DAFTAR PUSTAKA

Anonim, 1981, JIS Handbook, Machine Element, Japanese Standards Association.

Anonim, 1981, SKF General Katalogue, Erlanders, Sweden.

Cengel, Yunus A., 1989, Thermodynamics An Engineering Approach, McGraw Hill Book Company, Toronto.

Church, A. H., Zulkifli Harahap, 1990, Pompa dan Blower Sentrifugal, Erlangga, Jakarta.

Coulson, J. M., 1986, Chemical Engineering, Pergamon Press, New York.

Dietzel, F., Dakso Sriyono, 1990, Turbin Pompa dan Kompresor, Erlangga, Jakarta.

Dobrovolsky, V., Machine Elements, Foreign Languages, Publishing House, Moscow.

Karassik, I. J., 1976, Pump Handbook, McGraw Hill Book Company, Toronto.

KSB Aktiengesellscaft, Centrifugal Pump Design (Pump Valves), Frankenthal.

Khetagurov, M., Marine Auxiliary and Systems, Peace Publishers, Moscow.

Lazarkiewicz, S., 1965, Impeller Pumps, Pergamon Press, Ltd., Warszawa.

Levinson, etal., 1978, Machine Design, Reston Publishing Company, Virginia.

Odgaard, A. J., etal., 1994, Journal of Hydraulic Engineering, ASCE, Auckland.

Pao, Richard H. F., 1971, Fluid Mechanics, John Wiley and Sons, Sydney.

Peckner, Donald, 1977, Handbook of Stainless Steel, McGraw Hill Book Company, San Fransisco.

Shigley, J. E., 1986, Mechanical Engineering Design, McGraw Hill Book Company, Singapore.

Shigley, J. E., 1986, Perencanaan Teknik Mesin, Erlangga, Jakarta.

Stepanoff, A. J., 1957, Centrifugal and Axial Flow Pumps, John Wiley and Sons, Inc., New York.

Sularso, Haruo Tahara, 1985, Pompa dan Kompresor, PT. Pratnya Paramita, Jakarta.

Sularso, Kiyokatsu Suga, 1983, Dasar Perencanaan dan Pemilihan Elemen Mesin, PT. Pradnya Paramita, Jakarta.

White, Frank M., Liek Wilarjo, 1979, Mekanika Zalir, Erlangga, Jakarta.

Yedidiah, S., 1976, Centrifugal Pump User's Guidebook, An International Thomson Publishing Company, Washington.

Lampiran 1

Data-data kondisi pemompaan dan sistem pipa di *PT. KS*

DSD DÜSSELDORF

DEP. DTH

ROTATORY PUMPS

PUMP NO. P3o.1 - 3o.4 PIECE NUMBER 4

SERIAL NO.

DESIGNATION scale water mixing cyclone

MOTOR–DRIVEN

PLEASE STATE IN ALL CORRESPONDANCE		
33lo1 o79	I/51241/1-4	
Draw.No.	Fabr.No.	SUPPL.

DATE	DEPT.	ISS.	REV.	APPR.

DESIGN DATA		
LIQUID scale water		
WORKING TEMPERATURE	35	°C
VISCOSITY AT W.T.		cST
SPEC. GRAVITY AT W.T.	1.0	
VESSEL PRESSURE		ata
SAT. VAPOUR PRESS. AT W.T.		ata
GEOD. HEAD GR.		m
SUCTION HEAD		m
FRICT. LOSS IN SUCT. PIPE		m
NPSH (AVAILABLE)		m
NORM. CAPACITY	45o	m³/h
DESIGN CAPACITY	475	m³/h
INLET PRESSURE		kp/cm²
DISCHARGE PRESSURE		kp/cm²
DIFFERENTIAL PRESSURE	[illegible]	kp/cm²
TOTAL HEAD	[illegible]	m
HYDR. POWER		PS
DESIGN-AND-MATERIAL		
CASING cast iron25 SPLIT radial		
SHAFT ST 5o-7o.11		
SHAFT SLEEVE ST with wolframcarbide		
IMPELLER hard cast iron		
DIFFUSER armour cast iron		
CASE SEALING RING		
IMPELLER SEALING RING		
STUFFING BOX		
STUFFING BOX GLAND cast iron 25		
PACKING 35/1330x13 NUMBER 5 RINGS		
LANTERN RING		
MECHANICAL SEAL		
BEARING BRACKET cast iron		
[illegible] 7315 BUA / RADIAL: NU 314		
INCLUSIVE SPARE PARTS		
ISOLATION		
BASEPLATE f. PUMP AND DRIVE		
COUPLING [illegible] 35, A= 2oomm		
LUBRICATION grease		
ANCHOR BOLTS [illegible] 24 x 5oo.DIN 529		
CLEARANCE AND TEST		
SEALING RING Ø	MIN.	
DIFFUSER Ø	MIN.	
BALANCE PISTON Ø	MIN.	
HYDR. TEST CASING	7,5	kp/cm²
REMARKS:		

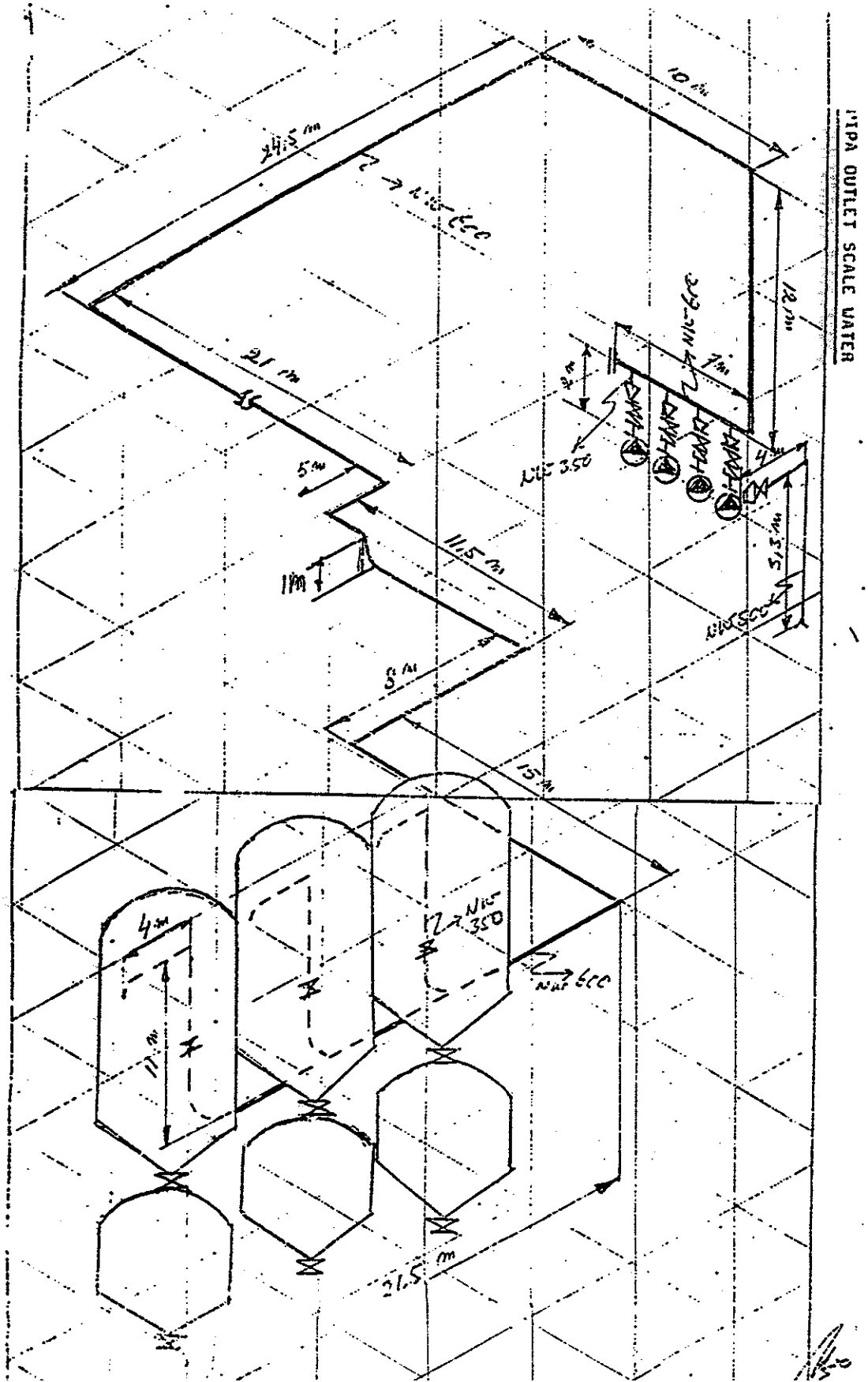
PLANT DATA	
MANUFACTURER Halbermann	148o U/min
TYPE RPL 1o3/7	STAGES 1
ROTATION FROM DRIVE END right	
COOLING WATER °C kp/cm²	SYSTEM
CONSUMPTION m³/h BEARING	STUFFING BOX 3o1/min
FLUSHING WATER l/h OF	°C MAX.
QUENCH WATER l/h OF	35 °C MAX.
NPSH (REQUIRED)	m
IMPELLER Ø 42o MAX. Ø 45o MIN. Ø 375	
EFFICIENCY AT RATED POINT	%
POWER REQUIRED AT SHAFT	97,4 kw
REQUIRED DRIVER POWER	132 kw
SHAFT DIAMETER Ø	65 mm
NOZZLES	
SUCTION SITE DN 25o	PN 1o
DISCHARGE SITE DN 2oo	PN 1o
TURB. INLET DN	PN
TURB. OUTLET DN	PN
WEIGHTS AND DRAWINGS	
PUMP 55o kg	BASE PLATE 32o kg
MOTOR 935 kg	TURBINE kg
PUMP OUTLINE DR.NO. RPL 1o3157	
TURBINE OUTLINE DR.NO.	
PERFORMANCE CURVE NO. K 1o3 65	
TEST CURVE NO.	
STARTING TORQUE CURVE NO. K 1o3 35	
MOTOR FOR OF	
MANUFACTURER AND TYPE	
kw rpm SERIAL NO.	
VOLTAGE V PHASE(S)	Cycle
POWER CONSUMPTION	kw/h
TURBINE FOR OF	
MANUFACTURER AND TYPE	
PS rpm	
STEAM CONSUMPTION kg/h	kg/PSh
HOT VAPOR kp/cm²/TEMP. °C	°C MAX.
EXHAUST VAPOR kp/cm². SATURATED	

	UNIT PRICE	TOTAL PRICE
PUMP		
MOTOR		
TURBINE		
BASE PLATE WITH BOLTS		
COUPLING WITH GUARD		
SPARE PARTS		
FINAL PRICE		

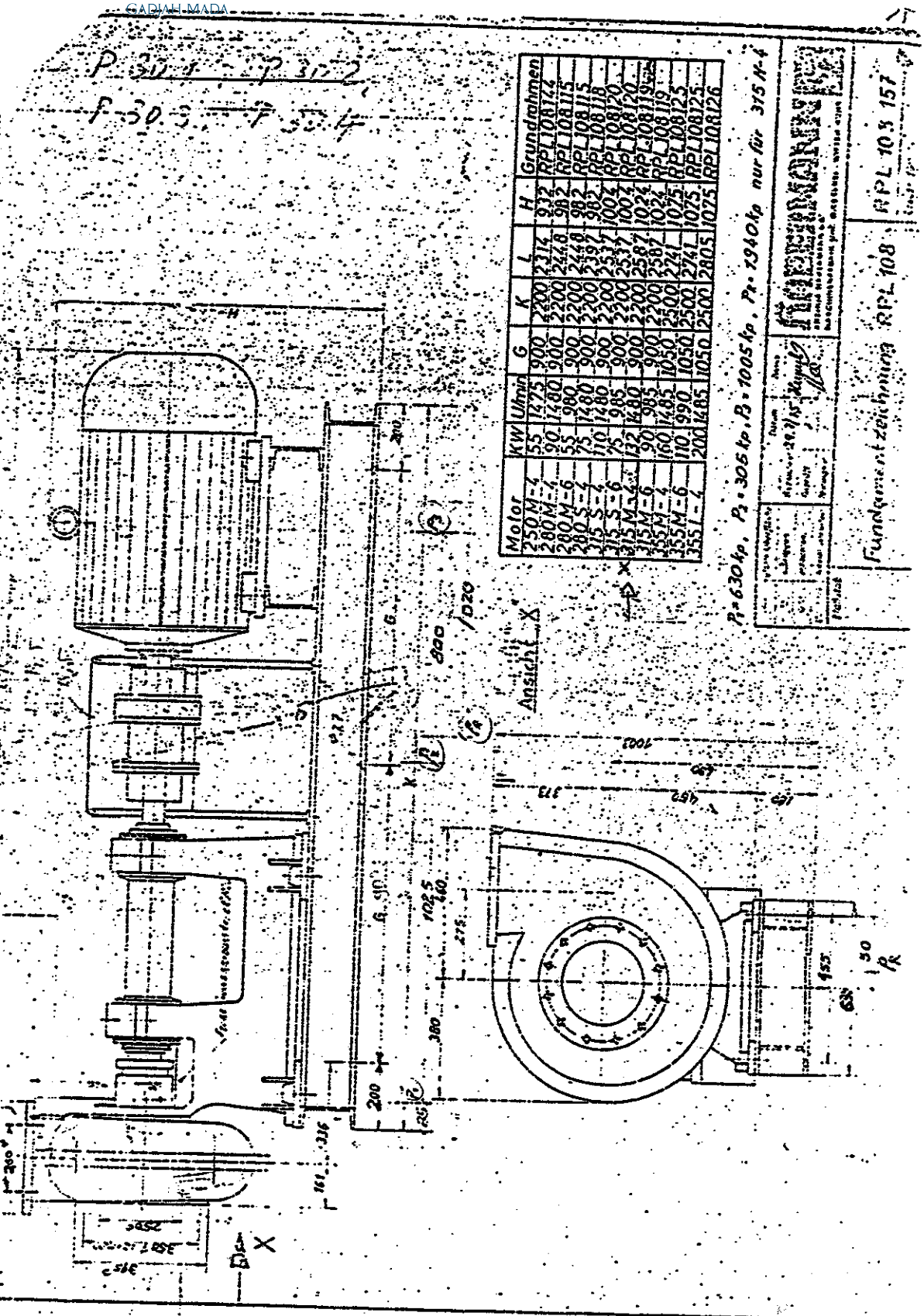
PERIOD OF DELIVERY

Lampiran 1 (sambungan)

Data-data kondisi pemompaan dan sistem pipa di *PT. KS*



Data-data kondisi pemompaan dan sistem pipa di PT. FG



Lampiran 2

Karakteri[illegible]

(Sumber : Odgaard, 1994)

TABLE 1. Flow Characteristics (Flat Bed Conditions)

Run (1)	ν ($m^2/s \times 10^{-6}$) (2)	h (m) (3)	r (m) (4)	U (m/s) (5)	F (6)	R ($\times 10^3$) (7)	S (8)	u_* (m/s) (9)	θ (10)	$w/(\kappa u_*)$ (11)	R_* (12)
(*a*) Fine to medium sand: d_{50} = 0.21 mm; d_g = 0.20 mm; σ_g = 1.24; s = 2.65; u_{*c} = 0.0128 m/s; θ_c = 0.051; w = 0.026 m/s											
F1	0.963	0.160	0.052	0.335	0.267	18.0	0.00052	0.0169	0.088	3.55	3.51
F2	0.963	0.162	0.052	0.393	0.312	21.1	0.00072	0.0207	0.132	2.90	4.30
F3	0.963	0.163	0.052	0.451	0.356	24.3	0.00100	0.0250	0.193	2.40	5.19
F4	0.963	0.166	0.052	0.598	0.469	32.4	0.00149	0.0294	0.267	2.04	6.11
F5	0.963	0.068	0.036	0.355	0.434	13.3	0.00088	0.0195	0.117	3.08	4.05
F6	0.963	0.071	0.037	0.427	0.512	16.3	0.00121	0.0242	0.181	2.48	5.03
F7	0.963	0.072	0.037	0.462	0.550	17.8	0.00141	0.0261	0.210	2.30	5.42
F8	0.963	0.076	0.038	0.541	0.625	21.5	0.00199	0.0296	0.271	2.03	6.15
F9	0.963	0.114	0.046	0.484	0.457	23.0	0.00135	0.0240	0.178	2.50	4.98
(*b*) Medium to coarse sand: d_{50} = 0.83 mm; d_g = 0.82 mm; σ_g = 1.25; s = 2.62; u_{*c} = 0.0215 m/s; θ_c = 0.035; w = 0.112 m/s											
C1	0.963	0.163	0.052	0.485	0.383	26.2	0.00115	0.0283	0.061	9.14	24.10
C2	0.963	0.165	0.052	0.579	0.455	31.4	0.00161	0.0353	0.096	7.33	30.06
C3	0.963	0.168	0.052	0.677	0.527	36.8	0.00202	0.0448	0.154	5.77	38.15
C4	0.985	0.075	0.038	0.449	0.523	17.2	0.00170	0.0294	0.066	8.80	24.48
C5	0.985	0.078	0.039	0.496	0.567	19.4	0.00211	0.0335	0.086	7.72	27.89
C6	0.985	0.080	0.039	0.545	0.614	21.6	0.00254	0.0375	0.108	6.90	31.22
C7	1.007	0.115	0.046	0.482	0.453	22.0	0.00137	0.0289	0.064	8.95	23.53
C8	1.007	0.119	0.046	0.580	0.538	26.7	0.00200	0.0370	0.105	6.99	30.13
C9	1.007	0.123	0.047	0.688	0.628	32.1	0.00271	0.0446	0.153	5.80	36.32
C10	1.007	0.126	0.048	0.800	0.719	37.7	0.00343	0.0515	0.204	5.02	41.94
C11	1.007	0.132	0.048	0.896	0.787	43.1	0.00420	0.0593	0.270	4.36	48.29

Lampiran 3

Kekasaran pipa-pipa komersial

(Sumber : Sularso, 1983)

Tabel 6-1

KEKASARAN RERATA PIPA–PIPA KOMERSIAL

Bahan (dalam keadaan baru)	ε ft	ε mm
Baja keling	0,003–0,03	0,9–9,0
Beton	0,001–0,01	0,3–3,0
Bilah tahang-kayu	0,0006–0,003	0,18–0,9
Besi cor	0,00085	0,26
Besi bersalut-seng	0,0005	0,15
Besi-cor beraspal	0,0004	0,12
Baja komersial atau besi tempa	0,00015	0,046
Tabung/pipa tarik	0,000005	0,0015
Kaca	"Halus"	"Halus"

Lampiran 4

Properties of Saturated Water (Sumber: Cengel, 1989)

TABLE A-4

Saturated water–Temperature table

Temp. °C T	Sat. press. kPa P_{sat}	Specific volume m³/kg: Sat. liquid v_f	Specific volume m³/kg: Sat. vapor v_g	Internal energy kJ/kg: Sat. liquid u_f	Internal energy kJ/kg: Evap. u_{fg}	Internal energy kJ/kg: Sat. vapor u_g	Enthalpy kJ/kg: Sat. liquid h_f	Enthalpy kJ/kg: Evap. h_{fg}	Enthalpy kJ/kg: Sat. vapor h_g	Entropy kJ/(kg·K): Sat. liquid s_f	Entropy kJ/(kg·K): Evap. s_{fg}	Entropy kJ/(kg·K): Sat. vapor s_g
0.01	0.6113	0.001 000	206.14	0.00	2375.3	2375.3	0.01	2501.3	2501.4	0.0000	9.1562	9.1562
5	0.8721	0.001 000	147.12	20.97	2361.3	2382.3	20.98	2489.6	2510.6	0.0761	8.9496	9.0257
10	1.2276	0.001 000	106.38	42.00	2347.2	2389.2	42.01	2477.7	2519.8	0.1510	8.7498	8.9008
15	1.7051	0.001 001	77.93	62.99	2333.1	2396.1	62.99	2465.9	2528.9	0.2245	8.5569	8.7814
20	2.339	0.001 002	57.79	83.95	2319.0	2402.9	83.96	2454.1	2538.1	0.2966	8.3706	8.6672
25	3.169	0.001 003	43.36	104.88	2304.9	2409.8	104.89	2442.3	2547.2	0.3674	8.1905	8.5580
30	4.246	0.001 004	32.89	125.78	2290.8	2416.6	125.79	2430.5	2556.3	0.4369	8.0164	8.4533
35	5.628	0.001 006	25.22	146.67	2276.7	2423.4	146.68	2418.6	2565.3	0.5053	7.8478	8.3531
40	7.384	0.001 008	19.52	167.56	2262.6	2430.1	167.57	2406.7	2574.3	0.5725	7.6845	8.2570
45	9.593	0.001 010	15.26	188.44	2248.4	2436.8	188.45	2394.8	2583.2	0.6387	7.5261	8.1648
50	12.349	0.001 012	12.03	209.32	2234.2	2443.5	209.33	2382.7	2592.1	0.7038	7.3725	8.0763
55	15.758	0.001 015	9.568	230.21	2219.9	2450.1	230.23	2370.7	2600.9	0.7679	7.2234	7.9913
60	19.940	0.001 017	7.671	251.11	2205.5	2456.6	251.13	2358.5	2609.6	0.8312	7.0784	7.9096
65	25.03	0.001 020	6.197	272.02	2191.1	2463.1	272.06	2346.2	2618.3	0.8935	6.9375	7.8310
70	31.19	0.001 023	5.042	292.95	2176.6	2569.6	292.98	2333.8	2626.8	0.9549	6.8004	7.7553
75	38.58	0.001 026	4.131	313.90	2162.0	2475.9	313.93	2321.4	2635.3	1.0155	6.6669	7.6824
80	47.39	0.001 029	3.407	334.86	2147.4	2482.2	334.91	2308.8	2643.7	1.0753	6.5369	7.6122
85	57.83	0.001 033	2.828	355.84	2132.6	2488.4	355.90	2296.0	2651.9	1.1343	6.4102	7.5445
90	70.14	0.001 036	2.361	376.85	2117.7	2494.5	376.92	2283.2	2660.1	1.1925	6.2866	7.4791
95	84.55	0.001 040	1.982	397.88	2102.7	2500.6	397.96	2270.2	2668.1	1.2500	6.1659	7.4159

Tabel 2.12 Sifat-sifat fisik air (Air di bawah 1 atm, dan air jenuh di atas 100°C).

Temperatur (°C)	Kerapatan (kg/l)	Viskositas kinematik (m^2/s)	Tekanan uap jenuh (kgf/cm^2)
0	0,9998	$1,792 \times 10^{-6}$	0,00623
5	1,0000	1,520	0,00889
10	0,9998	1,307	0,01251
20	0,9983	1,004	0,02383
30	0,9957	0,801	0,04325
40	0,9923	0,658	0,07520
50	0,9880	0,554	0,12578
60	0,9832	0,475	0,20313
70	0,9777	0,413	0,3178
80	0,9716	0,365	0,4829
90	0,9652	0,326	0,7149
100	0,9581	0,295	1,0332
120	0,9431	0,244	2,0246
140	0,9261	0,211	3,685
160	0,9073	0,186	6,303
180	0,8869	0,168	10,224
200	0,8647	0,155	15,855
220	0,8403	0,150	23,656
240	0,814	0,136	34,138
260	0,784	0,131	47,869
280	0,751	0,128	65,468
300	0,712	0,127	87,621

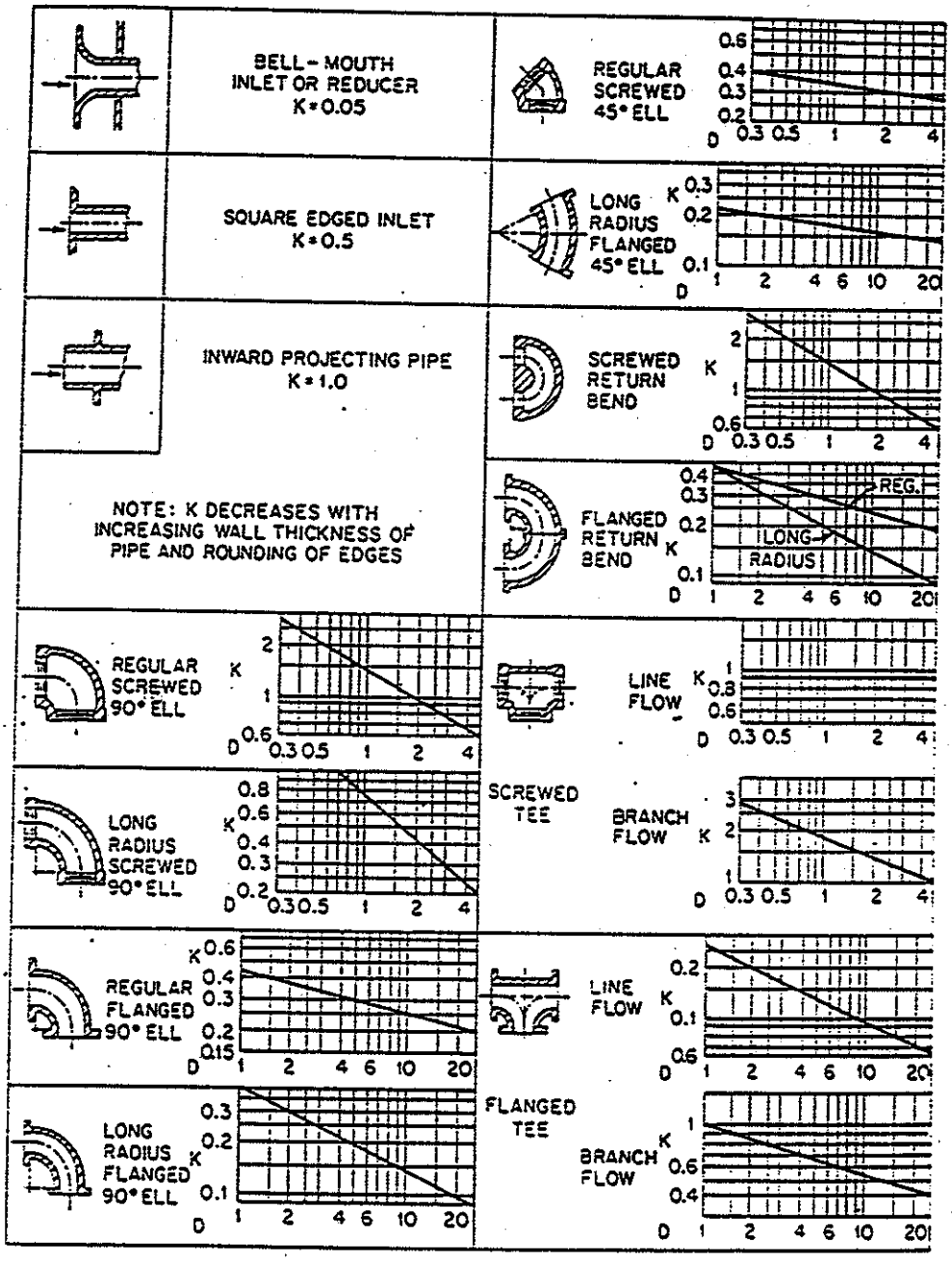
Catatan: 1 atm = 101,3 kPa 1 kgf/cm² = 98,1 kPa

Lampiran 5

Koefisien t[illegible] untuk berbagai peralatan pipa

(Sumber : Karassik, 1976)

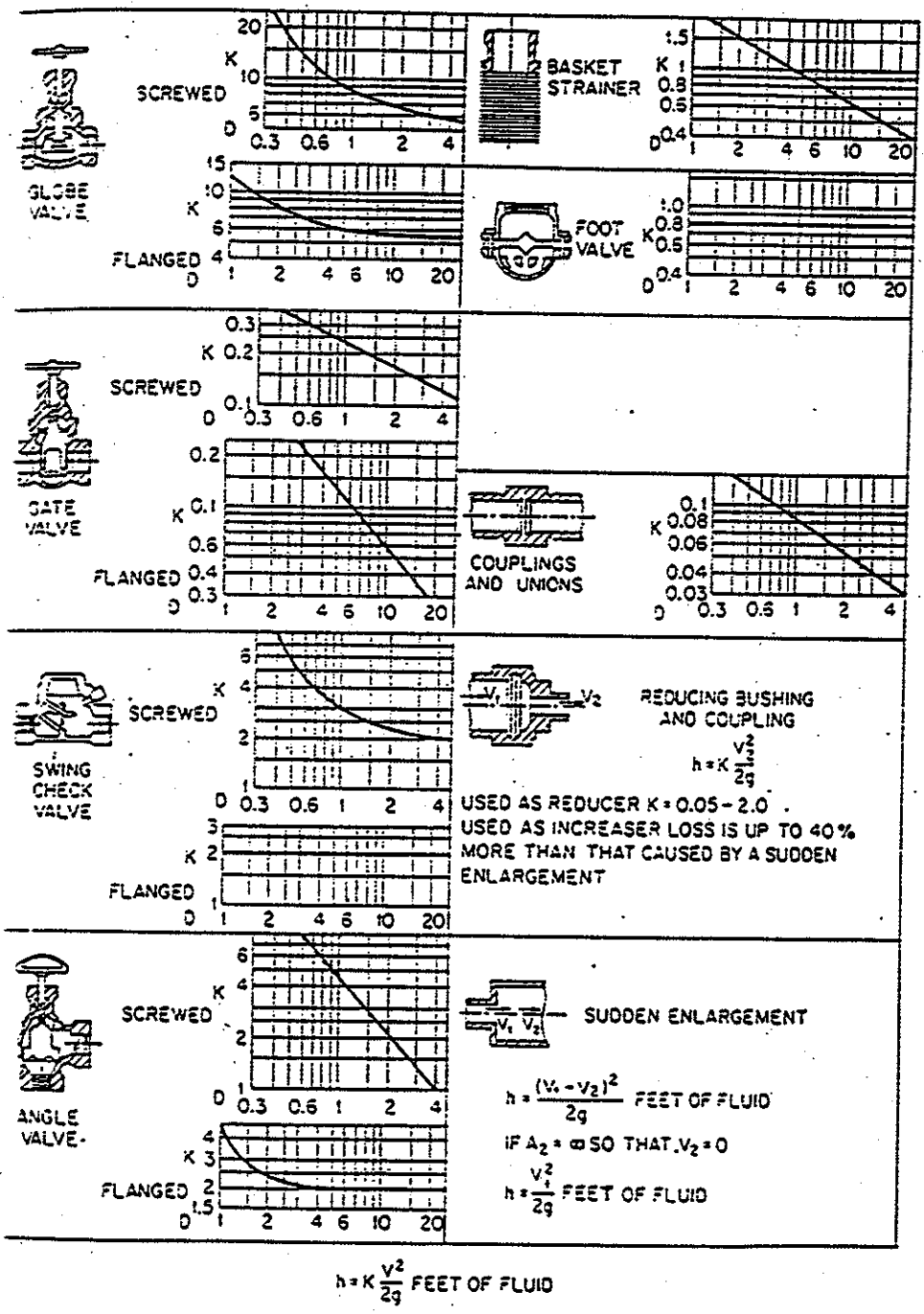
TABLE 4a Resistance Coefficients for Valves and Fittings. (From "Pipe Friction Manual," 3d ed. Copyright 1961 by Hydraulic Institute, Cleveland, Ohio)



$$h = K \frac{V^2}{2g} \text{ FEET OF FLUID}$$

Koefisien kehilangan ... pada perlengkapan pipa

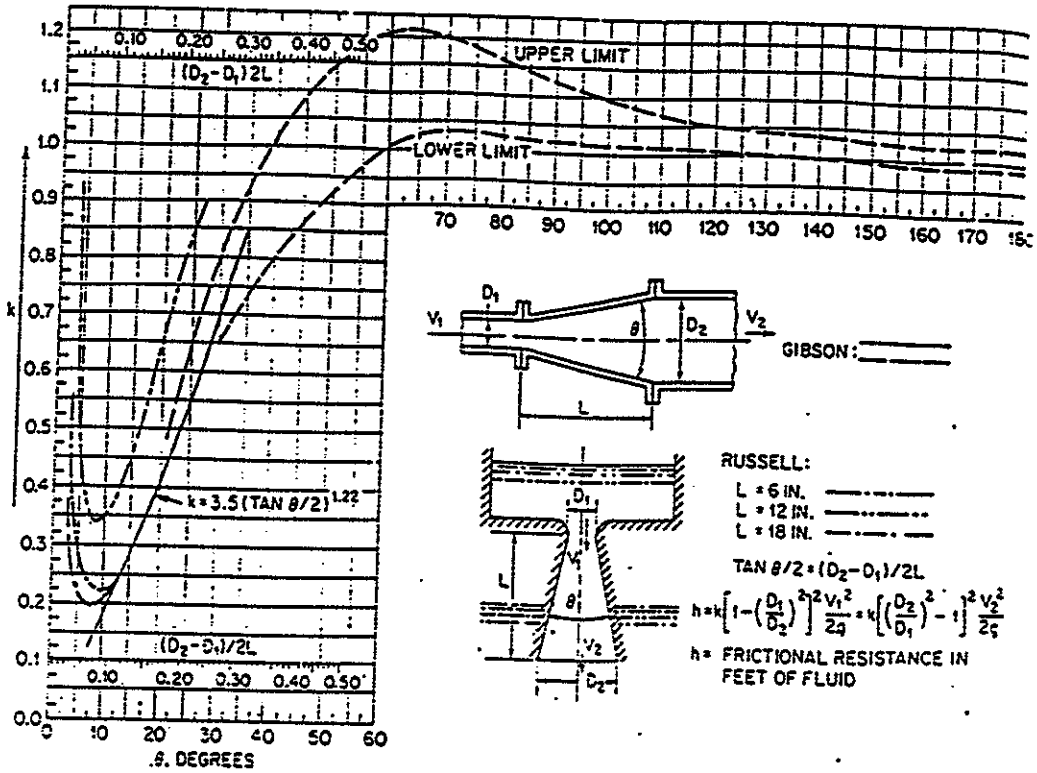
TABLE 4b Resistance Coefficients for Valves and Fittings. (From "Pipe Friction Manual," 3d ed. Copyright 1961 by Hydraulic Institute, Cleveland, Ohio)

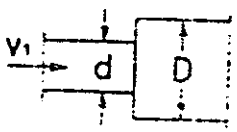
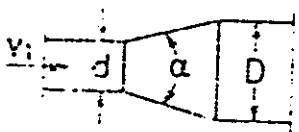
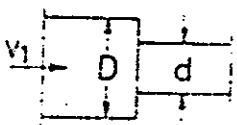
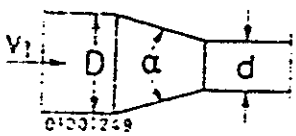


$$h = K\frac{V^2}{2g} \text{ FEET OF FLUID}$$

Lampiran 5 (sambungan)

Koefisien kerugian peralatan pipa



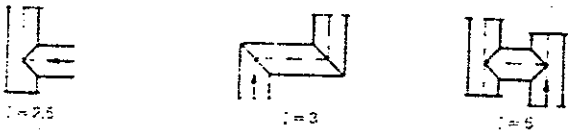
Expansion			Reduction
			
Form I	II	III	IV

Form		d/D =	0.5	0.6	0.7	0.8	0.9
I		ζ ≈	0.56	0.41	0.26	0.13	0.04
II for	α = 8°	ζ ≈	0.07	0.05	0.03	0.02	0.01
	α = 15°	ζ ≈	0.15	0.11	0.07	0.03	0.01
	α = 20°	ζ ≈	0.23	0.17	0.11	0.05	0.02
III		ζ ≈	4.80	2.01	0.88	0.34	0.11
IV for 20° < α ≤ 40°		ζ ≈	0.21	0.10	0.05	0.02	0.01

Fig. 18: Determination of head losses H_v in valves and fittings; flow velocity v relating to the actual cross-sectional area through which the fluid flows

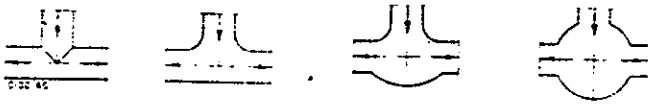
Knee piece	α	45°		60°		90°	
		Surface		Surface		Surface	
		smooth	rough	smooth	rough	smooth	rough
	ζ	0.25	0.35	0.50	0.70	1.15	1.30

Combinations with 90° knee pieces



ζ = 2.5 ζ = 3 ζ = 6

Transition of flow



with sharp edges ζ = 1.3

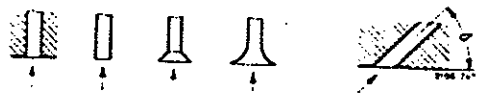
rounded with straight bottom ζ = 0.7

spherical with inward-rounded neck ζ = 0.9

spherical ζ = 2.5 to 4.5

Fig. 19: Illustration of fittings with related loss coefficients ζ

Inlet pipe fittings:



Inlet edge

sharp ζ ≈ 0.5 3

chamfered ζ ≈ 0.25 0.55 0.20 0.05

for δ = 75° 60° 45°
ζ ≈ 0.6 0.7 0.8

Elbows:

Cast elbows 90°, R = D + 100 mm, all nominal size ζ ≈ 0.5

D : diameter
R : jari-jari

Pipe bends 90°, R = 2 to 4 × D

Nominal size DN	50	100	200	300	500
ζ	≈ 0.26	0.23	0.21	0.19	0.18

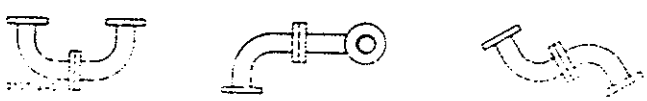
If the deflection angle only amounts to the above ζ values should be multiplied by	60°	45°	30°	15°
	0.85	0.7	0.45	0.3

Knee pieces:

Deflection angle	90°	60°	45°	30°	15°
ζ	≈ 1.3	0.7	0.35	0.2	0.1

Combinations of elbows and pipe bends.

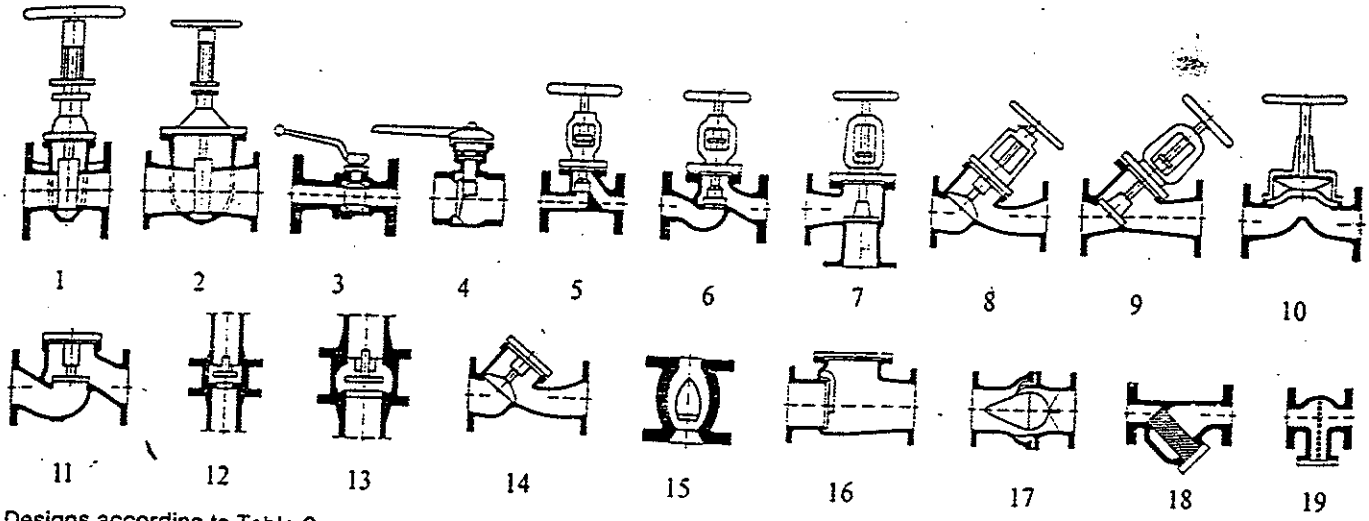
The ζ value of the single 90° elbow should not be doubled, but only be multiplied by the factors indicated to obtain the pressure loss of the combination elbows illustrated:



1.4 1.6 1.8

Lampiran 5 (sambungan)

Koefisien Scale Water Pump untuk berbagai peralatan pipa



Designs according to Table 2

Table 2: Loss coefficients ζ of valves and fittings (referred to the velocity of flow in the adjoining cross-section DN = nominal diameter)

	Type of valve/fitting		Design[2]	Loss coefficient ζ for DN = 15	20	25	32	40	50	65	80	100	125	150	200	250	300	400	500	600	800	1000
Shut-off valves	flat gate valves (d_E = DN)	min	1	0.1	←																	
		max		0.65	0.6	0.55	0.5	0.5	0.45	0.4	0.35	0.3	←									
	round-body gate valves (d_E = DN)	min	2	•					0.25	0.24	0.23	0.22	0.21	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11
		max							0.32	0.31	0.30	0.29	0.26	0.25	0.23	0.22	0.20	0.19	0.18	0.17	0.16	0.15
	cocks (d_E = DN)	min	3	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02				
		max		0.15	←													0.15				
	swing-type valves	PN ≥ 2.5	4					0.90	0.76	0.60	0.50	0.42	0.36	0.30	0.25	0.20	0.15	0.13	0.10	0.09	0.08	0.07
		PN ≤ 40												1.50	1.20	1.00	0.92	0.83	0.76	0.71	0.67	0.63
	valves, forged	min	5	•		6.0	←	←	6.0													
		max				6.8	←	←	6.8													
	valves, cast	min	6	3.0	←												3.0					
		max		6.0	←												6.0					
	angle valves	min	7	2.0	←												►	2.0				
		max		3.1	←	←	3.1	3.4	3.6	4.1	4.4	4.7	5.0	5.1	5.7	6.0	6.3	6.6				
	slanted-seat valves	min	8	1.5	←												1.5					
		max		2.6	←												2.6					
	full-bore valves	min	9	0.6	←												►	0.6				
		max		1.6	←												►	1.6				
	diaphragm valves	min	10	0.8	←											0.8						
		max		2.2	←											2.2						
	non-return valves, straight-seat	min	11	3.0	←											3.0						
		max		6.0	←											6.0						
Backflow preventers	non-return valves, axial	min	12	3.2	←				3.2	3.7	5.0	7.3										
		max		3.4	3.4	3.5	3.6	3.8	4.2	5.0	6.4	8.2										
	non-return valves, axially expanded	min	13										4.3	←			4.3					
		max											4.6	←			4.6					
	non-return valves, slanted seat	min	14	2.5	2.4	2.2	2.1	2.0	1.9	1.7	1.6	1.5	←				1.5					
		max		3.0	←												3.0					
	foot valves	min	15						1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.4	(7.0)	(6.1)	(5.5)	(4.5)	(4.0)
		max							3.0	←							3.0					
	swing-type check valves	min	16	0.5	←			0.5	0.4	←							0.4	0.3	←		0.3	
		max		2.4	2.3	2.3	2.2	2.1	2.0	1.9	1.8	1.8	1.7	1.6	1.5	1.5	1.4	1.3	1.2	1.2	1.1	1.0
	hydrostops v = 4 m/s		17	•					0.9			3.0		3.0	2.5	2.5	1.2	2.2				
	v = 3 m/s								1.8			4.0		4.5	4.0	4.0	1.8	3.4				
	v = 2 m/s								5.0			6.0		8.0	7.5	6.5	6.0	7.0				
	filters		18					2.6	←								2.6					
	screens		19					1.0	←								1.0					

[1] If the narrowest shut-off diameter d_E is smaller than the nominal diameter DN, the loss coefficient ζ must be increased by $(DN/d_E)^x$, with x = 5 to 6
[2] In the case of partial opening, i.e. low flow velocities, the loss coefficients increase
[3] Designs: cf. page 15

(7.0) (6.1) (5.5) (4.5) (4.0) ( ) in groups

swing-type valves without levers and weights 5)

Lampiran 6

Material selection chart untuk ...

(Sumber : Karassik, 1976)

TABLE 1 Material Selection Chart, Volute Casing Pumps

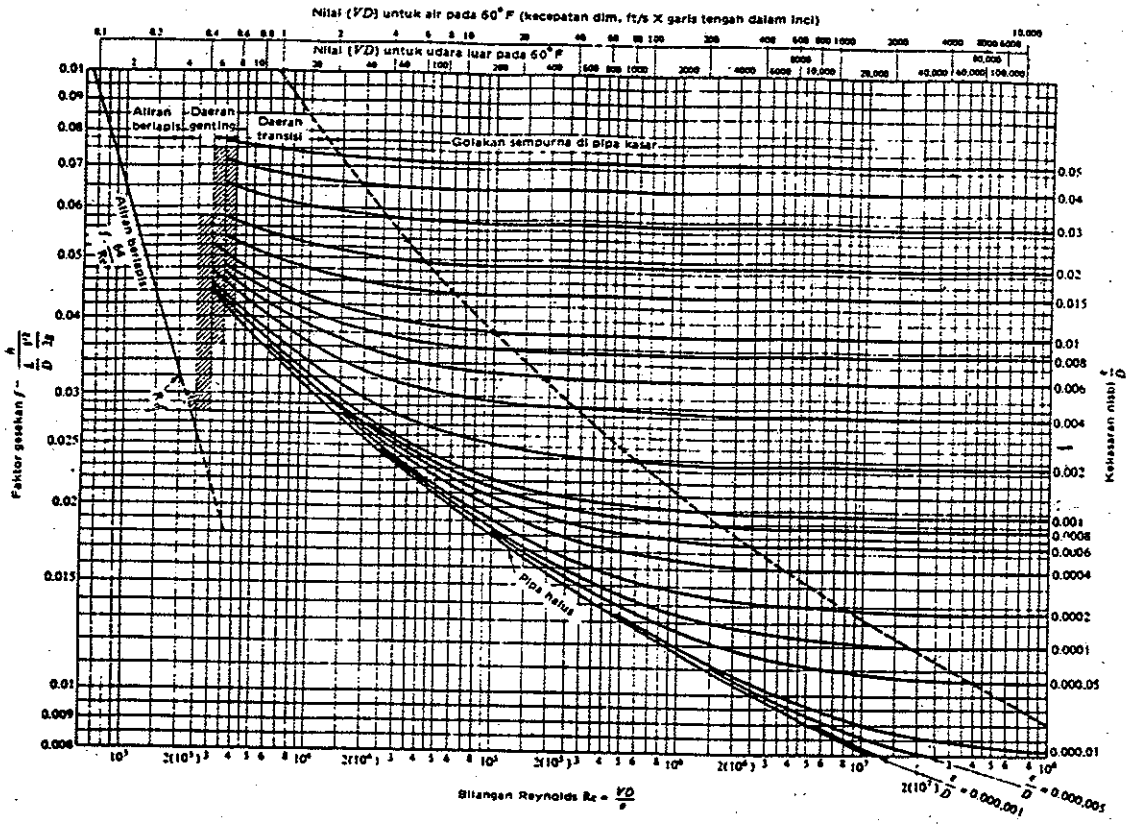
(1) Most economical to give acceptable service; (2) extended life at additional cost; temperatures of °F

Part	Fresh water (40–250°)	Seawater 40–80°	Seawater >80°	Boiler feed 250°	Boiler feed 350°	Boiler feed >350°	Sewage (40–90°)	Mine water (40–90°)	Condensate (90–120°)
Impeller:									
Cast iron	...	...	...	...	...	...	1		
Bronze	1	1	...	1	...	...	...	...	1
400 series stainless steel	...	...	...	2	1	1	2	...	2
300 series stainless steel	...	2	1	...	...	...	...	2	
Ni resist	...	1	...	...	...	...	...	1	
Casing:									
Cast iron	1	1	...	1	...	...	1	...	1
Bronze	...	2	2						
400 series stainless steel	...	...	...	2	1	1	...	...	2
300 series stainless steel	...	...	...	...	...	...	...	2	
Ni resist	...	2	1	...	...	...	...	1	
Wearing rings:									
Bronze	1	1	...	1	...	...	...	...	1
400 series stainless steel	2	...	...	2	1	1	1	...	2
300 series stainless steel	...	2	1	...	...	...	...	1	
Monel	...	...	2	...	...	...	...	2	
Shaft:									
Steel	1	...	...	1	...	...	1	...	1
400 series stainless steel	...	...	...	2	1	1	2	1	2
300 series stainless steel	...	1	1	...	...	...	...	2	
Monel	...	2	2						

Lampiran 7

Diagram Moody

(Sumber : White, 1986)

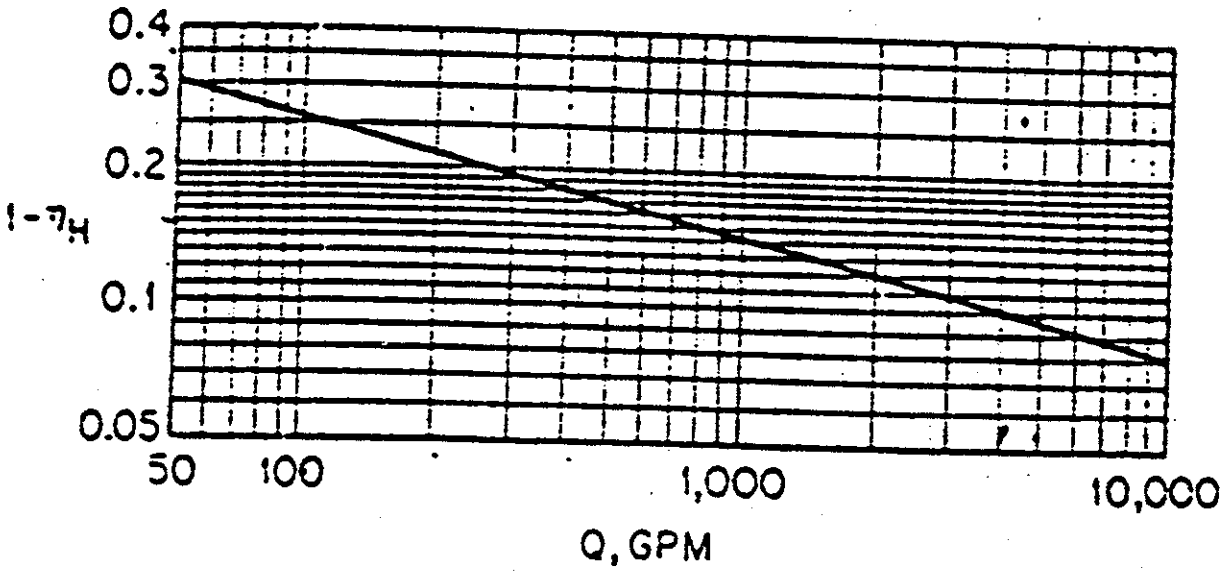


Gambar 6-13 Gaftar Moody untuk gesekan pipa berdinding halus/kasar (*Dari Acuan 8, dengan izin ASME.*)

Lampiran 8

Grafik penentuan efisiensi hidrolis

(Sumber : Karassik, 1976)



Lampiran 9

Tabel berat jenis stainless steel

(Sumber : Peckner, 1977)

TABLE 1 Wrought Alloys—Nominal Room-Temperature Properties

Alloy	Density		Thermal diffusivity		Thermal conductivity		Specific heat	
	lb/in.³	kg/m³	ft²/h	m²/h	Btu/(h·ft²)(°F/ft)	cal/(s)(cm²)(°C/cm)	Btu/(lb)(°F)	cal/(g)(°C)
201	0.28	7700			9.4*	0.039	0.12	0.39
202	0.28	7700	0.13	0.012	9.4*	0.039	0.12	0.39
301	0.28	7700	0.16	0.015	8.5	0.035	0.11	0.36
302	0.29	8000			7.0	0.029	0.12	0.39
303	0.29	8000			7.0	0.029	0.12	0.39
304	0.29	8000	0.15	0.014	8.0	0.033	0.09	0.29
305	0.29	8000			9.4	0.039	0.12	0.39
308	0.29	8000			8.5	0.036	0.12	0.39
309	0.29	8000	0.13	0.012	9.0	0.037	0.12	0.39
310	0.29	8000			7.0	0.029	0.10	0.33
316	0.29	8000	0.15	0.014	7.8	0.032	0.11	0.36
321	0.29	8000	0.14	0.013	9.3*	0.038	0.11	0.36
347	0.29	8000			8.5	0.035	0.10	0.33
403	0.28	7700			14.4*	0.059	0.11	0.36
405	0.28	7700			15.6*	0.064	0.11	0.36
409	0.28	7700			14.4*	0.059	0.11	0.36
410	0.28	7700	0.23	0.021	14.4*	0.059	0.11	0.36
414	0.28	7700			14.4*	0.059	0.11	0.36
416	0.28	7700	0.26	0.024	14.4*	0.059	0.11	0.36
420	0.28	7700			13.5	0.055	0.11	0.36
430	0.28	7700	0.23	0.021	11.9	0.049	0.11	0.36
434	0.28	7700					0.11	0.36
436	0.28	7700			13.8*	0.057	0.11	0.36
440-C	0.28	7700			14.0*	0.057	0.11	0.36
446	0.27	7500	0.21	0.020	10.5	0.043	0.11	0.36
AM350					8.2	0.034		
AM355	0.28	7700			8.2	0.034		
Custom 450	0.28	7700						
Custom 455†	0.28	7700			10.0	0.041		
PH15-7MO†	0.28	7700			9.0	0.037		
15-5 PH†	0.28	7700					0.11	0.36
17-4 PH†	0.28	7700			6.5	0.027	0.10	0.33

*Thermal conductivity at 212°F.
†Annealed.

Tabel tegangan tarik dan tegangan luluh dari stainless steel

(Sumber : Peckner, 1977)

TABLE 3 Effect of Temperature on Yield Strength, ksi (MN/m²), of Wrought Austenitic Stainless Steels[3]

Temperature		Grades					
°F	°C	304	304L	316	316L	321	347
75	24	36.9 (254.4)	33.8 (233.1)	38.0 (262)	33.7 (232.4)	29.7 (204.8)	38.2(263.4)
100	38	35.4 (244.1)	32.8 (226.2)	36.9 (254.4)	32.7 (225.5)	28.8 (198.6)	37.4 (259.9)
200	93	30.6 (211)	28.7 (197.9)	32.7 (225.5)	28.6 (197.2)	25.2 (173.8)	35.1 (242)
300	149	27.7(191)	26.0 (179.3)	29.7 (204.8)	25.6 (176.5)	22.6 (155.8)	32.5 (224.1)
400	204	25.5(175.8)	23.7 (163.4)	26.6 (183.4)	23.6 (162.7)	20.5 (141.3)	30.6 (211)
500	260	24.0 (165.5)	22.0 (151.7)	25.1 (173.1)	21.6 (148.9)	19.0 (131)	28.7 (197.9)
600	316	22.5 (155.1)	21.0 (144.8)	23.9 (164.8)	20.6 (142)	18.1 (124.8)	27.5 (189.6)
700	371	21.8 (150.3)	20.3 (140)	22.8 (157.2)	19.5 (134.5)	17.5 (120.7)	26.4 (182)
800	427	20.7 (142.7)	19.6 (135.1)	22.4 (154)	18.5 (127.6)	16.9 (116.5)	26.0 (179.3)
900	482	19.9 (137.2)	18.9 (130.3)	22.0 (151.7)	17.9 (123.4)	16.9 (116.5)	25.6 (176.5)
1000	538	19.2 (132.4)	17.9 (123.4)	21.7 (148.6)	16.9 (116.5)	16.6 (114.5)	25.6 (176.5)
1100	593	18.1 (124.8)	16.9 (116.5)	20.9 (144.1)	15.8 (108.9)	16.3 (112.4)	25.2 (173.8)
1200	649	17.3 (119.3)	15.2 (104.8)	20.5 (141.3)	14.2 (97.9)	15.7 (108.3)	24.8 (171)
1300	704	16.2 (111.7)		19.4 (133.8)		14.8 (102)	23.3 (160.7)
1400	760	14.4 (99.2)		18.2 (125.5)		14.0 (96.5)	20.6 (142)
1500	816	11.4 (78.6)		16.3 (112.4)		13.7 (94.5)	16.4 (113.1)
1600	871	7.4 (51)					

TABLE 4 Effect of Temperature on Ultimate Tensile Strength, ksi (MN/m²), of Wrought Austenitic Stainless Steels[3]

Temperature		Grades					
°F	°C	304	304L	316	316L	321	347
75	24	83.9 (578.5)	79.2 (546.1)	83.3 (574.4)	78.9 (544)	81.8 (564)	87.0 (600)
100	38	81.4 (561.3)	76.8 (529.5)	80.8 (557.1)	76.5 (527.5)	79.3 (546.8)	84.4 (581.9)
200	93	72.1 (497.1)	68.1 (469.5)	75.8 (522.6)	69.4 (478.5)	72.8 (502)	75.7 (522)
300	149	87.1 (600.6)	62.6 (431.6)	74.1 (510.9)	65.5 (451.6)	68.7 (473.7)	69.6 (480)
400	204	65.4 (450.9)	60.2 (415.1)	72.5 (499.9)	63.9 (440.6)	67.9 (468.2)	65.3 (450.2)
500	260	64.6 (445.4)	59.4 (409.6)	72.5 (499.9)	63.1 (435.1)	67.9 (468.2)	63.5 (437.8)
600	316	64.6 (445.4)	58.6 (404)	73.3 (505.4)	63.1 (435.1)	67.9 (468.2)	62.7 (432.3)
700	371	64.6 (445.4)	57.8 (398.5)	72.5 (499.9)	63.1 (435.1)	67.9 (468.2)	61.8 (426.1)
800	427	63.8 (439.9)	57.0 (393)	71.6 (493.7)	62.3 (429.6)	67.9 (468.2)	61.8 (426.1)
900	482	62.1 (428.2)	55.4 (382)	69.1 (476.4)	60.0 (413.7)	67.9 (468.2)	61.8 (426.1)
1000	538	58.7 (404.7)	52.3 (360.6)	65.0 (448.2)	56.8 (391.6)	64.6 (445.4)	60.9 (419.9)
1100	593	52.9 (364.7)	47.5 (327.5)	59.1 (407.5)	52.1 (359.2)	58.1 (400.6)	58.3 (402)
1200	649	46.1 (317.9)	42.0 (289.6)	51.6 (355.8)	46.6 (321.3)	50.0 (344.8)	53.9 (371.6)
1300	704	38.6 (266.1)	35.6 (245.5)	43.3 (298.6)	39.5 (272.4)	40.1 (276.5)	47.0 (324.1)
1400	760	29.4 (202.7)	28.5 (196.5)	34.2 (235.8)	32.3 (222.7)	30.3 (208.9)	37.4 (257.9)
1500	816	21.0 (144.8)	20.6 (142)	25.0 (172.4)	24.5 (168.9)	20.5 (141.3)	24.4 (168.2)

Lampiran 11

Tabel modulus geser dan modulus elastisitas *stainless steel*

(Sumber: Peckner, 1977)

TABLE 5 Modull of Elasticity at Various Temperatures for Several Austenitic Stainless Steels[1]

Temperature			Grades					
°F	°C	Modulus*	302	304	310	316	321	347
200	93	E	27.9 (192.4)	27.9 (192.4)	28.2 (194.4)	28.1 (193.7)	28.0 (193.1)	28.2 (194.4)
		G	10.8 (74.5)	11.1 (76.5)	10.9 (75.2)	11.0 (75.8)	10.8 (74.5)	11.0 (75.8)
300	149	E	27.3 (188.2)	27.1 (186.9)	27.5 (189.6)	27.5 (189.6)	27.3 (188.2)	27.5 (189.6)
		G	10.4 (71.7)	10.8 (74.5)	10.6 (73.1)	10.6 (73.1)	10.6 (73.1)	10.7 (73.8)
400	204	E	26.7 (184.1)	26.6 (183.4)	26.8 (184.8)	26.9 (185.5)	26.5 (182.7)	26.8 (184.8)
		G	10.1 (69.6)	10.5 (72.4)	10.3 (71)	10.3 (71)	10.3 (71)	10.4 (71.7)
500	260	E	26.0 (179.3)	26.0 (179.3)	26.2 (180.6)	26.3 (181.3)	25.8 (177.9)	26.1 (180)
		G	9.8 (67.6)	10.2 (70.3)	10.0 (69)	10.0 (69)	9.9 (68.3)	10.1 (69.6)
600	316	E	25.4 (175.1)	25.6 (176.5)	25.5 (175.8)	25.6 (176.5)	25.3 (174.4)	25.4 (175.1)
		G	9.5 (65.5)	9.9 (68.3)	9.7 (66.9)	9.7 (66.9)	9.7 (66.9)	9.8 (67.6)
700	371	E	24.8 (171)	24.7 (170.3)	24.9 (171.7)	24.9 (171.7)	24.5 (168.9)	24.8 (171)
		G	9.3 (64.1)	9.7 (66.9)	9.4 (64.8)	9.4 (64.8)	9.4 (64.8)	9.5 (65.5)
800	427	E	24.2 (166.9)	24.1 (166.2)	24.2 (166.9)	24.2 (166.9)	23.8 (164.1)	24.1 (166.2)
		G	9.0 (62.1)	9.5 (65.5)	9.1 (62.7)	9.1 (62.7)	9.1 (62.7)	9.2 (63.4)
900	482	E	23.6 (162.7)	23.2 (160)	23.6 (162.7)	23.5 (162)	23.2 (160)	23.4 (161.3)
		G	8.8 (60.7)	9.2 (63.4)	8.8 (60.7)	8.8 (60.7)	8.8 (60.7)	8.9 (61.4)
1000	538	E	23.0 (158.6)	22.5 (155.1)	23.0 (158.6)	22.8 (157.2)	22.5 (155.1)	22.8 (157.2)
		G	8.6 (59.3)	8.9 (61.4)	8.5 (58.6)	8.5 (58.6)	8.5 (58.6)	8.6 (59.3)
1110	593	E	22.3 (153.8)	21.8 (150.3)	22.4 (154.4)	22.2 (153.1)	21.9 (151)	22.0 (151.7)
		G	8.4 (57.9)	8.6 (59.3)	8.2 (56.5)	8.3 (57.2)	8.2 (56.5)	8.3 (57.3)
1200	649	E	21.8 (150.3)	21.1 (145.5)	21.8 (150.3)	21.5 (148.2)	21.2 (146.2)	21.4 (147.6)
		G	8.2 (56.5)	8.3 (57.2)	7.9 (54.5)	8.1 (55.8)	7.9 (54.5)	8.1 (55.8)
1300	704	E	21.2 (146.2)	20.4 (140.7)	21.2 (146.2)	20.8 (143.4)	20.4 (140.7)	20.7 (142.7)
		G	7.9 (54.5)	8.0 (55.2)	7.6 (52.4)	7.9 (54.5)	7.7 (53.1)	7.8 (53.9)
1400	760	E	20.6 (142)	19.4 (133.8)	20.5 (141.3)	20.0 (137.9)	19.7 (135.8)	20.0 (137.9)
		G	7.7 (53.1)	7.7 (53.1)	7.2 (49.6)	7.7 (53.1)	7.4 (51)	7.5 (51.7)
1500	816	E	20.0 (137.9)	18.1 (124.8)	19.0 (131)	19.1 (131.7)	19.1 (131.7)	19.4 (133.8)
		G	7.5 (51.7)	7.4 (51)	6.9 (47.6)	7.5 (51.7)	7.1 (49)	7.2 (49.6)

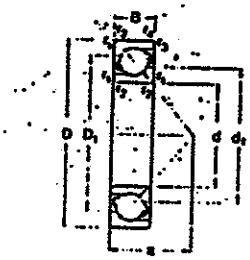
*E, modulus of elasticity in tension × 10^6 psi (GN/m²). G, modulus of elasticity in shear × 10^6 psi (GN/m²).

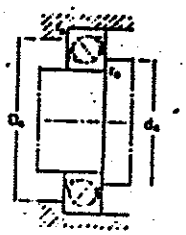
Lampiran 12

Dimensi bantalan bola

(Sumber : Katalog SKF, 1981)

d 10–70 mm

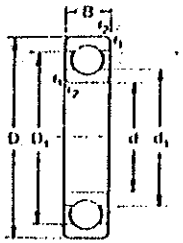




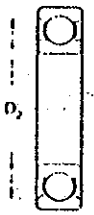
Principal dimensions			Basic load ratings dynamic	static	Limiting speeds Lubrication grease	oil	Mass	Designation
d	D	B	C	C_0				
mm			N		r/min		kg	-
10	30	9	4 940	2 120	19 000	28 000	0,031	7200 B
12	32	10	7 020	3 050	17 000	24 000	0,045	7201 B
15	35	11	8 060	3 650	16 000	22 000	0,049	7202 B
	42	13	11 700	5 200	14 000	19 000	0,090	7302 B
17	40	12	9 950	4 750	14 000	19 000	0,070	7203 B
	47	14	14 800	7 200	12 000	17 000	0,12	7303 B
20	47	14	13 300	6 550	11 000	16 000	0,11	7204 B
	52	15	17 400	8 500	10 000	15 000	0,15	7304 B
25	52	15	14 800	7 650	9 500	14 000	0,13	7205 B
	62	17	24 200	12 700	8 500	12 000	0,25	7305 B
30	62	16	20 300	11 000	8 500	12 000	0,21	7206 B
	72	19	31 200	17 000	7 500	10 000	0,37	7306 B
35	72	17	27 000	15 000	7 500	10 000	0,30	7207 B
	80	21	36 400	20 400	7 000	9 500	0,51	7307 B
40	80	18	31 900	18 600	6 700	9 000	0,39	7208 B
	90	23	44 500	25 500	6 300	8 500	0,67	7308 B
45	85	19	35 800	21 200	6 300	8 500	0,44	7209 B
	100	25	56 500	34 500	5 600	7 500	0,90	7309 B
50	90	20	37 700	22 800	5 600	7 500	0,48	7210 B
	110	27	67 600	45 000	5 000	6 700	1,15	7310 B
55	100	21	46 200	28 500	5 300	7 000	0,65	7211 B
	120	29	78 000	48 000	4 500	6 000	1,45	7311 B
60	110	22	55 900	35 500	4 800	6 300	0,84	7212 B
	130	31	90 400	56 000	4 300	5 600	1,85	7312 B
65	120	23	63 700	41 500	4 300	5 600	1,05	7213 B
	140	33	101 000	64 000	4 000	5 300	2,25	7313 B
70	125	24	68 900	45 500	4 300	5 600	1,15	7214 B
	150	35	114 000	72 000	3 600	4 800	2,75	7314 B

Dimensions						Abutment and fillet dimensions		
d	d_1 ≈	D_1 ≈	$r_{1,2}$ min	$r_{3,4}$ max	a	d_a min	D_a max	r_a max
mm			mm			mm		
10	16,3	22	0,6	0,3	13	15	25	0,6
12	18,9	25	0,6	0,3	14	17	27	0,6
15	23,2	29,2	0,6	0,3	16	20	30	0,6
	25,8	32,8	1	0,6	18	21	36	1
17	26,1	31,8	0,6	0,6	18	22	35	0,6
	29	36,2	1	0,6	21	23	41	1
20	30,7	37,4	1	0,6	21	26	41	1
	32,7	40,7	1,1	0,6	23	27	45	1
25	36,3	42,9	1	0,6	24	31	46	1
	39,7	48,8	1,1	0,6	27	32	55	1
30	42,7	50,6	1	0,6	27	36	56	1
	47,7	58	1,1	0,6	31	37	65	1
35	49,7	60,6	1,1	0,6	32	42	65	1
	52,6	64,1	1,5	1	35	44	71	1,5
40	55,9	65,7	1,1	0,6	34	47	73	1
	59,8	72,5	1,5	1	38	48	81	1,5
45	60,8	71,1	1,1	0,6	37	52	78	1
	66,5	80,8	1,5	1	43	54	91	1,5
50	65,6	78,1	1,1	0,6	39	57	83	1
	73,4	89,3	2	1	42	60	100	2
55	72,6	84,3	1,5	1	43	64	91	1,5
	80,4	97,5	2	1	51	65	110	2
60	79,5	92,7	1,5	1	47	69	101	1,5
	87,4	106	2,1	1,1	55	72	118	2
65	86,6	101	1,5	1	50	74	111	1,5
	94,3	114	2,1	1,1	60	77	128	2
70	91,5	106	1,5	1	53	79	116	1,5
	101	123	2,1	1,1	64	82	138	2

SKF

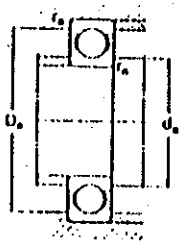


with full outer ring shoulder



with recessed outer ring shoulder

Principal dimensions			Basic load ratings dynamic	static	Limiting speeds Lubrication grease	oil	Mass	Designation
d	D	B	C	C_0				
mm			N		r/min		kg	-
45	58	7	6 050	3 800	9 500	12 000	0.040	61809
	75	10	15 600	9 300	9 000	11 000	0.17	16009
	75	16	21 200	12 200	9 000	11 000	0.25	6009
	85	19	33 200	18 600	7 500	9 000	0.41	6209
	100	25	52 700	30 000	6 700	8 000	0.83	6309
	120	29	76 100	45 500	6 000	7 000	1.55	6409
50	65	7	6 240	4 250	9 000	11 000	0.052	61810
	80	10	16 300	10 000	8 500	10 000	0.18	16010
	80	16	21 600	13 200	8 500	10 000	0.26	6010
	90	20	35 100	19 000	7 000	8 500	0.46	6210
	110	27	61 800	35 500	6 300	7 500	1.05	6310
	130	31	87 100	52 000	5 300	6 300	1.90	6410
55	72	9	8 320	5 600	8 500	10 000	0.083	61811
	90	11	19 500	12 200	7 500	9 000	0.26	16011
	90	18	28 100	17 000	7 500	9 000	0.39	6011
	100	21	43 600	25 000	6 300	7 500	0.61	6211
	120	29	71 500	41 500	5 600	6 700	1.35	6311
	140	33	99 500	63 000	5 000	6 000	2.30	6411
60	78	10	8 710	6 100	7 500	9 000	0.11	61812
	95	11	19 900	13 200	6 700	8 000	0.28	16012
	95	18	29 600	18 300	6 700	8 000	0.42	6012
	110	22	47 500	28 000	6 000	7 000	0.78	6212
	130	31	81 900	48 000	5 000	6 000	1.70	6312
	150	35	108 000	69 500	4 800	5 600	2.75	6412
65	85	10	11 700	8 300	7 000	8 500	0.13	61813
	100	11	21 200	14 600	6 300	7 500	0.30	16013
	100	18	30 700	19 600	6 300	7 500	0.44	6013
	120	23	55 900	34 000	5 300	6 300	0.99	6213
	140	33	92 300	56 000	4 800	5 600	2.10	6313
	160	37	119 000	78 000	4 500	5 300	3.30	6413
70	90	10	12 100	9 150	6 700	8 000	0.14	61814
	110	13	28 100	19 000	6 000	7 000	0.43	16014
	110	20	37 700	24 500	6 000	7 000	0.60	6014
	125	24	61 800	37 500	5 000	6 000	1.05	6214
	150	35	104 000	63 000	4 500	5 300	2.50	6314
	180	42	143 000	104 000	3 800	4 500	4.85	6414



Dimensions					Abutment and fillet dimensions		
d	d_1 ≈	D_1 ≈	D_2 ≈	$r_{1,2}$ min	d_a min	D_a max	r_a max
mm					mm		
45	46.7	54.3	-	0.3	47	58	0.3
	55	65.4	-	0.6	49	71	0.6
	54.7	65.6	67.6	1	50	70	1
	57.6	72.9	75.2	1.1	51.5	78.5	1
	62.1	83.7	86.7	1.5	53	92	1.5
	66.9	90.9	-	2	54	111	2
50	54.7	60.3	-	0.3	52	63	0.3
	60	70.4	-	0.6	54	76	0.6
	59.7	70.6	72.6	1	55	75	1
	62.5	78.1	81.7	1.1	56.5	83.5	1
	66.7	92.1	95.2	2	59	101	2
	75.4	106	-	2.1	61	119	2
55	60.2	66.8	-	0.3	57	70	0.3
	67	78	-	0.6	59	86	0.6
	66.3	79.1	81.5	1.1	61.5	83.5	1
	69	86.6	89.4	1.5	63	92	1.5
	75.3	101	104	2	64	111	2
	81.5	115	-	2.1	66	129	2
60	65.8	72.4	-	0.3	62	76	0.3
	72	83.4	-	0.6	64	91	0.6
	71.3	84.1	86.5	1.1	66.5	88.5	1
	75.5	94.9	97	1.5	68	102	1.5
	81.6	109	113	2.1	71	119	2
	86.1	123	-	2.1	71	139	2
65	71.1	78.9	-	0.6	69	81	0.6
	76.5	88.5	-	0.6	69	96	0.6
	76.3	89.1	91.5	1.1	71.5	93.5	1
	83.3	103	106	1.5	73	112	1.5
	88.3	118	122	2.1	76	129	2
	94	132	-	2.1	76	149	2
70	76.1	83.9	-	0.6	74	86	0.6
	83.3	97.1	-	0.6	74	101	0.6
	82.6	97.6	99.9	1.1	76.5	103.5	1
	87	109	111	1.5	78	117	1.5
	94.9	120	130	2.1	81	139	2
	103	147	-	3	83	167	2.5

Tabel koefisien gesek untuk berbagai hantalan

(Sumber : Katalog SKF, 1986)

Table 1 Coefficient of friction

Bearing type	μ
Deep groove ball bearings	0,0015
Self-aligning ball bearings	0,0010
Angular contact ball bearings	
single row	0,0020
double row	0,0024
Cylindrical roller bearings	
with cage	0,0011
full complement (without seals)	0,0020
Spherical roller bearings	0,0018
Taper roller bearings	0,0018
Thrust ball bearings	0,0013
Cylindrical roller thrust bearings	0,0050
Spherical roller thrust bearings	0,0018

Calculation factors X and Y for deep groove ball bearings

	Normal clearance					C3 clearance					C4 clearance				
		$F_a/F_r \le e$		$F_a/F_r > e$			$F_a/F_r \le e$		$F_a/F_r > e$			$F_a/F_r \le e$		$F_a/F_r > e$	
F_a/C_0	e	X	Y	X	Y	e	X	Y	X	Y	e	X	Y	X	Y
0,025	0,22	1	0	0,56	2	0,31	1	0	0,46	1,75	0,4	1	0	0,44	1,42
0,04	0,24	1	0	0,56	1,8	0,33	1	0	0,46	1,62	0,42	1	0	0,44	1,36
0,07	0,27	1	0	0,56	1,6	0,36	1	0	0,46	1,46	0,44	1	0	0,44	1,27
0,13	0,31	1	0	0,56	1,4	0,41	1	0	0,46	1,3	0,48	1	0	0,44	1,16
0,25	0,37	1	0	0,56	1,2	0,46	1	0	0,46	1,14	0,53	1	0	0,44	1,05
0,5	0,44	1	0	0,56	1	0,54	1	0	0,46	1	0,56	1	0	0,44	1

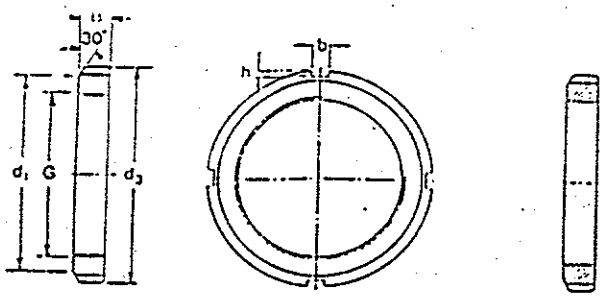
Guide to values of requisite basic rating life L_{10h} for different classes of machines

Class of machine	L_{10h} operating hours
Domestic machines, agricultural machines, instruments, technical apparatus for medical use	300 to 3 000
Machines used for short periods or intermittently: Electric hand tools, lifting tackle in workshops, construction machines	3 000 to 8 000
Machines to work with high operational reliability during short periods or intermittently:: Lifts, cranes for packaged goods or slings of drums, bales etc.	8 000 to 12 000
Machines for use 8 hours per day but not always fully utilised: Gear drives for general purposes, electric motors for industrial use, rotary chrushers	10 000 to 25 000
Machines for use 8 hours per day and fully utilised: Machine tools, woodworking machines, machines for the engineering industry, cranes for bulk materials, ventilator fans, conveyor belts, printing equipment, seperators and centrifuges	20 000 to 30 000
Machines for continuous use 24 hours per day: Rolling mill gear units, medium sized electrical machinery, compressors, mine hoists, pumps, textile machinery	40 000 to 50 000
Water works machinery, rotary furnaces, cable stranding machines, propulsion machinery for ocean-going vessels	60 000 to 100 000
Pulp and papermaking industry, large electric machinery, power station plant, mine pumps and mine ventilator fans, tunnel shaft bearings for ocean-going vessels	~ 100 000

SKF

Ukuran *lock nut*

(Sumber : Katalog SKF, 1981)

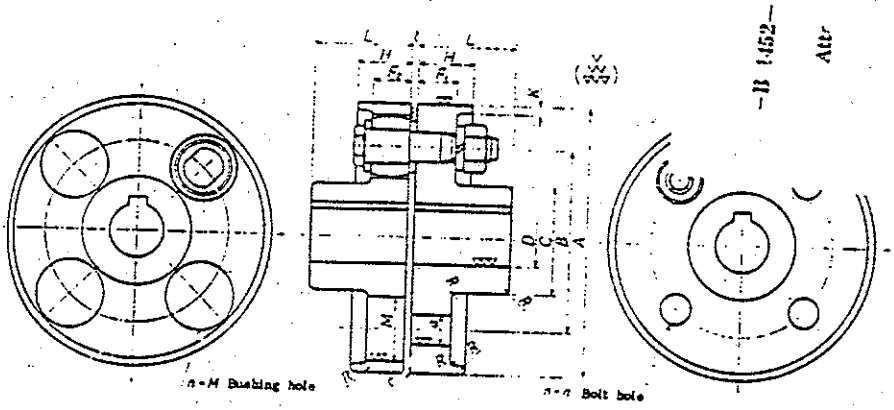


Dimensions						Mass	Designation	Appropriate locking washer	hook impact spanner
G	d_1	d_3	B	b	h				
mm						kg	-	-	
M 10 - 0,75	13,5	18	4	3	2	0.004	KM 0	MB 0	-
M 12 - 1	17	22	4	3	2	0.007	KM 1	MB 1	-
M 15 - 1	21	25	5	4	2	0.010	KM 2	MB 2	-
M 17 - 1	24	28	5	4	2	0.013	KM 3	MB 3	-
M 20 - 1	26	32	6	4	2	0.015	KM 4	MB 4	HN 4
M 25 - 1,5	32	38	7	5	2	0.025	KM 5	MB 5	HN 5
M 30 - 1,5	38	45	7	5	2	0.033	KM 6	MB 6	HN 6
M 35 - 1,5	44	52	8	5	2	0.053	KM 7	MB 7	HN 7
M 40 - 1,5	50	58	9	6	2,5	0.065	KM 8	MB 8	HN 8
M 45 - 1,5	56	65	10	6	2,5	0.12	KM 9	MB 9	HN 9
M 50 - 1,5	61	70	11	6	2,5	0.15	KM 10	MB 10	HN 10
M 55 - 2	67	75	11	7	3	0.16	KM 11	MB 11	HN 11
M 60 - 2	73	80	11	7	3	0.17	KM 12	MB 12	HN 12
M 65 - 2	79	85	12	7	3	0.20	KM 13	MB 13	HN 13
M 70 - 2	85	92	12	8	3,5	0.24	KM 14	MB 14	HN 14
M 75 - 2	90	98	13	8	3,5	0.29	KM 15	MB 15	HN 15
M 80 - 2	95	105	15	8	3,5	0.40	KM 16	MB 16	HN 16
M 85 - 2	102	110	16	8	3,5	0.45	KM 17	MB 17	HN 17
M 90 - 2	108	120	16	10	4	0.56	KM 18	MB 18	HN 18
M 95 - 2	113	125	17	10	4	0.66	KM 19	MB 19	HN 19
M 100 - 2	120	130	18	10	4	0.70	KM 20	MB 20	HN 20
M 105 - 2	126	140	18	12	5	0.85	KM 21	MB 21	HN 21
M 110 - 2	133	145	19	12	5	0.97	KM 22	MB 22	HN 22
M 115 - 2	137	150	19	12	5	1.00	KM 23	MB 23	718909
M 120 - 2	138	155	20	12	5	1.10	KM 24	MB 24	718909
M 125 - 2	148	160	21	12	5	1.20	KM 25	MB 25	718909
M 130 - 2	149	165	21	12	5	1.25	KM 26	MB 26	718909
M 135 - 2	160	175	22	14	6	1.55	KM 27	MB 27	718909

Ukuran kopling

(Sumber : JIS Handbook, Ship Building)

Attached Table 1. Flexible Flanged Shaft Cou



Remark: The bolt holes shall be arranged approximately symmetrically with respect to the key way.

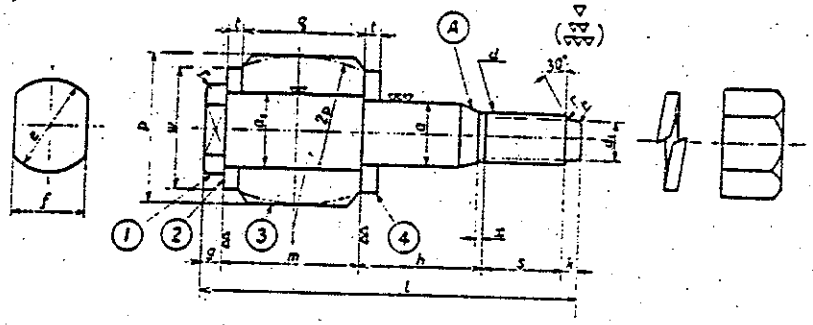
Unit: mm

Nominal diameter of coupling A	D: Largest shaft bore diameter	D: Smallest shaft bore diameter	L	C	B	F_1	F_2	H	K	(1) n	a	M	(2) t	Reference: K	Reference: c	Reference: Diameter and length of bush
90	18	—	28	35.5	60	14	14	20	4	4	8	19	3	2	1	50
100	22	—	35.5	40	67	16	16	22.4	4	4	10	23	3	2	1	56
112	25	16	40	45	75	16	16	22.4	4	4	10	23	3	2	1	56
125	28	18	45	50	85	18	18	25	4	4	14	32	3	2	1	64
140	35	20	50	63	100	18	18	25	4	6	14	32	3	2	1	64
160	45	25	56	80	115	18	18	25	6	8	14	32	3	3	1	64
180	50	28	63	90	132	18	18	25	6	8	14	32	3	3	1	64
200	56	32	71	100	145	22.4	22.4	31.5	6	8	20	41	4	3	1	85
224	63	35	80	112	170	22.4	22.4	31.5	6	8	20	41	4	3	1	85
250	71	40	90	125	180	28	28	40	8	8	25	51	4	4	1	100
280	80	50	100	140	200	28	40	45	8	8	28	57	4	4	1	116
315	90	63	112	160	236	28	40	45	8	10	28	57	4	4	1	116
355	100	71	125	180	260	35.5	56	63	10	8	35.5	72	5	5	1	150
400	110	80	125	200	300	35.5	56	63	10	10	35.5	72	5	5	1	150
450	125	90	140	224	355	35.5	56	63	10	12	35.5	72	5	5	1	150
560	140	100	160	250	450	35.5	56	63	12	14	35.5	72	5	6	1	150
630	160	110	180	280	530	35.5	56	63	12	18	35.5	72	5	6	1	150

Notes (1) The letter n indicates the number of bush holes or bolt holes.
(2) The letter t indicates the clearance produced at the time of assembling the coupling bodies, and is equivalent to the thickness of coupling bolt washer.

Remarks 1. The drawn-out length of bolt indicates the dimension from the shank end.
2. The screw hole to facilitate the drawing out of a coupling from a shaft is allowed to make optionally.

5.3 ...ed Table 2. Coupling Bolt for Flexible Flanged Shaft Coupling
net...



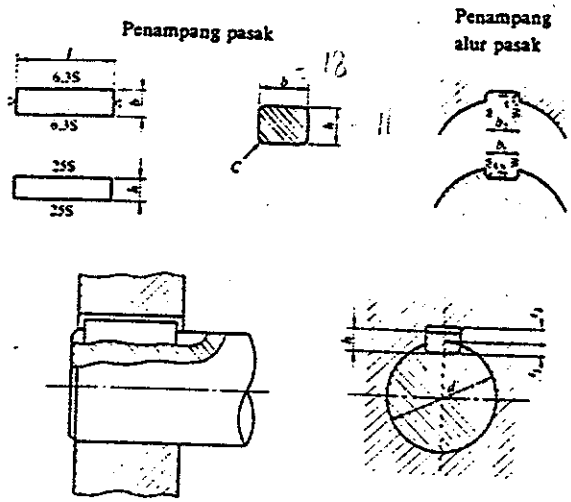
Unit: mm

tion	① Bolt												
	Diameter of screw thread d	a_1	a	d_1	c	f	g	m	h	s	k	l	r (approx.)
50	M 8	9	8	5.5	12	10	4	17	15	12	2	50	0.4
56	M 10	12	10	7	16	13	4	19	17	14	2	56	0.5
54	M 12	16	14	9	19	17	5	21	19	16	3	64	0.6
35	M 20	22.4	20	15	28	24	5	26.4	24.6	25	4	85	1
20	M 24	28	25	18	34	30	6	32	30	27	5	100	1
16	M 24	31.5	28	18	38	32	6	44	30	31	5	116	1
50	M 30	40	35.5	23	48	41	8	61	38.5	36.5	6	150	1.2

...on	② Washer			③ Bushing			④ Washer		
	a_1	w	t	a_1	p	q	a	w	t
50	9	14	3	9	18	14	8	14	3
56	12	18	3	12	22	16	10	18	3
64	16	25	3	16	31	18	14	25	3
85	22.4	32	4	22.4	40	22.4	20	32	4
00	28	40	4	28	50	28	25	40	4
16	31.5	45	4	31.5	56	40	28	45	4
50	40	56	5	40	71	56	35.5	56	5

1. The hexagon nuts shall be such that of Class 1 ordinary finish specified in JIS B 1181, of which strength class shall be 4 and thread accuracy 6 H (or Class 2).
2. The spring washers shall be No. 2 S specified in JIS B 1251.
3. The dimensions of width across flats are in accordance with JIS B 1002. The dimensional tolerance shall be of Class 2.
4. The shape and dimensions of the screw end shall be same as the half dog point specified in JIS B 1003.
5. The accuracy of the screw thread shall conform to 6 g (or Class 2) of JIS B 0209.
6. The portion (A) may be either tapered or terraced.
7. The length x may be constituted either by an incomplete-threads or by an under-cut for thread cutting. However, a length of approximately two threads shall be taken for x in the case of the incomplete-threads.
8. Bushing may be formed either to cylindrical shape or to spherical shape. When the bushing is of cylindrical shape, both ends of external periphery shall be chamfered.
9. The bushing may provide metallic lining.

Tabel 1.8 Ukuran pasak dan alur pasak.



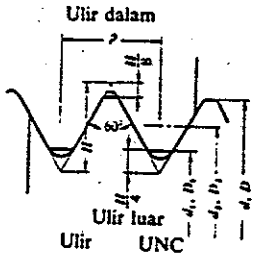
Ukuran-ukuran utama

(Satuan : mm)

Ukuran nominal pasak $b \times h$	Ukuran standar b, b_1, dan b_2	Ukuran standar h: Pasak prismatis / Pasak luncur	Ukuran standar h: Pasak tirus	C	l^*	Ukuran Standar r_1	Ukuran standar r_2: Pasak prismatis	Ukuran standar r_2: Pasak luncur	Ukuran standar r_2: Pasak tirus	r_1 dan r_2	Referensi: Diameter poros yang dapat dipakai d**
2 × 2	2	2		0,16–0,25	6–20	1,2	1,0		0,5	0,08–0,16	Lebih dari 6–8
3 × 3	3	3			6–36	1,8	1,4		0,9		8–10
4 × 4	4	4			8–45	2,5	1,5		1,2		10–12
5 × 5	5	5			10–56	3,0	2,3		1,7		12–17
6 × 6	6	6			14–70	3,5	2,5		2,2		17–22
(7 × 7)	7	7	7,2	0,25–0,40	16–80	4,0	3,0	3,5	3,0	0,16–0,25	20–25
8 × 7	8	8			18–90	4,0	3,3		2,4		22–30
10 × 8	10	8			22–110	5,0	3,3		2,4		30–38
12 × 8	12	8			28–140	5,0	3,3		2,4		38–44
14 × 9	14	9			36–160	5,5	3,8		2,9		44–50
(15 × 10)	15	10	10,2	0,40–0,60	40–180	5,0	5,0	5,5	5,0	0,25–0,40	50–55
16 × 10	16	10			45–180	6,0	4,3		3,5		50–58
18 × 11	18	11			50–200	7,0	4,4		3,4		58–65
20 × 12	20	12			56–220	7,5	4,9		3,9		65–75
22 × 14	22	14			63–250	9,0	5,4		4,4		75–85
(24 × 16)	24	16	16,2	0,60–0,80	70–280	8,0	8,0	8,5	8,0	0,40–0,60	80–90
25 × 14	25	14			70–280	9,0	5,4		4,4		85–95
28 × 16	28	16			80–320	10,0	6,4		5,4		95–110
32 × 18	32	18			90–360	11,0	7,4		6,4		110–130

* *l* harus dipilih dari angka-angka berikut sesuai dengan daerah yang bersangkutan dalam tabel.
6, 8, 10, 12, 14, 16, 18, 20, 22, 25, 28, 32, 36, 40, 45, 50, 56, 63, 70, 80, 90, 100, 110, 125, 140, 160, 180, 200, 220, 250, 280, 320, 360, 400.

Tabel 7.2 Ukuran standar ulir kasar UNC (JIS B 0206).



$$p = \frac{25{,}4}{n} \qquad d = (d) \times 25{,}4 \qquad D = d$$

$$H = \frac{0{,}866025}{n} \times 25{,}4 \qquad d_2 = \left(d - \frac{0{,}649519}{n}\right) \times 25{,}4 \qquad D_2 = d_2$$

$$H_1 = \frac{0{,}541266}{n} \times 25{,}4 \qquad d_1 = \left(d - \frac{1{,}082532}{n}\right) \times 25{,}4 \qquad D_1 = d_1$$

Garis tebal menyatakan profil patokan dari ulir

Ulir[2]		Jumlah ulir (tiap 25,4 mm) n	Jarak bagi p	Tinggi kaitan H_1	Ulir dalam		
					Diameter luar D	Diameter efektif D_2	Diameter dalam D_1
					Ulir luar		
1	2				Diameter luar d	Diameter efektif d_2	Diameter inti d_1
No. 2-56 UNC	No. 1-64 UNC	64	0,3969	0,215	1,854	1,598	1,425
	No. 3-48 UNC	56	0,4536	0,246	2,184	1,890	1,694
		48	0,5292	0,286	2,515	2,172	1,941
No. 4-40 UNC		40	0,6350	0,344	2,845	2,433	2,156
No. 5-40 UNC		40	0,6350	0,344	3,175	2,764	2,487
No. 6-32 UNC		32	0,7938	0,430	3,505	2,990	2,647
No. 8-32 UNC		32	0,7938	0,430	4,166	3,650	3,307
No. 10-24 UNC	No. 12-24 UNC	24	1,0583	0,573	4,826	4,138	3,660
		24	1,0583	0,573	5,486	4,798	4,341
1 4-20 UNC		20	1,2700	0,687	6,350	5,524	4,976
5 16-18 UNC		18	1,4111	0,764	7,938	7,021	6,411
3 8-16 UNC		16	1,5875	0,859	9,525	8,494	7,805
7 16-14 UNC		14	1,8143	0,982	11,112	9,934	9,149
1-2-13 UNC		13	1,9538	1,058	12,700	11,430	10,584
9/16-12 UNC		12	2,1167	1,146	14,288	12,913	11,996
5 8-11 UNC		11	2,3091	1,250	15,875	14,376	13,376
3 4-10 UNC		10	2,5400	1,375	19,050	17,399	16,299
7 8-9 UNC		9	2,8222	1,528	22,225	20,391	19,169
1-8 UNC		8	3,1750	1,719	25,400	23,338	21,963
1(1/8)-7 UNC		7	3,6286	1,964	28,575	26,218	24,648
1(1/4)-7 UNC		7	3,6286	1,964	31,750	29,393	27,823
1(3/8)-6 UNC		6	4,2333	2,291	34,925	32,174	30,343
1(1/2)-6 UNC		6	4,2333	2,291	38,100	35,349	33,518
1(3/4)-5 UNC		5	5,0800	2,750	44,450	41,151	38,951
2-4(1/2) UNC		4(1/2)	5,6444	3,055	50,800	47,135	44,689
2(1/4)-4(1/2) UNC		4(1/2)	5,6444	3,055	57,150	53,485	51,039
2(1/2)-4 UNC		4	6,3500	3,437	63,500	59,375	56,627
2(3/4)-4 UNC		4	6,3500	3,437	69,850	65,725	62,977
3-4 UNC		4	6,3500	3,437	76,200	72,075	69,327
3(1/4)-4 UNC		4	6,3500	3,437	82,550	78,425	75,677
3(1/2)-4 UNC		4	6,3500	3,437	88,900	84,775	82,027
3(3/4)-4 UNC		4	6,3500	3,437	95,250	91,125	88,377
4-4 UNC		4	6,3500	3,437	101,600	97,475	94,727

Catatan: (2) Kolom 1 merupakan pilihan utama. Kolom 2 hanya dipilih jika terpaksa.

Ukuran *flange* pipa baja

(Sumber : JIS Handbook, 1991)

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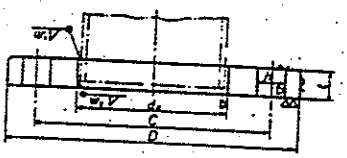
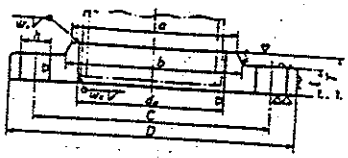
Attached Table

Nominal Size 10 to 400



Nominal Size 450 to 1000



Unit: mm

Nominal size	Outside dia. of steel pipe applicable to	Dia. of slip-on hole d_4	Outside dia. of flange D	Detailed dimension of flange t	T	Dia. of hub a	Dia. of hub b	r	Bolt hole: Dia. of pitch circle C	Bolt hole: Number	Bolt hole: Diameter h	Designation of screw threads on bolts	Leg length of weld (Reference) w_1	Leg length of weld (Reference) w_2	Approx. calculated mass (kg)
10	17.3	17.8	75	9	-	-	-	-	55	4	12	M 10	5	2.5	0.27
15	21.7	22.2	80	9	-	-	-	-	60	4	12	M 10	5	3	0.3
20	27.2	27.7	85	10	-	-	-	-	65	4	12	M 10	5	3	0.37
25	34	34.5	95	10	-	-	-	-	75	4	12	M 10	5	3	0.45
32	42.7	43.2	115	12	-	-	-	-	90	4	15	M 12	6	3	0.78
40	48.6	49.1	120	12	-	-	-	-	95	4	15	M 12	6	3	0.83
50	60.5	61.1	130	14	-	-	-	-	105	4	15	M 12	6	3	1.07
65	76.3	77.1	155	14	-	-	-	-	130	4	15	M 12	6	4	1.49
80	89.1	90	180	14	-	-	-	-	145	4	19	M 16	6	4	1.99
(90)	101.6	102.6	190	14	-	-	-	-	155	4	19	M 16	6	4	2.09
100	114.3	115.4	200	16	-	-	-	-	165	8	19	M 16	7	4	2.39
125	139.8	141.2	235	16	-	-	-	-	200	8	19	M 16	7	4	3.23
150	165.2	166.6	265	18	-	-	-	-	230	8	19	M 16	7	5	4.41
(175)	190.7	192.1	300	18	-	-	-	-	260	8	23	M 20	7.5	5	5.51
200	216.3	218	320	20	-	-	-	-	280	8	23	M 20	8.5	6	6.33
(225)	241.8	243.7	345	20	-	-	-	-	305	12	23	M 20	9	6	6.64