	6	9
NHG-10		10	15	8	12
NHG-12		12	18	10	15
NHG-15		15	22	12	18
NHG-20	100×80	20	30	16	25
NHG-25		25	—	20	30
NHG-30	125×100	30	—	25	—

構造及び材質 Structure and Material



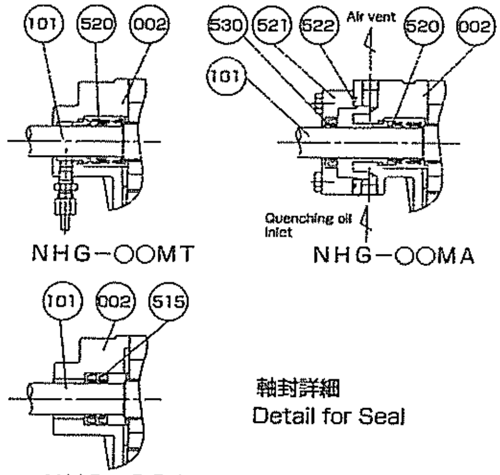
NHG−0.3 to 10



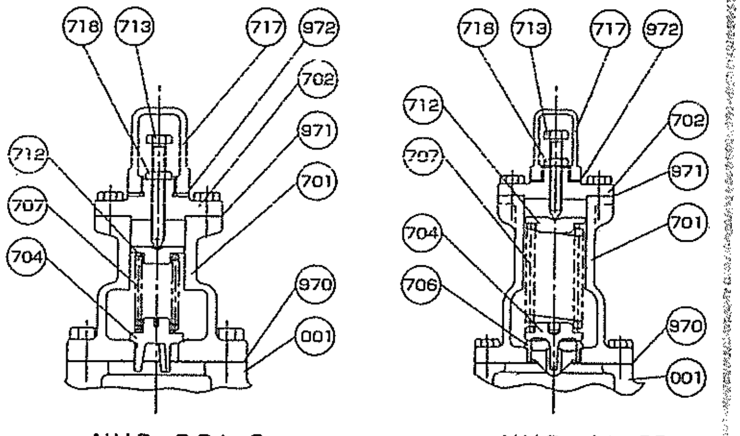
NHG−12 to 30
歯車軸詳細
Detail for Gear Shaft

No.	Name		Material Symbol	Name of Material	Q'ty
001	ケーシング	Casing	FC200	Cast iron	1
002	サイドカバー	Side cover	FC200	Cast iron	1
003	サイドカバー	Side cover	FC200	Cast iron	1
101	主動軸	Drive shaft	S45C	Carbon steel	1
102	従動軸	Driven shaft	S45C	Carbon steel	1
103	主動歯車	Drive gear	S45C	Carbon steel	1
104	従動歯車	Driven gear	S45C	Carbon steel	1
105	キー	Key	S45C	Carbon steel	1
106	キー	Key	S45C	Carbon steel	1
107	キー	Key	S45C	Carbon steel	1
110	歯車締付ナット	Gear set ring	S45C	Carbon steel	2
201/1	平軸受	Bearing metal	CAC603	(Lead bronze)	3
201/2			SPCE	Carbon steel sheet	1
202/1	ベアリングハウジング	Bearing housing	FC200	Cast iron	3
202/2					1
301	軸継手	Coupling	FC200	Cast iron	1
302	軸継手	Coupling	FC200	Cast iron	1
304	カップリングブッシュ又は軸継手用リング	Coupling bush or coupling ring	NBR	Rubber	—
305	軸継手用ボルト,ナット	Coupling bolt & nut	SS400	Mild steel	—
380	油受皿	Oil pan	FC200	Cast iron	1
501	グランドパッキン	Gland packing	—	Carbonized fiber	4

No.	Name		Material Symbol	Name of Material	Q'ty
504	グランド	Gland	AC4C-T6	Al-alloy casting	1
515	オイルシール	Oil seal	NBR	Rubber	2
520	メカニカルシール	Mechanical seal	—	SiC & Carbon or Ceramic & Carbon	1
521	メカニカルシールカバー	Seal cover	FC200	Cast iron	1
522	Oリング	O−Ring	FPM	Rubber	1
530	オイルシール	Oil seal	NBR	Rubber	1
701	逃し弁本体	Safety v. box	FC200	Cast iron	1
702	逃し弁カバー	Safety v. cover	FC200	Cast iron	1
704	逃し弁	Safety valve	CAC402or SUS410	Bronze or Stainless steel	1
706	弁座	Safety v. seat	CAC402	Bronze	1
707	逃し弁ばね	Safety v. spring	SWPA or SUP6	Piano wire or spring steel	1
712	ばね押さえ	Spring carrier	SS400	Mild steel	1
713	調整ねじ	Adjust screw	SS400	Mild steel	1
717	キャップ	Safety v. cap	FC200	Cast iron	1
718	ロックナット	Lock nut	SS400	Mild steel	1
900	ガスケット	Gasket	—	Paper	2
970	ガスケット	Gasket	—	Paper	1
971	ガスケット	Gasket	—	Paper	1
972	ガスケット	Gasket	PTFE	Teflon	1



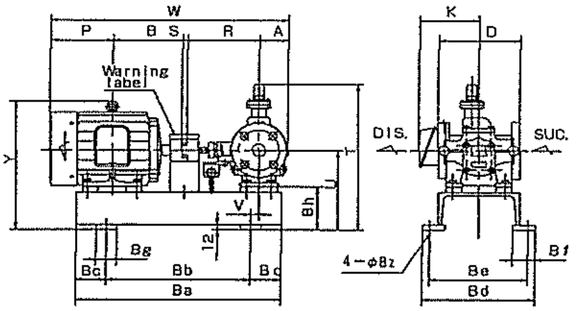
軸封詳細
Detail for Seal



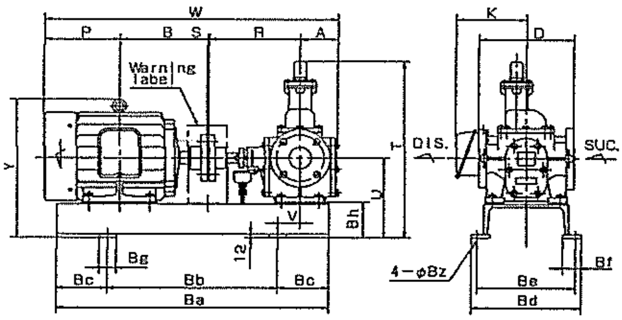
逃し弁詳細
Detail for Safety Valve

寸法 Dimension

A



B



形番 Model No.	図 fig.	電動機 Motor (kW)		寸法 Dimension (mm)																					質量 Weight (kg)			軸継手 Coupling
		6P	4P	A	B	D	K	P	R	S	T	U	V	W	Y	Ba	Bb	Bc	Bd	Be	Bf	Bg	Bh	Bz	ポンプ Pump	台板 Base	電動機 Motor	
NHG-0.3 / 0.5	A	0.4	0.75	80	140	180	145	122	150	13	340	185	15	505	270	500	350	75	275	240	55	50	105	15	8	14	11	AL090
		0.75	1.5		168.5		160	143						555	285												19	CL095
NHG-1 / 1.5 / 2		0.4	0.75	85	140	200	145	122	175	13	365	195	20	535	280	500	350	75	275	240	55	50	105	15	12	15	11	AL090
		0.75	1.5		168.5		160	143						585	295										14		19	CL095
		1.5	2.2		193		165	168.5		18				640	335	600	400	100								17	31	CL100
NHG-2.5 / 3		0.75	1.5	90	168.5	200	160	143	180	13	385	210	20	595	310	600	400	100	275	240	55	50	110	15	16	18	19	CL095
		1.5	2.2		193		165	168.5		18				650	350												31	CL100
NHG-4	B	1.5	2.2	95	193	240	165	168.5	220	3	435	210	35	680	350	600	400	100	275	240	55	50	98	15	22	18	31	A-125
		2.2	3.7		200		175	176						694	370											17	41	
NHG-5 / 6		1.5	2.2	95	193	240	165	168.5	220	3	440	210	35	680	350	600	400	100	275	240	55	50	98	15	27	18	31	A-125
		2.2	3.7		200		175	176						694	370											17	41	
		3.7	5.5		239		190	207.5			470	240		765	415	700	450	125	325	290			128			28	58	A-140
NHG-7.5 / 10		2.2	3.7	105	200	250	175	176	250	3	515	240	45	734	400	700	450	125	325	290	55	50	108	15	37	28	41	A-125
		3.7	5.5		239		190	207.5						805	415												58	A-140
		5.5	7.5		258			226.5						843		800	500	150								32	70	
NHG-12 / 15		3.7	5.5	110	239	280	190	207.5	270	3	545	240	45	830	415	700	450	125	325	290	55	50	108	15	47	30	58	A-140
		5.5	7.5		258			226.5					65	868		800	500	150								31	70	
		7.5	11		323		265	252			575	270	45	958	485	900	550	175	390	350	65	60	138	19		41	105	A-160
NHG-20 / 25		5.5	7.5	130	258	320	190	226.5	320	3	630	270	45	938	445	900	550	175	390	350	65	60	110	19	71	40	70	A-160
		7.5	11		323		265	252					75	1028	485	1000	600	200								42	105	
		11	15		345			274						1072													130	
NHG-30		11	—	145	345	320	265	274	320	3	630	270	75	1087	485	1000	600	200	390	350	65	60	110	19	75	42	130	A-160
		15	—		351.5		290	294.5			660	300	90	1114	550				470	430			140			64	175	A-180

※電動機メーカー及び形番によりW.P.Y.K寸法及び質量が異なります。
Depend on motor manufacturer and model, measurement of W.P.Y. K and weight maybe changed.

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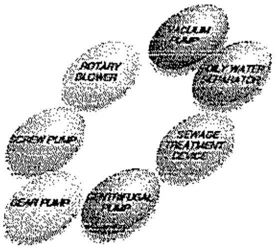

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2 | SPESIFIKASI

2.1 Spesifikasi Pompa

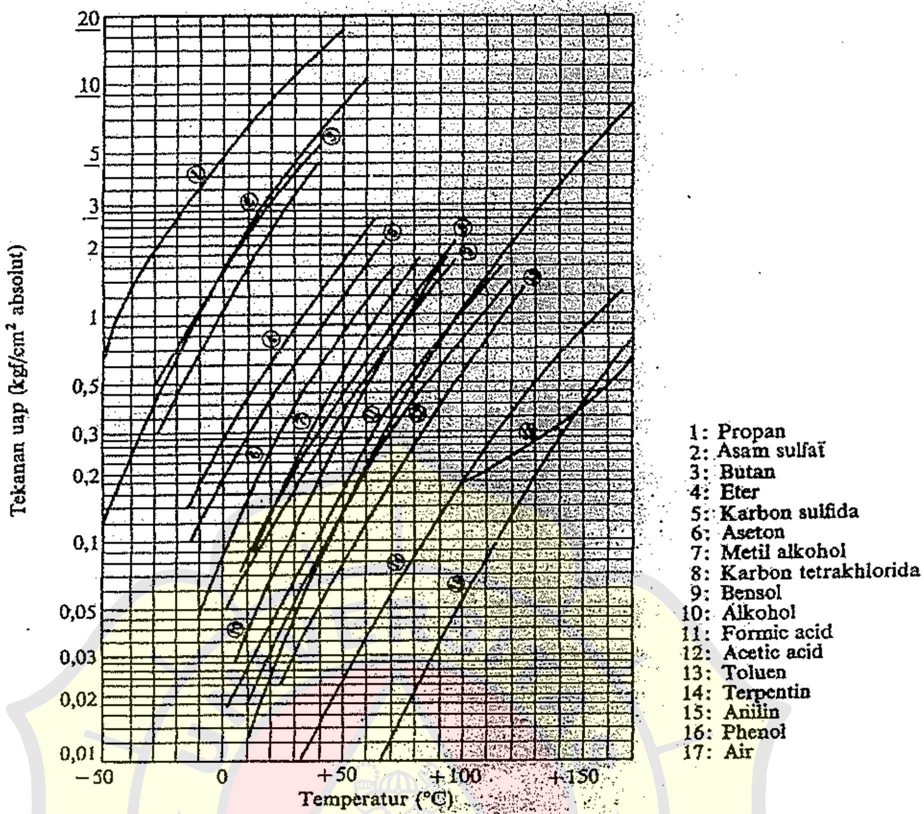
Dalam memilih suatu pompa untuk suatu maksud tertentu, terlebih dahulu harus diketahui kapasitas aliran serta head yang diperlukan untuk mengalirkan zat cair yang akan dipompa.

Selain dari pada itu, agar pompa dapat bekerja tanpa mengalami kavitasi, perlu ditaksir berapa tekanan minimum yang tersedia pada sisi masuk pompa yang terpasang pada instalasinya. Atas dasar tekanan isap ini maka putaran pompa dapat ditentukan.

Kapasitas aliran, head, dan putaran pompa dapat ditentukan seperti tersebut di atas. Tetapi apabila perubahan kondisi operasi sangat besar (khususnya perubahan kapasitas

Tabel 2.1 Data yang diperlukan untuk pemilihan pompa.

No.	Data yang diperlukan	Keterangan
1	Kapasitas	Diperlukan juga keterangan mengenai kapasitas maksimum dan minimum.
2	Kondisi isap	Tinggi isap dari permukaan air isap ke level pompa. Tinggi fluktuasi permukaan air isap. Tekanan yang bekerja pada permukaan air isap. Kondisi pipa isap.
3	Kondisi keluar	Tinggi permukaan air keluar ke level pompa. Tinggi fluktuasi permukaan air keluar. Besarnya tekanan pada permukaan air keluar. Kondisi pipa keluar.
4	Head total pompa	Harus ditentukan berdasarkan kondisi-kondisi di atas.
5	Jenis zat cair	Air tawar, air laut, minyak, zat cair khusus (zat kimia), temperatur, berat jenis, viskositas, kandungan zat padat, dll.
6	Jumlah pompa	
7	Kondisi kerja	Kerja terus-menerus, terputus-putus, jumlah jam kerja seluruhnya dalam setahun.
8	Penggerak	Motor listrik, motor bakar torak, turbin uap.
9	Poros tegak atau mendatar	Hal ini kadang-kadang ditentukan oleh pabrik pompa yang bersangkutan berdasarkan instalasinya.
10	Tempat instalasi	Pembatasan-pembatasan pada ruang instalasi, ketinggian di atas permukaan laut, di luar atau di dalam gedung, fluktuasi temperatur.
11	Lain-lain	



(b) Tekanan uap berbagai zat cair
(*Catatan*: 1 kgf/cm² = 0,1 M Pa)

Gb. 2.1 Sifat-sifat fisik berbagai zat cair.

2.4 Head

2.4.1 Head Total Pompa

Head total pompa yang harus disediakan untuk mengalirkan jumlah air seperti direncanakan, dapat ditentukan dari kondisi instalasi yang akan dilayani oleh pompa. Seperti diperlihatkan dalam Gb. 2.2, head total pompa dapat ditulis sebagai berikut:

$$H = h_a + \Delta h_p + h_l + \frac{v_d^2}{2g} \tag{2.6}$$

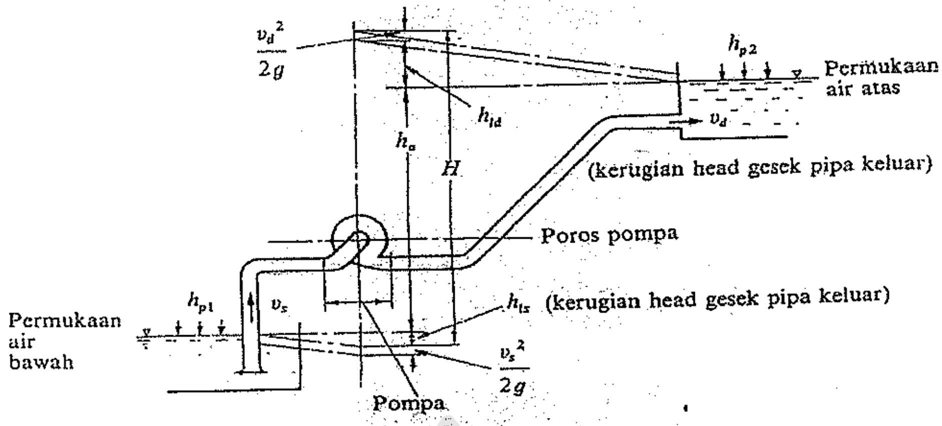
di mana H: Head total pompa (m)

h_a: Head statis total (m)
Head ini adalah perbedaan tinggi antara muka air di sisi keluar dan di sisi isap; tanda positip (+) dipakai apabila muka air di sisi ke luar lebih tinggi dari pada sisi isap.

Δh_p: Perbedaan head tekanan yang bekerja pada kedua permukaan air (m),

$$\Delta h_p = h_{p_2} - h_{p_1},$$

h_l: Berbagai kerugian head di pipa, katup, belokan, sambungan, dll (m),



Gb. 2.2 Head pompa (1).

$$h_l = h_{ld} + h_{ls}$$

$v^2/2g$: Head kecepatan keluar (m)

g: Percepatan gravitasi (= 9,8 m/s^2)

Dalam hal pompa menerima energi dari aliran yang masuk ke sisi isapnya, seperti pada pompa penguat (pompa booster), maka head total pompa dapat dihitung dengan rumus berikut:

$$H = h_a + \Delta h_p + h_l + \frac{1}{2g}(v_d^2 - v_s^2) \tag{2.7}$$

di mana h_a: Perbedaan tinggi antara titik sebarang Ⓐ di pipa keluar, dan sembarang titik Ⓑ di pipa isap (m) (Lihat Gb. 2.3).

Δh_p: Perbedaan tekanan statis antara titik Ⓐ dan titik Ⓑ (m)

h_l: Berbagai kerugian head di pipa, katup, belokan dll, antara titik Ⓐ dan titik Ⓑ (m)

v_d: Kecepatan aliran rata-rata di titik Ⓐ (m/s)

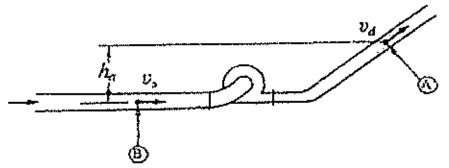
v_s: Kecepatan aliran rata-rata di titik Ⓑ (m/s)

Untuk pompa tegak yang tidak mempunyai pipa isap, $h_l = h_{ld}$.

Apabila permukaan air berubah-ubah dengan perbedaan besar, head statis total harus ditentukan dengan mempertimbangkan karakteristik pompa, besarnya selisih perubahan permukaan air, dan dasar yang dipakai untuk menentukan jumlah air yang harus dipompa.

Adapun hubungan antara tekanan dan head tekanan dapat diperoleh dari rumus berikut:

$$h_p = 10 \times \frac{p}{\gamma} \tag{2.8}$$



Gb. 2.3 Head pompa (2).

di mana h_p: Head tekanan (m)

p: Tekanan (kgf/cm^2)

γ: Berat per satuan volume zat cair yang dipompa (kgf/l)

Apabila tekanan diberikan dalam kPa, dapat dipakai rumus berikut:

$$h_p = \frac{1}{9{,}8}\frac{p'}{\rho} \tag{2.9}$$

di mana p': Tekanan (Pa)

ρ: Rapat masa (kg/l)

Menurut ISO, energi spesifik Y (J/kg) kadang-kadang dipakai sebagai pengganti head H (m). Adapun hubungannya adalah sebagai berikut:

$$Y = gH \tag{2.10}$$

Sebagaimana diutarakan di atas, untuk menentukan head total yang harus disediakan pompa, perlu dihitung lebih dahulu head kerugian h_l. Di bawah ini akan diuraikan cara menghitung kerugian head tersebut.

2.4.2 Head Kerugian

Head kerugian (yaitu head untuk mengatasi kerugian-kerugian) terdiri atas head kerugian gesek di dalam pipa-pipa, dan head kerugian di dalam belokan-belokan, reduser, katup-katup, dsb. Di bawah ini akan diberikan cara menghitungnya, satu per satu.

(1) Head kerugian gesek dalam pipa

Untuk menghitung kerugian gesek di dalam pipa dapat dipakai salah satu dari dua rumus berikut ini:

$$v = CR^pS^q \tag{2.11}$$

$$h_f = \lambda\frac{L}{D}\frac{v^2}{2g} \tag{2.12}$$

di mana v: Kecepatan rata-rata aliran di dalam pipa (m/s)

C, p, q: Koefisien-koefisien

R: Jari-jari hidrolik (m)

$$R = \frac{\text{Luas penampang pipa, tegak lurus aliran } (m^2)}{\text{Keliling pipa atau saluran yang dibasahi (m)}}$$

S: Gradien hidrolik

$$S = \frac{h_f}{L}$$

h_f: Head kerugian gesek dalam pipa (m)

λ: Koefisien kerugian gesek

g: Percepatan gravitasi (9,8 m/s^2)

L: Panjang pipa (m)

D: Diameter dalam pipa (m)

Selanjutnya, untuk aliran yang laminer dan yang turbulen, terdapat rumus yang berbeda. Sebagai patokan apakah suatu aliran itu laminer atau turbulen, dipakai bilangan Reynolds:

$$Re = \frac{vD}{\nu} \tag{2.13}$$

REFERENSI BAB VI

Pada kemudi balansir, untuk, mengurangi kemungkinan getaran, bag luasan balansir dianjurkan ≤ 23% dari seluruh luas kemudi dan lebar ba balansir pada potongan-potongan horisontal < 0,35 lebar sayap kemudi.

Pada kapal-kapal yang mempunyai batas sarat air yang cu tinggi, mempunyai ukuran yang tinggi (λ = hp/bp cukup tinggi).

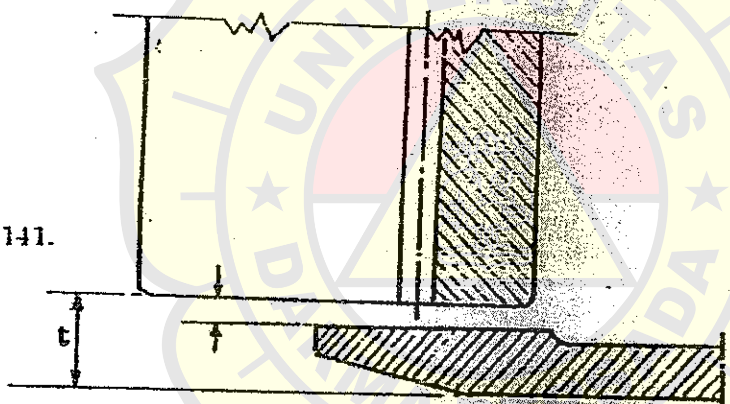
Tetapi tinggi kemudi harus diperlihatkan pula menurut ben buritan kapal.

Beberapa batasan untuk harga λ :

- Kapal barang dan kapal penumpang : λ = 1,8
- Kapal coaster : λ = 1,05 - 1,15
- Kapal tunda, pandu : λ = 1,8
- Kapal ikan ukuran sedang : λ = 1,55 - 2,0

Dianjurkan tinggi tiap-tiap kemudi harus menutupi diam baling-baling. Bagian bawah kemudi untuk menjaga kerusakan-kerus dari geseran dengan dasar laut harus lebih tinggi dari garis dasar kapal.

Batas-batasnya sebagai berikut :



Gambar 141.

- Untuk kemudi me gantung atau seten mengantung
  t = (4 - 10%) h
- Untuk kemudi ber
  t = (6 - 12)% h

Dimana :

h = tinggi kemudi

Catatan : Umumnya untuk semua bentuk diambil ketentuan :

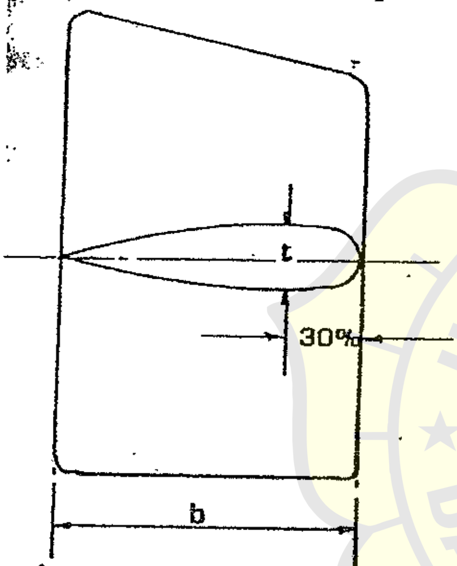
t 150 m/m.

Oleh Van Lammeren ditetapkan batasan-batasan λ = h/b sebagai berikut :

Type kapal dan kemudi	h/d
1. kapal barang 1 baling-baling dan kapal penumpang semuanya dengan kemudi balansir.	1,8
2. Kapal pantai 1 baling-baling dengan kemudi balansir.	1,15
3. Kapal tunda 1 baling-baling dan kapal pandu.	1,75

Untuk semua kapal dengan 2 baling-baling dengan-kemudi biasa.	1,5
Untuk kapal-kapal 2 baling-baling dengan kemudi-setengah balansir.	1,1
Untuk kapal-kapal dengan 2 baling-baling dengan-dua kemudi.	2,2

Bentuk kemudi harus dibuat sedemikian supaya dengan perubahan ...k kemudi dalam sudut attack yang tidak begitu besar, kapal dapat ...embuat belokan besar, dengan catatan pada saat yang sama dengan ...rubahan letak kemudi tersebut diperhitungkan supaya tidak mem-...ngaruhi kecepatan kapal.



...ambar 142.

Berdasarkan praktek yang dilakukan, koefisien tebal plat profil kemudi :
Ct = t/b terletak dalam batas-batas : 0,18 ÷ 0,22.
Tetapi untuk kemudi setengah menggantung pada kapal besar hanya Ct mencapai 0,5.
Untuk kemudi biasa (tak balansir) untuk twin screw diambil batas-batas:

Ct = 0,15 - 0,18

Untuk setengah balansir :

Ct = 0,18 - 0,22

Kemudi kembar menggantung biasanya lebih tebal dari ...emudi yang bertumpu, tetapi untuk menjaga kekuatan, kemudi ...rsebut mempunyai harga : Ct = 0,2

Untuk menghindari getaran dianjurkan supaya jarak maximum ...enampang kemudi yaitu 30% lebar profil, dihitung dari permukaan depan.

Koefisien kompensasi dihitung dengan rumus pendekatan yang ...enghasilkan perhitungan moment putar yang sangat kecil di poros, ...hingga memperkecil kekuatan motor penggerak kemudi serta penge-...aran energi untuk merubah letak kemudi.

STANDART UKURAN SEKOCI OLEH BOT (BOARD OF TRADE) ENGLAND

Tabel II

L. B. H (m)	L. B. H. (ft3)	Kapasitas (ft3)	Jumlah orang	berat sekoci (kg)	Berat Orang (kg)	berat perlengkapan (kg)	Total berat (kg)
9,4x2,74x1 x 1,114	30 x 9 x 3,75	607	60	2205	4500	356	7061
8,84 x 2,74 x 1,10	29 x 8,75 x 3,60	545	54	1976	4050	356	6382
8,53 x 2,59 x 1,07	28 x 8,50 x 3,50	500	50	1824	3750	330	5894
8,23 x 2,51 x 1,04	27 x 8,25 x 3,40	454	45	1646	3376	330	5351
7,92 x 2,44 x 0,99	26 x 8,00 x 3,25	405	40	473	3000	305	4778
7,62 x 2,36 x 0,96	25 x 7,75 x 3,15	366	36	1326	2700	305	4331
7,31 x 22,9 x 0,91	24 x 7,50 x 3,00	324	32	1180	2400	254	3843
7,01 x 2,29 x 0,88	23 x 7,50 x 2,90	300	30	1087	2250	254	3591
6,71 x 2,21 x 0,84	22 x 7,25 x 2,75	236	26	955	1950	229	3134
6,40 x 2,13 x 0,82	21 x 7,00 x 2,70	238	23	864	1725	229	2818
6,10 x 2,08 x 0,79	20 x 6,75 x 2,60	210	21	762	1575	203	2540
5,79 x 1,98 x 0,76	19 x 6,50 x 2,50	182	18	650	1350	178	2178
5,49 x 1,90 x 0,73	18 x 6,25 x 2,40	162	16	590	1200	152	1942
5,18 x 1,83 x 0,715	17 x 6,00 x 2,30	143	14	508	1050	152	1710
4,88 x 1,75 x 0,70	16 x 5,75 x 2,30	127	12	475	900	127	1484

TABEL ELECTRIC WINDLASS

Type	Diameter rantai		Gaya tarik kg.	kecepatan M/menit	Motor Hp.
	inch	m/m			
EAH - 1	$\frac{7}{8}$"	22	1850	11,8	9
	15/16"	24	2100	12,8	9
	1"	25	2300	13,4	12
	$1\frac{1}{16}$"	27	2600	11,4	12
	$1\frac{1}{8}$"	29	3175	12,0	15
EAH - 2	$1\frac{3}{16}$"	30	3675	9,0	17
	$1\frac{3}{4}$"	32	4250	9,0	17
	15/16"	33	4825	9,4	17
	$1\frac{3}{8}$"	35	5400	10,0	24
EAH - 3	$1\frac{7}{16}$"	37	5900	10,5	24
	$1\frac{1}{2}$"	38	6475	10,1	24
	$1\frac{9}{16}$"	40	7125	10,4	30
	$1\frac{5}{8}$"	41	7750	10,9	30
EAH - 4	$1\frac{11}{16}$"	43	8375	7,3	25
	$1\frac{3}{4}$"	44	9525	7,5	30
	$1\frac{13}{16}$"	46	9850	7,4	35
	$1\frac{7}{8}$"	48	10675	7,3	35
	$1\frac{15}{16}$"	49	11425	7,5	35
EAH - 5	2"	51	12375	7,3	40
	$2\frac{1}{16}$"	52	13325	7,5	40
	$2\frac{1}{8}$"	54	14300	7,3	50
	$2\frac{3}{16}$"	56	15250	7,4	50
	$2\frac{1}{4}$"	57	16200	7,6	50

Table 18.2 Anchor, Chain Cables and Ropes

No. for Reg.	Equipment numeral Z_1 or Z_2	Stockless anchor			Stud link chain cables						Recommended ropes				
		Bower anchor		Stream anchor	Bower anchors				Stream wire or chain for stream anchor		Towline		Mooring ropes		
		Number [1]	Mass per anchor		Total length	Diameter d_1	Diameter d_2	Diameter d_3	Length	Br. load [2]	Length	Br. load [2]	Number	Length	Br. load [2]
			[kg]		[m]	[mm]	[mm]	[mm]	[m]	[kN]	[m]	[kN]		[m]	[kN]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
101	up to 50	2	120	40	165	12,5	12,5	12,5	80	65	180	100	3	80	35
102	50 - 70	2	180	60	220	14	12,5	12,5	80	65	180	100	3	80	35
103	70 - 90	2	240	80	220	16	14	14	85	75	180	100	3	100	40
104	90 - 110	2	300	100	247,5	17,5	16	16	85	80	180	100	3	110	40
105	110 - 130	2	360	120	247,5	19	17,5	17,5	90	90	180	100	3	110	45
106	130 - 150	2	420	140	275	20,5	17,5	17,5	90	100	180	100	3	120	50
107	150 - 175	2	480	165	275	22	19	19	90	110	180	100	3	120	55
108	175 - 205	2	570	190	302,5	24	20,5	20,5	90	120	180	110	3	120	60
109	205 - 240	2	660		302,5	26	22	20,5			180	130	4	120	65
110	240 - 280	2	780		330	28	24	22			180	150	4	120	70
111	280 - 320	2	900		357,5	30	26	24			180	175	4	140	80
112	320 - 360	2	1020		357,5	32	28	24			180	200	4	140	85
113	360 - 400	2	1140		385	34	30	26			180	225	4	140	95
114	400 - 450	2	1290		385	36	32	28			180	250	4	140	100
115	450 - 500	2	1440		412,5	38	34	30			180	275	4	140	110
116	500 - 550	2	1590		412,5	40	34	30			190	305	4	160	120
117	550 - 600	2	1740		440	42	36	32			190	340	4	160	130
118	600 - 660	2	1920		440	44	38	34			190	370	4	160	145
119	660 - 720	2	2100		440	46	40	36			190	405	4	160	160
120	720 - 780	2	2280		467,5	48	42	36			190	440	4	170	170
121	780 - 840	2	2460		467,5	50	44	38			190	480	4	170	185
122	840 - 910	2	2640		467,5	52	46	40			190	520	4	170	200
123	910 - 980	2	2850		495	54	48	42			190	560	4	170	215
124	980 - 1060	2	3060		495	56	50	44			200	600	4	180	230
125	1060 - 1140	2	3300		495	58	50	46			200	645	4	180	250
126	1140 - 1220	2	3540		522,5	60	52	46			200	690	4	180	270
127	1220 - 1300	2	3780		522,5	62	54	48			200	740	4	180	285
128	1300 - 1390	2	4050		522,5	64	56	50			200	785	4	180	305
129	1390 - 1480	2	4320		550	66	58	50			200	835	4	180	325
130	1480 - 1570	2	4590		550	68	60	52			220	890	5	190	325
131	1570 - 1670	2	4890		550	70	62	54			220	940	5	190	335
132	1670 - 1790	2	5250		577,5	73	64	56			220	1025	5	190	350
133	1790 - 1930	2	5610		577,5	76	66	58			220	1110	5	190	375
134	1930 - 2080	2	6000		577,5	78	68	60			220	1170	5	190	400
135	2080 - 2230	2	6450		605	81	70	62			240	1260	5	200	425
136	2230 - 2380	2	6900		605	84	73	64			240	1355	5	200	450
137	2380 - 2530	2	7350		605	87	76	66			240	1455	5	200	480
138	2530 - 2700	2	7800		632,5	90	78	68			260	1470	6	200	480
139	2700 - 2870	2	8300		632,5	92	81	70			260	1470	6	200	490
140	2870 - 3040	2	8700		632,5	95	84	73			260	1470	6	200	500
141	3040 - 3210	2	9300		660	97	84	76			280	1470	6	200	520
142	3210 - 3400	2	9900		660	100	87	78			280	1470	6	200	555
143	3400 - 3600	2	10500		660	102	90	78			280	1470	6	200	590
144	3600 - 3800	2	11100		687,5	105	92	81			300	1470	6	200	620
145	3800 - 4000	2	11700		687,5	107	95	84			300	1470	6	200	650
146	4000 - 4200	2	12300		687,5	111	97	87			300	1470	7	200	650
147	4200 - 4400	2	12900		715	114	100	87			300	1470	7	200	660
148	4400 - 4600	2	13500		715	117	102	90			300	1470	7	200	670
149	4600 - 4800	2	14100		715	120	105	92			300	1470	7	200	680
150	4800 - 5000	2	14700		742,5	122	107	95			300	1470	7	200	685
151	5000 - 5200	2	15400		742,5	124	111	97			300	1470	8	200	685
152	5200 - 5500	2	16100		742,5	127	111	97			300	1470	8	200	695
153	5500 - 5800	2	16900		742,5	130	114	100			300	1470	8	200	705
154	5800 - 6100	2	17800		742,5	132	117	102			300	1470	9	200	705
155	6100 - 6500	2	18800		742,5		120	107			300	1470	9	200	715
156	6500 - 6900	2	20000		770		124	111			300	1470	9	200	725
157	6900 - 7400	2	21500		770		127	114			300	1470	10	200	725
158	7400 - 7900	2	23000		770		132	117			300	1470	11	200	725
159	7900 - 8400	2	24500		770		137	122			300	1470	11	200	735
160	8400 - 8900	2	26000		770		142	127			300	1470	12	200	735
161	8900 - 9400	2	27500		770		147	132			300	1470	13	200	735
162	9400 - 10000	2	29000		770		152	132			300	1470	14	200	735
163	10000 - 10700	2	31000		770			137			300	1470	15	200	735
164	10700 - 11500	2	33000		770			142			300	1470	16	200	735
165	11500 - 12400	2	35500		770			147			300	1470	17	200	735
166	12400 - 13400	2	38500		770			152			300	1470	18	200	735
167	13400 - 14600	2	42000		770			157			300	1470	19	200	735
168	14600 - 16000	2	46000		770			162			300	1470	21	200	735

d_1 = Chain diameter Grade K 1 (Ordinary quality)
d_2 = Chain diameter Grade K 2 (Special quality)
d_3 = Chain diameter Grade K 3 (Extra special quality)
See also D

[1] see C.1.
[2] see F.1.2

REFERENSI BAB VII

COOLMAR®

SPLIT TYPE MARINE AIR CONDITIONER

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Brand Name: COOLMAR

MODEL NO
MAS 008
MAS 010
MAS 012
MAS 015
MAS 018
MAS 020
MAS 022
MAS 024

IKSUM01.R0.12.05

are made of chrome. The fan body can turn between 0 – 90 for the convenience during the air duct installation.

3. TECHNICAL SPECIFICATIONS TABLE

SPECIFICATIONS		Model / Unit	MAS 008	MAS 010	MAS 012	MAS 015	MAS 018	MAS 020	MAS 022	MAS 024
Cooling Capacity		Btu/h	7.500	9.500	12.200	15.000	18.200	20.000	22.100	24.600
Heating Capacity		Btu/h	7.600	9.700	12.600	15.800	18.700	20.300	22.600	25.000
Power Consumption		W	680	900	1.270	1.600	2.000	2.200	2.400	2.630
Currrent	Indoor Unit	A	0,3	0,4	0,5	0,6	0,6	0,7	0,7	0,7
	Outdoor Unit	A	3,0	3,7	5,3	6,6	8,7	10,1	10,5	11,3
Indoor Unit	Length	mm	290	290	320	450	450	450	450	450
	Width	mm	270	270	270	320	320	320	320	320
	Height	mm	320	320	320	350	350	350	350	350
	Net Weight	kg	12	12	14	18	19	19	20	22
	Air Flow	m^3/h	275	320	520	650	780	950	1.100	1.250
	Fan Motor Power	W	60	70	100	110	110	115	120	120
Outdoor Unit	Length	mm	330	330	330	330	330	330	330	330
	Width	mm	270	270	270	320	320	320	320	320
	Height	mm	320	320	340	370	370	370	400	400
	Net Weight	kg	17	18	19	25	27	27	29	32
Suction Pipe		Inch	3/8"	3/8"	3/8"	1/2"	1/2"	1/2"	1/2"	1/2"
Discharge Pipe		Inch	1/4"	1/4"	1/4"	3/8"	3/8"	3/8"	3/8"	3/8"
Condenser Pipe		Inch	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"
Drain Pipe		Inch	5/8"	5/8"	5/8"	5/8"	5/8"	5/8"	5/8"	5/8"
Duct Diameter		mm	100	100	125	125	2x125	150	150	150
Proposed Fuse for the System		A	C 16	C 16	C 16	C 20	C 20	C 25	C 25	C 25
Max Pump Current That can be Connected to the Unit Electrical Box		A	4	4	4	4	4	4	4	4
Condenser water flow		l/m	9	11	13	13	16	19	19	20
Voltage		V	230							
Frequency		Hz	50							
IP Class			IP 22							
Feeding Cable Cross Section /Type			3 x 2,5 / Tin Coated							

Refrigerant Pressure Temperature Table

°F Temp	R717 psig	R22 psig	R134a psig	R404a psig	R507 psig
-60	18.6	11.9	21.6	-	-
-55	16.7	9.2	20.2	-	-
-50	14.4	6.4	18.6	0.64	1.1
-45	11.8	2.7	16.7	2.77	3.3
-40	8.8	0.6	14.7	5.12	5.7
-35	5.5	2.6	12.3	7.72	8.4
-30	1.7	4.9	9.7	10.57	11.3
-25	1.2	7.5	6.8	14.99	14.6
-20	3.5	10.2	3.6	17.08	23.8
-18	4.5	11.4	2.2	18.52	19.5
-16	5.6	12.6	0.7	19.47	21.0
-14	6.7	13.9	0.4	21.55	22.6
-12	7.8	15.2	1.2	23.15	24.3
-10	9.0	16.5	2.0	24.79	26.0
-8	10.2	17.9	2.8	26.50	27.7
-6	11.5	19.4	3.7	28.25	29.6
-4	12.8	20.9	4.6	30.07	31.4
-2	14.2	22.4	5.5	31.94	33.4
0	15.6	24.0	6.5	33.87	35.3
1	16.4	24.8	7.0	34.86	36.4
2	17.1	25.7	7.5	35.87	37.4
3	17.9	26.5	8.0	36.89	38.5
4	18.7	27.4	8.6	37.92	39.5
5	19.5	28.3	9.1	38.97	40.6
6	20.3	29.1	9.7	40.04	41.7
7	21.1	30.0	10.2	41.12	42.8
8	22.0	31.0	10.8	42.22	44.0
9	22.8	31.9	11.4	43.34	45.1
10	23.7	32.8	12.0	44.47	46.3
11	24.6	33.8	12.6	45.62	47.5
12	25.5	34.8	13.2	46.79	48.7
13	26.4	35.8	13.8	48.97	49.9
14	27.4	36.8	14.4	49.17	51.1
15	28.3	37.8	15.1	50.39	52.4
16	29.3	38.8	15.7	51.63	53.6
17	30.3	39.9	16.4	52.88	54.9
18	31.3	40.9	17.1	54.35	56.2
19	32.4	42.0	17.7	55.44	57.6
20	33.4	43.1	18.4	56.75	58.9
21	34.5	44.2	19.2	58.08	60.3
22	35.5	45.3	19.9	59.42	61.7
23	36.6	46.5	20.6	60.79	63.1
24	37.7	47.6	21.4	61.17	64.5
25	38.8	48.8	22.1	63.57	65.9
26	40.0	50.0	22.9	64.99	67.4
27	41.2	51.2	23.7	66.44	68.9
28	42.4	52.4	24.5	67.90	70.4
29	43.7	53.7	25.3	69.38	71.9
30	44.9	54.9	26.1	70.88	73.4
31	46.1	56.2	26.9	72.40	75.0
32	47.4	57.5	27.8	73.94	76.6
33	48.7	58.8	28.6	85.50	78.2
34	50.0	60.2	29.5	77.08	79.8
35	51.4	61.5	30.4	81.68	81.4
36	52.7	62.9	31.3	80.31	83.1
37	54.1	64.3	32.2	81.95	85.5
38	55.5	65.7	33.1	83.62	86.3
39	57.0	67.1	34.1	85.31	88.3
40	58.4	68.6	35.0	87.02	90.3
41	59.2	70.0	36.0	88.72	91.3
42	61.4	71.5	37.0	90.50	93.3
43	62.9	73.0	38.0	92.98	95.3
44	64.5	74.5	39.0	94.08	97.3
45	66.1	76.1	40.0	95.90	99.3
46	67.6	77.0	41.1	97.75	101.3
47	69.3	79.2	42.2	99.61	103.3
48	70.9	80.8	43.2	101.5	105.3
49	72.6	82.4	44.3	103.42	106.3
50	74.3	84.1	45.4	105.36	108.3
55	83.2	92.6	51.2	115.41	119.3
60	92.6	101.5	57.4	126.08	130.3
65	102.8	111.3	64.0	137.39	141.3
70	113.8	121.5	71.1	149.38	154.3
75	125.5	132.2	78.7	162.05	166.3
80	138.0	143.7	86.7	175.45	180.3
85	151.4	155.7	95.2	189.54	195.3
90	165.5	168.4	104.3	204.51	210.3
95	180.6	181.9	113.9	220.22	226.3
100	196.7	196.0	124.1	236.76	243.3
105	213.9	210.8	134.9	254.15	260.3
110	231.8	226.4	146.4	272.43	279.3
115	251.0	242.8	158.4	291.62	299.3
120	271.1	260.0	171.1	347.75	319.3
125	292.5	278.1	184.5	332.85	341.3
130	314.9	297.0	198.7	354.96	364.3
135	338.8	316.8	213.5	377.96	388.3
140	363.5	337.5	229.2	377.30	413.3
145	390.2	359.1	245.6	402.30	439.3
150	417.4	381.7	262.8	427.30	467.3
155	447.0	405.4	281.0	454.02	-

Vacuum Inches of Hg

°C Temp	R717 bar	R22 bar	R134a bar	R404a bar	R507 bar
-60	0.218	0.375	0.159	0.522	0.522
-58	0.249	0.420	0.180	0.544	0.582
-56	0.283	0.469	0.205	0.608	0.646
-54	0.320	0.522	0.232	0.674	0.719
-52	0.362	0.580	0.261	0.747	0.796
-50	0.408	0.644	0.294	0.827	0.880
-48	0.459	0.713	0.330	0.913	0.970
-46	0.515	0.787	0.370	1.006	1.068
-44	0.576	0.868	0.413	1.106	1.173
-42	0.644	0.955	0.460	1.214	1.286
-40	0.717	1.049	0.516	1.330	1.408
-38	0.797	1.151	0.572	1.454	1.523
-36	0.885	1.204	0.633	1.587	1.663
-34	0.98	1.259	0.699	1.730	1.813
-32	1.083	1.376	0.770	1.882	1.973
-30	1.195	1.501	0.847	2.045	2.144
-28	1.315	1.635	0.930	2.218	2.325
-26	1.446	1.930	1.020	2.402	2.518
-24	1.587	2.092	1.116	2.598	2.723
-22	1.738	2.265	1.219	2.806	2.940
-20	1.901	2.448	1.330	3.027	3.170
-18	2.076	2.643	1.448	3.260	3.414
-16	2.263	2.849	1.575	3.507	3.671
-14	2.464	3.068	1.710	3.767	3.942
-12	2.679	3.299	1.854	4.043	4.228
-10	2.908	3.543	2.007	4.333	4.529
-8	3.152	3.801	2.170	4.639	4.846
-6	3.412	4.072	2.344	4.961	5.179
-4	3.688	4.358	2.527	5.299	5.529
-2	3.982	4.659	2.722	5.655	5.996
0	4.294	4.976	2.928	6.028	6.282
2	4.625	5.308	3.146	6.420	6.686
4	4.975	5.657	3.376	6.830	7.108
6	5.345	6.023	3.619	7.260	7.551
8	5.737	6.406	3.876	7.710	8.014
10	6.150	6.807	4.145	8.180	8.498
12	6.586	7.226	4.429	8.672	9.004
14	7.046	7.665	4.728	9.186	9.532
16	7.530	8.123	5.042	9.722	10.084
18	8.039	8.601	5.371	10.281	10.659
20	8.574	9.099	5.716	10.864	11.258
22	9.136	9.619	6.078	11.472	11.883
24	9.725	10.160	6.457	12.104	12.534
26	10.343	10.723	6.853	12.763	13.212
28	10.991	11.309	7.267	13.448	13.919
30	11.669	11.919	7.701	14.160	14.653
32	12.379	12.552	8.153	14.900	15.418
34	13.121	12.210	8.625	15.669	16.213
36	13.896	13.892	9.117	16.468	17.041
38	14.705	14.601	9.630	17.297	17.901
40	15.549	15.335	10.164	18.157	18.795
42	16.429	16.097	10.720	19.049	19.724
44	17.347	16.885	11.299	19.974	20.689
46	18.302	17.702	11.901	20.932	21.692
48	19.297	18.548	12.526	21.925	22.734
50	20.331	19.423	13.176	22.953	23.816
52	21.407	20.328	13.851	24.018	24.94
54	22.525	21.265	14.552	25.120	26.107
56	23.686	22.232	15.278	26.260	27.319
58	24.892	23.232	16.032	27.440	28.578
60	26.143	24.266	16.813	28.660	29.884
62	27.440	25.333	17.623	29.921	31.241
64	28.785	26.435	18.462	31.225	32.649
66	30.179	27.573	19.331	32.572	34.112
68	31.622	28.747	20.231	33.984	35.63
70	33.117	29.959	21.162	35.402	37.207
72	34.664	31.210	22.126	36.887	-
74	36.264	32.500	23.123	-	-
76	37.919	33.832	24.154	-	-
78	39.629	35.205	25.221	-	-
80	41.397	36.623	26.324	-	-

CONVERSIONS

- Δ1°C = Δ1.8°F or Δ1°F = Δ5⁄9 °C
- Temperature in °F = 1.8°C + 32
- Temperature in °C = 5⁄9 (F -32)
- 1 psi = 0.06895 bar = 6.895 kPa or 1 bar = 14.5 psi = 100 kPa
- Cv (U.S. GPM) = Kv multiplied by 1.156 or Kv = Cv multiplied by 0.865
- 1 American Standard Commercial Ton of Refrigeration = 12000 Btu/h = 3024 kcal/h = 3.517 kW
- 1 kW = 0.284 American Standard Commercial Ton of Refrigeration
- 1" (inch) = 25.4 mm or 1 mm = 0.03937"
- 1 ft = 0.3048 m or 1 m = 3.2806 ft
- 1 lb = 0.4536 kg or 1 kg = 2.2046 lbs

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HANSEN TECHNOLOGIES CORPORATION

Table 4-4 Thermal resistance of unit areas of selected building materials at 24°C mean temperature (cont.)

	$1/k$, m · K/W	R, m^2 · K/W
Air resistance		
Surface, still air (surface emissivity of 0.9) horizontal, heat flow up		0.11
Horizontal heat flow down		0.16
Vertical, heat flow horizontal		0.12
Surface, moving air, heating season, 6.7 m/s		0.029
" " " cooling season, 3.4 m/s		0.044
Air space, surface emissivity of 0.8, horizontal		0.14
Vertical		0.17
Surface emissivity of 0.2, horizontal		0.24
Vertical		0.36

Flat glass

	U, W/m^2 · K†	
	Summer	Winter
Single glass	5.9	6.2
Double glass, 6-mm air space	3.5	3.3
13-mm air space	3.2	2.8
Triple glass, 6-mm air spaces	2.5	2.2
13-mm air spaces	2.2	1.8
Storm windows, 25 to 100-mm air space	2.8	2.3

† Includes inside and outside air film resistance

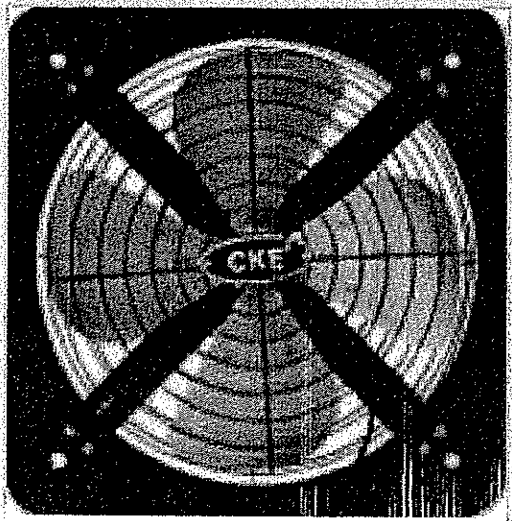
Solution The following resistances are obtained from Table 4-4:

Outside air film	0.029 m^2 · K/W
Face brick, 90 mm	0.068
Air space	0.170
Sheathing, 13-mm fiberboard	0.232
Insulation, 75-mm mineral fiber	1.940
Air space	0.170
Gypsum board, 13 mm	0.080
Inside air film	0.120
R_{tot}	2.809 m^2 · K/W

course, the air entering must also leave by natural means, i.e., exfiltration, or be exhausted by mechanical means.

In commercial and institutional buildings it is considered advisable to control the entry of outside air to assure proper ventilation and minimize energy use. As infiltration is uncontrolled, these buildings are designed and constructed to limit it as much as possible. This is done by sealing the building envelope where possible, using vestibules or revolving doors, or maintaining a pressure within the building slightly in excess of

Katalog Produk



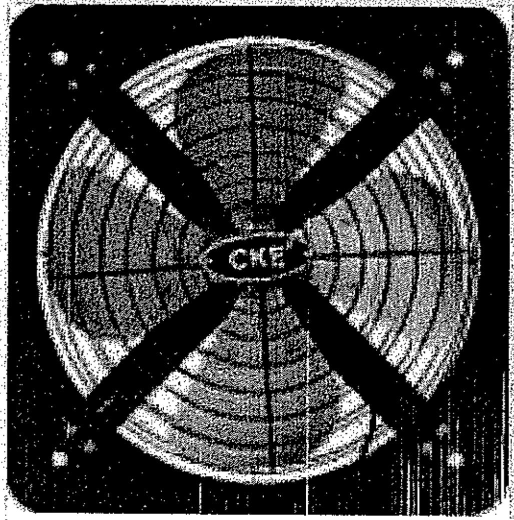
(Gambar)

EXHAUST FAN CKE 16 " STANDAR ESN-D16/ 1

Keterangan

Merk: CKE
Type : ESN-D16/ 1
Diameter : 16 " / 400 mm
Speed : 1.400 rpm
Air Flow : 1.695 CFM
Power : 150 Watt
Rating : 220/ 50 Hz

Katalog Produk



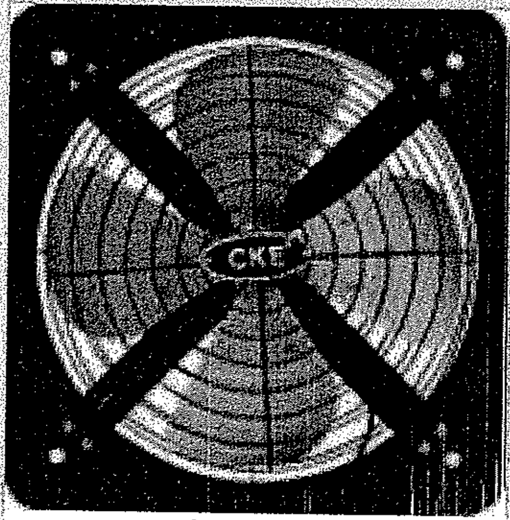
(Gambar)

EXHAUST FAN CKE 20 " STANDAR ESN-D20/ 1

Keterangan

Merk: CKE
Type : ESN-D20/ 1 atau 3PH
Diameter : 20 " / 500 mm
Speed : 1.400 rpm
Air Flow : 3354 CFM
Power : 300 Watt
Rating : 220V

Katalog Produk



(Gambar)

EXHAUST FAN CKE 18 " STANDAR ESN-D18/ 1

Keterangan

Merk: CKE
Type : ESN-D18/ 1
Diameter : 18 " / 450 mm
Speed : 1.400 rpm
Air Flow : 3.531 CFM
Power : 300 Watt
Rating : 220/ 1PH

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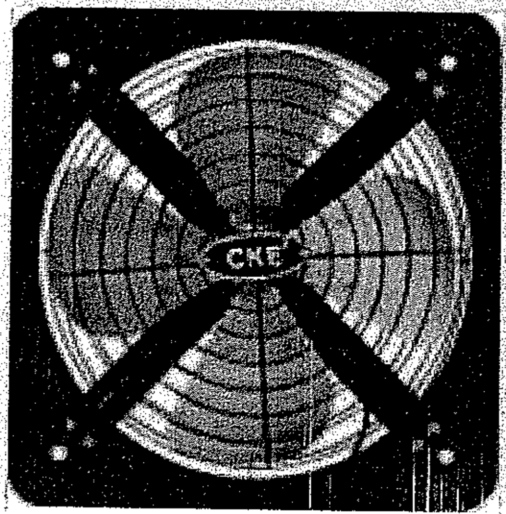
Katalog Produk



(Gambar)

EXHAUST FAN CKE 30 " STANDAR ESN-D30/ 1

Keterangan

Merk : CKE
Type : EEN-D30/ 1
Diameter : 30 " / 750 mm
Speed : 950 Rpm
Air Flow : 12.000 CFM
Power : 1.300 Watt

Exhaust ini mempunyai ciri-ciri, blade / sudunya berbentuk lebar seperti daun semanggi, dengan jumlah 4 buah. Motor yang dipakai adalah general motor dengan spesifikasi class B IP 44 tersedia dalam tegangan 220V/ 50 HZ dan 380V/ 50 HZ an sering merupakan satu-satunya bagian beban internal yang terbesar, maka perlu kewaspadaan dalam memperhitungkannya. Pemancaran kalor dari penerangan merupakan bentuk energi radiasi, bukan beban yang diperoleh segera bagi sistem pengkondisian udara. Energi radiasi dari lampu pertama-tama diserap oleh dinding lantai, dan peralatan-peralatan di dalam ruangan hingga suhunya naik dengan laju yang ditentukan oleh massanya. Oleh karena suhu permukaan benda-benda tersebut naik di atas suhu udara, maka dari permukaan-permukaan tersebut kalor dikonveksikan sehingga akhirnya menjadi beban bagi sistem pendinginan. Jadi, disebabkan oleh massa benda-benda yang menyerap radiasi, terjadi penundaan (delay) antara penyalaan lampu dan energi dari lampu menimbulkan pengaruh pada beban. Dengan alasan yang sama, beban masih tetap bertahan setelah lampu dimatikan. Untuk menyesuaikan terhadap hal-hal ini, telah dikembangkan rumusan berikut untuk memperkirakan perolehan kalor dari lampu-lampu[4] :

$$q = \text{(daya lampu, Watt)}\,(F_u)\,(F_b)\,\text{(CLF)}$$

dengan F_u = faktor penggunaan atau fraksi penggunaan lampu yang terpasang
F_b = faktor balast untuk lampu-lampu fluerescent = 1,2 untuk fluerescent biasa
CLF = faktor beban-pendinginan dari Tabel 4-6

Tabel 4-6 memuat faktor beban pendinginan untuk dua macam pemasangan (fixture lampu-lampu yang umum, yang dioperasikan 10 dan 16 jam sehari. Tambahan keterangan tentang variasi pemasangan, massa lantai, dan periode penyalaan lampu, tersedia.[4, 6]

Tabel 4-6 Faktor beban-pendinginan dari penerangan[4]

Lama-jam setelah lampu dinyalakan	Pemasangan X† Lama-jam penyalaan		Pemasangan Y† Lama-jam penyalaan	
	10	16	10	16
0	0,08	0,19	0,01	0,05
1	0,62	0,72	0,76	0,79
2	0,66	0,75	0,81	0,83
3	0,69	0,77	0,84	0,87
4	0,73	0,80	0,88	0,89
5	0,75	0,82	0,90	0,91
6	0,78	0,84	0,92	0,93
7	0,80	0,85	0,93	0,94
8	0,82	0,87	0,95	0,95
9	0,84	0,88	0,96	0,96
10	0,85	0,89	0,97	0,97
11	0,32	0,90	0,22	0,98
12	0,29	0,91	0,18	0,98
13	0,26	0,92	0,14	0,98
14	0,23	0,93	0,12	0,99
15	0,21	0,94	0,09	0,99
16	0,19	0,94	0,08	0,99
17	0,17	0,40	0,06	0,24
18	0,15	0,36	0,05	0,20

†Penjelasan pemasangan X, lampu terbenam tanpa lubang angin. Pengatur (register) udara suplai d udara balik berada di bawah langit-langit atau di ruang langit-langit dan grill. Y, lampu yang dib lubang angin atau tergantung bebas. Pengatur udara suplai berada di bawah atau di dalam langit-lan dengan pengatur udara balik di sekitar pemasangan dan melalui ruang langit-langit.

Tabel 4-11 Koefisien peneduhan (shading coefficients)4

Jenis kaca	Ketebalan mm	Koefisien peneduhan: Tanpa peneduh dalam	Krei Pelindung: Sedang	Krei Pelindung: Terang	Tirai Gulung: Gelap	Tirai Gulung: Terang
Kaca tunggal						
Lembaran biasa	3	1,00	0,64	0,55	0,59	0,25
Pelat (tebal)	6-12	0,95	0,64	0,55	0,59	0,25
Penyerap panas	6	0,70	0,57	0,53	0,40	0,30
	10	0,50	0,54	0,52	0,40	0,28
Kaca rangkap						
Lembaran biasa	3	0,90	0,57	0,51	0,60	0,25
Pelat (tebal)	6	0,83	0,57	0,51	0,60	0,25
Reflektif	6	0,2–0,4	0,2–0,33			

Energi matahari yang menembus suatu jendela dapat dirumuskan sebagai berikut:

$$q_{sg} = (SHGF_{maks})(SC)A$$

dengan q_{sg} = energi matahari yang menembus jendela.

Ada satu faktor lagi yang harus diperhitungkan, bahwa energi matahari memasuki ruangan tidak segera menjadi beban pendinginan. Energi radiasi ini pertama-tama diserap oleh permukaan-permukaan di dalam ruangan, selama waktu ini suhu permukaan-permukaan tersebut naik dengan laju yang ditentukan oleh sifat-sifat termal dinamisnya. Jadi energi matahari yang diserap ditunda sebelum dilepaskan lagi ke udara di ruangan secara konveksi. Oleh karena proses ini dapat menimbulkan perbedaan waktu yang berarti maka hal ini juga dimasukkan menjadi suatu *faktor beban pendinginan* (CLF) dalam menghitung beban radiasi melalui kaca. Harga CLF yang diturunkan dari suatu analisis komputer ekstensif dimuat dalam Tabel 4-12.

Dalam menentukan kalor yang diterima dari radiasi matahari melalui permukaan-permukaan tembus cahaya, peneduhan dari luar juga harus diperhitungkan. Peneduhan oleh *overhang* atau peneduh-peneduh lain, seperti ditunjukkan dalam Gambar 4-5,

Tabel 4-12 Faktor-faktor beban pendinginan untuk kaca yang dilengkapi dengan peneduh dalam, di lintang utara[4].

Waktu matahari (jam)	Arah jendela: U	TL	T	Teng	S	BD	B	BL	Hor
6	0,73	0,56	0,47	0,30	0,09	0,07	0,06	0,07	0,12
7	0,66	0,76	0,72	0,57	0,16	0,11	0,09	0,11	0,27
8	0,65	0,74	0,80	0,74	0,23	0,14	0,11	0,14	0,44
9	0,73	0,58	0,76	0,81	0,38	0,16	0,13	0,17	0,59
10	0,80	0,37	0,62	0,79	0,58	0,19	0,15	0,19	0,72
11	0,86	0,29	0,41	0,68	0,75	0,22	0,16	0,20	0,81
12	0,89	0,27	0,27	0,49	0,83	0,38	0,17	0,21	0,85
13	0,89	0,26	0,24	0,33	0,80	0,59	0,31	0,22	0,85
14	0,86	0,24	0,22	0,28	0,68	0,75	0,53	0,30	0,81
15	0,82	0,22	0,20	0,25	0,50	0,83	0,72	0,52	0,71
16	0,75	0,20	0,17	0,22	0,35	0,81	0,82	0,73	0,58
17	0,78	0,16	0,14	0,18	0,27	0,69	0,81	0,82	0,42
18	0,91	0,12	0,11	0,13	0,19	0,45	0,61	0,69	0,25

TABLE 9.4.1 Properties of Commonly Used Refrigerants 40°F Evaporating and 100°F Condensin

		Chemical Formula	Molecular Mass	Ozone Depletion Potential (ODP)	Global Warming Potential (HGWP)	Evaporating Pressure, psia	Condensing Pressure, psia	Compression Ratio	Refrigeration Effect, Btu/lb
Hydrofluorocarbons HFCs									
R-32	Difluoromethane	CH_2F_2	52.02	0.0	0.14	135.6	340.2	2.51	
R-125	Pentafluoroethane	CHF_2CF_3	120.03	0.0	0.84	111.9	276.2	2.47	37.1
R-134a	Tetrafluoroethane	CF_3CH_2F	102.03	0.0	0.26	49.7	138.8	2.79	65.2
R-143a	Trifluoroethane	CH_3CF_3	84.0	0.0					
R-152a	Difluoroethane	CH_3CHF_2	66.05	0.0		44.8	124.3	2.77	
R-245ca	Pentafluoropropane	$CF_3CF_2CH_3$	134.1	0.0					
HFC's azeotropics									
R-507	R-125/R-143 (45/55)			0.0	0.98				
HFC's near azeotropic									
R-404A	R-125/R-143a (44/52/4)			0.0	0.94				
R-407A	R-32/R-125/R-134a (20/40/40)			0.0	0.49				
R-407C	R-32/R-125/R-134a (23/25/52)			0.0	0.70				
Hydrochlorofluorocarbons HCFCs and their azeotropics									
R-22	Chlorodifluoromethane	$CHClF_2$	86.48	0.05	0.40	82.09	201.5	2.46	69.0
R-123	Dichlorotrifluoroethane	$CHCl_2CF_3$	152.93	0.02	0.02	5.8	20.8	3.59	62.9
R-124	Chlorotetrafluoroethane	$CHFClCF_3$	136.47	0.02		27.9	80.92	2.90	5.21
HCFC's near azeotropics									
R-402A	R-22/R-125/R-290 (38/60/2)			0.02	0.63				
HCFC's azeotropics									
R-401A	R-22/R-124/R-152a (53/34/13)			0.37	0.22				
R-401B	R-22/R-124/R-152a (61/28/11)			0.04	0.24				

SECTION 14
PRODUCT LOAD

The product load is composed of any heat gain occurring due to the product in the refrigerated space. The load may arise from a product placed in the refrigerator at a temperature higher than the storage temperature, from a chilling or freezing process, or from the heat of respiration of perishable products. The total product load is the sum of the various types of product load which may apply to the particular application.

TABLES OF SPECIFIC PRODUCT DATA

The following tables list data on specific products that is essential in calculating the refrigeration product load. Table 10 covers food products, Table 11 solids, and Table 12 liquids.

HEAT OF RESPIRATION

Fruits and vegetables, even though they have been removed from the vine or tree on which they grew, are still living organisms. Their life processes continue for some time after being harvested, and as a result they give off heat. Certain other food products also undergo continuing chemical reactions which produce heat. Meats and fish have no further life processes and do not generate any heat.

The amount of heat given off is dependent on the specific product and its storage temperature. Table 10 lists various food products with pertinent storage data. Note that the heat of respiration varies with the storage temperature.

(continued on p. 14-7)

Table 10
FOOD PRODUCTS DATA

Product	Average Freezing Point F	Percent Water	SP ht, Btu/ (lb) (F deg)		Latent Heat of Fusion Btu/lb	Heat of Respiration Btu per (24 hr) (ton) at Temp. Indicated	
			Above Freezing	Below Freezing		°F	BTU
VEGETABLES							
Artichokes	29.1	83.7	0.87	0.45	120	40	10,140
Asparagus	29.8	93	0.94	0.48	134	40	11,700-23,100
Beans, string	29.7	88.9	0.91	0.47	128	40	9700-11400
Beans, Lima	30.1	66.5	0.73	0.40	94	40	4300-6100
Beans, dried		12.5	0.30	0.24	18		
Beets	31.1	87.6	0.90	0.46	126	32	2700
						40	4100
Broccoli	29.2	89.9	0.92	0.47	130	40	11,000-17,000
Brussels sprouts	31	84.9	0.88	0.46	122	40	6600-11,000
Cabbage	31.2	92.4	0.94	0.47	132	40	1700
Carrots	29.6	88.2	0.90	0.46	126	32	2100
						40	3500
Cauliflower	30.1	91.7	0.93	0.47	132	40	4500
Celery	29.7	93.7	0.95	0.48	135	32	1600
						40	2400
Corn (green)	28.9	75.5	0.79	0.42	106	32	7200-11,300
						40	10,600-13,200
Corn (dried)		10.5	0.28	0.23	15		
Cucumbers	30.5	96.1	0.97	0.49	137		
Eggplant	30.4	92.7	0.94	0.48	132		
Endive (escarole)	30.9	93.3	0.94	0.48	132		
Horseradish	26.4	73.4	0.78	0.42	104		
Kale	30.7	86.6	0.89	0.46	124		
Kohlrabi	30	90	0.92	0.47	128		
Lettuce	31.2	94.8	0.96	0.48	136	32	2300
						40	2700
Mushrooms	30.2	91.1	0.93	0.47	130	32	6200
						50	22,000
Olives	28.5	75.2	0.80	0.42	108		
Onions	30.1	87.5	0.90	0.46	124	32	700-1100
						40	1800

Table 10 (cont.)

FOOD PRODUCTS DATA

Product	Average Freezing Point F	Percent Water	SP ht, Btu/(lb)(F deg) Above Freezing	Below Freezing	Latent Heat of Fusion Btu/lb	Heat of Respiration Btu per (24 hr) (ton) at Temp. Indicated °F	BTU
Parsnips	28.9	78.6	0.84	0.46	112		
Peas (green)	30	74.3	0.79	0.42	106	40	13,200-16,000
Peas (dried)		9.5	0.28	0.22	14		
Peppers (sweet)	30.1	92.4	0.94	0.47	132	40	4700
Potatoes (white)	28.9	77.8	0.82	0.43	111	40	1300-1800
Potatoes (sweet)	28.5	68.5	0.75	0.40	97	40	1710
Pumpkin	30.1	90.5	0.92	0.47	130		
Radishes	30.1	93.6	0.95	0.48	134		
Rhubarb	28.4	94.9	0.96	0.48	134		
Sauerkraut	26	89	0.92	0.47	129		
Spinach	30.3	92.7	0.94	0.48	132	40	8000
Squash	30.1	90.5	0.92	0.47	130		
Tomatoes (green)	30.4	94.7	0.95	0.48	134	60	6230
Tomatoes (ripening)	30.4	94.1	0.95	0.48	134	40	1260
Turnips	30.5	90.9	0.93	0.47	130	32	1900
						40	2200
Vegetables (mixed)	30	90	0.90	0.45	130		
MEATS AND FISH							
Bacon		20	0.50	0.30	29		
Beef (dried)		5-15	0.22-0.34	0.19-0.26	7-22		
Beef (fresh-lean)	29	68	0.77	0.40	100		
Beef (fresh-fat)	28		0.60	0.35	79		
Brined meats			0.75				
Cod fish (fresh)	28		0.90	0.49	119		
Cut meats	29	65	0.72	0.40	95		
Fish (frozen)	28	70	0.76	0.41	101		
Fish (iced)		70	0.76	0.41	101		
Fish (dried)			0.56	0.34	65		
Hams and loins	27	60	0.68	0.38	86.5		
Lamb	29	58	0.67	0.30	83.5		
Livers	29	65.5	0.72	0.40	93.3		
Oyster (shell)	27	80.4	0.83	0.44	116		
Oysters (tub)	27	87	0.90	0.46	125		
Pork (fresh)	28	60	0.68	0.38	86.5		
Pork (smoked)		57	0.60	0.32			
Poultry (fresh)	27	74	0.79	0.37	106		
Poultry (frozen)	27	74	0.79	0.37	106		
Sausage (casings)			0.60				
Sausage (drying)	26	65.5	0.89	0.56	93		
Sausage (franks)	29	60	0.86	0.56	86		
Sausage (fresh)	26	65	0.89	0.56	93		
Sausage (smoked)	25	60	0.86	0.56	86		
Scallops	28	80.3	0.89	0.48	116		
Shrimp	28	70.8	0.83	0.45	119		
Veal	29	63	0.71	0.39	91		
MISCELLANEOUS							
Beer	28	92	1.0				
Bread		32-37	0.70	0.34	46-53		
Bread (dough)		58	0.75				
Butter	30-0	15	0.64	0.34	15		
Candy			0.93				
Caviar (tub)	20	55				40	3820
Cheese (American)	17	60	0.64	0.36	79	40	4680
Cheese (Camembert)	18	60	0.70	0.40	86	40	4920
Cheese (Limburger)	19	55	0.70	0.40	86	40	4920
Cheese (Roquefort)	3	55	0.65	0.32	79	45	4000
Cheese (Swiss)	15	55	0.64	0.36	79	40	4660
Chocolate (coating)	95-85	55	0.30	0.55	40		
Cream (40%)	28	73	0.85	0.40	90		
Eggs (crated)	27		0.76	0.40	100		
Eggs (frozen)	27			0.41	100		
Flour		13.5	0.38	0.28			
Flowers (cut)	32					480/sq. ft. Floor Area	
Furs—Woolens				0.40			

Table 10 (cont.)

FOOD PRODUCTS DATA

Product	Average Freezing Point F	Percent Water	SP ht, Btu/(lb) (F deg)		Latent Heat of Fusion Btu/lb	Heat of Respiration Btu per (24 hr) (ton) at Temp. Indicated	
			Above Freezing	Below Freezing		°F	BTU
Honey		18	0.35	0.26	26	40	1420
Hops						35	1500
Ice cream	27.0	58-66	0.78	0.45	96		
Lard			0.52				
Malt						50	1500
Maple sugar		5	0.24	0.21	7	45	1420
Maple syrup		36	0.49	0.31	52	45	1420
Milk	31	87.5	0.93	0.49	124		
Nuts (dried)		3-10	0.21-0.29	0.19-0.24	4.3-14	35	1000
Oleomargarine		15.5	0.32	0.25	22		
Tobacco and cigars	25						
Yeast		70.9	0.77	0.41	102		
FRUITS							
Apples	28.4	84.1	0.86	0.45	121	32	830
						40	1435
Apricots	28.1	85.4	0.88	0.46	122		
Avocadoes	27.2	94	0.91	0.49	136	60	13,200-39,700
Bananas	28	74.8	0.80	0.42	108	68	8400-9200
Blackberries	28.9	85.3	0.88	0.46	122		
Blueberries	28.6	82.3	0.86	0.45	118	32	1300-2200
Cantaloupes	29	92.7	0.94	0.48	132	40	2000
						60	8500
Cherries	26	83	0.87	0.45	120		
Cranberries	27.3	87.4	0.90	0.46	124		
Currants	30.2	84.7	0.88	0.45	120		
Dates (dry)	—4.1	20	0.36	0.26	29		
Dates (fresh)	27.1	78	0.82	0.43	112		
Figs (fresh)	27.1	78	0.82	0.43	112		
Figs (dried)		24	0.39	0.27	34		
Gooseberries	28.9	88.3	0.90	0.46	126		
Grapefruit	28.4	88.8	0.91	0.46	126	32	460
						40	1070
Grapes	26.3	81.7	0.86	0.44	116	35	830
Honey Dew Melon	20	92.6	0.94	0.48	132	40	1000
Lemons	28.1	89.3	0.92	0.46	127	40	810
						60	2970
Limes	29	86	0.89	0.46	122	40	810
						60	2970
Mangoes	32	93	0.90	0.46	134		
Nectarines	29	82.9	0.90	0.49	119		
Oranges	28	87.2	0.90	0.46	124	32	795
						40	1400
Peaches	29.4	86.9	0.90	0.46	124	32	1110
						40	1735
Pears	28.5	83.5	0.86	0.45	118	32	770
Persimmons	28.3	78.2	0.84	0.43	112		
Pineapples	29.4	85.3	0.88	0.45	123		
Plums	28	85.7	0.88	0.45	122		
Pomegranates	28	77	0.87	0.48	112		
Prunes (fresh)	28	85.7	0.88	0.45	123		
Quinces	28.1	85.3	0.88	0.45	122		
Raspberries	30.1	82	0.85	0.45	122	40	6800-8500
						60	18,100-22,300
Strawberries	29.9	90	0.92	0.47	129		
Tangerines	28.0	87.3	0.93	0.51	126	32	3265
						40	5865
Watermelons	29.2	92.1	0.97	0.48	132		

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Technische Daten — Technical data — Caractéristiques techniques

Verdichter Typ / Compressor type / Type de compresseur	Motor Version / Motor version / Version moteur	Fördervolumen bei 87 Hz / Displacement at 87 Hz / Volume balayé à 87 Hz (m³/h)	Anzahl der Zylinder / Number of cylinders / Nombre de cylindres	Ölfüllung / Oil charge / Charge d'huile (dm³)	Gewicht / Weight / Poids (kg ①)	Rohranschlüsse / Pipe connections / Raccords: DL Druckleitung / Discharge line / Conduite de refoulement (mm)	DL (Zoll / inch / pouce)	SL Saugleitung / Suction line / Conduite d'aspiration (mm)	SL (Zoll / inch / pouce)	Elektrische Daten ② / Electrical data ② / Caractéristiques électriques ②: FU Anschluss / FI connection / Raccordement de CF (Volt)	Max. Betriebsstrom bei 380V/3/50Hz / Max. operating current for 380V/3/50Hz / Courant de service max. à 380V/3/50Hz (Amp.)	Max. Leistungsaufnahm… Verdicht… / Max. power c… sumptio… compres… / Puissanc… absorbée max. compres… (kW)
2DC-3.F1Y	1	23,7	2	1,5	88	16	5/8	22	7/8	380..480 V/3/50 Hz 380..480 V/3/60 Hz	15	9
4FC-5.F1Y	1	32,0	4	2,0	105	16	5/8	28	1 1/8		20	11
4EC-6.F1Y	1	40,1	4	2,0	105	16	5/8	28	1 1/8		22	12
4DC-7.F1Y	1	47,3	4	2,0	106	22	7/8	35	1 3/8		22	12
4DC-7.F3Y	1	47,3	4	2,0	106	22	7/8	35	1 3/8		28	17
4CC-6.F1Y	2	57,4	4	2,0	106	22	7/8	35	1 3/8		22	12
4CC-9.F3Y	1	57,4	4	2,0	106	22	7/8	35	1 3/8		34	21
4VES-6.F3Y	2	61,3	4	2,6	163	28	1 1/8	42	1 5/8		17	11
4VCS-10.F4Y	1	61,3	4	2,6	163	28	1 1/8	42	1 5/8		35	22
4TES-8.F3Y	2	73,0	4	2,6	158	28	1 1/8	42	1 5/8		20	12
4TCS-12.F4Y	1	73,0	4	2,6	165	28	1 1/8	42	1 5/8		42	26
4PES-10.F3Y	2	85,6	4	2,6	163	28	1 1/8	42	1 5/8		23	14
4PCS-15.F4Y	1	85,6	4	2,6	171	28	1 1/8	42	1 5/8		48	30
4NES-12.F3Y	2	99,2	4	2,6	165	28	1 1/8	42	1 5/8		27	17
4NCS-20.F4Y	1	99,2	4	2,6	174	28	1 1/8	42	1 5/8		55	36

Frequenzbereich

2DC-3.F1Y: 30 ... 87 Hz
4FC-5.F1Y ... 4NCS-20.F4Y: 25 ... 87 Hz
4VES-6.F3Y ... 4NES-12.F3Y: 25 ... 87 Hz

Ölsumpfheizung

- 230 V
  PTC-Heizung selbst-regulierend
  2DC-3.F1Y ... 4CC-9.F3Y: 0 ... 120 W
  4VES-6.F3Y ... 4NES-12.F3Y: 0 ... 140 W
  4VCS-10.F4Y ... 4NCS-20.F4Y: 0 ... 140 W
- obligatorisch bei
  - Außenaufstellung des Verdichters
  - langen Stillstandszeiten
  - großer Kältemittel-Füllmenge
  - Gefahr von Kältemittel-Kondensation in dem Verdichter

Erläuterungen

① Inkl. Frequenzumrichter
② Eingang Frequenzumrichter

Frequency range

2DC-3.F1Y: 30 ... 87 Hz
4FC-5.F1Y ... 4NCS-20.F4Y: 25 ... 87 Hz
4VES-6.F3Y ... 4NES-12.F3Y: 25 ... 87 Hz

Crankcase heater

- 230 V
  self-regulating PTC heater
  2DC-3.F1Y ... 4CC-9.F3Y: 0 ... 120 W
  4VES-6.F3Y ... 4NES-12.F3Y: 0 ... 140 W
  4VCS-10.F4Y ... 4NCS-20.F4Y: 0 ... 140 W
- mandatory in case of
  - outdoor installation of the compressor
  - long shut-off periods
  - high refrigerant charge
  - danger of refrigerant condensation into the compressor

Explanations

① Including frequency inverter
② Input frequency inverter

Plage de fréquences

2DC-3.F1Y: 30 ... 87 Hz
4FC-5.F1Y ... 4NCS-20.F4Y: 25 ... 87 Hz
4VES-6.F3Y ... 4NES-12.F3Y: 25 ... 87 Hz

Résistance de carter

- 230 V
  résistance CTP autorégulante
  2DC-3.F1Y ... 4CC-9.F3Y: 0 ... 120 W
  4VES-6.F3Y ... 4NES-12.F3Y: 0 ... 140 W
  4VCS-10.F4Y ... 4NCS-20.F4Y: 0 ... 140 W
- obligatoire pour
  - installation extérieure du compresseur
  - longues périodes d'immobilisation
  - haute charge de fluide frigorigène
  - risque de condensation de fluide frigorigèr dans le compresseur

Explications

① Compris convertisseur de fréquences
② Entrée convertisseur de fréquences

… secara termodinamis … mungkin.

_____ 46. Konstanta kesetimbangan kimia K bertambah dengan naiknya T, asalkan perubahan entalpi reaksi baku ΔH^o positif.

_____ 47. Ada dua derajat kebebasan di dalam sebuah sistem reaktif kimia yag mengandung spesies-spesies gas N_2, H_2, dan NH3.

_____ 48. Pada suhu konstan, kenaikan tekanan akan menyebabkan kenaikan hasil metanol (CH_3OH) dari reaksi gas ideal

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$$

_____ 49. W sama untuk semua proses aliran tunak yang menghasilkan perubahan keadaan yang sama, asalkan suhu lingkungannya sama.

_____ 50. Kerja yang hilang merupakan sebuah besaran yang dibuat untuk menerang-kan pengecualian terhadap hukum termodinamika pertama.

JAWAB:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S	S	B	B	S	B	S	B	S	S	S	S	B	S	B
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
B	S	B	S	B	S	S	B	B	B	B	B	S	S	B
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
S	B	S	S	B	B	B	S	S	B	S	S	B	B	S
46	47	48	49	50										
B	S	B	B	S										

Lampiran A

Faktor Pengubahan

Untuk ringkasnya, satuan-satuan untuk tiap besaran di bawah ini dihubungkan dengan sebuah satuan dasar atau satuan SI turunan. Pengubahan antara pasangan satuan yang lain untuk sebuah besaran dibuat dengan menggunakan aturan biasa untuk manipulasi satuan.

CONTOH Ubahlah ft^3 menjadi gal.
Dari bagian volume kita dapatkan 1 m^3 = 35,3147 ft^3 = 264,172 gal, dari situ diperoleh

Besaran	Pengubahan	Besaran	Pengubahan
Panjang	1 m = 100 cm = 3,28084 ft = 39,3701 in.	Energi	1 kJ = 10^3 kg · m^2 · s^{-2} = 10^3 N · m = 10^3 W · s = 10^{10} dyne · cm = 10^{10} erg = 10^4 cm^3 · bar = 239,006 kal = 9869,23 cm^3 · atm = 5,12197 psia · ft^3 = 737,562 ft · lb_f = 0,947831 Btu
Massa	1 kg = 10^3 g = 2,20462 lb_m		
Gaya	1 N = 1 kg · m · s^{-2} = 10^5 dyne = 0,224809 lb_f		
Tekanan	1 bar = 10^5 kg · m^{-1} · s^{-2} = 10^5 N · m^{-2} = 100 kPa = 10^6 dyne · cm^{-2} = 0,986923 atm = 14,5038 psia = 750,061 mmHg = 750,061 torr	Daya	1 kW = 103 kg · m^2 · s^{-3} = 10^3 W = 10^3 J · s^{-1} = 10^3 V · A = 239,006 kal · s^{-1} = 737,562 ft · lb_f · s^{-1} = 56,8699 Btu · min^{-1} = 1,34102 hp
Volume	1 m^3 = 10^6 cm^3 = 10^3 L = 35,31147 ft^3 = 264,172 gal		
Kerapatan	1 kg · m^{-3} = 10^{-3} g · cm^{-3} = 1 g · L^{-1} = 0,0624278 lb_m · ft^{-3} = 0,00834540 lb_m · gal^{-1}		

Catatan: atm ≡ atmosfir baku
kal ≡ kalori termokimia
Btu ≡ Btu Tabel Uap Air Internasional
L ≡ liter

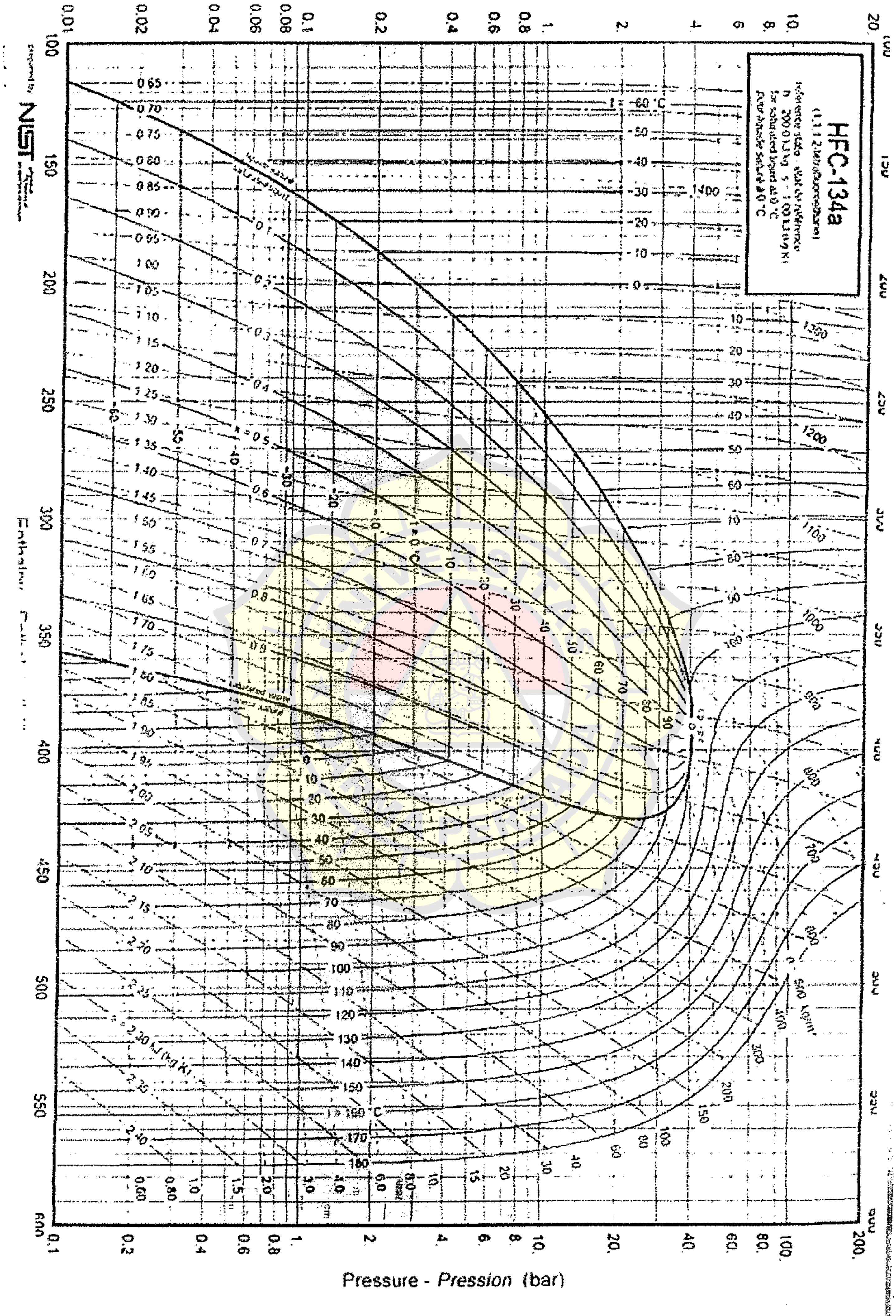

HFC-134a
NIST
Pressure - Pression (bar)
2.30 kJ/(kg K)
500 kg/m³

Table AE.1 Saturation Properties of Refrigerant R-134a: Temperature Increments

Temp., F	Press., P_{sat}, psia	Specific Volume, ft³/lbm		Internal Energy, Btu/lbm		Enthalpy, Btu/lbm			Entropy, Btu/lbm · R	
		Sat. Liquid, v_f	Sat. Vapor, v_g	Sat. Liquid, u_f	Sat. Vapor, u_g	Sat. Liquid, h_f	Evap., h_{fg}	Sat. Vapor, h_g	Sat. Liquid, s_f	Sat. Vapor, s_g
-40	7.4272	0.011299	5.7839	63.718	152.95	63.733	97.167	160.90	0.19016	0.42169
30	9.8624	0.011429	4.4330	66.725	154.32	66.740	95.664	162.41	0.19724	0.41989
20	12.898	0.011565	3.4449	69.756	155.69	69.784	94.136	163.92	0.20421	0.41831
15	14.671	0.011635	3.0514	71.281	156.38	71.313	93.357	164.67	0.20766	0.41760
10	16.632	0.011706	2.7109	72.812	157.06	72.848	92.562	165.41	0.21109	0.41693
5	18.794	0.011779	2.4154	74.350	157.75	74.391	91.759	166.15	0.21449	0.41631
0	21.171	0.011853	2.1579	75.894	158.43	75.940	90.950	166.89	0.21786	0.41572
5	23.777	0.011929	1.9330	77.445	159.11	77.497	90.123	167.62	0.22122	0.41518
10	26.628	0.012007	1.7357	79.002	159.79	79.062	89.288	168.35	0.22456	0.41467
15	29.739	0.012086	1.5623	80.567	160.47	80.634	88.436	169.07	0.22787	0.41419
20	33.124	0.012168	1.4094	82.140	161.14	82.214	87.576	169.79	0.23117	0.41374
25	36.800	0.012251	1.2742	83.720	161.82	83.803	86.697	170.50	0.23445	0.41332
30	40.784	0.012337	1.1543	85.307	162.49	85.401	85.799	171.20	0.23771	0.41293
35	45.092	0.012425	1.0478	86.903	163.15	87.007	84.893	171.90	0.24095	0.41257
40	49.741	0.012515	0.95280	88.507	163.81	88.623	83.967	172.59	0.24418	0.41222
45	54.749	0.012608	0.86796	90.120	164.47	90.248	83.022	173.27	0.24739	0.41190
50	60.134	0.012703	0.79198	91.742	165.12	91.883	82.057	173.94	0.25059	0.41159
55	65.913	0.012802	0.72380	93.372	165.77	93.529	81.071	174.60	0.25378	0.41131
60	72.105	0.012903	0.66246	95.013	166.41	95.185	80.075	175.26	0.25695	0.41103
65	78.729	0.013008	0.60718	96.663	167.05	96.853	79.047	175.90	0.26011	0.41077
70	85.805	0.013116	0.55724	98.324	167.67	98.532	77.998	176.53	0.26327	0.41052
75	93.351	0.013229	0.51204	99.995	168.30	100.22	76.930	177.15	0.26641	0.41028
80	101.39	0.013348	0.47104	101.68	168.91	101.93	75.820	177.75	0.26955	0.41005
85	109.93	0.013465	0.43379	103.37	169.51	103.65	74.690	178.34	0.27268	0.40982
90	119.01	0.013590	0.39988	105.08	170.11	105.38	73.540	178.92	0.27580	0.40959
95	128.65	0.013720	0.36896	106.80	170.69	107.13	72.380	179.48	0.27892	0.40937
100	138.85	0.013856	0.34070	108.53	171.26	108.89	71.130	180.02	0.28204	0.40914
105	149.65	0.013998	0.31483	110.28	171.82	110.67	69.880	180.55	0.28515	0.40891
110	161.07	0.014146	0.29113	112.04	172.37	112.46	68.590	181.05	0.28827	0.40867
115	173.14	0.014301	0.26933	113.82	172.90	114.28	67.250	181.53	0.29139	0.40842
120	185.86	0.014464	0.24928	115.62	173.41	116.12	65.870	181.99	0.29451	0.40815
140	243.92	0.015214	0.18332	123.00	175.26	123.64	59.880	183.54	0.30708	0.40689
160	314.73	0.016191	0.13428	130.79	176.64	131.74	52.720	184.46	0.31995	0.40503
180	400.34	0.017588	0.096375	139.24	177.19	140.54	43.790	184.33	0.33350	0.40196
200	503.59	0.020096	0.064663	149.07	175.80	150.95	30.880	181.83	[illegible]	
210	563.35	0.023150	0.047695	155.85	[illegible]					

Tahap 4: Perhitungan faktor Penggunaan

Faktor penggunaan didefinisikan sebagai persen dari lumen lampu kosong yang mengeluarkan cahaya dan mencapai bidang kerja. Faktor ini bertanggungjawab langsung terhadap cahaya dari luminer dan cahaya yang dipantulkan permukaan ruangan. Fihak pabrik akan memasok setiap luminer dengan tabel CU nya sendiri yang berasal dari laporan pengujian fotometrik. Dengan menggunakann tabel yang tersedia dari pabrik, ditentukan faktor penggunaan untuk pemasangan berbagai cahaya jika pantulan dari dinding dan langit-langit diketahui, indeks ruangan telah ditentukan dan jenis luminer diketahui. Untuk peralatan tabung kembar, faktor pengunaannya adalah 0,66, sesuai untuk indeks ruangan 2,5.

Tahap 5: Perhitungan jumlah fitting yang diperlukan dengan penerapan rumus sebagai berikut:

$$N = \frac{E \times A}{F \times UF \times LLF}$$

Dimana:
N = Jumlah *fitting*
E = Tingkat *lux* yang diperlukan pada bidang kerja
A = Luas ruangan (L x W)
F = Flux total (Lumens) dari seluruh lampu dalam satu *fitting*
UF = Faktor penggunaan dari tabel untuk peralatan yang digunakan
LLF = Faktor kehilangan cahaya. Kehilangan ini disebabkan oleh penurunan keluaran lampu yang sudah lama dan penumpukan kotoran pada peralatan dan dinding bangunan.
LLF = Lumen lampu $_{MF}$ x Luminer $_{MF}$ x Permukaan ruangan $_{MF}$

Nilai LLF

Kantor ber AC	0,8
Industri bersih	0,7
Industri kotor	0,6

$$N = \frac{200 \times 100}{2 \times 3050 \times 0{,}66 \times 0{,}8}$$

= 6,2; Sehingga, lampu tabung kembar nomor 6 diperlukan. Jumlah total lampu 36-Watt adalah 12.

Tahap 6: Ruang luminer untuk mencapai keseragaman yang dikehendaki

Setiap luminer akan memiliki ruang yang direkomendasikan terhadap perbandingan tinggi. Pada metodologi perancangan sebelumnya, perbandingan keseragaman, yakni perbandingan terang minimum terhadap terang rata-rata dijaga pada 0,8 dan ruang yang cocok untuk perbandingan tinggi ditentukan untuk mencapai keseragaman. Dalam perancangan modern memadukan efisiensi energi dengan tugas pencahayaan, konsep yang muncul adalah memberi keseragaman 1/3 hingga 1/10 tergantung pada tugasnya. Nilai luminer diatas yang direkomedasikan adalah

Tabel 2. Karakteristik Kinerja Pencahayaan (*Luminous*) dari Luminer yang Umum Digunakan

Jenis Lampu	Lum / Watt		Indeks Perubahan Warna	Penerapan	Umur (Jam)
	Kisaran	Rata-rata			
Lampu pijar	8-18	14	Baik sekali	Rumah, restoran, penerangan umum, penerangan darurat	1000
Lampu Neon	46-60	50	Lapisan w.r.t yang baik	Kantor, pertokoan, rumah sakit, rumah	5000
Lampu Neon Kompak (CFL)	40-70	60	Sangat Baik	Hotel, pertokoan, rumah, kantor	8000-10000
Merkuri tekanan tinggi (HPMV)	44-57	50	Cukup	Penerangan umum di pabrik, garasi, tempat parkir mobil, penerangan berlebihan/ sangat terang	5000
Lampu halogen	18-24	20	Baik Sekali	Peraga, penerangan berlebihan, arena pameran, area konstruksi	2000-4000
Sodium tekanan tinggi (HPSV) SON	67-121	90	Cukup	Penerangan umum di pabrik, gudang, penerangan jalan	6000-12000
Sodium tekanan rendah (LPSV) SOX	101-175	150	Buruk	Jalan raya, terowongan, kanal, penerangan jalan	6000-12000

3. PENGKAJIAN SISTIM PENCAHAYAAN

Bagian ini meliputi perancangan sistim penerangan untuk interior dan juga metodologi studi efisiensi energi sistim pencahayaan. Bagian ini juga memberi rekomendasi nilai penerangan yang diperlukan oleh berbagai jenis pekerjaan sesuai dengan standar India.

3.1 Merancang Sistim Pencahayaan

3.1.1 Berapa banyak cahaya yang diperlukan?

Setiap pekerjaan memerlukan tingkat pencahayaan pada permukaannya. Pencahayaan yang baik menjadi penting untuk menampilkan tugas yang bersifat visual. Pencahayaan yang lebih baik akan membuat orang bekerja lebih produktif. Membaca buku dapat dilakukan dengan 100 to 200 lux. Hal ini merupakan pertanyaan awal perancang sebelum memilih tingkat pencahayaan yang benar. CIE (Commission International de l'Eclairage) dan IES (Illuminating Engineers Society) telah menerbitkan tingkat pencahayaan yang direkomendasikan untuk berbagai pekerjaan. Nilai-nilai yang direkomendasikan tersebut telah dipakai sebagai standar nasional dan internasional bagi perancangan pencahayaan (Tabel diberikan dibawah). Pertanyaan kedua adalah mengenai kualitas cahaya. Dalam kebanyakan konteks, kualitas dibaca sebagai perubahan warna.

Table 2 Lamps for Indicating Light

Type	Rated wattage W	Rated voltage V	Classification	Glass bulb Type	Glass bulb Dia. mm	Length mm	Base	Standard direction of lamp	Initial characteristics Consumption W	Initial characteristics Light flux lm (Reference value)	Endurance time for vibration under cover-voltage h	Static life h	Shape
KP 18 V 2 W	2	18	Vacuum	T13	13 ± 1	33 ± 2	E12/15	Horizontal	2.0 ± 0.3	–	20	1500	Fig. (2)
KP 24 V 2 W	2	24	Vacuum	T10	10 ± 1	28 ± 2	BA9S/13	Horizontal	2.0 ± 0.3	–	20	1500	
KP 24 V 3 WC	3	24	Vacuum	T19	19 ± 1	45 ± 3	E12/15 or BA15D/19	Horizontal	3.0 ± 0.5	(15)	20	1500	
KP 24 V 3 WE						50 ± 3	E14/22						
KP 24 V 5 WB	5	24	Vacuum	T19	19 ± 1	65 ± 3	E12/15 or BA15D/19	Horizontal	5.0 ± 0.8	(32)	20	1500	
KP 24 V 5 WC	5	24	Vacuum	T19	19 ± 1	45 ± 3	E12/15 or BA15D/19	Horizontal	5.0 ± 0.8	(32)	20	1500	
KP 24 V 5 WE						90 ± 3	E14/22						
KP 24 V 5 WD	5	24	Vacuum	G19	19 ± 1	35 ± 2	E12/15 or BA15D/19	Horizontal	5.0 ± 0.8	(30)	20	1500	Fig. (3)
KP 115 V 5 WC	5	115	Vacuum	T19	19 ± 1	45 ± 3	E12/15 or BA15D/19	Horizontal	8 max	(20)	15	1500	Fig. (2)
KP 115 V 5 WE						50 ± 3	E14/22						
KP 115 V 10 WA	10	115	Vacuum	T26	26 ± 1	75 ± 3	E26/25 or B22D/26 × 26	Horizontal	10.0 ± 1.5	(50)	15	1500	
KP 115 V 10 WC	10	115	Vacuum	T19	19 ± 1	45 ± 3	E12/15 or BA15D/19	Horizontal	10.0 ± 1.5	(50)	15	1500	
KP 115 V 10 WE						50 ± 3	E14/22						
KP 220 V 10 W	10	220	Vacuum	T19	19 ± 1	50 ± 3	E14/22	Horizontal	15 max	(35)	15	1500	

Remarks: 1. The letters for types shall mean as follows:

P: Lamps for indicating light

A,B,C,D: Length

2. The glass bulbs shall be of transparent.

Appendix table 1 Dimension, cap and characteristics (Continued)

Types	Classification of size	Rated lamp wattage	Rated input voltage	Start test voltage	Initial characteristics: Lamp wattage	Lamp current	(Reference) Lamp voltage	Total luminous flux lm: D	N	W, WW, L	EX-D	EX-N	EX-W, WW-L	Lumen maintenance factor	(Reference) Rated life
		W	V	V	W	A	V							%	h
FL4	4	4	100	94	4.6	0.162±0.020	30	(90)	(95)	(100)	-	-	-	-	2400 or more,
FL6	6	6			5.9	0.147±0.020	44	(155)	(170)	(180)	-	-	-	-	
FL8	8	8			7.9	0.170±0.020	56	(260)	(280)	(290)	-	-	-	-	
FL10	10	10			9.5	0.230±0.030	46	410	440	460	490	530	540	75 or more	4000 or more
FL15	15	15			14.7	0.300±0.030	55	710	780	820	860	920	940		
FL20SS/18	20	18			18.0	0.340±0.040	59	1010	1100	1160	1320	1400	1430	85 or more	6000 or more
FL20S		20			19.0	0.360±0.040	58								
FL30S	30	30			30.0	0.610±0.050	55	1480	1620	1700	1790	1900	1940	75 or more	
FL40SS/37	40	37	200	180	37.0	0.410±0.040	108	2610	2850	3000	3180	3380	3450	85 or more	8000 or more
(FL40SS/38)		38			38.0	0.410±0.040	109								
FL40S		40			39.5	0.420±0.040	106								

Remarks
1. The value attaching ( ) to the value of total luminous flux shall be the reference value.
2. Total luminous flux of –DL, -SDL and –EDL in color rendering property classification shall be 75% or more, 65% or more and 60% or more of this table's value respectively.
3. Total luminous flux of shatterproof types shall be 97% or more of this table's value.
4. Lumen maintenance factor of –DL, -SDL and –EDL in color rendering property classification shall be more than the value deducting 5 from this table's value.

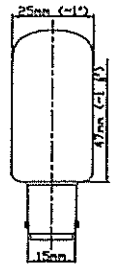
Series 40

2NM Single Color Index Models (for Aqua Signal series 40, 41, 42, 55 etc.; Perko 200 (Fig. 0375), Hella 2984, 2986, 2988, etc.)

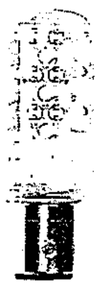
Part #	8001757	8001764	8001771	8000043
Description	For anchor, steaming, & stern nav. lights	For port nav. lights.	For starboard nav. lights.	For amber/yellow nav. lights
LED Color	White	Red	Green	Amber / Yellow
Voltage	12/24 VDC	12/24 VDC	12/24 VDC	12/24 VDC
Bulb Type	Indexed	Indexed	Indexed	Indexed

2NM Single Color Non-Index Models
(for Perko series 1127, 1130, etc.; Perko Bulb Fig. 0374)

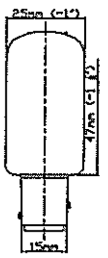
Part #	8001078	8001382	8001405
Description	For anchor, steaming, & stern nav. lights	For port nav. lights.	For starboard nav. lights.
LED Color	White	Red	Green
Voltage	12 VDC	12 VDC	12 VDC
Bulb Type	Non-Index	Non-Index	Non-Index


Non-Indexed (Level Side Pins)

Bi-Color



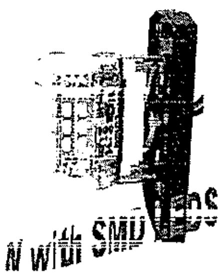
Part #	8001085	8001092
Description	Bi-Color	Bi-Color
	PS40	PS41
Bulb Type	Aqua Signal series 40 Base Mount	Aqua Signal series 41 Top Mount
LED Color	Red / Green	Red / Green
Voltage	12 VDC	12 VDC
Remark	Indexed	Indexed


Indexed (Offset Side Pins)

Tri-Color

Part #	8001450	8001436
Description	Tri-Color MKII	24 Tri-Color
Replacement	For aqua signal, Hella, & Perko tri-color nav lights	For 24V aqua signal series 40 tri-color stack
LED Color	White / Red / Green	White / Red / Green
Voltage	12 VDC	24 VDC
Remark	Indexed	Indexed

Series 25



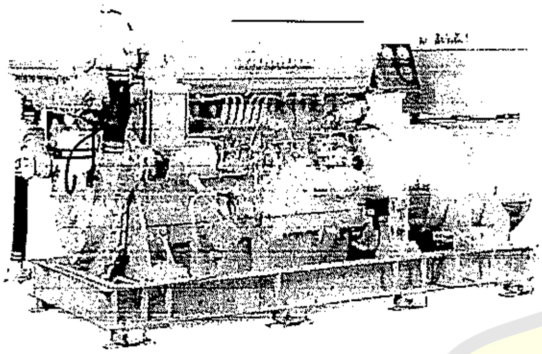
Part #	8001122	9000241
Description	Bi-Color (Dimpled Festoon)	2NM 39-44mm White Festoon
Bulb Type	Port, starboard, and bi-color nav. lights	
LED Color	Red / Green	White
Voltage	12 VDC	12 VDC

REFERENSI BAB VIII

6HAL2 series

MARINE AUXILIARY DIESEL ENGINE

122~414hp / 1200~1800rpm
100~350kVA (80~280kW)



- 6-cylinder, direct injection.
- Natural aspirated or turbocharged. (with intercooler)
- 6HAL2-WT, 6HAL2-WHT and 6HAL2-WDT conform to IMO Tier II emissions regulations.
- Type approved by NK, BV, GL, KR.

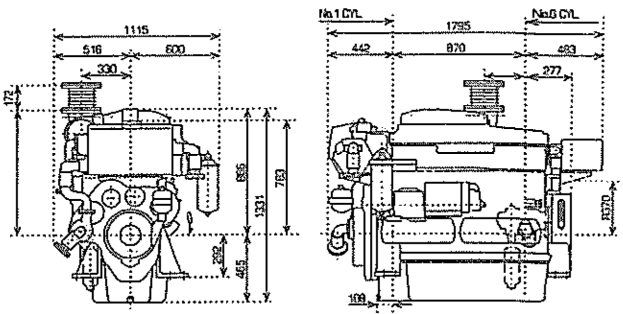
Model	6HAL2-N		6HAL2-TN	6HAL2-WT		6HAL2-WHT			6HAL2-WDT		
Number of cylinders mm	In-line 6										
Bore × stroke mm	130×165										
Displacement lit.	13.14										
Continuous rated engine speed rpm	1200	1500	1200	1500	1800	1200	1500	1800	1200	1500	1800
Continuous rated output hp	122	156	163	204	244	217	299	360	271	346	414
Applicable generator capacity kVA(kW)	100 (80)	125 (100)	130 (104)	170 (136)	200 (160)	180 (144)	250 (200)	300 (240)	225 (180)	290 (232)	350 (280)
Frequency Hz	60	50	60	50	60	60	50	60	60	50	60
Combustion system	Direct injection										
Aspiration	Natural aspiration		Exhaust Turbocharger			Exhaust Turbocharger with intercooler					
Dry weight (Engine only) kg	1380		1422			1437			1447		
Dry weight (Gen. set) kg	2360		2410			2750			2850		

- •Instrumental panel (attached to engine)
- •Cooling system : Sea water pump / Centrifugal type fresh water pump / Heat exchanger / Fresh water reservoir / Thermostat for fresh water / Emergency use sea water inlet
- •Lubrication system : Lubrication oil pump / Lubrication oil cooler / Lubrication oil filter (Tandem switch type) / Manual priming pump
- •Fuel system : Paper filter type fuel strainer / Drain separator to be mounted on vessel
- •Turbocharging system : Exhaust gas outlet expansion joint from engine
- •Electrical equipment : Starter motor (DC24V) 6.0kW / Alternator (DC24V600W) / Battery switch / 2 pole wiring
- •Thermometer : Exhaust gas at outlet of each cylinder / Cooling water outlet / Lubrication oil at cooler inlet

Unit:mm

Engine only (6HAL2-TN, -WT, -WHT, -WDT)

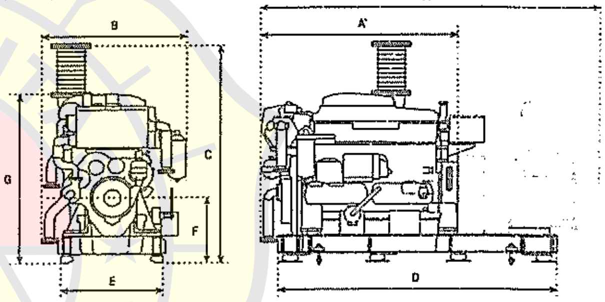
Front view Left side view



Unit:mm

Generator set dimensions shown below depend on generator model

Front view Left side view



G : Minimum Height for Removing Piston (Not included the dimension for bolt fitting to piston remove.)

Model	A	A'	B	C	D	E	F	G
6HAL2-N	2499	1589	1164	1654	2100	820	544	1327
6HAL2-TN	2499	1589	1164	1774	2100	820	544	1327
6HAL2-WT	2499	1589	1164	1774	2100	820	544	1327
6HAL2-WHT	2574	1589	1164	1804	2200	820	544	1327
6HAL2-WDT	2684	1589	1164	1804	2200	820	544	1327

– Generator

- •Cooling system : Kingston cock
- •Lubrication system : Inlet and outlet joint for semi dry sump
- •Fuel system : Primary fuel strainer to be mounted on vessel
- •Generator (and common bed) : Taiyo or Stamford
- •Thermometer : Exhaust gas at inlet of turbocharger (WT, TN, WHT, WDT) / Lubrication oil at cooler outlet
- •Electrical governor for parallel operation
- •Exhaust piping : Expansion joint for piping / Silencer
- •Compressed air starting device
- •Remote control device : Trip panel / Stop solenoid / LO pressure switch / FW temperature switch / Speed relay / Junction box & wiring

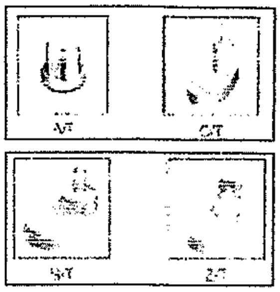
TECHNICAL DATA SHEET

Crown Battery Mfg. Co. • Fremont, Ohio USA
419-334-7181 • FAX 419-334-7124

CR-395
Commercial Deep Cycle Battery

Crown Battery Manufacturing Company offers a complete lineup of high-performing and low-maintenance commercial deep cycle batteries produced in standard BCI industry profiles for voltage, electrical capacity and physical dimension. Crown Battery's innovative and proven deep cycle product design makes it the battery of choice for many tough commercial battery applications, including commercial floor care and aerial access equipment, electric motorcars, personnel carriers, material handling equipment and photovoltaic systems.

Available Terminals



SPECIFICATIONS

Nominal Voltage		6 Volts	
Amp Hour Capacity		395 (C20)	320 (C5)
Reserve Capacity Minutes		225 @ 75 Amperes	
Physical Characteristics	Length	12.19"	310 mm
	Width	7.19"	183 mm
	Height	16.50"	419 mm
	Wet Weight	121 Lbs	55.0 Kgs
Terminal Options		A/T, C/T, S/T, Z/T	

ELECTRICAL SPECIFICATIONS

Amp Hour Capacity	20 Hour Rate	19.75 A	395 Ah
	10 Hour Rate	33.20 A	332 Ah
	5 Hour Rate	57.00 A	285 Ah
	2 Hour Rate	108.0 A	216 Ah
Internal Resistance	80 F	27 C	8.1 mOhm
Capacity affected by Temperature (20 Ah Rate)	104 F	40 C	102%
	80 F	27 C	100%
	32 F	0 C	65%

Cover Style:	Exposed Vent Opening
Cover Vent Style:	Quarter-Turn Bayonet St
Container and Cover Material:	Black Polypropylene
Case to Cover Seal Method:	Heat Seal
Inner-Cell Connector Type:	Through Partition Welc
Plate Lug to Collector Bar Fusion Method:	Inverted Automatic Cast-On
Number of Plates per Battery:	51 Plates
Positive Grid Material:	Antimony Lead Alloy
Positive Grid Design:	Z³ Horizontal Pellet
Positive Plate Dimension:	5.750" x 11.500" x 0.140 146mm x 292mm x 3.6m
Negative Grid Material:	Antimony Lead Alloy
Negative Grid Design:	Z³ Horizontal Pellet
Negative Plate Dimension:	5.750" x 11.500" x 0.105 146mm x 292mm x 2.7m
Separator Type:	Microporous Polyethylen Envelope with Glass

Visit our website www.crownbattery.c

Table (cont'd)

(4) Operating area

Space	Illumination lx	Method of measurement	Remark
Main passage, stair and entrance in eng. room, boiler room and aux. machine room	100	Fig. 3, Fig. 5, Fig. 6	
Operation area in engine room, boiler room and aux. machine room	150	–	At a height of 850 mm above floor of operation area and monitoring station
Access to the rear of tanks in eng. room, boiler room and aux. machine room	20	Fig. 6	
Engine control room	200	Fig. 1	
on gauge	300	Fig. 12	Not applicable to photoelectric digital instrument board, display surface of CRT etc.
on operating table	300	Fig. 12	Not applicable to photoelectric digital instrument board, display surface of CRT etc.
Work shop	100	Fig. 1	
on work bench	300	–	Centre of work bench surface
at work face of machine and tool	500	–	
Engine room store	50	Fig. 1	
Shaft tunnel	20	Fig. 6	
Cargo control room	200	Fig. 1	
on gauge	300	Fig. 12	Not applicable to photoelectric digital instrument board, display surface of CRT, etc.
on operating table	300	Fig. 12	Not applicable to photoelectric digital instrument board, display surface of CRT, etc.
Emergency generator room	100	Fig. 1	
on gauge	200	Fig. 12	
Battery room	50	Fig. 1	
Boatswain's store	50	Fig. 1	
Paint store	50	Fig. 1	
Cargo oil pump room	50	Fig. 5, Fig. 6	Near passageway, stairway, and pump
Steering gear room, aircond. room etc.	50	Fig. 1	
Refrigerated cargo hold	30	Fig. 7	
General cargo hold (fixed light)	20	Fig. 8	
Under deck passage	20	Fig. 2	Container ship, dredger
Cargo handling space	20	–	Horizontal plane near operating handle
Mooring area	20	–	Mean value of measurements at several suitable points in a horizontal plane at a height of 850 mm above deck

(1) *Living area*

Space	Illumination lx	Method of measurement	Remark
Captain class day room	150	Fig. 1	
Captain class bed room	100	Fig. 1	
Cabin	100	Fig. 1	
State room, passenger room	100	Fig. 1	
On desk	250	Fig. 11	Local lighting in captain class room, captain class bed room, cabin, and state room
Berth at pillow	200	Fig. 9	Local lighting in captain class room, captain class bed room, cabin, and state room
Mirror front	200	Fig. 10	Local lighting in captain class room, captain class bed room, cabin, and state room
Bath room	50	Fig. 1	
Lavatory, toilet	50	Fig. 1	
Mirror front	200	Fig. 10	
Barber shop and beauty parlor	200	Fig. 1	
Dining saloon, mess room	200	Fig. 1	
on dining table	250	Fig. 11	
on table (writing, game)	250	Fig. 11	
Smoking room	200	Fig. 1	
Recreation room	200	Fig. 1	For a Japanese-style room, illumination at a height of 400 mm above floor
on dining table	250	Fig. 11	
on table (writing, game)	250	Fig. 11	
Sports room, gymnasium	200	Fig. 1	
Library	200	Fig. 1	
on table	250	Fig. 11	
Lounge	200	Fig. 1	
Cocktail lounge	–	–	Mood lighting; suitable illumination
Hospital	100	Fig. 1	
Dispensary	200	Fig. 1	
on dispensary table	500	–	Table face right under lamp or bulb
Shopping area	200	Fig. 1	For ferry boat, passenger ship, etc.
Passage, alley way, corridor passage	50	Fig. 2	
Staircase	50	Fig. 3	Including companion way

Table (cont'd)

Space	Illumination lx	Method of measurement	Remark
Entrance for passenger	100	–	Mean value of several suitable points near entrance
Outer passage	10	Fig. 4	
Swimming pool	50	–	Measuring point shall be on water surface at pool centre

(2) Navigation area

Space	Illumination lx	Method of measurement	Remark
Wheelhouse	50	Fig. 1	
Chart room	50	Fig. 1	
on chart table	250	–	Table face right under lamp or bulb
Radio office	200	Fig. 1	
Operating table	250	Fig. 11	
Electric room, such as gyro room, radar room, etc.	100	Fig. 1	
Pilot house	100	Fig. 1	Crane barge, rig
Navigation room	200	Fig. 1	Crane barge, rig
Operating room	200	Fig. 1	Crane barge, rig
Rig management room	200	Fig. 1	Crane barge, rig

(3) Service area

Space	Illumination lx	Method of measurement	Remark
Office	100	Fig. 1	
on desk	250	Fig. 11	
Galley	100	Fig. 1	
on cooking table	250	–	Centre of cooking table surface
Pantry, butcher shop, bakery etc.	100	Fig. 1	
Provision store (dry)	50	Fig. 1	
Refrigerated provision chamber	30	Fig. 1	
Laundry	100	Fig. 1	
Drying room	50	Fig. 1	
Locker and store	50	Fig. 1	

Table 1 Lamps for General Illumination

Type	Rated wattage W	Rated voltage V	Classification	Glass bulb Type	Glass bulb Dia. mm	Length mm	Base	Standard direction of lamp	Initial characteristics Consumption W	Initial characteristics Light flux lm	Initial characteristics Efficiency lm/W	Endurance time for vibration under over voltage h	Static life h	Shape
KG 24 V 10 W	10	24	Gas-filled	A55	55 ± 1	98 ± 3	E26/25 or B22D/26 × 26	Down	10.0 ± 0.7	85 ± 13	8.5 ± 1.0	25	1000	
KG 100 V 110 V 115 V 10 W	10	100 110 115	Vacuum	A55	55 ± 1	98 ± 3	E26/25 or B22D/26 × 26	Down	10.0 ± 0.7	60 ± 7	6.0 ± 0.6	15	2000	
KG 24 V 20 W	20	24	Gas-filled	A55	55 ± 1	98 ± 3	E26/25 or B22D/26 × 26	Down	20.0 ± 1.4	220 ± 33	11.0 ± 1.3	45	1000	
KG 100 V 110 V 115 V 20 W	20	100 110 115	Vacuum	A55	55 ± 1	98 ± 3	E26/25 or B22D/26 × 26	Down	20.0 ± 1.4	142 ± 17	7.1 ± 0.7	40	2000	
KG 220 V 230 V 20 W	20	220 230	Vacuum	A55	55 ± 1	98 ± 3	E26/25 or B22D/26 × 26	Down	20.0 ± 1.4	112 ± 17	5.6 ± 0.7	15	2000	
KG 24 V 40 W	40	24	Gas-filled	A55	55 ± 1	105 ± 3	E26/25 or B22D/26 × 26	Down	40.0 ± 2.8	540 ± 81	13.5 ± 1.6	50	1000	
KG 100 V 110 V 115 V 40 W	40	100 110 115	Gal-filled	A55	55 ± 1	105 ± 3	E26/25 or B22D/26 × 26	Down	40.0 ± 2.8	335 ± 41	8.4 ± 0.9	40	1500	
KG 220 V 230 V 40 W	40	220 230	Vacuum	A60	60 ± 1	110 ± 4	E26/25 or B22D/26 × 26	Down	40.0 ± 2.8	260 ± 39	6.5 ± 0.8	30	2000	
KG 24 V 60 W	60	24	Gas-filled	A60	60 ± 1	110 ± 4	E26/25 or B22D/26 × 26	Down	60.0 ± 4.2	870 ± 130	14.5 ± 1.7	50	1000	
KG 100 V 110 V 115 V 60 W	60	100 110 115	Gas-filled	A60	60 ± 1	110 ± 4	E26/25 or B22D/26 × 26	Down	60.0 ± 4.2	590 ± 71	9.8 ± 1.0	50	1500	Fig. (1)
KG 220 V 230 V 60 W	60	220 230	Gas-filled	A60	60 ± 1	110 ± 4	E26/25 or B22D/26 × 26	Down	60.0 ± 4.2	440 ± 66	7.4 ± 0.9	40	1500	
KG 24 V 100 W	100	24	Gas-filled	A70	70 ± 1	136 ± 4	E26/25 or B22D/26 × 26	Down	100 ± 7	1550 ± 230	15.5 ± 1.9	50	1000	
KG 100 V 110 V 115 V 100 W	100	100 110 115	Gas-filled	A70	70 ± 1	136 ± 4	E26/25 or B22D/26 × 26	Down	100 ± 7	1150 ± 140	11.5 ± 1.2	50	1500	
KG 220 V 230 V 100 W	100	220 230	Gas-filled	A70	70 ± 1	136 ± 4	E26/25 or B22D/26 × 26	Down	100 ± 7	920 ± 140	9.2 ± 1.1	40	1500	
KG 100 V 110 V 115 V 200 W	200	100 110 115	Gas-filled	PS 80	80 ± 1	175 ± 5	E26/30 × 28 or B22D/26 × 26	Down	200 ± 14	2740 ± 320	13.7 ± 1.4	50	1500	
KG 220 V 230 V 200 W	200	220 230	Gas-filled	PS 80	80 ± 1	175 ± 5	E26/30 × 28 or B22D/26 × 26	Down	200 ± 14	2280 ± 350	11.4 ± 1.1	50	1500	
KG 100 V 110 V 115 V 300 W	300	100 110 115	Gas-filled	PS 95	95 ± 1	213 ± 7	E39/41	Down	300 ± 21	4500 ± 540	15.0 ± 1.5	50	1500	
KG 220 V 230 V 300 W	300	220 230	Gas-filled	PS 95	95 ± 1	213 ± 7	E39/41	Down	300 ± 21	3810 ± 570	12.7 ± 1.5	50	1500	
KG 100 V 110 V 115 V 500 W	500	100 110 115	Gas-filled	PS110	110 ± 1	232 ± 8	E39/41	Down	500 ± 35	8200 ± 980	16.5 ± 1.6	50	1500	
KG 220 V 230 V 500 W	500	220 230	Gas-filled	PS110	110 ± 1	232 ± 8	E39/41	Down	500 ± 35	7100 ± 1100	14.2 ± 1.7	50	1500	

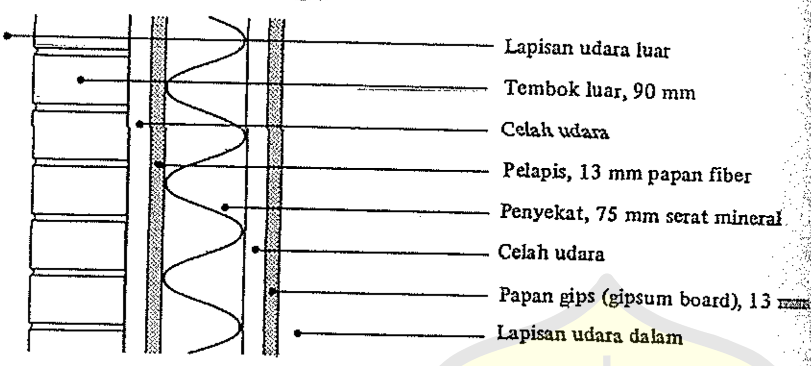
Remarks:

1. The letters and figures for types shall mean as follows:
   K: Marine lamps
   G: Lamps for general use
   Figures following G: Rated voltage
   Figures following V: Rated wattage
2. The glass bulbs shall be of transparent of frosted (300 % or less).

Untuk memperkirakan beban-penghangatan, perbedaan suhu adalah ha... persen suhu luar dikurangi harga rancangan dalam.

Seperti dibicarakan dalam Bab 2, koefisien perpindahan kalor total U ada... dari hambatan-hambatan termal. Tabel 4-4 (hal. 68) memuat harga-harga ... termal untuk 1 m^2 permukaan bahan-bahan bangunan yang umum digunak... udara tertutup, dan batas-batas selubung bangunan. Contoh 4-3 melukiskan ... nentuan harga U dari suatu penampang dinding yang khas. Luas-luas permuk... digunakan dalam perhitungan transmisi ini adalah luas-luas bagian dalam no... ruangan-ruangan.

Contoh 4-3 Tentukan hambatan termal total dari suatu satuan luas pot... ding seperti dalam Gambar 4-3.



Gambar 4-3 Penampang dinding dalam Contoh 4-3

Penyelesaian Hambatan-hambatan berikut didapat dari Tabel 4-4 :

Lapisan udara luar	0,029 m^2.K/W
Bata luar, 90 mm	0,068
Celah udara	0,170
Sisipan, 13 mm papan fiber	0,232
Penyekat, 75 mm serat mineral	1,940
Celah udara	0,170
Papan gip, 13 mm	0,080
Lapisan udara dalam	0,120
R_{tot}	2,812 m^2.K/W

Bila ruang tingkat bawah tak dikondisikan, kehilangan kalor melalui per... permukaan yang ada dibagian bawah seringkali diabaikan. Beban-beban pengh... *yang termasuk dalam kasus seperti itu didasarkan pada perkiraan suhu ruan...* tak dikondisikan tersebut dan penjalaran kalor melalui lantai. Bila ruang tingka... tersebut akan dikondisikan, perambatan kalor yang hilang didasarkan pada ha... termal dinding dan lantai, suhu ruang yang akan dikondisikan, dan suhu tan... terdekat dengan permukaan tersebut.

Untuk konstruksi *slab-on-grade* (tingkat di atas slab) kehilangan ... lebih sebanding dengan panjang perimeter slab tersebut daripada luasnya, sehingga

$$q_{slab} = F(\text{perimeter})\,(t_o - t_i) \quad \text{dengan } F = \text{konstanta}$$

... dari satu sat

Bahan-ba

... koral, 200 m
... lapped
... pel dengan

Baha

... ler, 13 mm
... ngah
... menengah

Bahan

... beraspal)

Beton

Bahan-b

... mineral, 75 – 90 mm
... , organic bond
... rene, extruded
... thane
... t, 160 mm

Bahan-b

... plaster, 15 mm
... , plaster semen
... , 16 mm
... nus, dan lain-lain)
... aple, oak, dan lain-lain)

... keterangan untuk men... k slab-slab skala rumal... tidak disekat, dan F

edaan suhu adalah harga 97,5

ahan kalor total U adalah fu[illegible]
memuat harga-harga hamba[illegible]
yang umum digunakan, ru[illegible]
ontoh 4-3 melukiskan cara [illegible]
as. Luas-luas permukaan y[illegible]
uas bagian dalam nominal [illegible]

atu satuan luas potongan [illegible]

udara luar

luar, 90 mm

ara

3 mm papan fiber

75 mm serat mineral

a

(gipsum board), 13 mm

ara dalam

oh 4-3

abel 4-4 :

alor melalui permuk[illegible]
ban-beban penghang[illegible]
iraan suhu ruangan [illegible]
Bila ruang tingkat b[illegible]
dasarkan pada hamb[illegible]
n, dan suhu tanah [illegible]

lab) kehilangan [illegible]
luasnya, sehingga

konstanta

[illegible] 4-4 Hambatan termal dari satu satuan luas permukaan bahan bangunan tertentu [illegible] rata-rata 24°C.

	$1/k$, m · K/W	R, m² · K/W
Bahan-bahan eksterior		
[illegible] (bata luar)	0,76	
[illegible]	1,39	
[illegible]	0,55	
[illegible] block, agregat pasir dan koral, 200 mm		0,18
[illegible] ringan, 200 mm		0,38
" " 150 mm		0,29
[illegible])	1,39	
[illegible]tos-cement, 6 mm, lapped		0,04
[illegible] penyekat, 13 mm		0,14
[illegible] ply-wood, 10 mm		0,10
[illegible]ium atau baja, ditempel dengan [illegible] penyekat, 10 mm		0,32
Bahan pelapis		
[illegible] cement	1,73	
[illegible]	8,66	
[illegible], massa jenis reguler, 13 mm		0,23
[illegible], massa jenis menengah	9,49	
[illegible], massa jenis menengah	7,35	
Bahan-bahan atap		
[illegible] (sirap beraspal)		0,08
[illegible], 10 mm		0,06
Beton (concrete)		
[illegible] dan kerikil	0,55	
[illegible]	1,94	
Bahan-bahan penyekat		
[illegible], serat mineral, 75–90 mm		1,94
[illegible] mm		3,35
[illegible], serat gelas, organic bond	27,7	
[illegible] polystyrene, extruded	27,7	
[illegible] polyurethane	43,8	
[illegible] tak padat, 160 mm		3,35
[illegible]	21,7–25,6	
Bahan-bahan interior		
[illegible] papan plaster, 15 mm		0,08
[illegible]		0,10
[illegible] plaster, plaster semen	1,39	
[illegible], ringan, 16 mm		0,066
[illegible] (fir, pinus, dan lain-lain)	8,66	
[illegible] (maple, oak, dan lain-lain)	6,31	

[illegible] sedikit keterangan untuk mendasarkan harga-harga F bagi slab-slab besar. [illegible] untuk slab-slab skala rumah tinggal ditentukan sebesar F = 1,4 W/m.K [illegible] yang tidak disekat, dan F = 0,9 W/m.K untuk suatu *slab* yang bersekat