

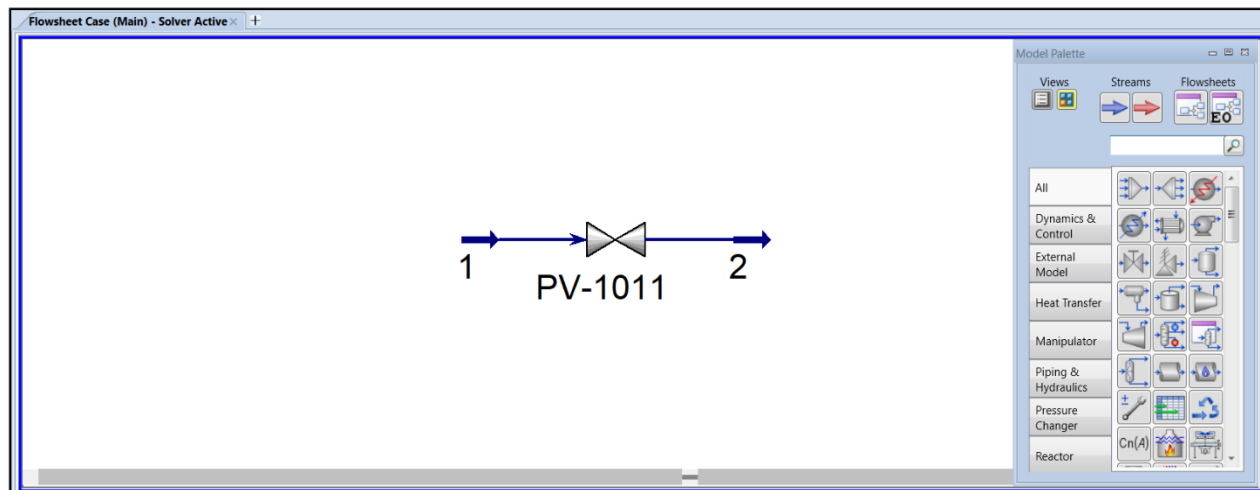


Safety Analysis in Aspen Hysys



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

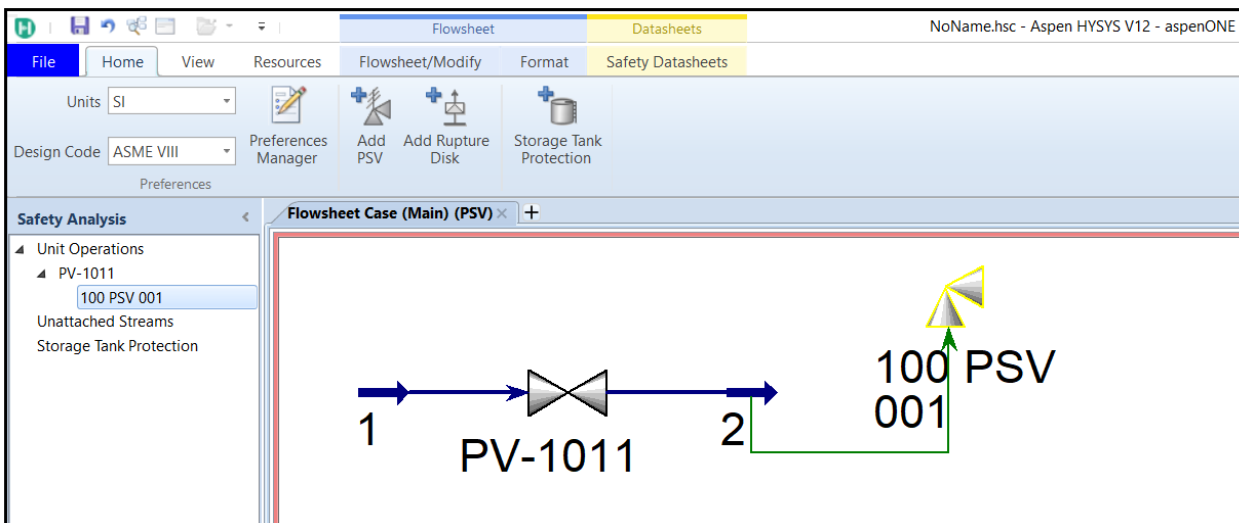
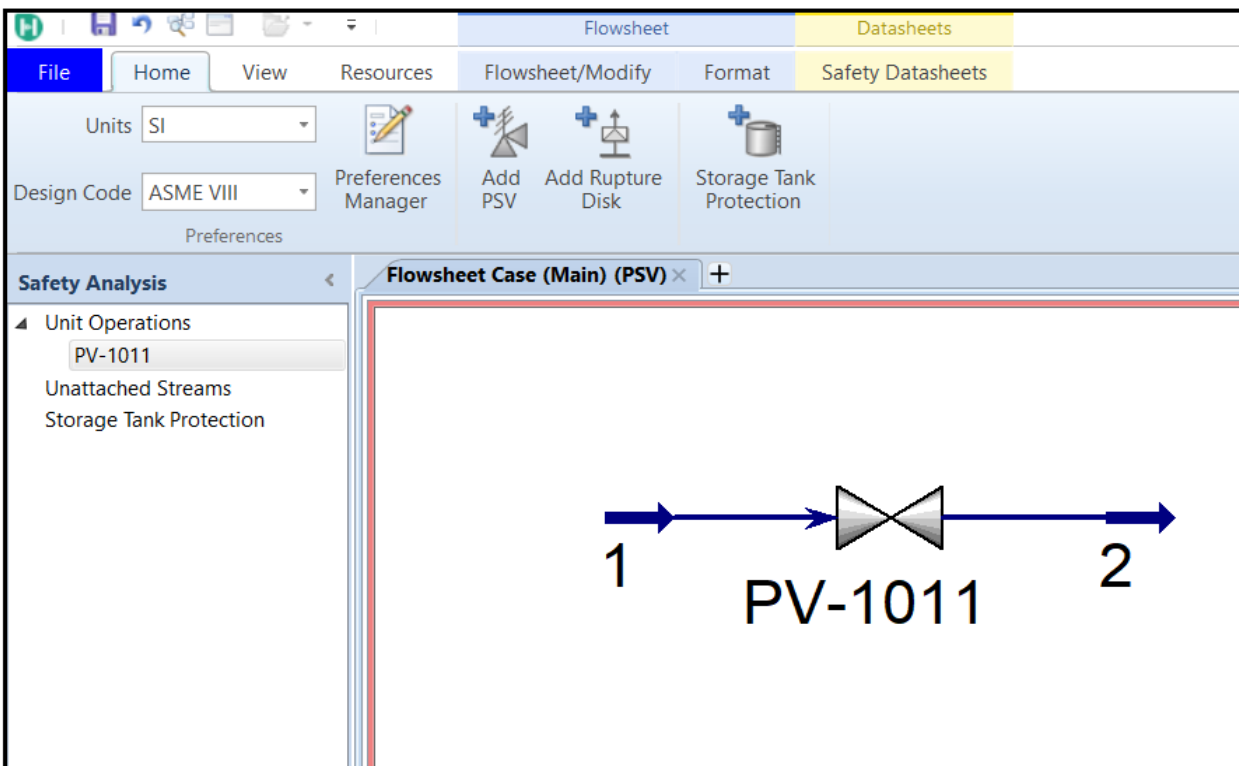
Since the difference between design pressure of high-pressure side, which is 55 barg and that of low-pressure side, which is 7 barg is high. So, we need a PSV in case of control valve failure and the possibility of high flow passage from high-pressure side to low-pressure side.

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.

The screenshot shows the configuration window for a Pressure Safety Valve (PSV) named '100 PSV 001'. The 'Equipment' tab is selected, showing the following settings:

Parameter	Value	Source
Unit Op Protected	PV-1011	
Operating Temperature	19.51 °C	Reference
Design Temperature	85.00 °C	Manual
Operating Pressure	4.500 barG	Reference
Design Pressure	7.000 barG	Manual





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.

Flowsheet Case (Main) (PSV) x 100 PSV 001 x +

Equipment Scenarios PRD Data Rating Line Sizing

Create Scenario Open Scenario Duplicate & Rename Delete Scenario

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								

100 PSV 001: Please select a Sizing Case

4. Now open scenario.

Flowsheet Case (Main) (PSV) x 100 PSV 001 x 100 PSV 001-Scenario100 x +

Scenario Setup Fluid Properties Relief Composition

Scenario Name: Scenario100

Scenario Type: Control Valve Failure

Scenario Reference Stream

Stream: 1 @ Main Select...

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

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

PSV Results

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

Scenario Description Notes

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

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

Design | Rating

State/Phase - Method: Direct Integration (HEM)

Flow Rate Method: Required

Sizing Method: Rigorous Line Sizing Using Aspen Hydraulics

Current Scenario: Scenario100 [Calculated]

Run Line Sizing | Run For All Scenarios | Configure

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*v2 [kg/m/s 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 [Calculated]

[Run Line Sizing] [Run For All Scenarios] [Configure]

Line Sizing Inputs	In Line	Out Line
PSV Flange Size [in]	6.000	8.000
Schedule	40	STD
N.D. [in]	8.000	10.00
I.D. [in]	7.981	10.02
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]	0.2062	0.3087
Maximum DP [bar]	0.2100	0.7000
Average $\rho \cdot v^2$ [kg/m 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



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Mohammadreza Behrouzi

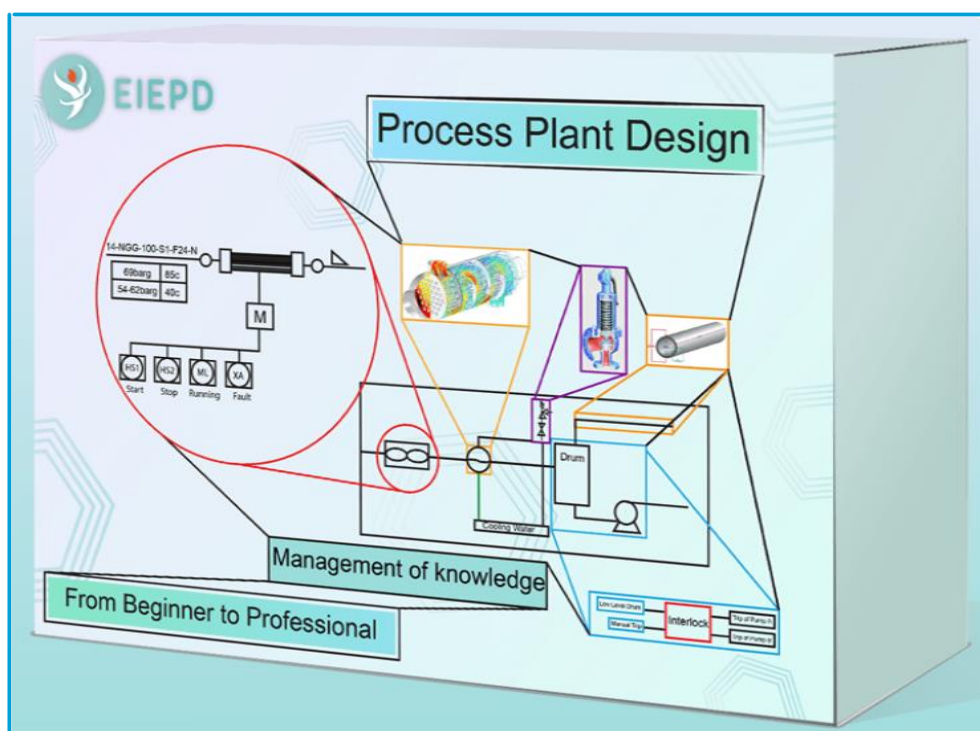
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Featured Course

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

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- ☒ EIEPD Criteria
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- ☒ 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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