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# Design of High Rate Blender Hydraulic Power Pack Unit on Stimulation Vessel – Study Case Stim Star Borneo for Offshore Operations at Delta Mahakam Area – East Borneo

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***Abstract*— currently application of hydraulic power technology in world industry is still increased. Those phenomenon not only in Industrial field but also in Marine, Onshore and Offshore that use these technologies. Requirement of service in Offshore Delta Mahakam region makes PT. Halliburton Indonesia as a Service Company increase his fleet service. One of the Type Stimulation Vessel Fleets - Stim Star Borneo is planned to improve the service unit of High Rate Water Pack (HRWP) with High Pressure Pump unit plus Gravel Pack Sand (GP) and High Rate Blender Unit as its tools. Blender High Rate is a unit tubular mixing blender driven by hydraulic power, motors blender, sand screw, pump suction and discharge pump that is installed as an unity. In order to analyze those installation, it needs to be planned the section of its system, calculation and specifications of Hydraulic Power Pack Unit for High Rate the Blender. Calculations start from the Operational Requirement Conditions, and continued with Design Block Diagram, P & ID, and also calculations of systems parameter such as Head, RPM, Pipe Diameter, Pipe Thickness, Main Hydraulic Pump, Reservoir Tank and Cooler. The Requirement of Hydraulic Main Pump Power is 950 kW with Electric Motor as prime mover 950 kW. The final result of the design is shown as Layout and Detail drawing in attachment.**

*Keywords* — hydraulic, power pack, high rate blender, stim star borneo

## I. INTRODUCTION

The application of technology Hydraulic Power Pack Unit in the industry today's world is continues to increase. Not only in Industrial alone, but also in Marine, Onshore and Offshore field use these technologies.

The growing demands for well servicing services - offshore Mahakam Delta region makes PT. Halliburton Indonesia as a Service Company increasing its fleet in the Production Enhancement (PE) Department. PE Department which has a fleet of Stimulation Vessel Type - Stim Star Borneo plan to improve the service unit of High Rate Water Pack (HRWP) with High Pressure Pump unit plus Gravel Pack Sand (GP) with High Rate Blender Unit. Blender High Rate This is a unit that is tubular mixing blender is driven by hydraulic power, motors, sand screw, pump suction and discharge pump installed as one unit. High Rate Blender function is to rotate and mix the sand, water and chemicals in the form of a gel called gravel pack which will be pumped by High Pressure Pump to the Well. Rate of Blender where this should be able to generate a rate or debit corresponding services required Delta Mahakam area.

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In this research the system specifications Hydraulic Power Pack Unit for High Rate the Blender will be planned and calculated.

In this research the planning of the Hydraulic Power Pack Unit covers the systems, equipment and technical specifications in the form of Layout and Detail drawing.

## II. METHOD

The methodology is to determine the objectives and measures of the research. The methodology serves as the main framework to be the determination of the discussion. The method used in this research is a mixed method which briefly shows: (1) identify the problem and research objectives, (2) search for data and literature supporting, (3) analyze and interpret data (4) create a design and report

### 2.1. Literatur Review

Literature is the first step in the research to look for references and materials to be used as reference material in accordance with the analysis that is reliable so as to help the research . The literature study can be taken from a reference source document or Data Operations, Engineering Books, Catalogs and related Journal. include: Primary Data Ship, Ship Specification Data and Operational Data Tools.

### 2.2. Data Analysis Operational Requirement

After data collection, data analysis performed for the calculation and determination of the operational condition in accordance with the data being before and is the next step to process the detailed data to assist the research. Data analysis and operational requirements were conducted to determine the parameters and operational requirements based on the data that has been collected previously in this research.

**Figure.1.** Stimullation *Vessel* - SSB

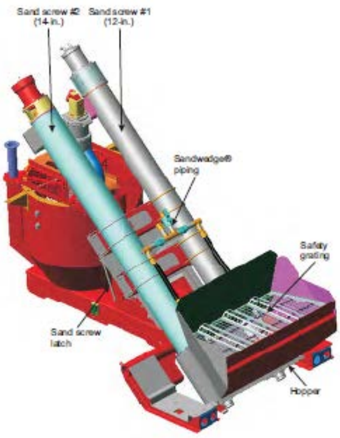


**Figure.2.** *High Rate Blender Unit*

**2.3.Drafting Design Systems**

Drafting Design System includes Block Diagram and P & ID diagrams. This is done because the calculation system and design should be consistent. Where the Block Diagram explaining the work process flow diagram Hydraulic Power Pack, which describes the unit - the unit that become manual hydraulic pump unit. While P & ID is a more specific system design that describes the flow or pipe system, instrument - instrument and unit - including the number of units and specifications as the reference for the calculation system.

**2.4. Calculation sytem and Specifications**

The Data Design / Draft drom previous Design and Operational Requirement, needs to have the calculation of those system. Where the calculation of this system include：

a) Calculation of Unit Head and RPM user
b) Adjustment Calculation RPM Motor Hydraulic
c) Calculation of Diameter Pipe Unit Users
d) Calculation of Diameter Pipes Main Hydraulic Pump
e) Calculation mateial and minimum thickness of pipe
f) Calculation of Main Pump Head
g) The need Hhydraulic Main Pump
h) Electric Motor Supplies (Driver)
i) The need Reservoir Tank
j) The need Cooler

**2.5. Design Block Diagram, P & ID, Specifications System and Equipment**

Search units available in the market in accordance with the specifications and catalog ang available.

**2.6. Making Design Layout and Cost Analysis**

System designs that already mee the requirement will be created its Design Layout plotted on the General Arrangement Stimulation Vessel - SSB in accordance with the specifications and the size of the catalog according to standard drawing. Then in doing analysis calculation installation costs.

**2.7. Conclusions and recommendations**

Conclusions and Recommendations are made based on all aspects of the discussion of this research.

## III. RESULTS AND DISCUSSION

**3.1 Operasional Data and Desain**

Operational planning design Hydraulic Power Pack Unit is in accordance with the Regional Operational Delta Mahakam block in East Kalimantan. Data is obtained from PT. Total E & P Indonesia and PT. Halliburton Indonesia – Balikpapan, the process that could happen on the system are:

a.**Fluid Mixing Process** : HRB is used to manufacture a mixture of gel fluid or process fluid

b. **Circulating Mixing Process** : HRB is used on mixing fluid. In those process is inside fluid tanks and then return the pump to the process fluid tanks. This is done to maintain the mixture composition and process fluid in ideal conditions.

c. **Direct Discharge or Direct Mixing Discharge** : ie unit Pump Suction and Discharge HRB used as a reservoir discharge path which is then directly connected to the suction pipe High Pressure Pump. On the other conditions are also designed HRB used in a condition to Tab Fluid

Mixing Blender then in mixing and pumped to the High Pressure Pump Suction pipe discharge

TABLE. 1.
PUMPING SCHEDULE ZONE 1 DATA

PUMPING SCHEDULE - Gravel Pack Version: 0 PK-J9 ZONE 1
7/31/15 9:59

| Worksring Volume | Surface Lines Volume | Volume to Xover | Volume to top perfs | Volume to btm perf |
|---|---|---|---|---|
| 4480 Gal<br>106.7 bbl | 126 Gal<br>3.0 bbl | 4606 Gal<br>109.7 bbl | 4986 Gal<br>118.7 bbl | 5005 Gal<br>119.2 bbl |

| | | | |
|---|---|---|---|
| Base fluid | 8.996 ppg | Pressure Test | 6,000 psi |
| Proppant Bulk Density | 97 lbs/ft3 | Tubing Pop Off | 5,000 psi |
| Proppant Volume Factor | 0.0449 gal/lbs | Set Pump Kick Outs | 4,800 psi |
| | | Set Annulus Kickout | 3,500 psi |
| | | Hydrostatic Pressure | 2,659 psi at top perf |

TOOL POSITIONS

**Circulate** Around screen into annulus- BOP open
**Reverse** Down Annulus - Up Tubing - BOP Open
**Squeeze** Down Tubing, BOP Closed

*Displacement*
Gravel Pac Displacement 5.0 bbls from x-over
Gravel Pac Displacement @ slowdown ** from x-over
** slow down started so that screen starts when annulur fill volume is still in tubing plus safety factor

PROCEDURE

| Stage No. | Stage Type | Clean Vol. gals | Dirty Vol. gals | Dirty Vol. bbls | Sand Wt lbs | Rate bpm | Start Prop ppg | End Prop ppg | Stage Time mins | Fluid Type | Fluid at Perf's |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Flush Lines & Test Line | 1,000 | 1,000 | 24 | 0 | 1.0 | | | 23.81 | Completion Brine | Completion Brine |
| 2 | Circulate Test in weight down position | 4,606 | 4,606 | 110 | 0 | 1, 2, 4, 6 | | | TBA | Completion Brine | Completion Brine |
| | **Shut-In - Move Tool to Squeeze Position** | | | | | | | | | | |
| 3 | Injectivity & Breakdown Test | 630 | 630 | 15 | 0 | 1, 2 | | | to 1000 psi | 30# HEC (breaker) | Completion Brine |
| 4 | Step Rate Test | 4200 | 4,200 | 100 | 0 | 1 to 10 | | | TBA | 30# HEC (breaker) | Completion Brine |
| | **Shut-In - Hard Shut Down** - Monitor Pressure until company man or engineer gives signal to continue | | | | | | | | | | |
| 5 | PAD | 1260 | 1,260 | 30 | 0 | 14.0 | 0.0 | 0.0 | 2.14 | 30# HEC (breaker) | 30# HEC (breaker) |
| 6 | Sand Laden Linear Gel | 6,968 | 7,281 | 173 | 6,968 | 14.0 | 1.0 | 1.0 | 12.38 | 30# HEC (breaker) | 30# HEC (breaker) |
| 7 | Displacement | 4,396 | 4,396 | 105 | 0 | 14.0 | | | 7.48 | Completion Brine | 30# HEC (breaker) |

Of the three operational conditions above can be obtained following data:

TABLE. 2.
OPERASIONAL REQUIREMENT

| No | Equipment /User | Requirement | Unit |
|---|---|---|---|
| **A** | **Fluid Mixing Process** | **Time per Mixing 1xcap.tube/min**<br>**As designed**<br>**10.5 bbl/min**<br>**Or 1670 Ltr/Min** | **bbl/min**<br><br>**Ltr/min** |
| 1 | Base Fluid ;<br>LA Pump 1 / 2 | 200 ml/L x 1670 Lt<br>334 x$10^3$ ml = 334 Lt/min per pump | Ltr/min |
| 2 | pH Buffer (caustic)<br>Dry Additive 1 | 0.1 ml/L x 1670 Lt<br>167 ml = 0.167 Lt/0.5min per pump<br>Or 0.334 Ltr/min | Ltr/min |
| | pH Buffer (acid)<br>Dry Additive 1 | 0.55 ml/L x 1670 Lt<br>918.5 ml = 0.9185 Lt/0.5min per pump<br>Or 1.837 Ltr/Min | Ltr/min |
| 3 | Polymer / Sand<br>Sand screw 1 / 2 | 2000 gr/L x 1670Lt =<br>167 x$10^4$ gr = 3681 gr/0.5min per screw<br>Or 1840.5 gr/min | gr/min |
| 4 | Blender<br>Turbin Agitator | Cap. 75-90 rev/min<br>Input 90 rev/min | rev/min |
| **B** | **Circulating Mixing Process** | **Every 20 minute** | |
| 5 | Suction Centrifugal Pump<br>Max. Flow rate<br>100 bbl/min | Cap. Tank/time<br>649 bbls/20 min<br>32.45 bbl/min<br>Or 5.192 $m^3$/min | bbl/min<br><br>$m^3$/min |
| 6 | Discharge Centrifugal Pump<br>Flow Rate<br>24 bbl/min at 500 rpm<br>138 bbl/min at 1000 rpm | Cap. Tank/time<br>649 bbls/20 min<br>32.45 bbl/min<br>Or 5.192 $m^3$/min | bbl/min<br><br>$m^3$/min |
| 7 | Blender<br>Turbin Agitator | Cap. 75-90 rev/min<br>Input 90 rev/min | rev/min |
| **C** | **Direct Mixing and Discharge** | **Req. 14 bbl/min**<br>**Design (Sf = 1.5)**<br>**Rate 21 bbl/min**<br>**Or~ 3.35 $m^3$/min** | bbl/min<br><br>$m^3$/min |
| 8 | Suction Centrifugal Pump | $\geq$ 3.35 $m^3$/min | $m^3$/min |
| 9 | Discharge Centrifugal Pump | $\geq$ 3.35 $m^3$/min | $m^3$/min |
| 10 | Blender<br>Turbin Agitator | Cap. 75-90 rev/min<br>Input 90 rev/min | rev/min |

## 3.2 Desain System

Before the Design System it is necessary to perform the manufacture of the block diagrams and P & ID's draft preliminary calculations needs head loss and the need for cooling equipment.

### 3.2.1 Blok Diagram

Block Diagram is a chart / diagram explaining the operation and the equipment used.

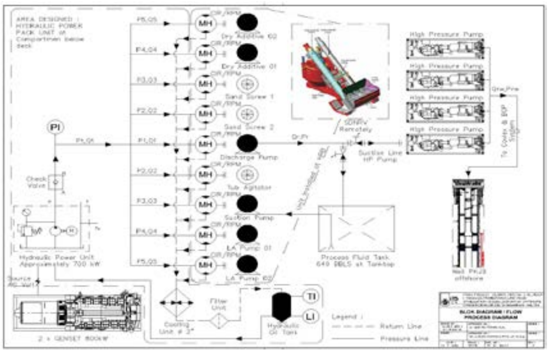

**Figure.4.** Blok Diagram Operasional and Equipment

### 3.2.2 P & ID (*Piping and Instrument Diagram*)

Piping and Instrument Diagrams (P & ID) is designed in accordance with the Block Diagram. Where this diagram will be the reference for the calculation of required equipment and instrument both specifications, the type and number of units required.

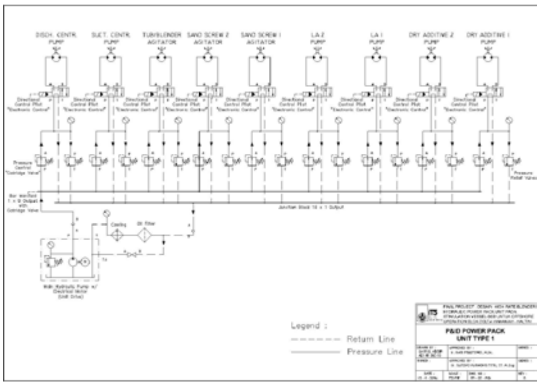

**Figure.5.** Piping and Instrument Diagram (P&ID)

## 3.3 Calculation System

### 3.3.1 Calculation of Unit Head and RPM User

The need for pumps (User Units) in accordance with the operational needs (offshore operation) needs to be in accordance with the previous calculation data that has been calculated and designed. Because there are changes, which include changes in the needs of Q (flow rate) and the Head of each pump of the conditions existing before the calculation of the adjustment.

TABLE 3.
CALCULATION ADJUSTMENT DEBIT AND HEAD PUMPS

| No | Equipment User | Qsp. ($m^3$/min) | Hsp. (psi) | Qreq. ($m^3$/min) | Hreq. (psi) |
|---|---|---|---|---|---|
| 1 | Suction centrifugal Pump | 15 | 26 | 5.2 | Cal. |
| 2 | Discharge centrifugal pump | 22 | 15 | 5.2 | 15 |
| 3 | Sand Screw | No adjustment (Rotated) | | | |
| 4 | Tub Agitator | No adjustment (Rotated blend) | | | |
| 5 | LA Pump | Accordance Unit | | | |
| 6 | Dry Additive | Accordance Unit | | | |

From the table above it can be seen that the two pump units, the number 1 and 2 should be an adjustment Flow rate and the Head, this adjustment is done by a decrease in RPM units according to the catalog specification unit / reference.

### 3.3.2 RPM Motor Hydraulic Adjustment Calculation

Because no adjustment Flow rate (Q) and Head accordance with the operational condition then this will also affect the speed (RPM) on the hydraulic motor unit that is connected directly to the pump (Direct Driver).

TABLE 4.
CALCULATION OF ADJUSTING THE RPM MOTOR HYDRAULIC

| No | Pump Unit User | Motor Unit | RPMsp. | RPMreq. |
|---|---|---|---|---|
| 1 | Suction centrifugal Pump | Parker 9.15 CIR | 1250 | 720 |
| 2 | Discharge centrifugal pump | Rexroth 30.51 CIR | 1000 | 900 |
| 3 | Sand Screw 2 | Eaton 45.76 CIR | 350 | 350 |
| 4 | Sand Screw 1 | Eaton 36.74 CIR | 400 | 400 |
| 5 | Tub Agitator | Charlynn 40.6 CIR | 150 | 150 |
| 6 | LA 1 | Parker 1.69 CIR | 600 | 600 |
| 7 | LA 2 | Parker 2.54 CIR | 600 | 600 |
| 8 | Dry Additive 1 | Rexroth 1.0 CIR | 180 | 180 |
| 9 | Dry Additive 2 | Rexroth 1.0 CIR | 180 | 180 |

### 3.3.3 Pipe diameter calculation unit User

Based on previous calculation, the calculation of the diameter of the pipe can be done.

TABLE 5.
DATA FLOW RATE (Q) X RPM

| No | Pump Unit | $Q \times 10^{-5}$ ($m^3$/rev) | Rpm | $Q \times 10^{-3}$ ($m^3$/s) |
|---|---|---|---|---|
| 1 | Suction centrifugal Pump | 14.64 | 720 | 1.7568 |
| 2 | Discharge centrifugal pump | 48.816 | 900 | 7.3224 |
| 3 | Sand Screw 2 | 73.216 | 350 | 4.2709 |
| 4 | Sand Screw 1 | 58.784 | 400 | 3.9189 |
| 5 | Tub Agitator | 64.96 | 150 | 1.6240 |
| 6 | LA 1 | 2.704 | 600 | 0.2704 |
| 7 | LA 2 | 4.064 | 600 | 0.4064 |
| 8 | Dry Additive 1 | 1.6 | 180 | 0.0480 |
| 9 | Dry Additive 2 | 1.6 | 180 | 0.0480 |

From the Data Flow Rate (Q) the above table it can be calculated diameter of the pipe using the formula:

$$dDisch. = \sqrt[0.5]{\frac{4Q}{\pi V}}$$

Where :
Q = *Flow rate*, 4.8, $m^3$/s
V = *Flow Velocity*
Rekomendation *flow velocity* :

1. *Velocity of pressure lines* = 7 – 20 ft/sec or 2.13 – 6.1 m/s
2. *Velocity of suction lines* = 2 – 5 ft/sec or 0.61 – 1.5 m/s

using V = 6 m/s
so that each Unit Discharge Pipe Users can be determined using ANSI Standard Pipe

### 3.3.4 Pipe diameter calculation Hydarulic Main Pump

Where the main hydraulic pump to supply to a hydraulic motor driver using one pump driven Electric Motor. Due to a series of pipeline pump as paralalel, then Q for this pipeline is the total of Q entire lifeline.

Qt1 = Qsuct. centr. + Qdisch.centr. +Qsand screw1 +Qsand screw2+Qagitator +Qla1 +Qla2 + Qdry add.1 + Qdry add.2

So the result Qt1 = 0.01967 $m^3$/s or 70.79 $m^3$/h

*Pipe as needed :*

$$dDisch. = \sqrt[0.5]{\frac{4Q}{\pi V}}$$

$$dDisch. = \sqrt[0.5]{\frac{4x0.01976}{\pi \ x \ 6}}$$

So the diameter = 64.62 mm or 2.54 inch
use Pipe Diameter 2½" Inch Standart ANSI

### 3.3.5 Pipe Material Calculation and Minimum Thickness

Pressure / high pressure 5070 psi in accordance with the specifications Pressure Control Valve to be used and in accordance with the specifications Hydraulic Motor.

Operation pressure = 5070 Psi
Using the Reference Year ASME B.31. In 2012 we can see the minimum thickness of each pipe to be used.

With Formula Lame's or Barlow's, the minimum thickness is as follows:

$$Thickness = \frac{PD}{2S}$$

Where ;
t = *thickness*, in inch
P = *Design pressure* in psi
D = *Outside Diameter Pipa*, inch
S = *Allowable stress*, psi
Grade material used is in accordance with ASME B31 or SAE standards as recommended material.
Using material no.2 = Steel C-1021
So that the minimum thickness calculation is as follows :

TABLE 6.
THE CALCULATION OF THE MINIMUM THICKNESS OF THE PIPE AND SCHEDULE

| No | Pump Unit | ø Pipe ANSI | Min. thk (in.) | Min. thk (mm) | Sch. ANSI |
|---|---|---|---|---|---|
| 1 | Suction centrifugal Pump | 1 " | 0.17 | 4.29 | 80 |
| 2 | Discharge centrifugal pump | 1½ " | 0.25 | 6.44 | 160 |
| 3 | Sand Screw 2 | 1¼" | 0.15 | 3.81 | 80 |
| 4 | Sand Screw 1 | 1¼" | 0.15 | 3.81 | 80 |
| 5 | Tub Agitator | 1 " | 0.12 | 3.05 | 80 |
| 6 | LA 1 | ½ " | 0.05 | 1.27 | 80 |
| 7 | LA 2 | ½ " | 0.05 | 1.27 | 80 |
| 8 | Dry Additive 1 | ½ " | 0.05 | 1.27 | 80 |
| 9 | Dry Additive 2 | ½ " | 0.05 | 1.27 | 80 |
| 10 | Main PP Q1 | 2½ " | 0.42 | 10.73 | 160S |
| 11 | Main PP Q2a | 2½ " | 0.42 | 10.73 | 160S |
| 12 | Main PP Q2b | ½ " | 0.05 | 1.27 | 80 |

**3.3.6 Calculations Head Main Pump**

**3.3.6.1 Specifications hydraulic oil used**

Brand = Mobile Exxon
Type = Mobile EAL 32
Colour = ISO 2049 : 1.5
Viscoity, ASTM D445
Cst at 40 $^{o}$ C = 32
Cst at 100 $^{o}$ C = 7

Viscocity Index, ASTM D2270 = 189
Pour Point $^{o}$C, ASTM D97 = - 39$^{o}$C
Flash Point $^{o}$C, ASTM D92 = 248$^{o}$C
Density at 15$^{o}$Ckg/l, ASTM D4052 = 911

Data from Exxon Hydraulic Oil Online Catalog

**3.2.5.2 Calculation of Pressure Head**

Where the Main Hydraulic Pump for supply to a hydraulic motor driver using one pump driven Parent Electric Motors.

Due to a series of pipeline pump server as paralalel then Head to Head this pipeline is needed most
.

**3.3.7 Main Hydraulic Pump**

From the data above calculation can resumed as follows :

Q = 70.79 m$^3$/h or 1179.83 l/min
Head / *Pressure* = 5890 psi – 406 Bar

So choosed Hydraulic Electric Mover Pump :
Brand = Uraca
Type = Plunger Pump – P5 80
Pmax = 1120 kW
Eff. = 0.92

**3.3.8 Requirement of Electric Motor**

- **Power of Fluids (Pimpsa)**

Water Power / Pump (Pw) is the energy effectively accepted by the fluid from the pump per unit time.

$$Pw = \gamma QH$$

Where :
Q = *flow rate*, 0.01966 m$^3$/s
H = *head / pressure*, 4058.605 m
γ = light of fluida / vol., 911 kg/m$^3$

❖ So Pw = 72690.67 watt or 726.91 kW

- **Shaft Power (Ps)**

Shaft power is the power required to drive a pump. where as follows :

$$Ps = Pw / \eta P$$

Where :
Pw = Power of fluida, 726.91 kW
Hp = Eff. Pump, 0.92

❖ So Ps = 790.12 kW

- **Power of Nominal (Pm)**

Nominal power is power derived from the transmission efficiency and the efficiency of the motor itself. Where Pm follows
:

$$Pm = \frac{Ps(1+\alpha)}{\eta t}$$

Where :
Pm = Power Nominal, kW
Ps = Power Shaft, 790.12 kW
α= Additional factor, 0.15
Due to Transmision used direct coupling so ηt = 1

❖ So Pm = [790.12(1+0.15) / 1]
= 908.638 kW

Choosed Electric Motor :
Brand = Loher - Motors
Type = IP5 8 Pole 50 Hz 450 Frame
Pmax = 950 kW
Eff. = 0.92

**3.3.9 Requirement *Reservoir Tank***

Rekomendation of volume Reservoir tank is
Vol. = (3-5) x Q at m$^3$/min + 10% *for aerating space*
= 3 x Q (m$^3$/min) x 110%
= 3 x 1.180 x 1.1
= 3.894 ~ 4 m$^3$

❖ So the Volume of Reservoir Tank = 4 m$^3$

**3.3.10 Requirement of *Cooler***

Cooling in instaaltion unit power pack aims to keep the hydraulic oil temperature remains in standard (40-50$^{o}$C).

- **Cooler Calculation**

$$Q = m\,C\;\Delta T / t \times 60$$

Where :
ΔT = Diff. temperature, 50 – 40 = 10°C
C = *Spesific heat*, 0.497 kCal/kg°C
m = *mass flow rate*, 17.91 kg/s
So Q = 17.91 x 0.497 x 10 / 1 x 60
= 1.484 kCal/s or 6.2 kW or 5342.4 kCal/h

- **Requirement of *surface area HO Cooler***

A = *Heat Dissipation* / (K x LMTD)

Where :
HD = *Heat Dissipation*, 5342.4 kCal/h
K = *Heat transfer coef*. 260 kCal/m$^2$.h. °C
LMTD = *Log Mean Temperature Diff.*
LMTD = [(T1-t2)-(T2-t1)]/Log[(T1-t2)/(T2-t1)]
$T_{water\ cooler}$
t1 = 32 °C ; t2 = 40 °C
$T_{heat\ fluid/oil}$
T1 = 50 °C ; T2 = 40 °C
So LMTD = 20.64 °C
❖ So A = 0.9955 m$^2$
Choosed Cooler :
Brand = Aalborg – Vesta MX
Type = MX 10 - Tube
Pmax = Up to 10 kW

- **Requierement of Cooler Pump**

**a. Calculation *Centrifugal Pump Cooler Pipe***

The calculation is performed with references from the Book of Pumps and Compressors, Ir. Sularso and Dr. H. Tahara
.
*Velocity of fluid design* = 3 m/s

Formula :

$$dDisch. = \sqrt[0.5]{\frac{4Q}{\pi V}}$$

Where :
Mass flow rate = 17.9 kg/s so Q = (17.9/1000)m$^3$/s
Q = Flow rate, 0.0179 m$^3$/s
V = velocity, 3 m/s

So D discharge = 0.087 m or 3.5 inch
Using Pipe Standart ANSI 3.5"sch 40
OD = 4.000 in
ID = 3.548 in
Thk = 0.226 in
Material *Carbon Steel with Galvanis Surface*

**b. Calculation *Head Centrifugal Pump Cooler***

*Head Pump Calculation*

$H_{total}$ = Hs + ΔHp + Hv + Hloss
Where :
Hs = *Head Statis*, Length *suction well* with *discharge pipe*
= 1.1 m
ΔHp = Diff head pressure, (P*disc* – P*suction*)/ρg
= 0 m, *pressure* at *suction* and *discharge* typically
Hv = head speed output, (V$^2$*disch* – V$^2$*suct*)/2g
= 0, *velocity* di *suction* and *discharge* same
Head Loss = Hloss disch + Hloss suct.
Total od head (Htot) = Hs + Hp + Hv + Hloss
= 1.1 + 0 +0 + 3.3
= 4.4 m

❖ From calculation :
Q = 0.0179 m$^3$/s or 10.74 l/min or 64.44 m$^3$/h
Head / *Pressure* = 4.4 m head or 44 bar
Choosed Centrifugal Pump :
Brand = Sili Pump
Type = Centrifugal Pump – 100CLZ-17A
Qmax = 72 m$^3$/h
Hmax = 18 m
Pmax = 7.5 kW

**c. Calculation of Volume Water Cooler**

Calculations were performed to determine the needs cooler where it is fresh water that will be placed on the tank 3CP
.

### 3.4 Calculation of Instalation Cost

The calculation of costs includes the cost of the work, the cost of materials and equipment, the cost of consultants and supervision, as well as administrative costs.

TABLE 7.
COST CALCULATION

| No | Items | Price (Rp) |
|---|---|---|
| 1 | Instalation | 43.800.000,00 |
| 2 | Material and Equipment | 335.750.000,00 |
| 3 | Consultan and Supervisi (10%) | 37.955.000,00 |
| 4 | Administration and Tax (15%) | 56.932.500,00 |
| | **Grand Total** | **474.437.500,00** |

TABLE 8.
MAIN EQUIPMENT

| No | Unit | Spec. |
|---|---|---|
| 1 | Main Hydraulic Pump | |
| | Brand : Uraca | P : 950 kW |
| | Type : Plunger Pump – P5 80 | Q : 1204 l/min |
| | | H : 450 bar |
| 2 | Electric Motor | |
| | Brand : Loher Motors | P : 950 kW |
| | Type : IP5 8 Pole 50 Hz 450 Frame | Eff. : 0.92 |
| 3 | Reservoir Tank | 4 $m^3$ |
| 4 | Cooler | |
| | Brand : Aalborg – Vesta MX | P : Up 10 kW |
| | Type : MX 10 - Tube | |
| 5 | Centrifug. Cooler Pump | |
| | Brand : SILI - Pump | P : 7.5 kW |
| | Type : 100CLZ – 17A | Q : 72 $m^3$/h |
| | | H : 18 m |
| 6 | Hydraulic Oil | |
| | Brand : Mobile Exxon | Cst40$^o$ : 32 |
| | Type : Mobile EAL 32 | Cst100$^o$ : 7 |
| 7 | Media Cooler - freshwater | 3 $m^3$ |

## IV CONCLUSION

From Analysis, Design and Calculation System that has been done it can be concluded that for this Final:

1. Design and Analysis Calculation starts include:
   - Operational Requirement or Performance Unit in accordance with the operational needs of the Mahakam Delta Offshore Blocks
   - System Design: Block Diagram, P & ID diagrams in accordance with Annex Figure
   - Calculation System includes :
     a. Performance adjustment calculation unit
     b. RPM adjustment calculation
     c. Calculation of diameter and thickness
     d. Calculation and selection of equipment Main

2. Design Layout and Detail Image refers to the General arrangment Stimulation Vessel - SSB where the main equipment, Power pack unit installed at the location Compartemen above the double bottom, the compartment 2CP or between frames 6 s / d frame 9. While Blender Pack Unit (High rate blender) installed on location in the Main deck, frame between 19 s / d frame 23

3. Calculation of installation costs are modest result for Rp. 474,437,500.00

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