Pump Datasheet Development

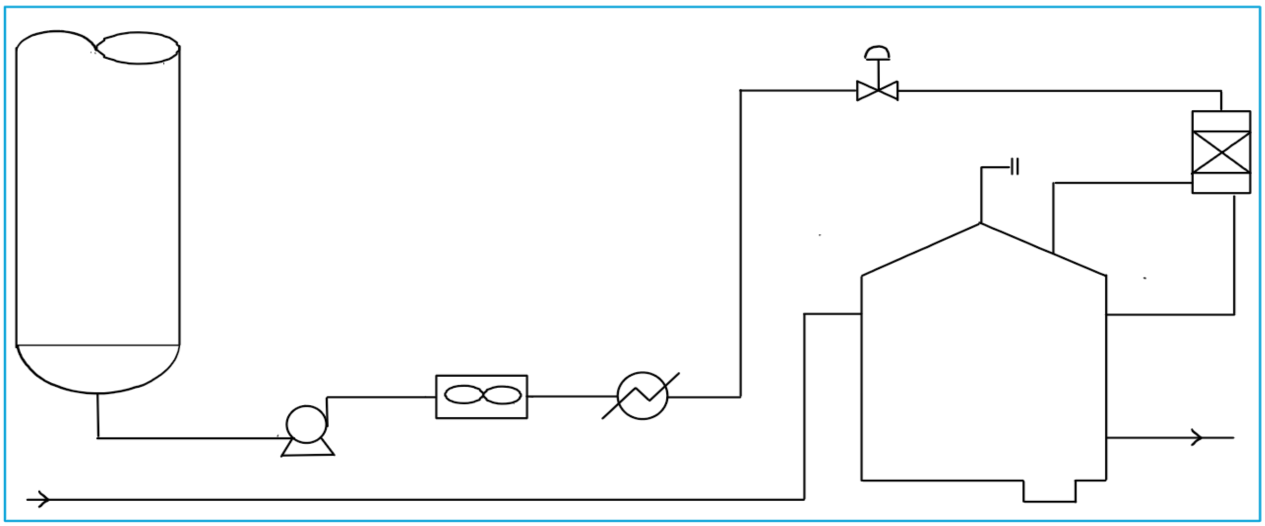
Second Webinar

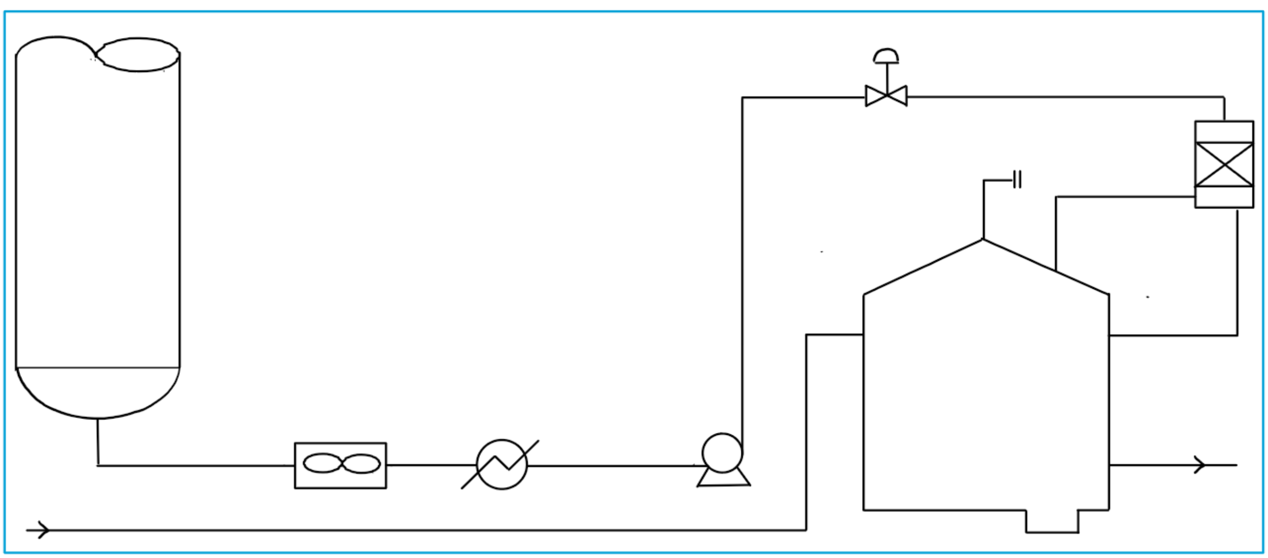
Process Description:

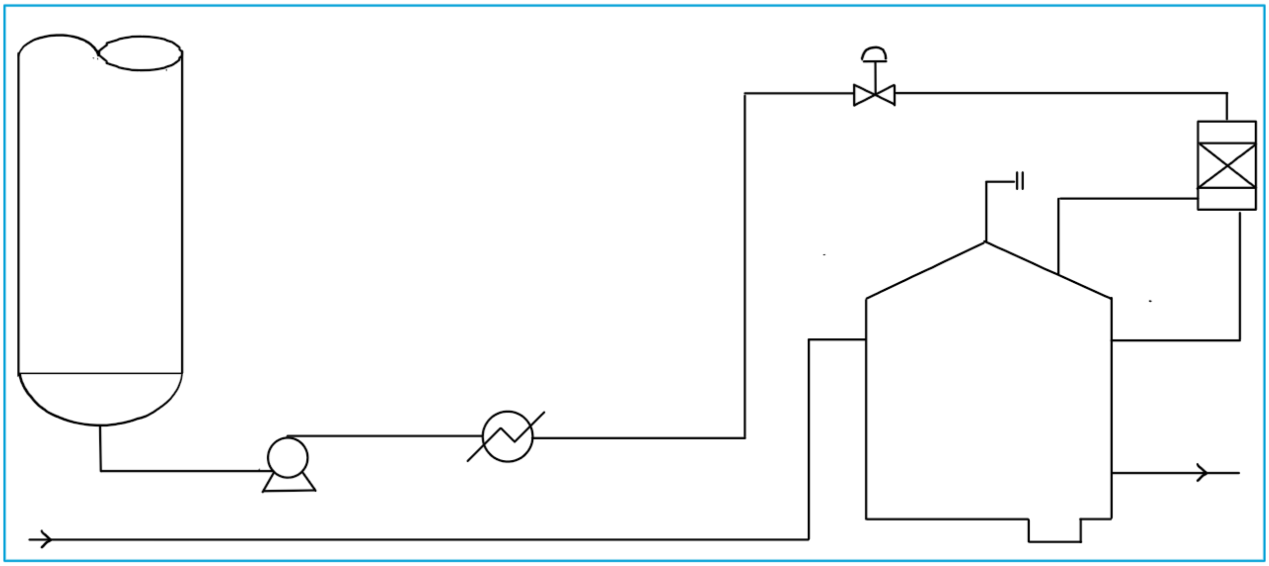
As stated before, water characteristic at the bottom of third tower is suitable to be re-used for wash column. Here is the exact info of the stream:

Temperature	148.9C
Pressure	3.6barg
Flowrate	97120 kg/hr.

Please provide process engineering sketches which are possible for this application:







Advantages and disadvantages:

First one:

- The pump casing is in contact with high-temperature fluid, thereby increasing the cost of pump.
- The pump creates the pressure and velocity suitable for the heat transfer which happens in the air-cooled heat exchanger and water-cooled heat exchanger.

Second one:

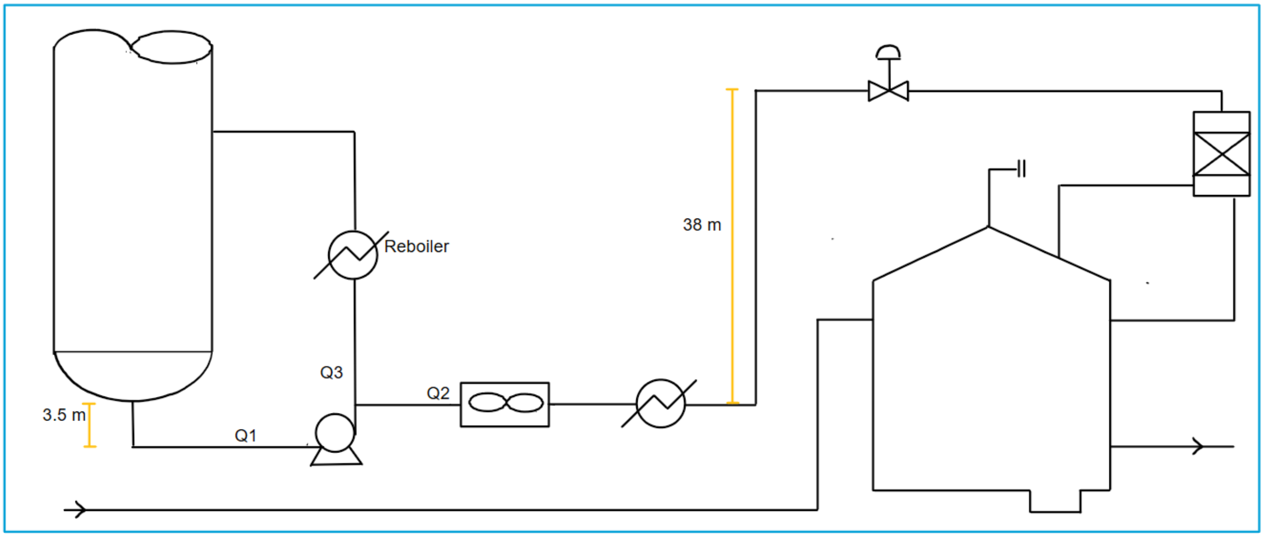
- The pump casing is in contact with low-temperature fluid, which helps the pump fabrication to be cost-effective.
- The pressure and velocity of the stream might not be suitable to get the maximum efficiency in the air-cooled heat exchanger and water-cooled heat exchanger.

Third one:

- The cost of construction and project is less due to elimination of air-cooled heat exchanger.
- The consumption of cooling water becomes dramatic.

Develop the datasheet for the pump and control valve using Hysys and Fisher FSM.

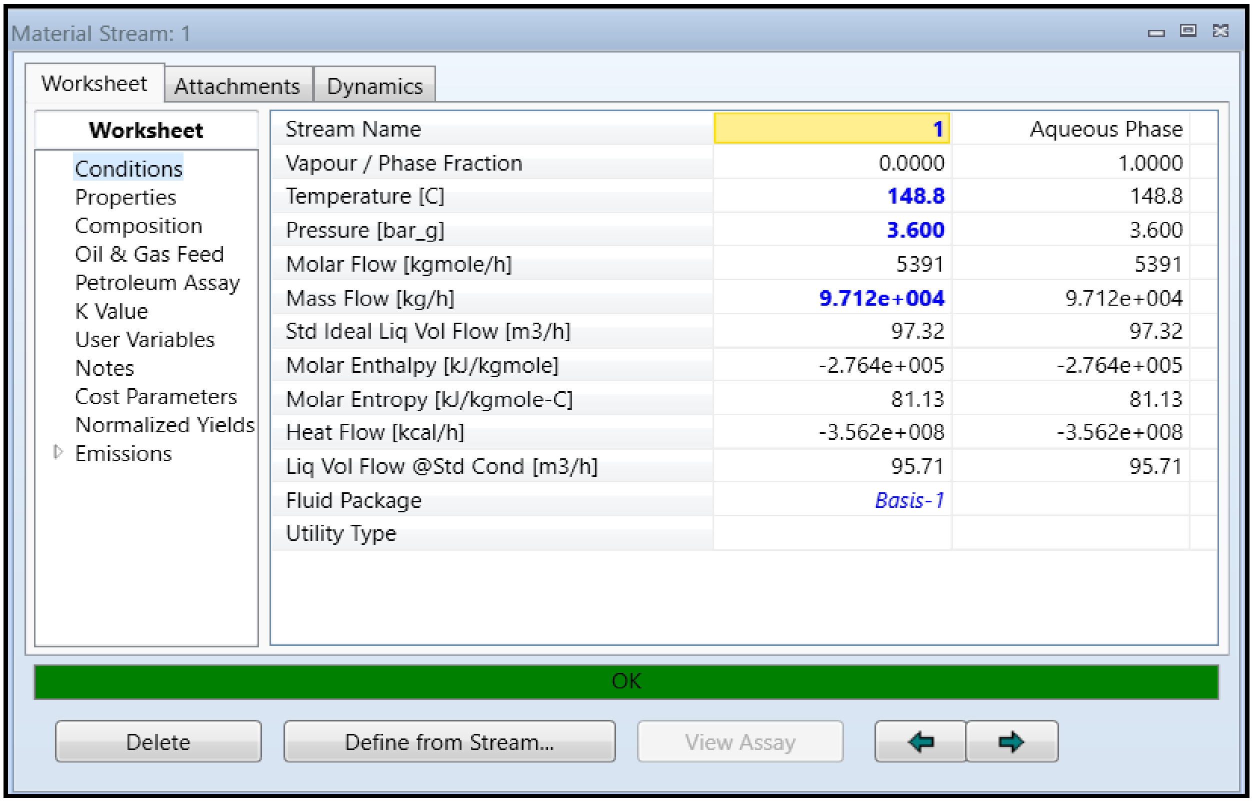
Here is more detailed sketch.

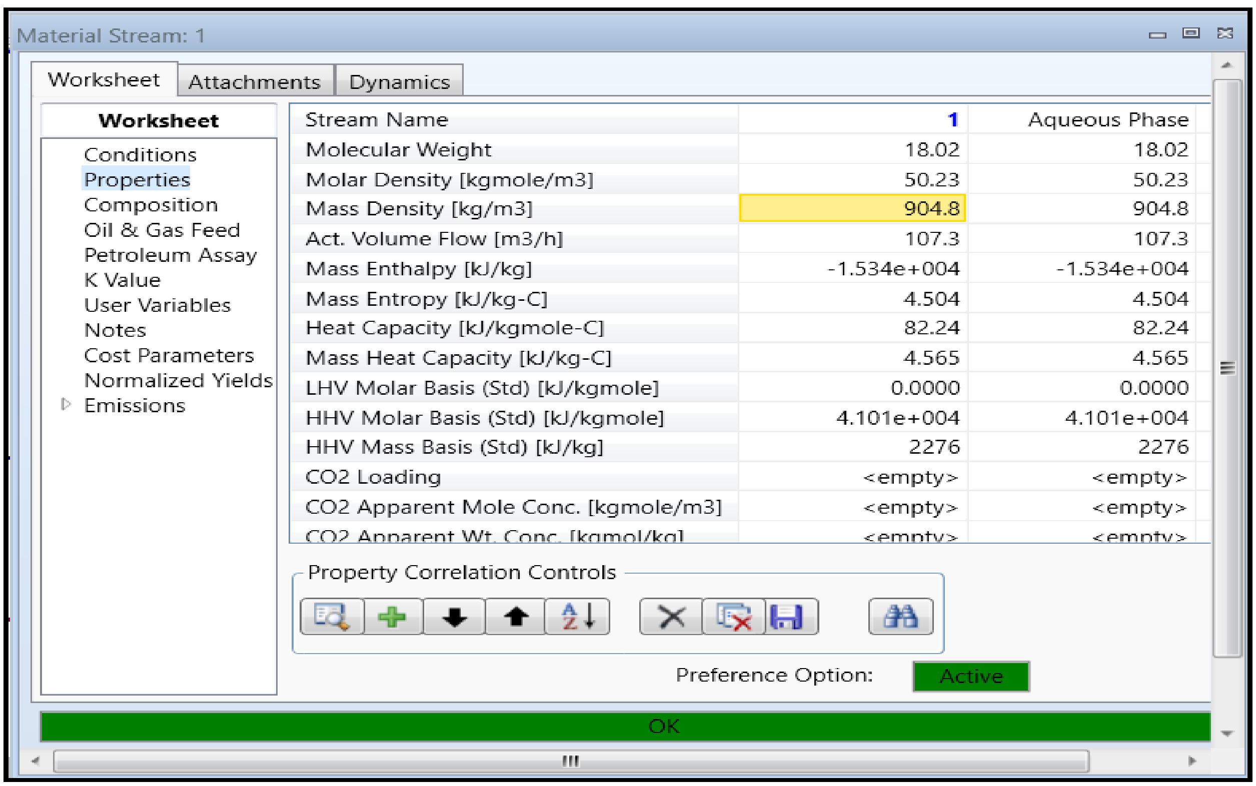


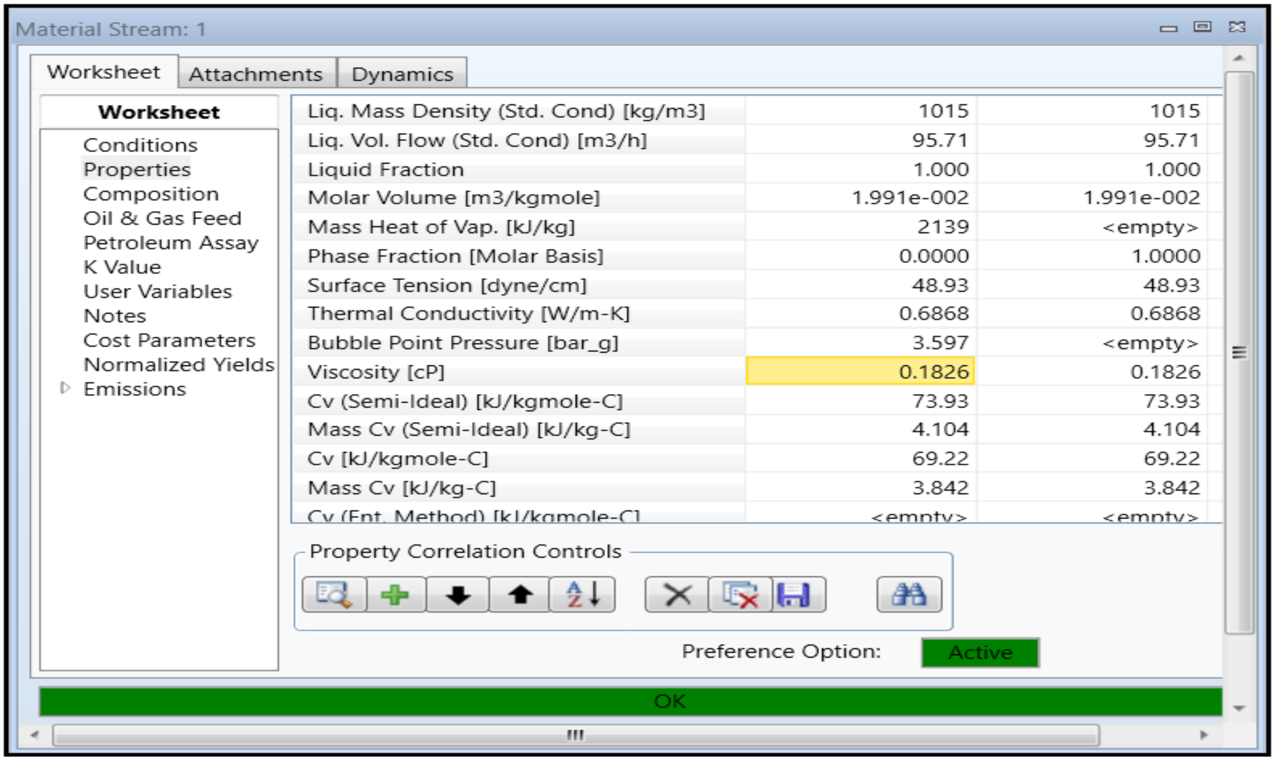
Operating Data

Capacity	105.8 m^3/hr.
Rated Capacity	105.8 × 1.1 = 116.38 m^3/hr.
Density	904 kg/hr.
Viscosity	0.1826 cP
Vapor Pressure	3.597 barg
Suction Vessel Pressure	4.6 bara
Discharge Vessel Pressure	1 bara

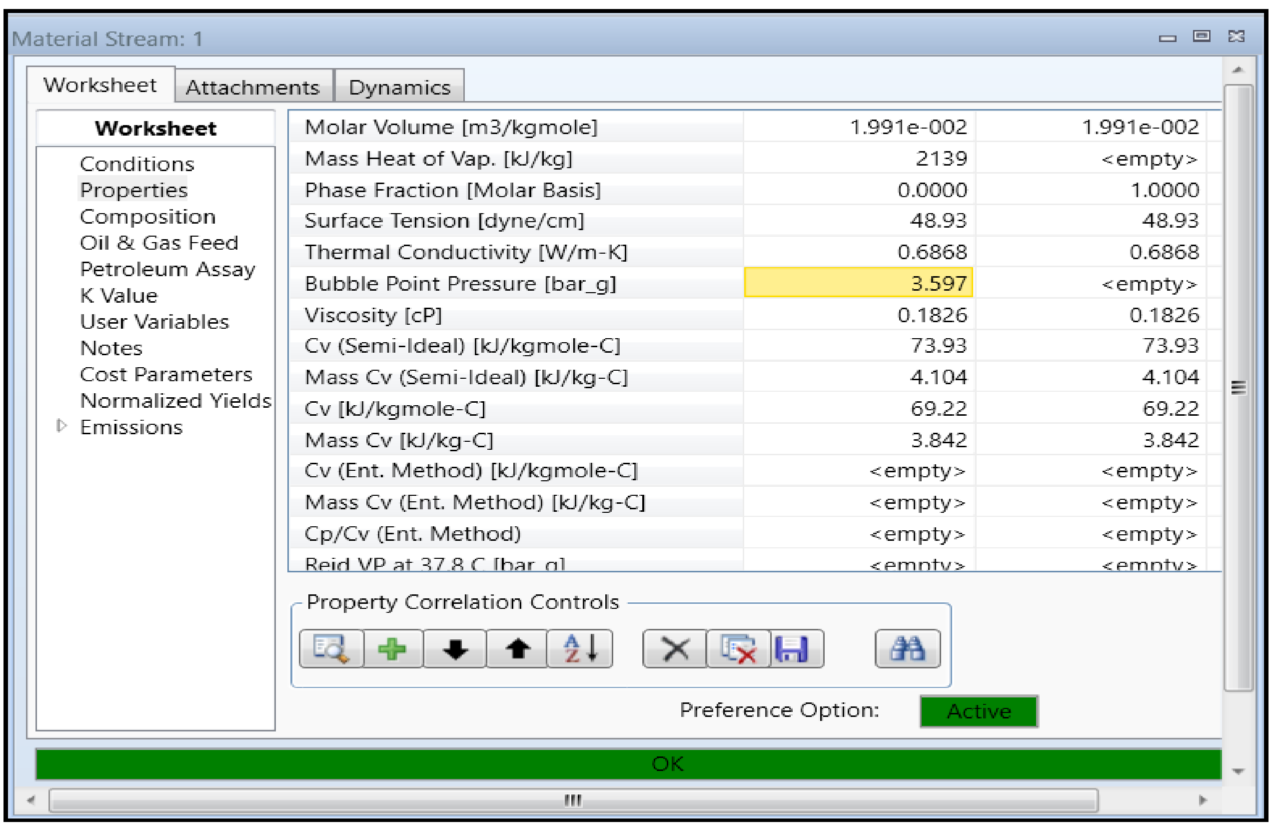
To determine density, Aspen Hysys is used. The stream with above conditions is defined and under property, the density is indicated.


Material Stream: 1
Worksheet
Attachments
Dynamics
Worksheet
Conditions
Properties
Composition
Oil & Gas Feed
Petroleum Assay
K Value
User Variables
Notes
Cost Parameters
Normalized Yields
Emissions
Stream Name | 1 | Aqueous Phase
Vapour / Phase Fraction | 0.0000 | 1.0000
Temperature [C] | 148.8 | 148.8
Pressure [bar_g] | 3.600 | 3.600
Molar Flow [kgmole/h] | 5391 | 5391
Mass Flow [kg/h] | 9.712e+004 | 9.712e+004
Std Ideal Liq Vol Flow [m3/h] | 97.32 | 97.32
Molar Enthalpy [kJ/kgmole] | -2.764e+005 | -2.764e+005
Molar Entropy [kJ/kgmole-C] | 81.13 | 81.13
Heat Flow [kcal/h] | -3.562e+008 | -3.562e+008
Liq Vol Flow @Std Cond [m3/h] | 95.71 | 95.71
Fluid Package | Basis-1
Utility Type
OK
Delete
Define from Stream...
View Assay


Material Stream: 1
Worksheet
Attachments
Dynamics
Worksheet
Conditions
Properties
Composition
Oil & Gas Feed
Petroleum Assay
K Value
User Variables
Notes
Cost Parameters
Normalized Yields
Emissions
Stream Name | 1 | Aqueous Phase
Molecular Weight | 18.02 | 18.02
Molar Density [kgmole/m3] | 50.23 | 50.23
Mass Density [kg/m3] | 904.8 | 904.8
Act. Volume Flow [m3/h] | 107.3 | 107.3
Mass Enthalpy [kJ/kg] | -1.534e+004 | -1.534e+004
Mass Entropy [kJ/kg-C] | 4.504 | 4.504
Heat Capacity [kJ/kgmole-C] | 82.24 | 82.24
Mass Heat Capacity [kJ/kg-C] | 4.565 | 4.565
LHV Molar Basis (Std) [kJ/kgmole] | 0.0000 | 0.0000
HHV Molar Basis (Std) [kJ/kgmole] | 4.101e+004 | 4.101e+004
HHV Mass Basis (Std) [kJ/kg] | 2276 | 2276
CO2 Loading | <empty> | <empty>
CO2 Apparent Mole Conc. [kgmole/m3] | <empty> | <empty>
CO2 Apparent Wt. Conc. [kgmol/kg] | <empty> | <empty>
Property Correlation Controls
Preference Option:
Active
OK



Liq. Mass Density (Std. Cond) [kg/m3]	1015	1015
Liq. Vol. Flow (Std. Cond) [m3/h]	95.71	95.71
Liquid Fraction	1.000	1.000
Molar Volume [m3/kgmole]	1.991e-002	1.991e-002
Mass Heat of Vap. [kJ/kg]	2139	<empty>
Phase Fraction [Molar Basis]	0.0000	1.0000
Surface Tension [dyne/cm]	48.93	48.93
Thermal Conductivity [W/m-K]	0.6868	0.6868
Bubble Point Pressure [bar_g]	3.597	<empty>
Viscosity [cP]	0.1826	0.1826
Cv (Semi-Ideal) [kJ/kgmole-C]	73.93	73.93
Mass Cv (Semi-Ideal) [kJ/kg-C]	4.104	4.104
Cv [kJ/kgmole-C]	69.22	69.22
Mass Cv [kJ/kg-C]	3.842	3.842
Cv (Ent. Method) [kJ/kgmole-C]	<empty>	<empty>



Molar Volume [m3/kgmole]	1.991e-002	1.991e-002
Mass Heat of Vap. [kJ/kg]	2139	<empty>
Phase Fraction [Molar Basis]	0.0000	1.0000
Surface Tension [dyne/cm]	48.93	48.93
Thermal Conductivity [W/m-K]	0.6868	0.6868
Bubble Point Pressure [bar_g]	3.597	<empty>
Viscosity [cP]	0.1826	0.1826
Cv (Semi-Ideal) [kJ/kgmole-C]	73.93	73.93
Mass Cv (Semi-Ideal) [kJ/kg-C]	4.104	4.104
Cv [kJ/kgmole-C]	69.22	69.22
Mass Cv [kJ/kg-C]	3.842	3.842
Cv (Ent. Method) [kJ/kgmole-C]	<empty>	<empty>
Mass Cv (Ent. Method) [kJ/kg-C]	<empty>	<empty>
Cp/Cv (Ent. Method)	<empty>	<empty>
Reid VP at 37.8 C [bar_g]	<empty>	<empty>

Suction Side

Suction Vessel Head	51.87 m
Height Above Pump Center	3.5 m
Pressure Loss	
Piping	0.033 m
Equipment	0
Flow Orifice	0
Total Minimum Suction Head	51.87 + 3.5 + 0.033 = 55.4 m
Vapor Pressure	51.83 m
NPSH	3.57 m

Suction Vessel Head = $(P_s \times 100000)/(9.81 \times 904) = (4.6 \times 100000)/(9.81 \times 904) = 51.87m$

Pressure Loss:

Piping:

Let's at first determine the inlet and outlet pipe size.

Line No. :	3315		**Service (From/To)**	
Total Flow Rate	kg/hr	97000	Washing Water	
Fluid phase (Liquid/Vapor)		Liquid		
Temperature	C	48		
Density	kg/m3	904.000	Material	
Viscosity	Cp	0.1826	CS	
Calculation Results		**Trial 1**	**Trial 2**	**Trial 3**
Pipe Length (DEF.)	m	1000	1000	1000
Nominal Pipe Size	inch	4	6	8
Schedule No.		80	40	80
Line Roughness (DEF.)	inch	0.0018	0.0018	0.0018
Pipe Internal Diameter	mm	97.2	154.1	193.7
Pipe Internal Area	mm^2	7,417	18,639	29,460
Reynold 's No.		1933195	1219523	970020
Friction Factor		0.0164	0.0153	0.0148
Velocity	**m/s**	**4.018**	**1.599**	**1.012**
Pressure Drop (ΔP)	**bar**	**12.2**	**1.1**	**0.3**
ρV^2	**kg/m.s2**	**14,597**	**2,312**	**925**

By checking pump suction and outlet criteria, 8 inch is selected as inlet pipe size and 6 inch as outlet pipe size.

Since the stream will be divided to two sub-streams, including one being returned to the reboilers and one being directed to wash column, another line sizing is performed for second sub-stream.

Line No. :	3315		**Service (From/To)**
Total Flow Rate	kg/hr	9000	Washing Water
Fluid phase (Liquid/Vapor)		Liquid	
Temperature	C	48	
Density	kg/m3	904.000	Material
Viscosity	Cp	0.1826	CS

Calculation Results		**Trial 1**	**Trial 2**	**Trial 3**
Pipe Length (DEF.)	m	1000	1000	1000
Nominal Pipe Size	inch	2	3	4
Schedule No.		80	80	80
Line Roughness (DEF.)	inch	0.0018	0.0018	0.0018
Pipe Internal Diameter	mm	49.3	73.7	97.2
Pipe Internal Area	mm^2	1,905	4,261	7,417
Reynold 's No.		353927	236643	179369
Friction Factor		0.0198	0.0188	0.0185
Velocity	**m/s**	**1.452**	**0.649**	**0.373**
Pressure Drop (ΔP)	**bar**	**3.8**	**0.5**	**0.1**
ρV^2	**kg/m.s2**	**1,905**	**381**	**126**

3 inch is selected.

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Based on the piping department layout during basic design, the initial distance between pump and the packed column is approximately 150m. So, the pressure loss would be:

Pressure loss or Head = $\frac{150}{1000} \times 0.5$ = 0.075 bar × $\frac{10000}{9.81\times 904}$ = 0.845 m

Also here is the calculation for pump suction:

L = 10 meter is the distance between vessel and pump suction.

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Pressure loss or Head = $\frac{10}{1000} \times 0.3 = 0.003\ bar = \frac{0.003 \times 100000}{9.81 \times 904} = 0.033\ m$

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Vapor Pressure = (4.597 bar × 100000)/(9.81 × 904) = 51.83 m

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NPSH = Suction Head – Vapor Pressure = 55.4 – 51.83 = 3.57 m

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Discharge Side

Discharge Vessel Head	11.27 m
Height Above Pump Center	38 m
Pressure Loss	
Piping	0.845 m
Equipment	11.26 m
Flow Measurement	1.57 m
Control Valve	7.89 m
Total Max. Discharge Head	70.83 m

Discharge Vessel Head = (Pd × 100000)/(9.81 × 904) = (1 × 100000)/(9.81 × 904) = 11.27 m

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Height Above Pump Center = 38 m

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Pressure Loss

Piping:

Based on the piping department layout during basic design, the initial distance between pump and the packed column is approximately 150m. So, the pressure loss would be:

Pressure loss or Head = $\frac{150}{1000} \times 0.5$ = 0.075 bar × $\frac{10000}{9.81 \times 904}$ = 0.845 m

Equipment:

We have air-cooled heat exchanger, water-cooled heat exchanger, orifice flowmeter and a control valve.

Equipment	Pressure Drop	Our Example	Head
Air-cooled Heat Exchanger	0.35-0.7 bar	0.5 bar	(0.5×100000)/ (9.81× 904) = 5.63m
Water-cooled Heat Exchanger	0.35-0.7 bar	0.5 bar	(0.5×100000)/ (9.81× 904) = 5.63m
Orifice Flowmeter	0.14 bar	0.14 bar	(0.14×100000)/(9.81×904) = 1.57m
Control Valve	0.7 bar	0.7 bar	(0.7×100000)/ (9.81× 904) = 7.89m

Total Max. Discharge Head: Discharge Vessel Head + Height Above Pump Center + Pressure Loss = 11.27 + 38 + 0.845 + 5.63 + 5.63 + 1.57 + 7.89 = 70.83 m

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Performance

Differential Head = Total Max. Discharge Head - Total Minimum Suction Head = 70.83 – 55.4 = 15.43 m

Differential Head	15.43 m
Power Required	6.4 kW
Efficiency	75%

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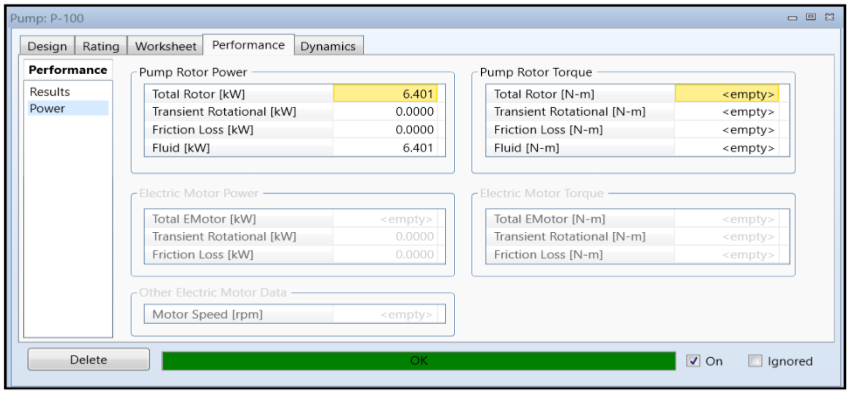
Power required = 6.4 kW. @ 75% capacity



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Pump

Material in liquid contact: CS

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Construction Code: API 610

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Max allowable total noise level: 85 db

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Max acceptable $NPSH_R = NPSH_A - 1 = 3.57 - 1 = 2.57$ m

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Process Plant Design			Educational Institute for Equipment and Process Design			
EIEPD			Document Number:			
			Page: 1		Item Info: P 5007 A/B	
Datasheet for Centrifugal Pump						
Item Info.	Pump Type	Driver Info.		Driver Type		Normal Status
P 5007 A	Centrifugal	MP 5007 A		Electric Motor		Running
P 5007 B	Centrifugal	MP 5007 B		Electric Motor		Stand-by
General Equipment Information						
Design Case			Summer-Winter or EOR/SOR Rich/Lean Case - EOR Rich Gas Case			
Location			Outdoor			
Operating Data						
Performance Point			Normal	Rated	Start-up	Unit
Capacity			105.8	116.38		m3/h
Temperature			148.8			C
Desnsity			904			kg/m3
Viscosity			0.1826			cP
Vapor Pressure			4.6			bar a
Suction Vessel Pressure			4.6			bar a
Discharge Vessel Pressure			1			bar a
Suction Side						
Suction Vessel Head			51.87			m liq.
Height Above Pump Center			3.5			m liq.
Pressure Loss: Piping			0.033			m liq.
Equipment			0			m liq.
Flow Orifice			0			m liq.
Total Min. Suction Head			55.4			m liq.
Vapour Pressure			51.83			m liq.
NPSHA			3.57			m liq.
Discharge Side						
Discharge Vessel Head			11.27			m liq.
Height Above Pump Center			38			m liq.
Pressure Loss: Piping			0.845			m liq.
Equipment			11.26			m liq.
Flow Orifice			1.57			m liq.
Control Valve			7.89			m liq.
Total Max. Discharge Pressure			70.83			m liq.
Pump Performance						
Differential Head			15.43			m liq.
Estimated Efficiancy			75			%
Estimated Shaft Power			6.4			kW

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2.Provision of Free Webinar

3.Specialized online Courses and Trainings

4.In-Person Trainings

5.Project Consultancy

6.Funding Free Graduation Programs

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The Founder and Instructor at EIEPD

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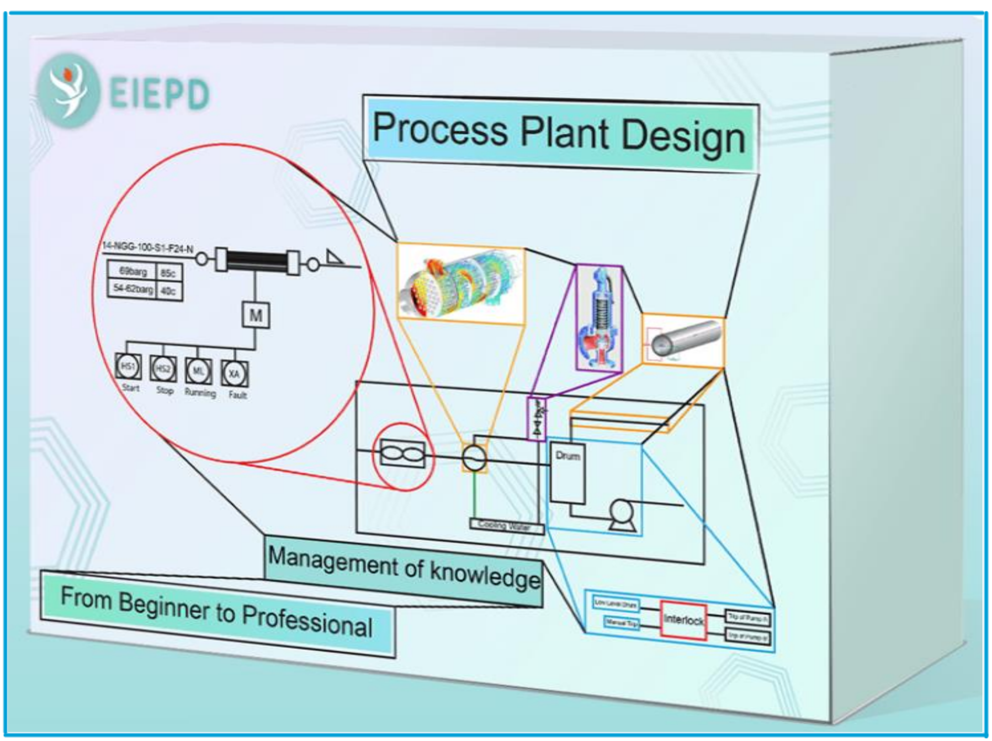
Featured Course

If you are looking for a course to boost your knowledge about basics of process plant design and the preparation of project documents, we highly recommend the “Process Plant Design Course” which covers the followings:

- ✅ Process Design Criteria
- ✅ PFD Development
- ✅ P&ID Development
- ✅ Process Safety Documents
- ✅ Interlock and Logic Diagram
- ✅ Projects
- ✅ Separator Detailed Sizing and Design
- ✅ Shell and Tube Heat Exchanger Detailed Sizing and Design
- ✅ PSV and Control Valve Sizing
- ✅ Pump Datasheet Development



Which Software Training will be included:

- ✅ KG Tower
- ✅ Aspen Hysys
- ✅ Heat Exchanger Software
- ✅ FSM (Fisher Specification Manager)
- ✅ Excel-Sheets

Which Standards Training will be provided:

- ✅ EIEPD Criteria
- ✅ GPSA
- ✅ TEMA
- ✅ API-521
- ✅ Sounders Handbook
- ✅ Fisher Handbook

To see what is covered in this course, please check out the following link:

https://eiepd.com/courses/process-plant-design

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