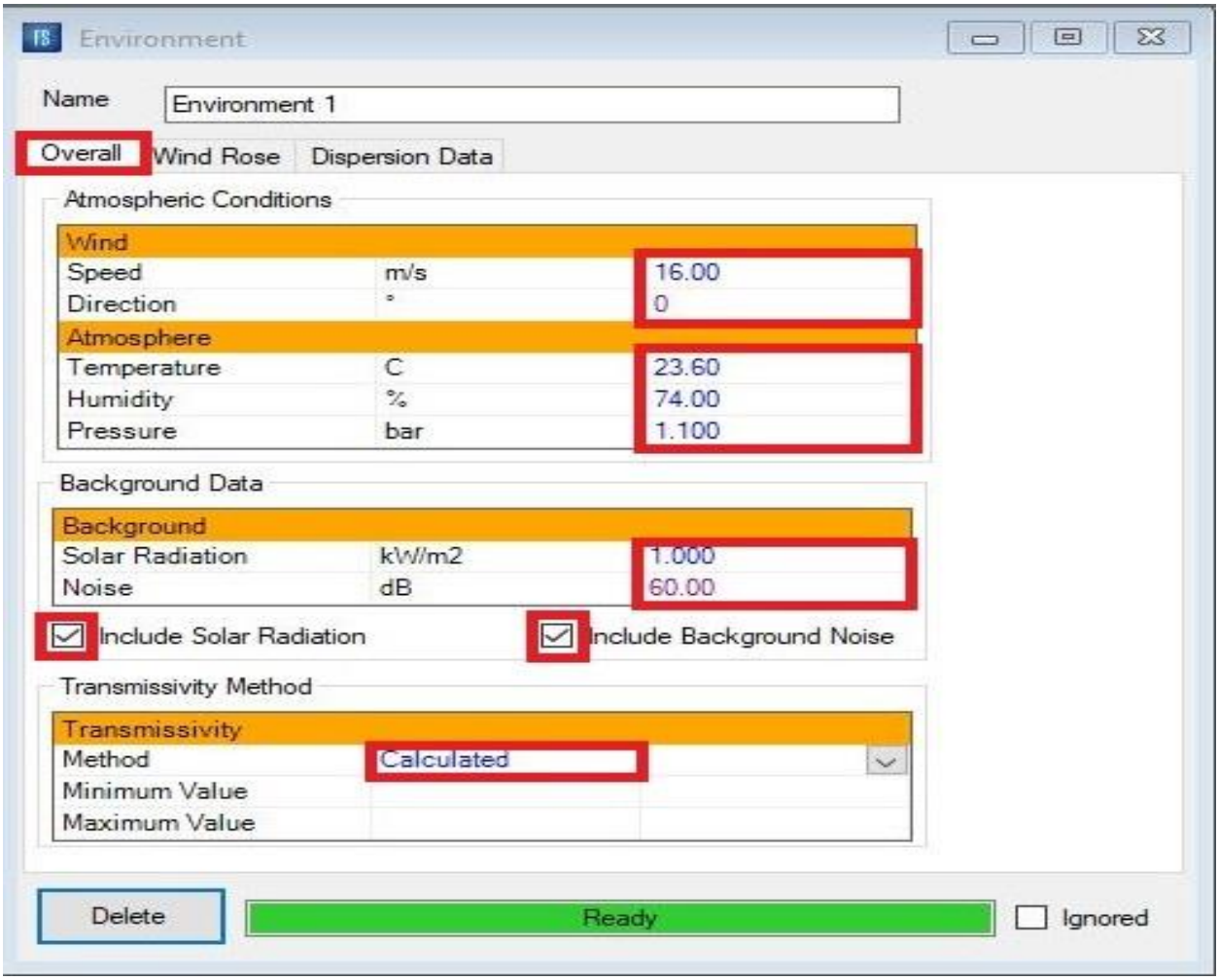
EIEPD Process Sizing Criteria Examples

Example 1: Data Entry in Flaresim for Flare Package Design

Wind velocity: 16 m/s

Humidity: 74%



Example 2: Maximum Noise

For a control valve

Flow Coefficient (Cv)		239.826	596.202	667.925
Volumetric Flow Rate Gas	Nm3/h	71749.68068	178368.36506	199826.21349
Pressure differential	bar	1.90000	1.90000	1.90000
Valve dP/P1 pressure ratio		0.036	0.036	0.036
Pipe and fitting flow correction factor		1.00	1.00	1.00
Combined recovery factor		0.90	0.90	0.90
Adjusted pressure drop ratio factor		0.72	0.72	0.72
Inlet Density	kg/m3	36.49	36.49	36.49
Kinematic viscosity	cSt	0.35624	0.35624	0.35624
Expansion factor		0.98	0.98	0.98
Reynolds Number		171092030.96	270636125.66	286732997.99
Choked flow pressure drop	bar	34.82331	34.82331	34.82331
Upstream Inside Diameter	in	12.000	12.000	12.000
Downstream Inside Diameter	in	12.000	12.000	12.000
IEC NOISE OUTPUTS				
Whisper III Trim Level				
Trim LpA at 1m	dB(A)	70	71	71
Outlet LpA at 1m	dB(A)	< 50	< 50	< 50
Valve LpA at 1m	dB(A)	70	71	71
Valve LpA at Rn	dB(A)	70	71	71
VELOCITY OUTPUTS				
Mach Number Upstream	Mach	0.012	0.031	0.035
Mach Number Valve Outlet	Mach	0.013	0.032	0.036
Mach Number Downstream	Mach	0.013	0.032	0.036
Fluid Velocity Upstream	m/s	5.5812	13.8749	15.5440

Example 3: Datasheet for a Reflux Pump

Rated Flow = 619.9 × 1.2 = 743.9 m^3/h

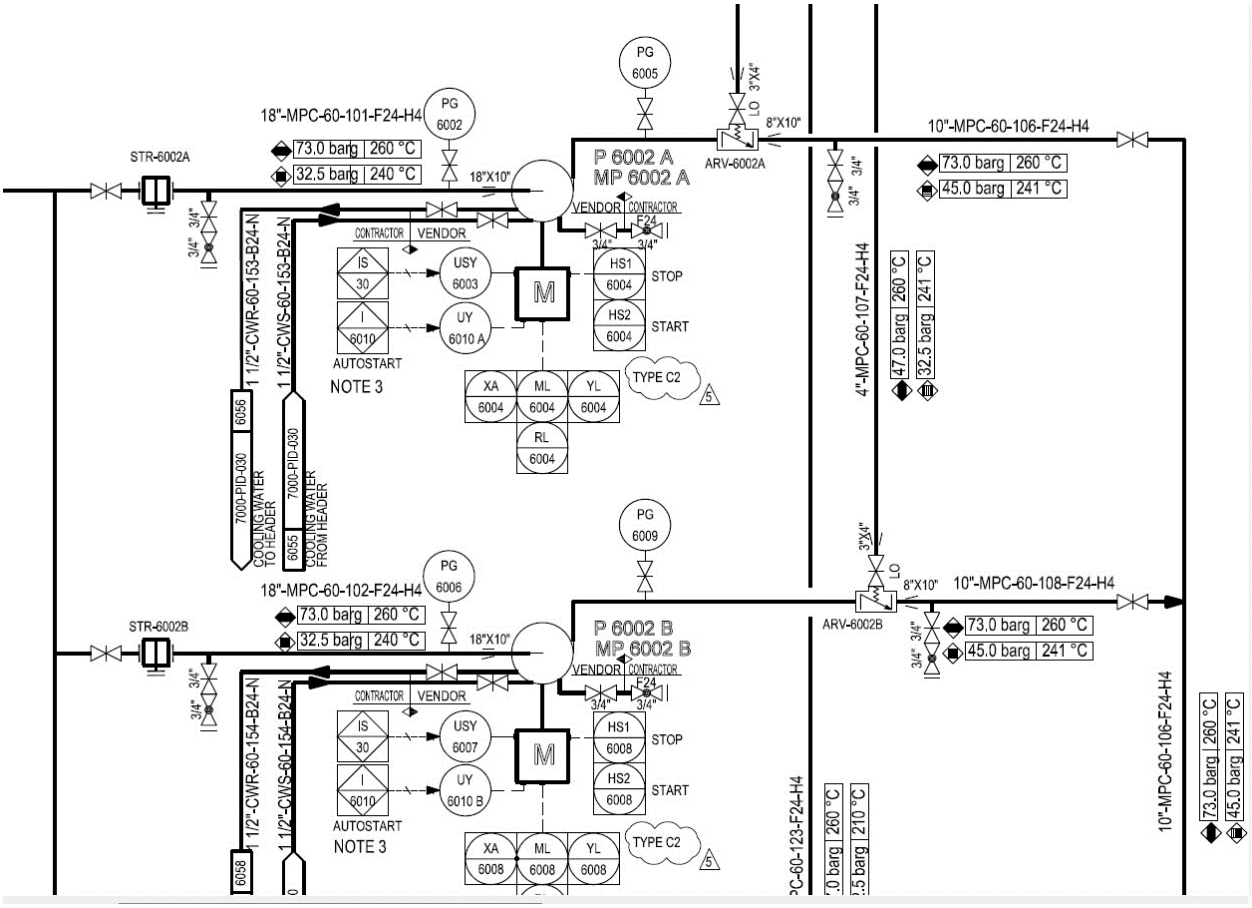
MP Column Reflux Pump					Page 2 of 3	Item No P 5006 A/B	
Datasheet for Centrifugal Pump							
Data for one pump							
Item No	Pump type	Item no of driver	Driver type	Normal status			
P 5006 A	Centrifugal	MP 5006 A	Electric motor	Running			
P 5006 B	Centrifugal	MP 5006 B	Electric motor	Stand by			
General Equipment Information							
Design case	SOR - Rich Gas						
Location	Outdoor						
Operating Data							
Performance point			Normal	Rated			
Capacity			619,9	743,9			m^3/h
Temperature	1)		101	101			°C
Density	2)		711	711			kg/m^3
Viscosity			0,229	0,229			cP
Vapour pressure			3,4	3,4			bar a
Suction vessel pressure			3,4				bar a
Discharge vessel pressure			3,8				bar a
Suction Side							
Suction vessel head			49,0				m liq.
Height above pump center	3)		4,0				m liq.
Pressure loss: piping			0,1				m liq.
equipment			0,0				m liq.
flow orifice			0,0				m liq.
Total min. suction head			52,9				m liq.
Vapour pressure			48,9				m liq.
NPSHA			3,9				m liq.

Example 4 : Datasheet for a Normal Pump

Rated Flow = 319.7 × 1.1 = 351.6 m^3/h

Steam Condensate Return Pump					Page 2 of 2	Item no. P 6002 A/B
Operating data						
Data for one pump.						
Item No	Pump type	Item no of driver	Driver type	Normal status		
P 6002 A	Centrifugal	MP 6002 A	Electric motor	Running		
P 6002 B	Centrifugal	MP 6002 B	Electric motor	Stand by		
Design case		EOR - Lean Gas				
Fluid description		Medium Pressure Steam Condensate				
		Normal	**Start-up**	**Rated**		
Flow		319,7	157	351,6	m^3/h	
Temperature		240	210	240	°C	
Density		814	853	814	kg/m^3	
Viscosity		0,114	0,13	0,114	cP	
Surface tension		29	36	29	dyn/cm	
Vapor pressure		33,5	18,9	33,5	bar a	
Suction vessel pressure		33,5	18,9		bar a	
Discharge vessel pressure		41,8	41,8		bar a	
Suction		**Normal**	**Start-up**	**Rated**		
Suction vessel head		419,6	226,0		m liq.	
Height above pump center	1)	4,0	4,0		m liq.	
Pressure loss: piping		0,1	0,1		m liq.	
equipment		0,0	0,0		m liq.	
flow measurement		0,0	0,0		m liq.	
Total min. suction head		423,5	229,9		m liq.	
Vapor pressure		419,6	226,0	419,6	m liq.	
NPSHA		3,9	3,9	3,9	m liq.	

Example 5 : Pump Automatic Start



Example 6 : Suction Calculation and NPSH Calculation

Steam Condensate Return Pump	Page 2 of 2	Item no. P 6002 A/B

Operating data

Data for one pump.

Item No	Pump type	Item no of driver	Driver type	Normal status
P 6002 A	Centrifugal	MP 6002 A	Electric motor	Running
P 6002 B	Centrifugal	MP 6002 B	Electric motor	Stand by

Design case	EOR - Lean Gas				
Fluid description	Medium Pressure Steam Condensate				
		Normal	**Start-up**	**Rated**	
Flow		319,7	157	351,6	m³/h
Temperature		240	210	240	°C
Density		814	853	814	kg/m³
Viscosity		0,114	0,13	0,114	cP
Surface tension		29	36	29	dyn/cm
Vapor pressure		33,5	18,9	33,5	bar a
Suction vessel pressure		33,5	18,9		bar a
Discharge vessel pressure		41,8	41,8		bar a
Suction		**Normal**	**Start-up**	**Rated**	
Suction vessel head		419,6	226,0		m liq.
Height above pump center	1)	4,0	4,0		m liq.
Pressure loss: piping		0,1	0,1		m liq.
equipment		0,0	0,0		m liq.
flow measurement		0,0	0,0		m liq.
Total min. suction head		423,5	229,9		m liq.
Vapor pressure		419,6	226,0	419,6	m liq.
NPSHA		3,9	3,9	3,9	m liq.

Total suction head =419.6 + 4 – 0.1 = 423.5 m liq

NPSHA = Total suction head – Vapor pressure = 423.5 – 419.6 = 3.9 m liq.

NPSHA ≥ NPSHR + 1 m

NPSHR MAX = 3.9 - 1 = 2.9 m

Vapor pressure		419,6	226,0	419,6	m liq.
NPSHA		3,9	3,9	3,9	m liq.
Discharge		**Normal**	**Start-up**	**Rated**	
Discharge vessel head		524,3	499,9		m liq.
Height above pump center	1)	25,0	25,0		m liq.
Pressure loss: piping		2,0	2,0		m liq.
equipment		0,0	0,0		m liq.
flow measurement		1,3	1,2		m liq.
control valve		12,5	11,9		m liq.
Total max. discharge head		565,1	540,0		m liq.
Performance		**Normal**	**Start-up**	**Rated**	
Differential head		141,6	310,1	155,7	m liq.
Estimated efficiency				80	%
Estimated shaft power				152	kW

Mechanical data

Location	Outdoor					
Design temperature (min.)		°C	Construction code		API 610	
Design temperature (max.)	260	°C	Stress relieving			
Design pressure (min.)		bar g	Material in liquid contact		CS	
Design pressure (max.) 4)	73,0	bar g	Corrosion allowance			mm
Max. suction pressure	45,7	bar g	Max. acceptable NPSHR 3)		2,9	m liq.
Capacity control 2)	Throttling		Max. allow. noise level @ 1 m		85	dBA
Controllable range (% of rated)	0 - 100	%				

Example 7: Equivalent Length-P6002

Based on the table:

Pipe Size: 18 inch > 8 inch, so we should specify 340 feet as the line length before the pump suction point.

Le = 340 × 12 × 2.54 = 10.3 m

Based on formula:

T> 150 :

Le = 12 × (18*2.54/100) + 30 = 35.5 m

Example 8: Pump Efficiency

For P-2003 the efficiency is 70%

General Equipment Information						
	Design case	EOR - Lean Gas				
	Location	Outdoor				
Operating Data						
	Performance point		Normal	Rated		
	Capacity		69,1	83		m³/h
	Temperature		48	48		°C
	Density		989	989		kg/m³
	Viscosity		0,566	0,566		cP
	Vapour pressure		12,1	12,1		bar a
	Suction vessel pressure		25,0			bar a
	Discharge vessel pressure		42,1			bar a
Suction Side						
	Suction vessel head		257,8			m liq.
	Height above pump center	1)	2,0			m liq.
	Pressure loss: piping		2,1			m liq.
	equipment		0,0			m liq.
	flow orifice		0,0			m liq.
	Total min. suction head		257,7			m liq.
	Vapour pressure		124,9			m liq.
	NPSHA		132,8			m liq.
Discharge Side						
	Discharge vessel head		433,9			m liq.
	Height above pump center	2)	18,0			m liq.
	Pressure loss: piping		10,0			m liq.
	equipment		10,3			m liq.
	flow orifice		1,0			m liq.
	control valve	3)	101,1			m liq.
	Total max. discharge head		574,3			m liq.
Pump Rating						
	Differential head		316,6	348,2		m liq.
	Estimated efficiency			70		%
	Estimated shaft power			112		kW

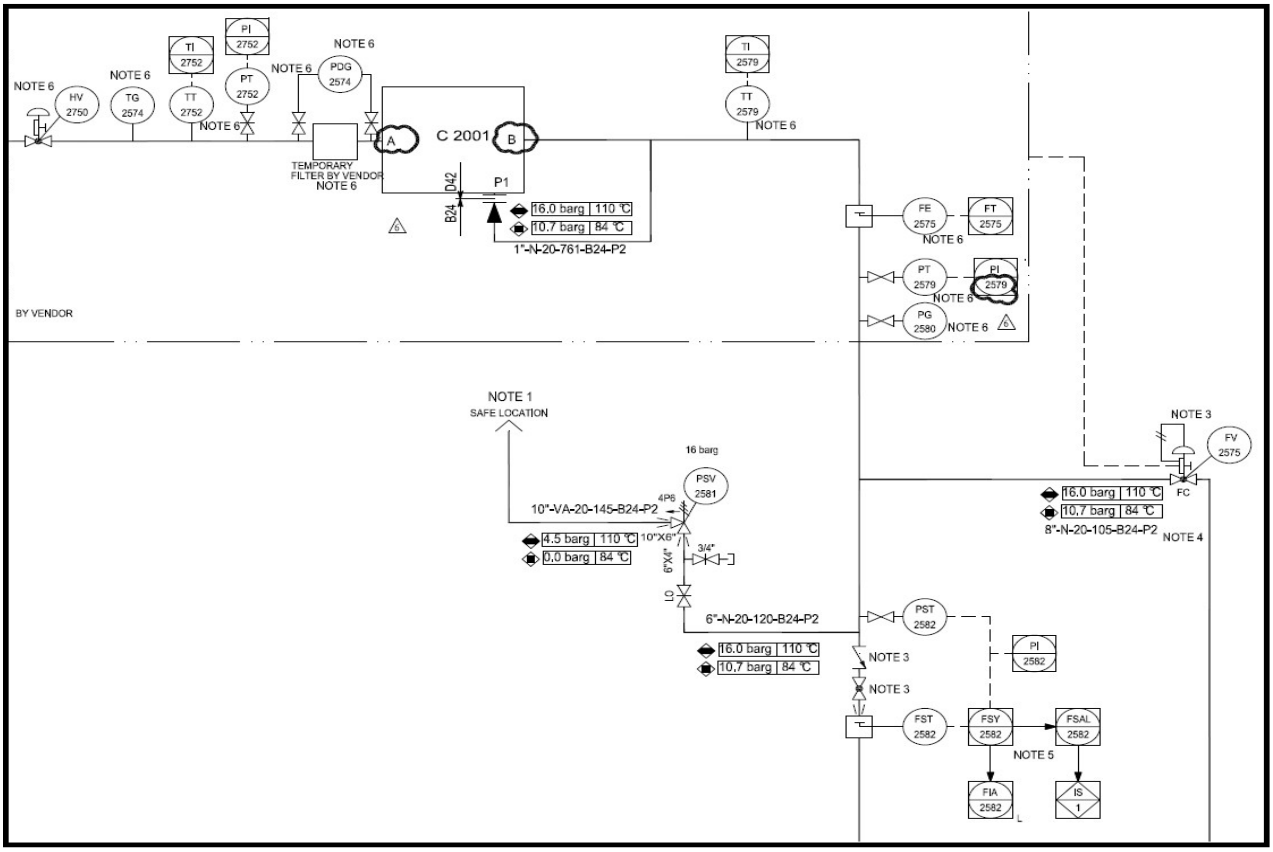
For P-6002, the efficiency is 80%.

Performance	Normal	Start-up	Rated	
Differential head	141,6	310,1	155,7	m liq.
Estimated efficiency			80	%
Estimated shaft power			152	kW

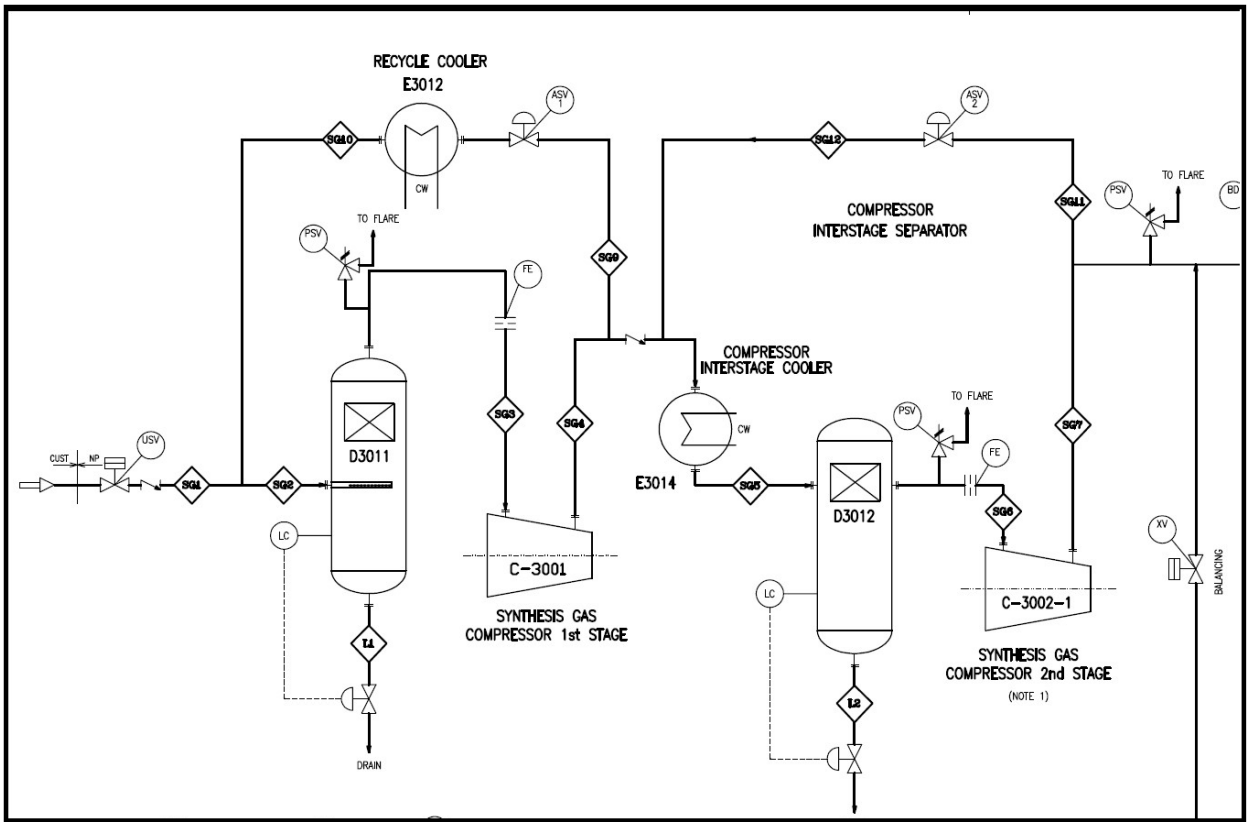
Example 9 : Centrifugal Compressor Datasheet

5,000 MTPD Methanol Plant Bandar Assaluyeh, Iran				Document ID S-02115 Job no.	4338822-55 Doc. no.	5 Rev.
Synthesis Gas Compressor / Recirculator				Page 3 of 6	Item no. C 3001 /C 3002	
Recycle Gas Inlet						
	Performance point	**Normal**	**Rated**	**EOR Lean Gas**	**SOR Rich Gas**	
	Flow	1660154	1826157	1648950	1294549	Nm³/h
	Temperature 18)	48	48	48	48	°C
	Pressure	83.7	83.1	84.1	76.1	bar g
	Molecular weight	11.40	11.40	9.37	11.60	kg/kmol
	Heat capacity ratio, Cp/Cv	1.3681	1.3681	1.3791	1.3664	
	Compressibility factor	1.03	1.03	1.04	1.03	
	Composition					
	Argon	0.20	0.20	0.20	0.25	mole %
	Byproducts	0.02	0.02	0.02	0.02	mole %
	Carbon Dioxide	9.09	9.09	6.38	8.91	mole %
	Carbon Monoxide	5.83	5.83	3.98	3.00	mole %
	Higher Alcohols	2	2	1	2	ppm
	Hydrogen	67.49	67.49	73.58	66.15	mole %
	Methane	4.76	4.76	4.90	5.83	mole %
	Methanol	0.71	0.71	0.67	0.76	mole %
	Nitrogen	11.85	11.85	10.22	15.02	mole %
	Water	0.05	0.05	0.05	0.05	mole %
	Performance point	**SOR Lean Gas**	**Start-up**			
	Flow 9)	1355825	108500			Nm³/h
	Temperature	48	Ambient			°C
	Pressure	76.2	6.0			bar g
	Molecular weight	9.23	28.01			kg/kmol
	Heat capacity ratio, Cp/Cv	1.3793	1.4090			
	Compressibility factor	1.03	1.00			
	Composition					
	Argon	0.24				mole %
	Byproducts	0.02				mole %
	Carbon Dioxide	5.62				mole %
	Carbon Monoxide	2.02				mole %
	Higher Alcohols	2				ppm
	Hydrogen	73.27				mole %
	Methane	5.77				mole %
	Methanol	0.72				mole %
	Nitrogen	12.29	100.00			mole %
	Water	0.05				mole %

Example 10: Safety Consideration



Item NO.	PSV-2581	P&ID NO.	2000-PID-018
Case	Outlets valve abnormally closed		
Equation	Total incoming steam and vapor plus that generated therein at relieving conditions		
Parameter		Unit	Value
Venting required (Ws)		kg/h	39000.00
Remark: The rated capacity is 31200Nm3/h or 39000kg/h. The capacity will be confirmed by C2001 vendor.			


RECYCLE COOLER
E3012
ASV 1
SG10
CW
TO FLARE
PSV
FE
SG9
D3011
SG3
SG4
C-3001
SYNTHESIS GAS
COMPRESSOR 1st STAGE
COMPRESSOR
INTERSTAGE SEPARATOR
ASV 2
SG12
SG11
TO FLARE
PSV
BD
COMPRESSOR
INTERSTAGE COOLER
E3014
CW
SG5
D3012
TO FLARE
PSV
FE
SG6
SG7
C-3002-1
SYNTHESIS GAS
COMPRESSOR 2nd STAGE
(NOTE 1)
XV
BALANCING
CUST
NP
USV
SG1
SG2
LC
LT
DRAIN
LC
LT2

Example 11: Separator Sizing of D-2005 and Hold-ups

Operating temperature	48	°C	Operating pressure	24,0	bar g
Liquid Outlet					
Liquid flow	68415	kg/h	Liquid density	989	kg/m³
Vapor Outlet					
Gas flow	282206	kg/h	Gas density	10,7	kg/m³
Gas molecular weight	11,44	kg/kmol			

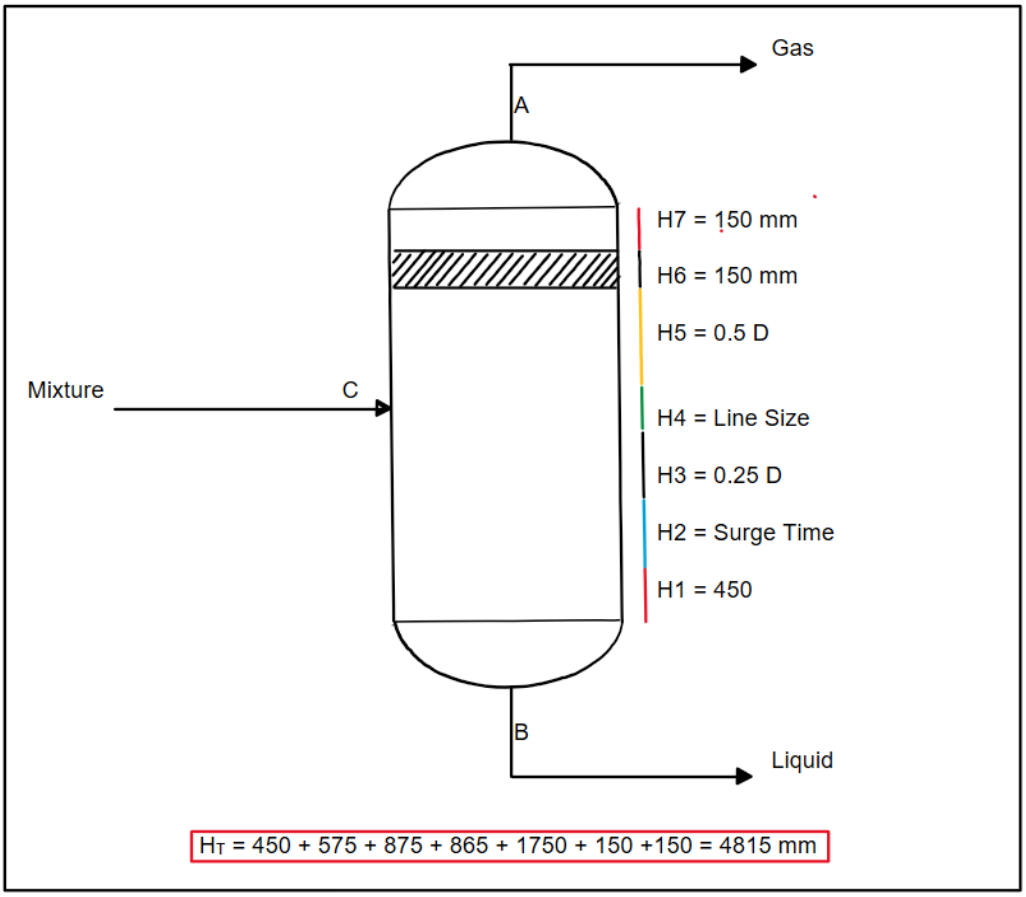
$K_{de\text{-}rated}$ = 0.11 ×0.83=0.09

V_g = 0.09 (989-10.7/10.7) ^0.5 = 0.84 m/s

Q_g = 282206/10.7/3600 = 7.32

D =(4Q/3.14×Vg) = 3293 mm

Selected ID = 3293 + 150 = 3500 mm



Operating Data

	Operating temperature	48	°C	Operating pressure	24,0	bar g
	Liquid Outlet					
	Liquid flow	68415	kg/h	Liquid density	989	kg/m³
	Vapor Outlet					
	Gas flow	282206	kg/h	Gas density	10,7	kg/m³
	Gas molecular weight	11,44	kg/kmol			

Vessel

	Mechanical Design Conditions					
	Fluid description	Reformed Gas				
	Design temperature (max.)	100	°C	Design pressure (max.)	29,0	bar g
	Vessel					
	Inner diameter	3500	mm	Tangent to tangent distance	4825	mm
	Construction code	ASME Sec. VIII Div. 1 or 2		Stress relieving	According to code	
	Construction material 1)	SS		Corrosion allowance	0	mm
	Insulation purpose	None		Insulation thickness		mm
	Top head type	Ellipsoidal		Bottom head type	Ellipsoidal	
	Liquid levels from lower tangent line					
	Maximum level	1000	mm	Low level	625	mm
	High level	875	mm	Minimum level	500	mm

Demister

	Type	York mesh type 709 or similar				
	Material	SS316				
	Effective Diameter	3500	mm	Thickness	150	mm
	Mounting	Support ring		Demister top to TL distance	525	mm
	Design of demister support shall ensure a negligible flow restriction.					

Nozzles and Connections

	Ref.	No.	Size	Rating	Face	Description
	A1	1	34"			Inlet
	A2 2)	1	3"			Pump return
	B1	1	28"			Vapor outlet
	B2	1	6"			Liquid outlet
	G1-2	2	1½"			Level gauge
	L1-6	6	1½"			Level transmitter
	M	1	24"			Manhole

	Nozzle Device			
	Type	Half-open pipe	Reference nozzle	A1
	Nozzle Device			
	Type	Vortex breaker	Reference nozzle	B2

Example 12 : Control Valve Type Selection

1. When the pressure drop is very high or there is the risk of accumulation of solids, or the fluid velocity is extreme an angle valve is used.

Just remember using angle type poses some ramifications.

2. Characterized ball valve is used when the fluid tends to crystallize or where a high Cv is required. Should they be used for as tight shut-off valve, the maximum pipe sizing should be 4 inch.

3. Butterfly valves are used for services with large flow rate and low pressure drop (less than 5 bar). They can be used as tight shut-off valve when the pipe diameter is more than 4 inch. High duty butterfly or triple offset butterfly are commonly used types.

Notice that single seated, unbalanced, line sized and full-sized trim globe valve as shut-down valve can be used if desired.

4. Globe Valve: For standard applications!

So, if you have High pressure condensate with 40 barg and its pressure should be reduced to 2barg and there are some flashing then angle type is used or if you have a a gas flow rate of 190000 Nm3/h which is a high amount, you can use a butterfly valve.

Condition / Valve Type	ΔP very high	Solid	V Very high	Cv high	Crystallization	Large flow with low ΔP	Tight shutoff Up to 4 inch	Tight shutoff Above 4 inch	Standrad
Globe									×
Angle	×	×	×						
Butterfly						×		×	
Ball				×	×		×		