



Turbine Simulation





Example: In a gas let-down station, a turbine is installed to reduce the HP-NG pressure to 3 bar, aiming to produce electricity. Here is the HP-NG info at the turbine suction:

| Stream Name | HP-NG |
|----------------|-------------------|
| Temperature | 25C |
| Pressure | 40barg |
| Mass Flow | 10000 kg/hr. |
| Component | Composition-Mole% |
| Methane | 95.2 |
| Ethane | 2.5 |
| Propane | 0.2 |
| Iso-Butane | 0.03 |
| Normal-Butane | 0.03 |
| Iso-Pentane | 0.01 |
| Normal-Pentane | 0.01 |
| Hexanes | 0.01 |
| Nitrogen | 1.3 |
| Carbon Dioxide | 0.7 |
| Oxygen | 0.02 |



How to simulate:

1. Select the aforementioned components in component list

Source Databank HYSYS

Select: **Pure Components** Filter: **All Families**

Search for: Search by: **Full Name/Synonym**

| Component | Type | Group |
|-----------|----------------|-------|
| Methane | Pure Component | |
| Ethane | Pure Component | |
| Propane | Pure Component | |
| i-Butane | Pure Component | |
| n-Butane | Pure Component | |
| i-Pentane | Pure Component | |
| n-Pentane | Pure Component | |
| n-Hexane | Pure Component | |
| Nitrogen | Pure Component | |
| CO2 | Pure Component | |
| Oxygen | Pure Component | |

< Add Replace Remove

| Simulation Name | Full Name / Synonym | Formula |
|-----------------|---------------------|---------|
| n-Heptane | C7 | C7H16 |
| n-Octane | C8 | C8H18 |
| n-Nonane | C9 | C9H20 |
| n-Decane | C10 | C10H22 |
| n-C11 | C11 | C11H24 |
| n-C12 | C12 | C12H26 |
| n-C13 | C13 | C13H28 |
| n-C14 | C14 | C14H30 |
| n-C15 | C15 | C15H32 |
| n-C16 | C16 | C16H34 |
| n-C17 | C17 | C17H36 |
| n-C18 | C18 | C18H38 |

Status: OK

2. Select PRSV as Fluid Package. To help you better understand how to use Method Assistance, for this example we use such tool as follows:

Aspen HYSYS V12 Help

Search Help

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Chemical Processes

At low pressures of less than 10 bars, an activity coefficient-based property package is appropriate, such as:

- NRTL-based packages (NRTL, Extended NRTL, General NRTL)
- UNIQUAC (for modeling LLE systems)
- van Laar or Wilson (for non-LLE systems)

For preliminary designs at Low Pressures, UNIFAC can be used.

At high pressures (>10 bars), use an equation of state method, such as:

- Peng-Robinson and variations (PR-Twu, PRSV)
- SRK and variations (SRK-Twu, Kabadi-Danner, Zudkevitch-Joffee)
- Lee-Kesler-Plocker
- CPA
- EOS for natural gas systems (BWRS, MBWR)
- Generalized Cubic EOS (GCEOS)

See Also

- Property Package Descriptions
- Carboxylic acids



Since the stream pressure is more than 10 bar, a Peng-Robinson variant like PRSV is selected.

Property Package Selection

Options

| Property | Method |
|------------------------|------------------------|
| Enthalpy | Peng-Robinson Equation |
| Density Method | Costald |
| Surface Tension Method | HYSYS Method |

PRSV Component Parameters

| Component | Kappa |
|-----------|---------|
| Methane | -0.0193 |
| Ethane | 0.0134 |
| Propane | 0.0316 |
| i-Butane | 0.0378 |
| n-Butane | 0.0395 |
| i-Pentane | 0.0445 |
| n-Pentane | 0.0223 |
| n-Hexane | 0.0700 |
| Nitrogen | 0.0089 |
| CO2 | 0.1430 |
| Oxygen | 0.0209 |

3. Enter Simulation Environment and define HP-NG stream like below:

Material Stream: HP-NG

Worksheet Attachments Dynamics

| Property | Value |
|-------------------------------|------------|
| Stream Name | HP-NG |
| Vapour / Phase Fraction | <empty> |
| Temperature [C] | 25.00 |
| Pressure [kPa] | 4101 |
| Molar Flow [kgmole/h] | <empty> |
| Mass Flow [kg/h] | 1.000e+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 | |

Unknown Compositions

Delete Define from Stream... View Assay



Input Composition for Stream: Material Stream: HP-NG

| | Mole Fraction |
|-----------|---------------|
| Methane | 0.9519 |
| Ethane | 0.0250 |
| Propane | 0.0020 |
| i-Butane | 0.0003 |
| n-Butane | 0.0003 |
| i-Pentane | 0.0001 |
| n-Pentane | 0.0001 |
| n-Hexane | 0.0001 |
| Nitrogen | 0.0130 |
| CO2 | 0.0070 |
| Oxygen | 0.0002 |

Composition Basis

- Mole Fractions
- Mass Fractions
- Liq Volume Fractions
- Mole Flows
- Mass Flows
- Liq Volume Flows

Composition Controls

Erase

Equalize Composition

Cancel

Normalize Total 1.0000 OK

Material Stream: HP-NG

Worksheet Attachments Dynamics

| Worksheet | Stream Name | HP-NG | Vapour Phase |
|-------------------|-------------------------------|-------------|--------------|
| Conditions | Vapour / Phase Fraction | 1.0000 | 1.0000 |
| Properties | Temperature [C] | 25.00 | 25.00 |
| Composition | Pressure [kPa] | 4101 | 4101 |
| Oil & Gas Feed | Molar Flow [kgmole/h] | 593.6 | 593.6 |
| Petroleum Assay | Mass Flow [kg/h] | 1.000e+004 | 1.000e+004 |
| K Value | Std Ideal Liq Vol Flow [m3/h] | 32.18 | 32.18 |
| User Variables | Molar Enthalpy [kJ/kgmole] | -7.729e+004 | -7.729e+004 |
| Notes | Molar Entropy [kJ/kgmole-C] | 152.7 | 152.7 |
| Cost Parameters | Heat Flow [kJ/h] | -4.587e+007 | -4.587e+007 |
| Normalized Yields | Liq Vol Flow @Std Cond [m3/h] | <empty> | <empty> |
| Emissions | Fluid Package | Basis-1 | |
| | Utility Type | | |

OK

Delete Define from Stream... View Assay



4. Select turbine from Model Palette/Pressure Change and put it in the flowsheet. Then, select HP-NG as the inlet stream and define LP-NG as the outlet stream. Finally specify a name like Electricity for the energy.

Expander: K-100

Design Rating Worksheet Performance Dynamics

Design

Name: K-100

Connections: HP-NG

Fluid Package: Basis-1

Energy: Electricity

Outlet: LP-NG

Unknown Duty

Expander: K-100

Design Rating Worksheet Performance Dynamics

Design

Efficiency

| | |
|-----------------------|--------|
| Isentropic Efficiency | 75.000 |
| Polytropic Efficiency | 68.610 |

Duty: 543.4 kW

Pressure Specs

Delta P: 3801

Pressure Ratio: 7.323e-002

Curve Input Option

- Single Curve
- Multiple IGV Curves
- Non-Dimensional
- Quasi-Dimensionless
- Atlas Copco/Mafi Trench

OK



5. Based on the result, the power produced is 543.4 kW.

6. By checking the Worksheet table or Performance table, more info could be gained.

| | HP-NG | LP-NG | Electricity |
|-------------------------------|-------------|-------------|-------------|
| Name | HP-NG | LP-NG | Electricity |
| Vapour | 1.0000 | 0.9996 | <empty> |
| Temperature [C] | 25.00 | -88.94 | <empty> |
| Pressure [kPa] | 4101 | 300.3 | <empty> |
| Molar Flow [kgmole/h] | 593.6 | 593.6 | <empty> |
| Mass Flow [kg/h] | 1.000e+004 | 1.000e+004 | <empty> |
| Std Ideal Liq Vol Flow [m3/h] | 32.18 | 32.18 | <empty> |
| Molar Enthalpy [kJ/kgmole] | -7.729e+004 | -8.058e+004 | <empty> |
| Molar Entropy [kJ/kgmole-C] | 152.7 | 159.2 | <empty> |
| Heat Flow [kJ/h] | -4.587e+007 | -4.783e+007 | 1.956e+006 |

| Results | Value |
|------------------------------|------------|
| Adiabatic Head [m] | 2.660e+004 |
| Polytropic Head [m] | 2.907e+004 |
| Adiabatic Fluid Head [kJ/kg] | 260.8 |
| Potential Fluid Head [kJ/kg] | 285.1 |
| Isentropic Efficiency | 75.000 |
| Polytropic Efficiency | 68.610 |
| Power Produced [kW] | 543.4 |
| Friction Loss [kW] | 0.0000 |
| Rotational inertia [kW] | 0.0000 |
| Fluid Power [kW] | 543.4 |
| Polytropic Head Factor | 0.9945 |
| Polytropic Exponent | 1.1911 |
| Isentropic Exponent | 1.3072 |