

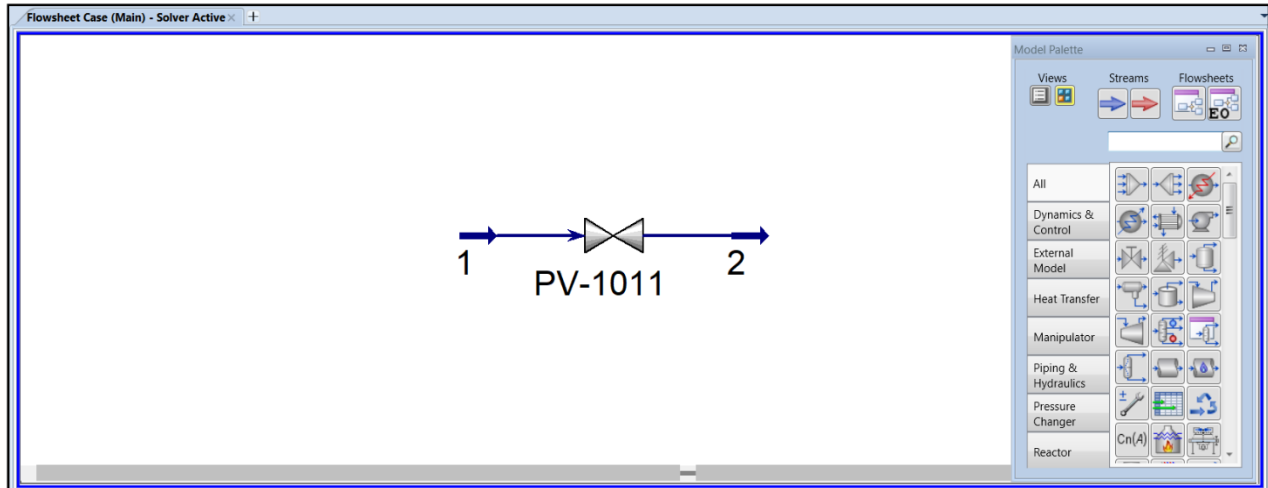


Safety Analysis in Aspen Hysys



Process description:

For fired heaters, one of the primary fuels is NG since it is more reliable and available. For a specific fired heater, 16000 kg/hr. of NG with operating pressure of 50 barg and temperature of 40C is let-down to operating pressure of 4barg via PV-1011 and later to 1 barg via another control valve to make it suitable for firing.

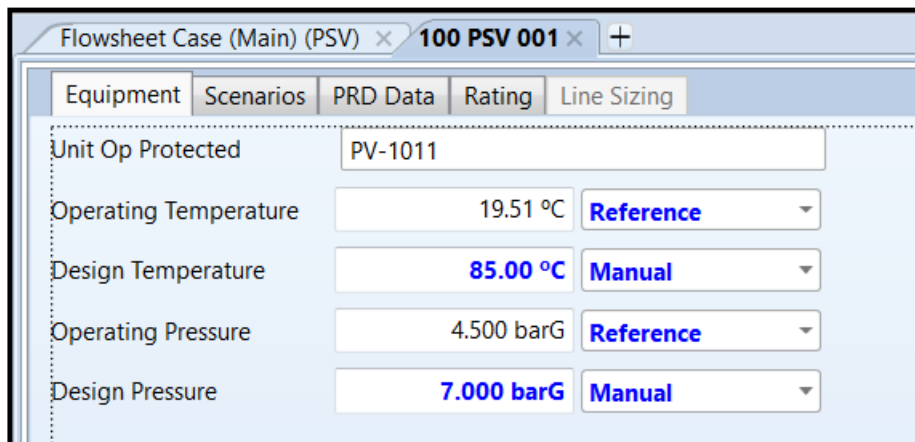


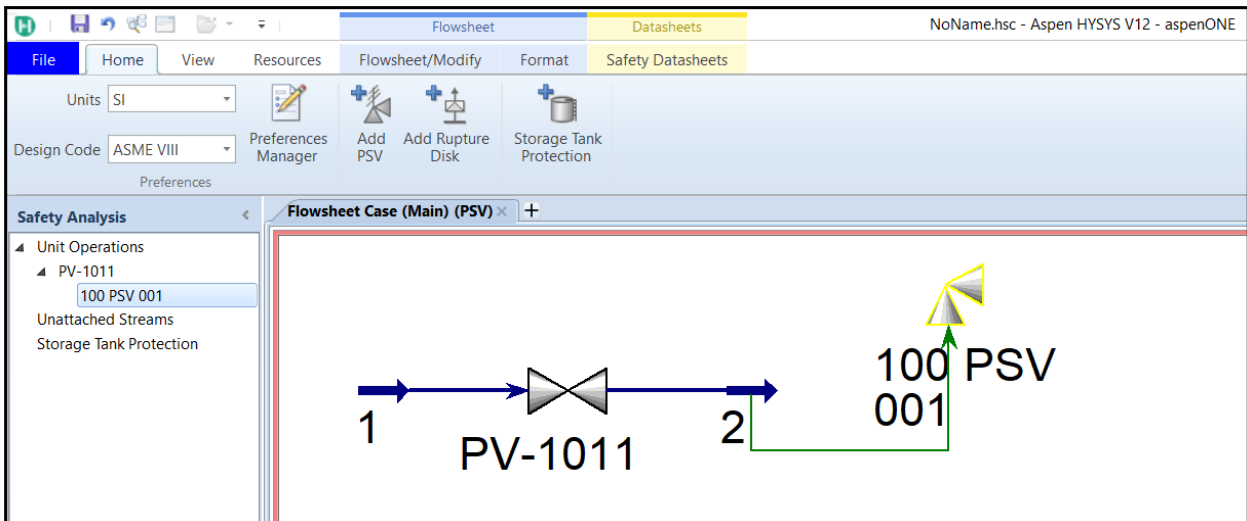
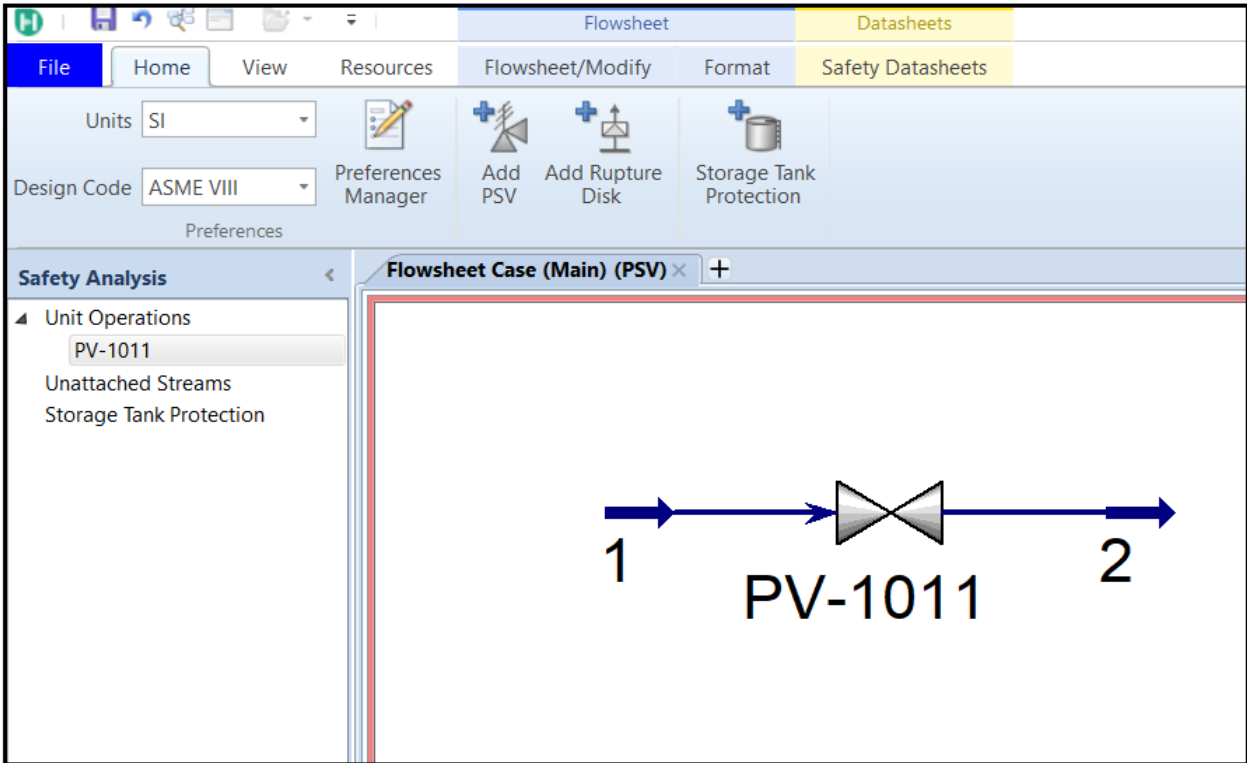
First Step: Let's check if we need a PSV

Since the difference between design pressure of high-pressure side, which is 55 barg and that of low-pressure side, which is 7 barg is high. So, we need a PSV in case of control valve failure and the possibility of high flow passage from high-pressure side to low-pressure side.

Second Step: Safety Analysis Environment

- 1.Go to safety analysis environment and add PSV on the outlet of control valve.
- 2.Double-click on PSV icon to see the following tab.







Manual means you are supposed to specify the matter while reference means the information is taken from the line, which just provide operating conditions.

3. Go to scenario tab, create a scenario and select control valve failure.

Sizing Case	Scenario Name	Type	Stream		Phase - Method	Flow Rate [kg/h]		Orifice Area [cm ²]		Capacity Used [%]	Pressure Drop [% of Set]		Notes
			Name	MW		Required	Rated	Calculated	Selected		Inlet	Outlet	
	Scenario100	User Defined	<empty>	<empty>	<empty>	Direct Integr	<empty>	<empty>	<empty>	<empty>	<empty>	<empty>	<empty>
		General	Control Valve Related		Heaters and Coolers								
		Fire	Blocked Outlet		Exch. Tube Rupture								
		Thermal Expansion	Control Valve Failure		Cold Side of Exchanger Blocked-In								
		Overfilling	Abnormal Flow through Valve		Blocked-In Fired Heater								
		User Defined	Failure of Automatic Controls		Fan Failure								
		Flare	Reaction/Mixing		Distillation Column/Tower								
		General Power Failure	Chemical Reaction		Reflux Failure								
		Local Power Failure	Accidental Mixing		Reflux Failure (Side Stream)								
		Cooling Water Failure	Inadvertent Loss of Segregation		Abnormal Heat or Vapor Input								
		Coolant Failure (Other than CW)	Pressure Surge or Internal Explosion		Accumulation of Non-Condensables								
		Loss of Heat			Loss of Absorbent								

4. Now open scenario.

Scenario Name: Scenario100
Scenario Type: Control Valve Failure

Scenario Reference Stream: 1 @Main

Relieving Temperature: 21.13 °C (Calculated)
Relieving Pressure: 7.700 barG (Edit)
Total Backpressure: 0.7000 barG (Edit)
Relieving Phase - Method: Vapor (Direct Integration (HEM))
Viscosity Correction (Kv): 1.000

Required Relieving Flow: 2.778E+004 kg/h
Relieving Flow Method: Manual Reference Calculated

Credit for Flow to Process: 0.0000 kg/h
Calculated Mass Flow: 2.778E+004 kg/h

	Upstream	Upstream Method	Downstream @ Relief
Pressure	50.00 barG	Reference	7.700 barG
Temperature	40.00 °C	Reference	21.13 °C
Phase	Vapor		Vapor

PSV Results		Value
Calculated Orifice [cm ²]		52.49
Selected Orifice [cm ²]		71.290 (Q)
Fraction of Full Lift		1.000
Rated Capacity [kg/h]		3.773E+004
Capacity Used [%]		73.62
Orifice Designation		6 Q 8
In/Out Flanges		150 x 150
Discharge Coefficient (Kd)		0.9750

Orifice Calculation Completed



Required Relieving Flow 2.778E+004 kg/h

Relieving Flow Method Manual Reference Calculated

Process Data

Credit for Flow to Process 0.0000 kg/h

Calculated Mass Flow 2.778E+004 kg/h

	Upstream	Upstream Method	Downstream @ Relief
Pressure	50.00 barG	Reference	7.700 barG
Temperature	40.00 °C	Reference	21.13 °C
Phase	Vapor		Vapor

Calculation Method PSV Plus

Valve Parameters

Vapor Flow Model N/A

Valve Type N/A

FI	0.9000
Cv [USGPM(60F,1psi)]	44.00

Handle multi-phase flows rigorously

Orifice Calculation Completed

Under scenario reference stream select stream 1:

Select Reference Stream

Flowsheet Case (Main)

Object

- 1
- 2

Object Filter

- All
- Streams
- UnitOps
- Logicals
- ColumnOps
- Custom

Custom...

OK



You can also change total backpressure like below:

Backpressure (BP) Parameters

Atmospheric Pressure: 1.013 barA

Constant Superimposed BP: 1.013 barA

Variable Superimposed BP: 0.0000 bar

Built-up Backpressure: 0.7000 bar

Total Backpressure: 0.7000 barG

Maximum Allowable BP %: 10.00

Maximum Allowable BP: 0.7000 barG

Backpressure (BP) Factor (Kb)

Calculated

Specified: 1.000

OK Cancel

Select relieving method to be calculated and also choose PSV plus as the calculation method. Specify the CV to be 44.

Required Relieving Flow: 2.778E+004 kg/h

Relieving Flow Method: Manual Reference Calculated

Process Data

Credit for Flow to Process: 0.0000 kg/h

Calculated Mass Flow: 2.778E+004 kg/h

	Upstream	Upstream Method	Downstream @ Relief
Pressure	50.00 barG	Reference	7.700 barG
Temperature	40.00 °C	Reference	21.13 °C
Phase	Vapor		Vapor

Calculation Method: PSV Plus

Valve Parameters

Vapor Flow Model: N/A

Valve Type: N/A

FI: 0.9000

Cv [USGPM(60F,1psi)]: 44.00

Handle multi-phase flows rigorously

Orifice Calculation Completed



Select a bigger orifice area than calculated orifice which is 52.49 cm².

PSV Results	Value
▶ Calculated Orifice [cm ²]	52.49
▶ Selected Orifice [cm ²]	71.290 (Q)
▶ Fraction of Full Lift	1.000
▶ Rated Capacity [kg/h]	3.773E+004
▶ Capacity Used [%]	73.62
▶ Orifice Designation	6 Q 8
▶ In/Out Flanges	150 x 150
▶ Discharge Coefficient (Kd)	0.9750

Based on the calculation, the orifice designation should be 6Q8.

5. Now go to line sizing tab

The screenshot shows the Aspen HYSYS Line Sizing interface. The 'Line Sizing' tab is selected. The 'Design' button is active. The 'State/Phase - Method' is 'Direct Integration (HEM)'. The 'Flow Rate Method' is 'Required'. The 'Sizing Method' is 'Rigorous Line Sizing Using Aspen Hydraulics'. The 'Current Scenario' is 'Scenario100'. The 'Calculated' checkbox is checked. The 'Run Line Sizing' button is active. The 'Configure' button is also visible.

Line Sizing Inputs	In Line	Out Line
▶ PSV Flange Size [in]	6.000	8.000
▶ Schedule	40	40
▶ N.D. [in]	6.000	8.000
▶ I.D. [in]	6.065	7.981
▶ Material	Mild Steel	Mild Steel
▶ Roughness [mm]	4.572E-002	4.572E-002
▶ Specified Equivalent Length [m]	50.00	50.00
▶ Elevation [m]	0.0000	0.0000
▶ Flow Rate [kg/h]	2.778E+004	2.778E+004

Line Sizing Results	In Line	Out Line
▶ Calculated DP [bar]	0.7471	1.226
▶ Maximum DP [bar]	0.2100	0.7000
▶ Average Rho*v ² [kg/m ²]	3.202E+004	7.764E+004
▶ Outlet Velocity [m/s]	<empty>	324.7
▶ Critical Velocity [m/s]	<empty>	424.4
▶ Critical Pressure [barA]	<empty>	0.7755
▶ Reaction Forces [N]	<empty>	3214

INLET Line Pressure Drop check ... ERROR: Maximum Pressure Drop exceeded
Outlet Line: Pressure Drop check ... ERROR: Back Pressure exceeds the maximum allowable by PSV
OUTLET Line Pressure Drop check ... ERROR: Calculated pressure drop (1.226 bar) is higher than specified built-up backpressure (0.7 bar). Modify your specifications.
OUTLET Line Velocity @ Exit check ... OK

INLET Line Pressure Drop check ... ERROR: Maximum Pressure Drop exceeded

Based on calculation, the pressure drop for both inlet and outlet has exceeded the criteria. In order to resolve the issue, let's select a line with bigger size for inlet and outlet.



Equipment | Scenarios | PRD Data | Rating | Line Sizing - 100 PSV 001

State/Phase - Method Direct Integration (HEM)

Flow Rate Method Required

Sizing Method Rigorous Line Sizing Using Aspen Hydraulics

Current Scenario Scenario100 [Checked] Calculated

Run Line Sizing Run For All Scenarios Configure

Line Sizing Results	In Line	Out Line
Calculated DP [bar]	0.2062	0.3087
Maximum DP [bar]	0.2100	0.7000
Average ρv^2 [kg/m ² s ²]	3.036E+004	6.152E+004
Outlet Velocity [m/s]	<empty>	216.5
Critical Velocity [m/s]	<empty>	434.3
Critical Pressure [barA]	<empty>	0.5052
Reaction Forces [N]	<empty>	3211

INLET Line Pressure Drop check ... OK
 OUTLET Line Velocity @ Exit check ... OK
 Outlet Line: Pressure Drop check ... OK

INLET Line Pressure Drop check ... OK

The problem solved!

Here is the summary of what we have obtained.

Relief load	27780 kg/hr.
Scenario	Control Valve Failure
Calculation Method	PSV Plus
Selected Orifice	71.29-Q
Orifice Designation	6Q8
Inlet Line Size	8 inch
Outlet Line Size	10 inch