



## Pumps Simulation





Example: Forty tons per hour of water with the temperature of 20 °C has to be pressured from 1 to 6 bar.

- Calculate the electricity requirement of the pump if its efficiency is 70%.
- The pump characteristic curve  $H=f(Q)$  provided by the producer is given in Table 4.1; considering the same efficiency as in point a, calculate the discharge pressure, head developed, and NPSH available.

Table 4.1 Pump performance curve data

$Q \text{ (m}^3 \cdot \text{h}^{-1}\text{)}$	10	20	30	40	50	60	70	80
$H \text{ (m)}$	60	57.5	55	53	50	47	42.5	37

Solution:

- Define water as the component in component list under Property

The screenshot shows the HYSYS Source Databank interface. On the left, a table lists components with columns for Component, Type, and Group. The first row shows 'H2O' as a 'Pure Component'. Below this table are buttons for '< Add', 'Replace', and 'Remove'. On the right, there are search filters: 'Select' is set to 'Pure Components', 'Filter' is set to 'All Families', 'Search for' is set to 'Water', and 'Search by' is set to 'Full Name/Synonym'. Below these filters is a table with columns for Simulation Name, Full Name / Synonym, and Formula. The first row shows 'No' under Simulation Name, 'Components' under Full Name / Synonym, and 'Match' under Formula. At the bottom left, a status bar shows 'Status: OK'.



2. Select NBS Steam as the Fluid Package for water applications.

The screenshot shows the 'Set Up' dialog box in HYSYS. The 'Package Type' is set to 'HYSYS'. The 'Component List Selection' is set to 'Component List - 1 [HYSYS Databanks]'. The 'Property Package Selection' list on the left includes the following options: CPA, ESO Tabular, Extended NRTL, GCEOS, General NRTL, Glycol Package, Grayson Streed, IAPWS-IF97, Kabadi-Danner, Lee-Kesler-Plöcker, MBWR, **NBS Steam**, NRTL, Peng-Robinson, PR-Twu, PRSV, Sour PR, and Sour SRK. The 'NBS Steam' option is highlighted. The 'OK' button is visible at the bottom right.

3. Enter Simulation Environment and create a material stream on the flowsheet.

The screenshot shows the 'Material Stream: 1' dialog box in HYSYS. The 'Worksheet' tab is selected. The 'Stream Name' is '1'. The 'Vapour / Phase Fraction' is '<empty>'. The 'Temperature [C]' is '20.00'. The 'Pressure [kPa]' is '100.0'. The 'Molar Flow [kgmole/h]' is '<empty>'. The 'Mass Flow [kg/h]' is '4.000e+004'. The 'Std Ideal Liq Vol Flow [m3/h]' is '<empty>'. The 'Molar Enthalpy [kJ/kgmole]' is '<empty>'. The 'Molar Entropy [kJ/kgmole-C]' is '<empty>'. The 'Heat Flow [kJ/h]' is '<empty>'. The 'Liq Vol Flow @Std Cond [m3/h]' is '<empty>'. The 'Fluid Package' is 'Basis-1'. The 'Utility Type' is '<empty>'. The 'Unknown Compositions' section is highlighted in yellow. The 'Delete', 'Define from Stream...', and 'View Assay' buttons are visible at the bottom.

Property	Value
Stream Name	1
Vapour / Phase Fraction	<empty>
Temperature [C]	20.00
Pressure [kPa]	100.0
Molar Flow [kgmole/h]	<empty>
Mass Flow [kg/h]	4.000e+004
Std Ideal Liq Vol Flow [m3/h]	<empty>
Molar Enthalpy [kJ/kgmole]	<empty>
Molar Entropy [kJ/kgmole-C]	<empty>
Heat Flow [kJ/h]	<empty>
Liq Vol Flow @Std Cond [m3/h]	<empty>
Fluid Package	Basis-1
Utility Type	<empty>



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

	Mole Fractions	Aqueous Phase
H2O	1.0000	1.0000

Total 1.00000

Edit... View Properties... Basis...

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

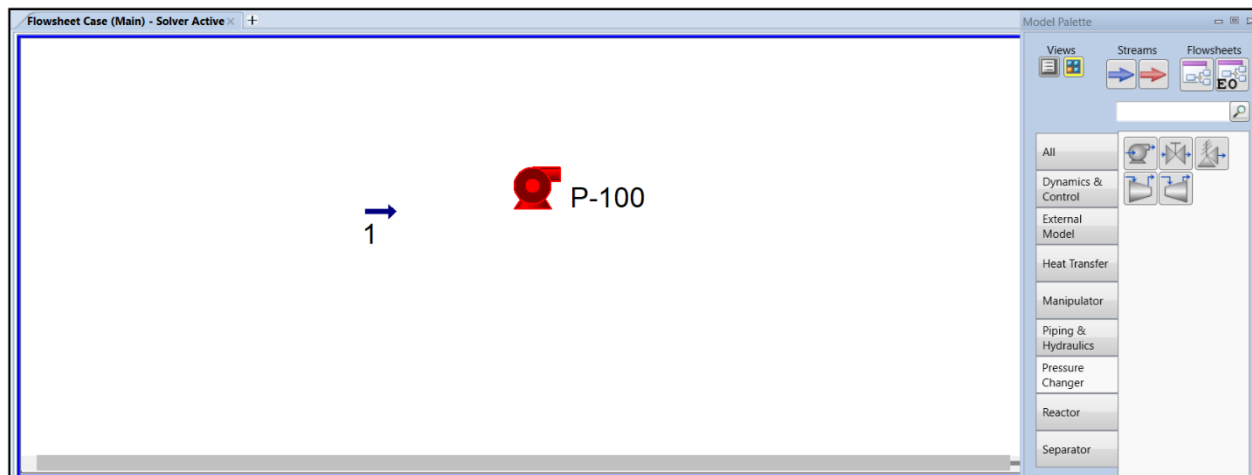
Stream Name	1	Aqueous Phase
Vapour / Phase Fraction	0.0000	1.0000
Temperature [C]	20.00	20.00
Pressure [kPa]	100.0	100.0
Molar Flow [kgmole/h]	2220	2220
Mass Flow [kg/h]	4.000e+004	4.000e+004
Std Ideal Liq Vol Flow [m3/h]	40.08	40.08
Molar Enthalpy [kJ/kgmole]	-2.854e+005	-2.854e+005
Molar Entropy [kJ/kgmole-C]	5.336	5.336
Heat Flow [kJ/h]	-6.336e+008	-6.336e+008
Liq Vol Flow @Std Cond [m3/h]	40.03	40.03
Fluid Package	Basis-1	
Utility Type		

OK

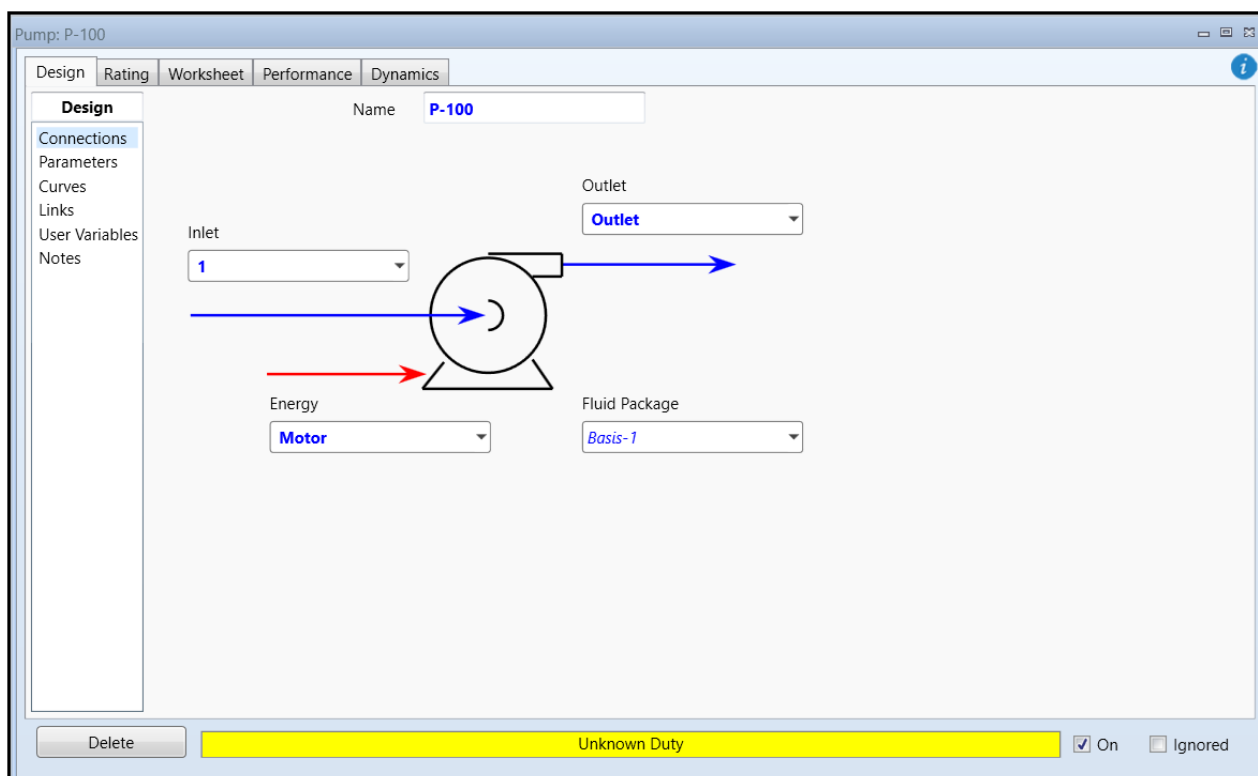
Delete Define from Stream... View Assay



4. Select Pump under Model Palette/Pressure Change and put it on the flowsheet.

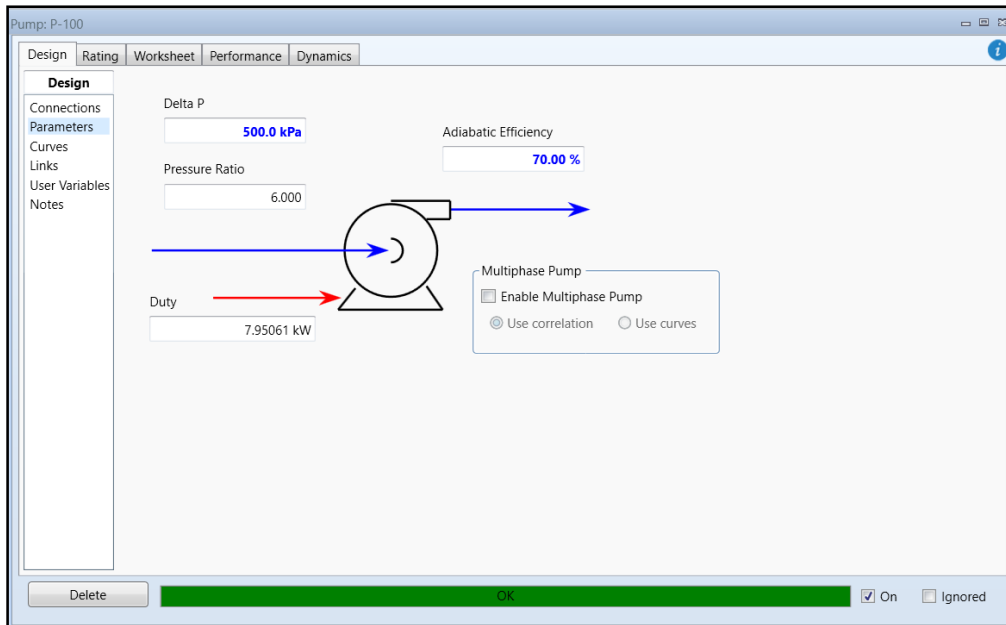


5. Double-click on the pump to see the following window, then select stream 1 as the inlet and write Outlet to create outlet stream. Finally write Motor on the energy blanket.



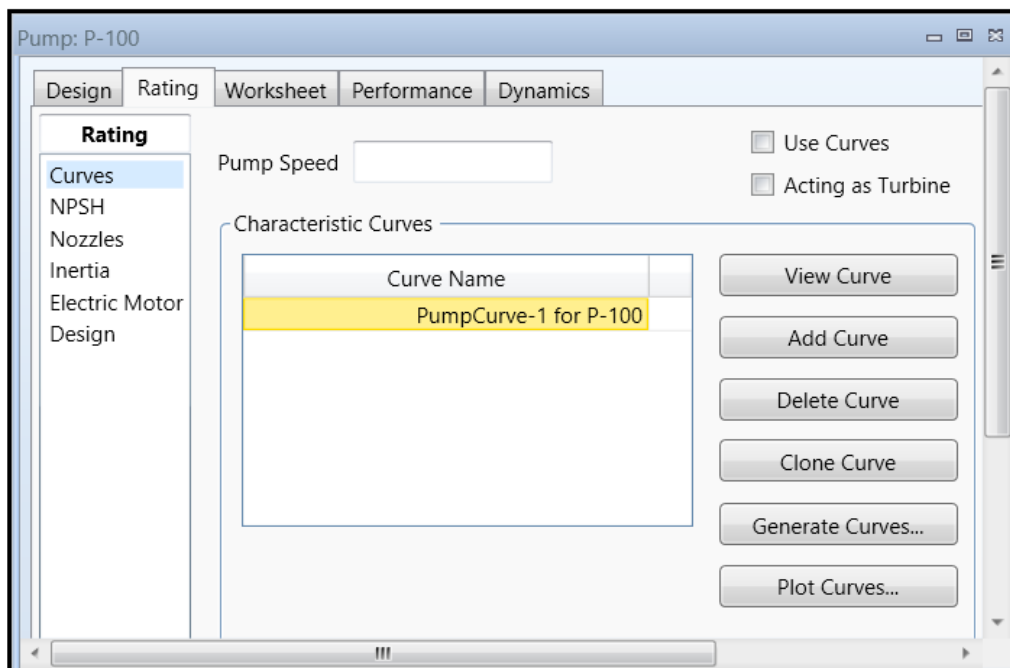


6. On the Parameter tab, enter 5 bar as the pressure difference and 70% as the pump efficiency as stated in the example.



7. Based on above results, the duty required is 7.95.

8. At this stage, the characteristic curve is used. To proceed with this stage, all data in Parameters sheet is erased. Instead click Rating tab and under Curve sheet, add the curve.





PumpCurve-1 for Pump: P-100

Curve Selections

Name: **PumpCurve-1** Flow Units: **m3/h**

Speed:  Head Units: **m**

Flow	Head	% Efficiency
10.00	60.00	70.00
20.00	57.50	70.00
30.00	55.00	70.00
40.00	53.00	70.00
50.00	50.00	70.00
60.00	47.00	70.00
70.00	42.50	70.00
80.00	37.00	70.00
<empty>	<empty>	<empty>

Erase Selected Erase All

9. Now activate "Use Curve"

Pump: P-100

Design Rating Worksheet Performance Dynamics

**Rating**

Curves NPSH Nozzles Inertia Electric Motor Design

Pump Speed

☒ Use Curves ☐ Acting as Turbine

Characteristic Curves

Curve Name
PumpCurve-1 for P-100

View Curve Add Curve Delete Curve Clone Curve Generate Curves... Plot Curves...



10. Based on the result, the electricity required is 8.24 kW.

Pump: P-100

Design Rating Worksheet Performance Dynamics

**Design**

Connections  
Parameters  
Curves  
Links  
User Variables  
Notes

Delta P  
518.6 kPa

Adiabatic Efficiency  
70.00 %

Pressure Ratio  
6.186

Duty  
8.24648 kW

Multiphase Pump  
☐ Enable Multiphase Pump  
☒ Use correlation ☐ Use curves

Delete OK ☒ On ☐ Ignored