1. Steps of Calculation

a. Calculation of pump capacity.

b. Calculation of main pipe diameter.

c. Calculation of pump head.

- installation calculation in engine room
- head losses calculation in suction
- head losses calculation in discharge
- total head

d. Pump Selection.

2. Detail of calculation

Ship Dimension

Lpp	=	Length between perpendiculars	=	102	m
B	=	Breadht of ship	=	17	m
H	=	Height of ship	=	8.934	m
T	=	Draught of ship	=	6.865	m

a. Calculation of pump capacity.

$$Q = V / t$$

V = Volume of ballast tank
= 1349.774 m^3

t = Time to unload ballast water
= 10 hours

So, the value of minimum capacity of ballast pump is

Q = 134.9774 m^3/h
= 0.0374937 m^3/s

b. Calculation of main pipe diameter

$$Q = A \times v$$

$$d_{BL} = (Q / 0.25 \times \pi \times v)^{1/2}$$

d_{BL} = inside diameter of ballast main pipe

A = Area of pipe

= $0.25 \times \pi \times d_{BL}^{2}$

v = Flow velocity in pipe

= 3 m/s

So, the value of main diameter of ballast system is

d_{BL} = 0.126 m

= 126.178 mm

Based on ***BKI Volume III Section 11 C.1 table 11.6***

Calculation of wall thickness and elasticity, minimum wall thickness.

from,

193.7 > d_a > 117.8

the mimimum wall thickness for steel pipes,

s = Nominal minimum wall thickness

s = 5.0 mm

in the market supply, the pipes which are used :

Inside diameter	=	126.6 mm	= 0.1266 m
Outside diameter	=	139.8 mm	
Nominal wall thickness	=	6.6 mm	(SCH 40)
Nominal pipe size	=	125A	(According JIS G-3442) Galvanized Steel Pipe Grade SPGW
Pipe Code	=		

c. Calculation of pump head

- Calculation of installation in engine room

Head static of bilge pump (hs)	=	hs discharge
	=	T + 0.75m
	=	7.615 m
Head of pressure difference (hp)	=	0 m
Head of velocity difference (hv)	=	0 m

- Calculation of head in suction

caused by friction,

Rn = Reynould number

Based on ***Pompa dan Kompresor*** by Sularso Haruo Tahara

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$$Rn=(V\ x\ d\_H)/u$$

assuming the temperature of water which flowing through the pipe is in 30˚C, So

u = kinematic viscocity

u = 8.414E-07 m^2/s

Rn_H = 451390.5

Based on ***Pompa dan Kompresor*** by Sularso Haruo Tahara

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$$\lambda = 0{,}020 + \frac{0{,}0005}{D}$$

So,

λ = Friction loss coefficient

λ_H = 0.0200039

the **major losses** in suction pipe could be determined by,

$$hf = \lambda \times L \times \frac{v^2}{D \times 2g}$$

L = Length of pipe

D = Diameter of pipe

V = Flow velocity

Main bilge pipe was designed,

L = 90 m

D = 126.6 m

Hf = 0.0065 m

So, the total head of major losses in suction

Hf1 = Total head of major losses in suction

Hf1 = 0.0065 m

the **minor losses** in suction pipe could be determined by,

$$hl = \frac{k_{total} \times v^2}{2g}$$

No	Type	N	k	N x k
1	Elbow 90°	3	0.75	2.25
2	Butterfly	2	0.6	1.2
3	Gate Valve	1	1.2	1.2
4	T Joint	4	1.8	7.2
5	Strainer	2	0.58	1.16
6	NRV	1	2	2
		Total		15.01

So, the total head of minor losses in suction

Hl1 = Total head of minor losses in suction

Hl1 = 6.8923 m

- Calculation of head in discharge

the friction losses and diameters are same,

the difference is on the length of pipe,

the **major losses** in discharge pipe could be determined by,

Main bilge pipe was designed,

L = 12 m

D = 126.6 m

Hf = 0.0009 m

So, the total head of major losses in discharge

Hf2 = Total head of major losses in discharge

Hf2 = 0.0009 m

the **minor losses** in discharge pipe could be determined by,

No	Type	N	k	N x k
1	Elbow 90°	0	0.75	0
2	Butterfly	2	0.6	1.2
3	Gate Valve	0	1.2	0
4	T Joint	5	1.8	9
5	Strainer	0	0.58	0
6	NRV	2	2	4
		Total		14.2

So, the total head of minor losses in discharge

Hl2 = Total head of minor losses in discharge

Hl2 = 6.5204 m

- Total head

$$H_TOTAL = Hs + Hp + Hv + Hf1 + Hl1 + Hf2 + Hl2$$

So, the total head is

H_{TOTAL} = Total head

H_{TOTAL} = 21.035 m

e. Pump selection.

From the calculation above,

we can choose the suitable pump for bilge system.

Based on calculation, minimum specification of pump below :

Head = 21.035 m

Capacity = 134.98 m^3/h

- **Bilge-Ballast-Fire Pump**

Equipment No. = GES-PCF-01

Brand = TAIKO - Centrifugal Pump

Type = VS-125

Capacity = 150 m3/h

Head = 65 m

RPM = 1800 rpm

Suction in BWT	BKI - Part I - Vol. III	Suctions in ballast water tanks are to be so arranged that the tanks can
Suction based or	BKI - Part I - Vol. III	Ships having very wide double bottom tanks are also to be provided wit
Ballast water pip	BKI - Part I - Vol. III	Ballast water pipes may not pass through drinking water, feedwater, the
3-way Valve	BKI - Part I - Vol. III	Where a tank is used alternately for ballast water and fuel (change- ove
The Use of Balla	BKI - Part I - Vol. III	Where ballast water tanks may be used exceptionally as dry cargo holds
Shut off valves	BKI - Part I - Vol. III	Where, on cargo ships, pipelines are led through the collision bulkhead
Anti Heeling Arr	BKI - Part I - Vol. III	Anti-heeling arrangements, which may produce heeling angles of more
Ballast Pump	BKI - Part I - Vol. III	The number and capacity of the pumps must satisfy the vessel's operati
Cross flooding A	BKI - Part I - Vol. III	As far as possible, cross-flooding arrangements for equalizing of asymm
Cross flooding A	BKI - Part I - Vol. III	Cross-flooding arrangements for equalizing of asymmetrical flooding in
Sounding arrang	BKI - Part I - Vol. III	Spaces for independent tanks are to be provided with sounding arrange
Ballast System A	BKI - Part I - Vol. III	Means for ballasting segregated ballast tanks adjacent to cargo tanks m
FP tank requirem	BKI - Part I - Vol. III	On oil tankers the fore peak tank may be connected to the above ballas
Sounding Pipe of	BKI - Part I - Vol. III	Cargo oil tank sounding and air pipes shall not run through ballast tanks
Ballast Line	BKI - Part I - Vol. III	Pipe lines laid through ballast tanks, which are coated in accordance wit
Another Functio	BKI - Part I - Vol. III	Ballast pumps or other suitable seawater pumps may be used as stand-l
Ballast water pip	BKI - Part I - Vol. III	May be approved to pass to cargo oil tank if : Minimum wall thickness: u

be emptied despite unfavourable conditions of trim and list.
h suctions at the outer sides of the tanks. Where the length of the ballast water tanks exceeds 30 m, the Socie
rmal oil or lubricating oil tanks
r tank), the suction in this tank is to be connected to the respective system by three-way cocks with L-type plu
, such tanks are also to be connected to the bilge system. The requirements specified in N.4.5 are applicable.
below the freeboard deck, a shut-off valve is to be fitted directly at the collision bulkhead inside the fore peak
than 10° according to Chapter 1,Section 1, E.3, are to be performed as follows: – A shut-off device is to be pro
ional requirements.
etrical flooding in case of damage hould operate automatically. Where the arrangement does not operate aut
case of damage are to be submitted to the Society for approval
ments. When ballast or cooling water lines are fitted in spaces for independent tanks bilge level alarms are to
ust be located in the cargo area and are to be independent of piping systems forward and aft of the cofferdam
t systems under following conditions: – The fore peak tank is considered as gas dangerous space. – The vent pi
. Exemptions are subject to para. 4.3.4 analogously.
h Hull Structures, Chapter 1, Hull Structures, Section 1, F35, are to be either effectively protected against corr
by cooling water pumps.
up to DN 50 6.3 mm, DN 100 8.6 mm, DN 125 9.5 mm, DN 150 11.0 mm, DN 200 and larger 12.5 mm Only com

ty may require suctions to be provided in the forward part of the tanks.

gs, cocks with open bottom or change-over piston valves.

. The valve has to be capable of being remotely operated from above the freeboard deck.
vided in the cross channel between the tanks destined for this purpose before and after the anti-heeling pum

omatically, any shut-off valves must be capable of being operated from the bridge or another central location.

be provided.
s.
ipe openings are to be located 3 metres away from sources of ignition. – Means are to be provided on the ope

osion or they are to be of a material of low susceptibility to corrosion.

npletely welded pipes or equivalent are permitted. Where cargoes other than oil products are carried, relaxati

p. – These shut-off devices and the pump are to be remotely operated. The control devices are to be arranged

The position of each closing device has to be indicated on the bridge and at the central operating location (se

n deck for the measurement of flammable gas concentrations inside the peak tank. – Access openings and so

on from these Rules may be approved by BKI.

in one control stand. – At least one of the arranged remote controlled shut-off devices shall automatically shu

e also Chapter 1, Section 28, G. and Chapter 3, Section 7, H.). The cross-flooding arrangements must ensure th

unding arrangements to this space are to be located on the open deck. In case were the fore peak is separatec

ıt down in the case of power supply failure. – The position "closed" of the shut-off devices shall be indicated o

ıat in case of flooding equalization is achieved within 10 minutes.

ł by a cofferdam from the cargo tanks a bolted manhole may be permitted in an enclosed space with the follo

n the control stand-by type approved end position indicators. – Additionally,Chapter 3, Section 7, G.is to be ob

wing warning notice: This manhole may only be opened after the tank has been proven gas free or electrical e

›served

quipment in this space which is not of certified safe type has been isolated.