COURSE OVERVIEW PE0531
Flare, Blowdown & Depressurization

Course Title
Flare, Blowdown & Depressurization

Course Date/Venue
December 16-20, 2024/Boardroom 2, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE

Course Reference
PE0531

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Description

This practical and highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.

The flare, blowdown and pressure relief systems are the most important elements for emergency and operational discharge of flammable substances in the process facilities. Safety relief and flare systems control vapors and liquids that are released by pressure-relieving devices and blow-downs. Pressure relief is an automatic, planned release when operating pressure reaches a predetermined level. Blowdown normally refers to the intentional release of material, such as blowdowns from process unit start-ups, furnace blowdowns, shutdowns, and emergencies. Vapor depressuring is the rapid removal of vapors from pressure vessels in case of fire. This may be accomplished by the use of a rupture disc, usually set at a higher pressure than the relief valve.

The principal elements of the safety relief and flare systems are the individual pressure relief devices, the flare piping system, the flare separator drum, and the flare (including igniters, tips, sealing devices, purge and steam injection for smokeless burning). Application of relief devices must comply with appropriate ASME Vessel Codes and API 520/521 standards.

Design of relief devices must comply with applicable national codes and laws as well as the requirements of the insurance covering the plant or installation. National regulations not only cover safety but also environmental considerations such as air and water pollution and noise abatement.

This course presents a convenient overview of relief system details based on the full scope of API, ASME, and other code and specification requirements. It covers all aspects of relief flare systems from the emergency relief sources through the valving and flare network right to the stack and flare tip. Descriptions and design criteria will be outlined for flare tips, seals, stacks, knockout drums, header systems, relief valves, depressurization systems and basic hazard analysis. Alternative design methods will be also described with reference to the specific nature of relief and flare systems worldwide.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply an in-depth knowledge and skills in the design, operation and maintenance of flare, blowdown and pressure relief systems
- Discuss product specification and identify the different types of flow measurement
- Review the various instrumentation and sensing devices used in flare, blowdown and pressure relief systems
- Carryout installation, troubleshooting and calibration of the control systems used in plant
- Determine the components and function of the relief systems and practice the sizing and installation of the relieving devices
- Identify the types, features and application of flare systems
- Determine the applicable codes, standards and recommended practices for flare, blowdown and pressure relief systems
- Acquire knowledge on product storage and tanks and recognize the importance of product recovery
- Evaluate the scope of waste heat recovery and explain its role in flare and pressure relief systems
- Operate, maintain and troubleshoot flare, blowdown and pressure relief system in a professional manner

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides systematic techniques on the design, operation and maintenance of flare, blowdown and pressure relief systems. Operations personnel, supervisors, engineers, maintenance personnel, senior plant supervisors, operations process support engineers, design engineers and process engineers will gain an outstanding knowledge from the practical and operational aspects of the course.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Dr. Hesham Abdou, PhD, MSc, PgDip, BSc, is a **Senior Process & Petroleum Engineer** with **40 years** of integrated experience within the **Oil & Gas** industries. His specialization widely covers in the areas of **Artificial Lift** System, **Artificial Lift** Methods, **Petroleum Economics**, **Petroleum Refinery Processing**, **Refinery** Material Balance Calculation, **Refinery** Gas Treating, **Asset Operational Integrity**, **Drilling** Operations, **Drilling Rig**, **Bits & BHA**, **Mud Pumps, Mud logging** Services, **Wireline & LWD Sensors**, **Casing & Cementing** Operation, **Completion & Workover** Operations, **Petroleum** Engineering, **Production Optimization**, **Well Completion**, **Rig & Rigless Workover**, Advanced **PVT & EOS Characterization**, **PVT/Fluid Characterization/EOS**, Advanced **Phase Behaviour & EOS Fluid Characterization**, **PVT Properties of Reservoir Fluids**, **Directional Drilling** Fundamentals, Application & Limitation, **Horizontal & Multilateral Wells** (Analysis & Design), **Directional**, **Horizontal & Multilateral Drilling**, Root Cause Analysis (**RCA**), Root Cause Failure Analysis (**RCFA**), **Root Cause Analysis** Study, **Root Cause Analysis** Techniques & Methodologies, Process Hazard Analysis (**PHA**), **Crude Oil Testing & Water Analysis**, **Crude Oil & Water** Sampling Procedures, **Equipment Handling** Procedures, **Crude & Vacuum Process** Technology, **Gas Conditioning & Processing**, **Cooling Towers** Operation & Troubleshooting, **Sucker Rod Pumping**, **ESP & Gas Lift**, **PCP & Jet Pump**, **Pigging** Operations, Electric Submersible Pumps (**ESP**), Progressive Cavity Pumps (**PCP**), **Natural & Artificial Flow Well Completion**, **Well Testing** Procedures & Evaluation, **Well** Performance, **Coiled Tubing** Technology, **Oil Recovery Methods** Enhancement**, Well Integrity** Management, **Well Casing & Cementing**, **Acid Gas** Removal, **Heavy Oil Production** & Treatment Techniques, **Water Flooding**, **Water Lift Pumps** Troubleshooting, **Water System Design** & Installation, **Water Networks Design** Procedures, **Water Pumping** Process, **Pipelines**, **Pumps**, **Turbines**, **Heat Exchangers**, **Separators**, **Heaters**, **Compressors**, **Storage Tanks**, **Valves** Selection, **Compressors**, **Tank & Tank Farms** Operations & Performance, **Oil & Gas Transportation**, **Oil & Gas Production** Strategies, **Artificial Lift** Methods, **Piping & Pumping** Operations, Oil & Water Source Wells Restoration, **Pump** Performance Monitoring, **Rotor Bearing** Modelling, **Hydraulic** Repairs & Cylinders, **Root Cause Analysis**, **Vibration & Condition** Monitoring, **Piping Stress** Analysis, **Amine Gas Sweetening & Sulfur Recovery**, Heat & Mass Transfer and Fluid Mechanics.

During his career life, Dr. Hesham held significant positions and dedication as the **General Manager**, **Petroleum Engineering Assistant General Manager**, **Workover Assistant General Manager**, **Workover Department Manager**, **Artificial Section Head**, **Oil & Gas Production Engineer** from Agiba Petroleum Company and **Engineering Consultant/Instructor** for various Oil & Gas companies as well as a **Senior Instructor/Lecturer** for **PhD, Master & BSc degree students** from **various universities** such as the Cairo University, Helwan University, British University in Egypt, Banha University.

Dr. Hesham has **PhD** and **Master** degrees as well as **Post Graduate Diploma** in **Mechanical Power Engineering** and a **Bachelor** degree in **Petroleum Engineering**. Further, he is a **Certified Instructor/Trainer** and a **Peer Reviewer**. Dr. Hesham is an active member of Egyptian Engineering Syndicate and the Society of Petroleum Engineering. Moreover, he has published technical papers and journals and has delivered numerous trainings, workshops, courses, seminars and conferences internationally.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons

Course Fee

US$ 5,500 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1: Sunday, 16th of December 2024

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Product Specification*** *LP-Gas Specification Parameters • Vapor Pressure • Moisture Content • Sulfur Content • Volatile Residue • Non-Volatile Residue • Non-Specification Contaminants • Odorization*
0930 – 0945	*Break*
0945 – 1100	***Flow Measurement*** *Flow Calculation Guide • Gas Measurement & Pipe Rupture • Liquid Measurement • Mass Measurement • Steam Measurement • Miscellaneous Measurement Devices • Auxiliary Equipment and Common Terms*
1100 – 1230	***Instrumentation & Sensing Devices*** *General Instrumentation Considerations • Identification • Pneumatic Power Supplies • Electronic Power Supplies • Pressure Sensors • Level Sensors • Temperature Sensors • Flow Sensors • Signal Transmitters • Pneumatic Transmitters • Electronic Transmitters • Signal Converters • Recorders and Indicators*
1230 – 1245	*Break*

1245 – 1420	***Control Systems*** *Control Concepts • Control Modes and Controllers • Controller Tuning • Control Valves • Liquid Service • Sizing Calculation Procedure • Installation, Troubleshooting, and Calibration • Digital Computers • Digital First-Level Control Systems • Analytical Instruments*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day One*

Day 2: Monday, 17th of December 2024

0730 – 0930	***Relief Systems*** *Relief Device Design • Blocked Discharge • Fire Exposure • Tube Rupture*
0930 – 0945	*Break*
0945 – 1115	***Relief Systems (cont'd)*** *Control Valve Failure • Thermal Expansion • Utility Failure*
1115 – 1230	***Relieving Devices*** *Safety Relief Valves • Rupture Disk • Sizing of Relief Devices*
1230 – 1245	*Break*
1245 – 1420	***Relieving Devices (cont'd)*** *Relief Valve Installation • Relief System Piping Design • Knockout Drums*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3: Tuesday, 18th of December 2024

0730 – 0930	***Flare Systems*** *Types of Flare Systems • Thermal Radiation • Smokeless Operation • Pilots and Ignition*
0930 – 0945	*Break*
0945 – 1115	***Flare Systems (cont'd)*** *Seals • Location and Regulations • Special Relief System Considerations • Low Temperature Flaring*
1115 – 1230	***Applicable Codes, Standards & Recommended Practices*** *ASME Codes • ANSI Codes • API Publications*
1230 – 1245	*Break*
1245 – 1420	***Applicable Codes, Standards & Recommended Practices (cont'd)*** *NFPA Publications • OSHA Publications • CGA (Compressed Gas Association) Publications*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4: Wednesday, 19th of December 2024

0730 – 0930	***Product Storage & Tanks*** *Storage Classification • Working Pressures • Types of Storage • Materials of Construction • Protective Coatings • Insulation • Appurtenances • Site Preparation and Installation • Cathodic Protection*
0930 – 0945	*Break*
0945 – 1100	***Product Recovery*** *Product Losses • Vapor Recovery Systems • Separators and Filters • Fired Equipment • Hot Oil System*

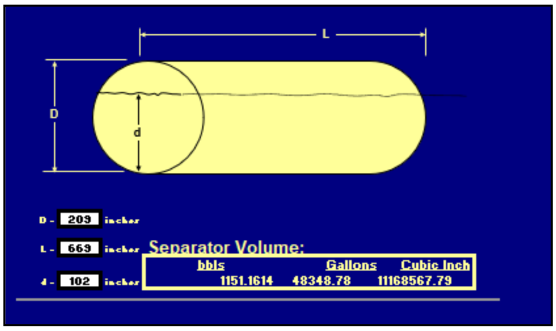
1100 – 1230	***Waste Heat Recovery*** *Heat Exchangers Overview ● Heat Balances ● Shell and Tube Exchangers ● Fouling Resistances ● Film Resistances ● Performance Evaluation with Sensible Heat Transfer ● Condensers*
1230 – 1245	*Break*
1245 – 1420	***Waste Heat Recovery*** *Reboilers and Vaporizers ● Selection of Exchanger Components ● Nomenclature ● Shell Size and Tube Count Estimation ● Operating Characteristics ● Inlet Gas Exchanger ● Hairpin Heat Exchangers*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Four*

Day 5: **Thursday, 20th of December 2024**

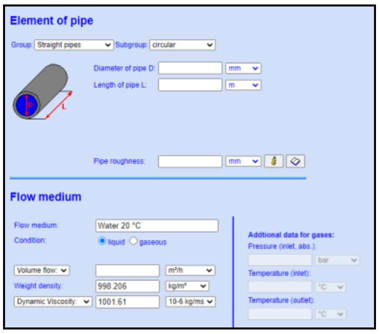
0730 – 0930	***Operation, Maintenance & Troubleshooting***
0930 – 0945	*Break*
0945 – 1100	***Operation, Maintenance & Troubleshooting (cont'd)***
1100 – 1230	***Operation, Maintenance & Troubleshooting (cont'd)***
1230 – 1245	*Break*
1245 – 1345	***Operation, Maintenance & Troubleshooting (cont'd)***
1345 – 1400	***Course Conclusion***
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulator (Hands-on Practical Sessions)

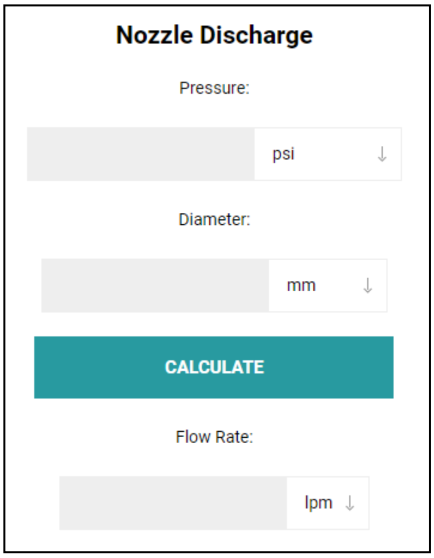
Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using various online system calculator.



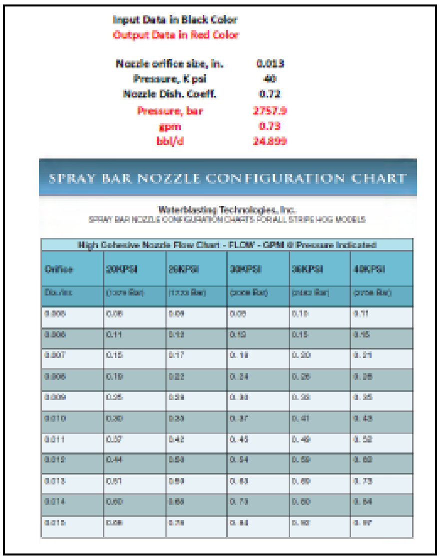
Tank Volume Calculator



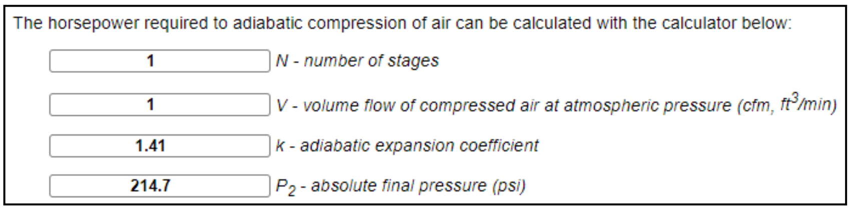
Pressure Drop Online-Calculator



Nozzle Discharge

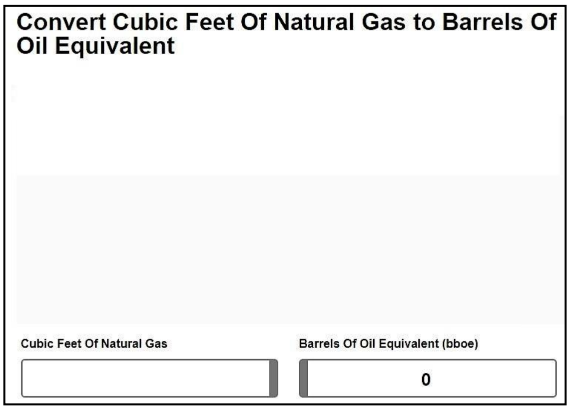


Nozzle Calculator

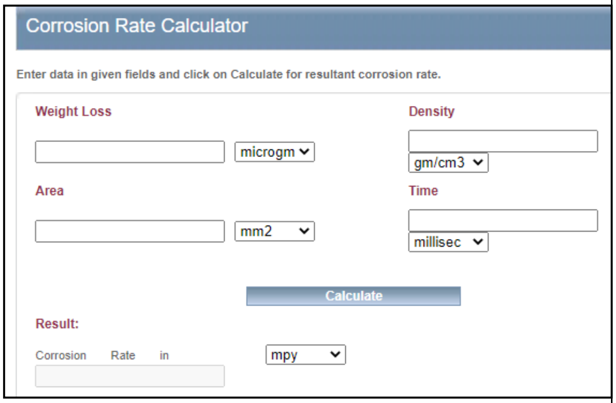


Horsepower Calculator

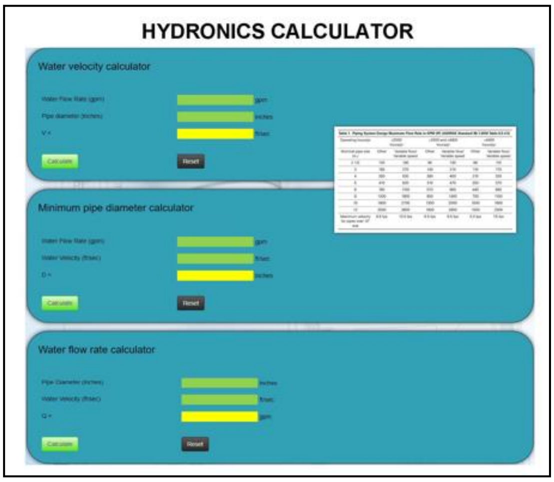
Water Flow Rate through an Orifice Calculator



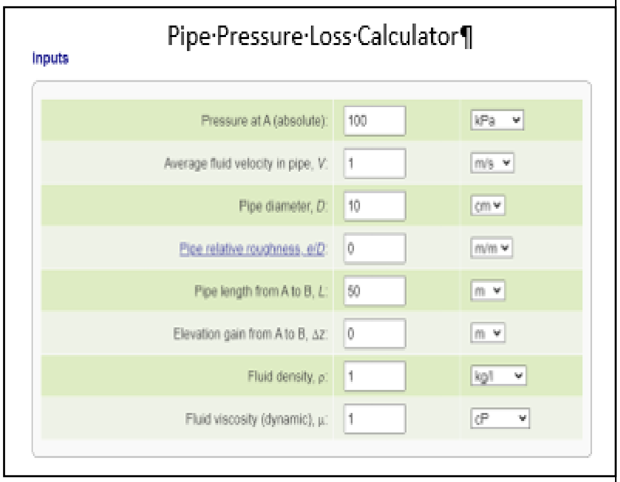
Cubic Feet Calculator



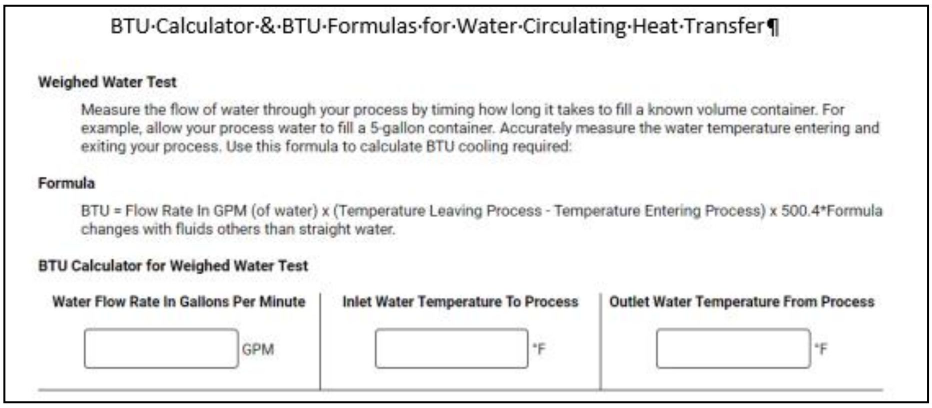
Corrosion Rate Calculator



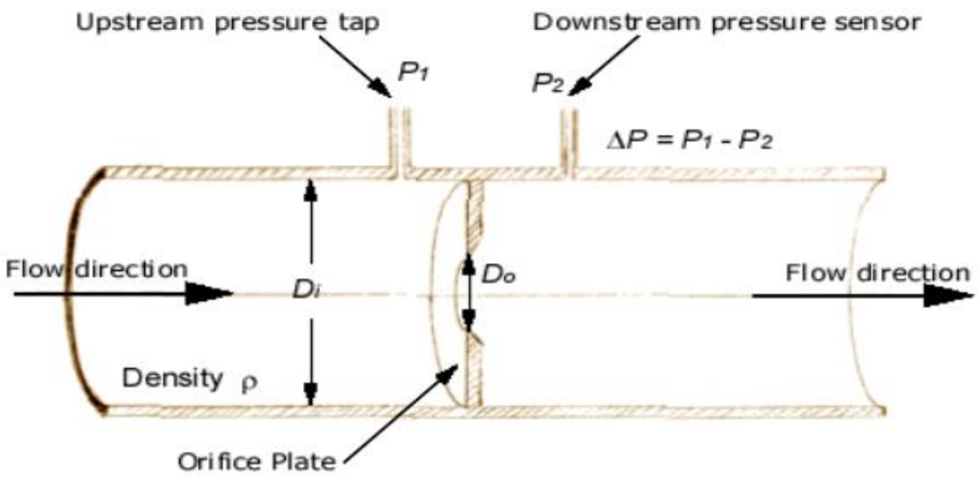
Hydronics Calculator



Pipe Pressure Loss Calculator



BTU Calculator



Inputs

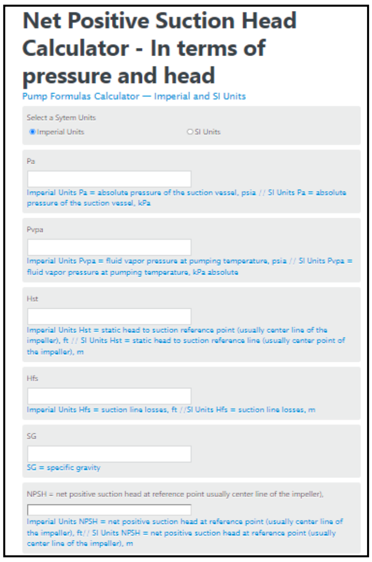
Pipe (inlet) diameter upstream of orifice, D_i:	8	in
Orifice diameter (less than the inlet diameter), D_o:	3	in
Pressure difference across the orifice, Δp:	20	psi
Fluid density, ρ:	835	kg/m^3
Flow Coefficient, C_f:	0.82	

Answers

Velocity at the inlet, V_i:	2.10 m/s	m/s
Volumetric Flowrate, Q:	1080 gpm	gpm
Mass Flowrate:	56.7 kg/s	kg/s

Flow Rate through an Orifice or Valve Calculator

Net Positive Suction Head Calculator



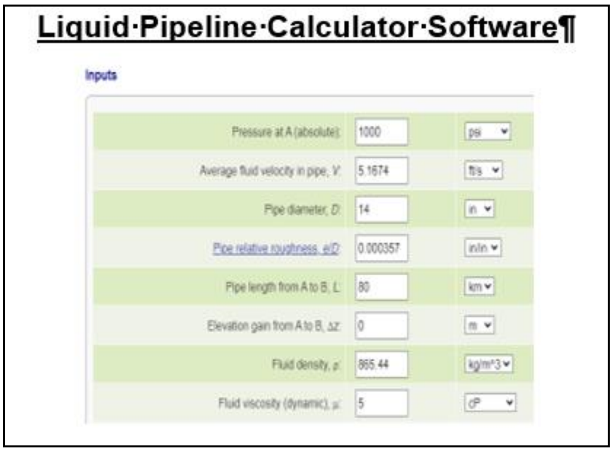
Net Positive Suction Head Calculator

Input Data in Black Color
Output Data in Red Color

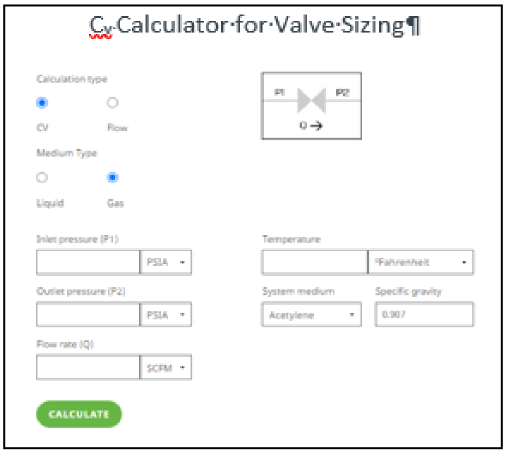
lbs/gall.	11
kg/lit.	1.318

Pounds per Gallon	Kilograms per Liter	Conversion Factor
7.0 lb/gal	0.84 kg/l	0.92
8.0 lb/gal	0.96 kg/l	0.98
8.34 lb/gal	1.00 kg/l (water)	1.00
9.0 lb/gal	1.08 kg/l	1.04
10.0 lb/gal	1.20 kg/l	1.10
10.65 lb/gal	1.28 kg/l (28% Nitrogen)	1.13
11.0 lb/gal	1.32 kg/l	1.15
12.0 lb/gal	1.44 kg/l	1.20
14.0 lb/gal	1.68 kg/l	1.30

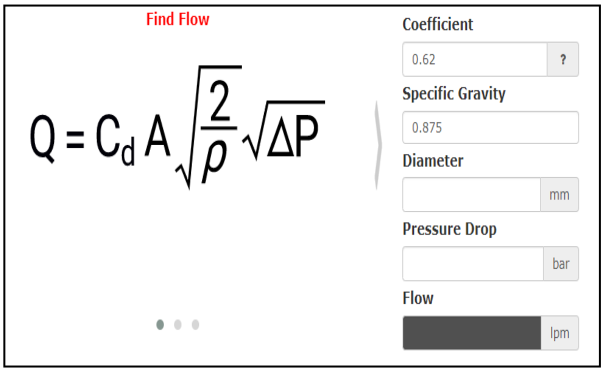
PPG to KG Calculator



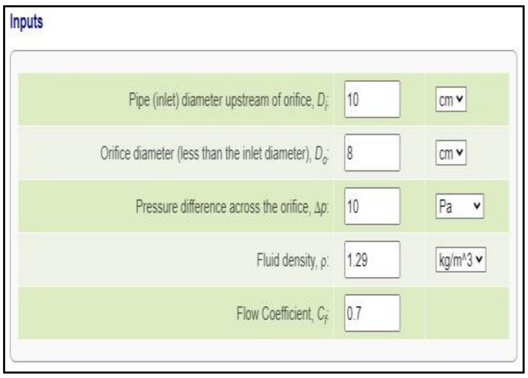
Liquid Pipeline Calculator



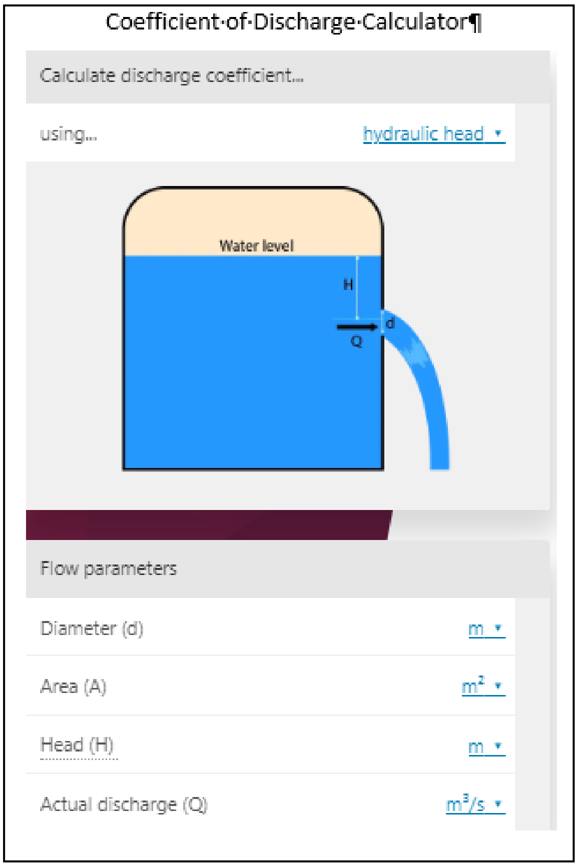
Cv Calculator



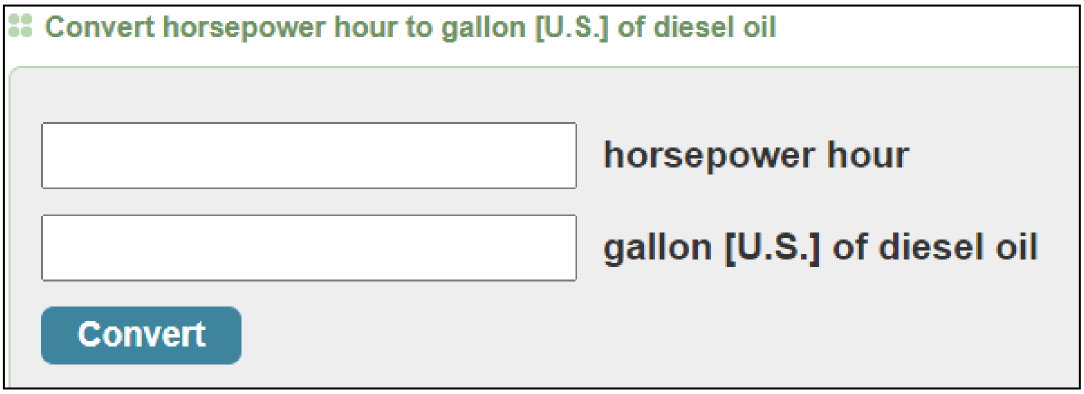
Find Flow Calculator



Flowrate Calculator



Coefficient Discharge Calculator



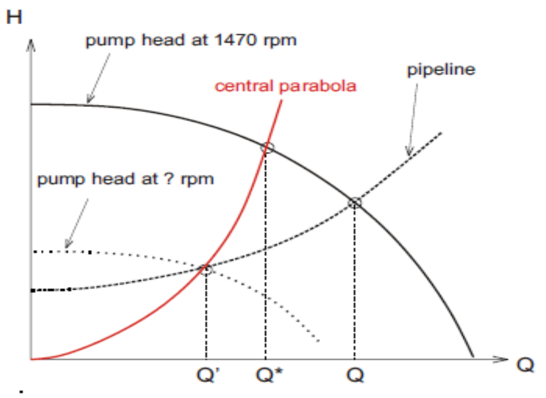
Horsepower Hour Calculator

Liquid Pumping Program

Input Data	
API	28
c.P.	5
1000 bbl/d	3.3
Length, km	2.4384
I.D., in.	2.800
Rough. (E), in.	0.005
Difference in elev., m	50
Destination press., psi	60
Pump Suc. psi	80
Overall Pump Eff., %	65
Motor Eff., %	90
Motor Loading %	80

Output Results	
Flow Velocity, ft/s	5.0154
Erosion Velocity, ft/s	13.440
E/I.D.	0.001786
sp.gr.	0.8871
Re	19290.3
F	0.02987
Hf, psi	153.67
Hf, m water	108.17
Total Pump Dich. psi	276.68
TDP, psi	196.68
Hydr. Power, HP	16.99
Hydr. Power, Kw	12.67
Shaft Power, HP	18.88
Shaft Power, Kw	14.083
Nama Plate Motor HP	23.60
Nama Plate Motor Kw	17.60

A pump running at $1470[rpm]$ with $H_{pump} = 45 - 2781Q^2$ head delivers water into a pipeline with $H_{pipe} = 20 + 1125Q^2$. Calculate the required revolution number for the reduced flow rate $Q' = 0.05[m^3/s]$.



Solution:

- The actual working point is given by the solution of $H_{pump} = H_{pipe}$, which gives $Q = 0.08[m^3/s]$ and $H = 27.2[m]$.
- Affinity states that while varying the revolutionary speed, H/n^2 and Q/n remain constant. Thus, also H/Q^2 remains constant, let's denote this constant by a. So, while varying the revolutionary speed, the working point moves along the *central parabola* (see figure), given by $H_{ap} = a\,Q^2$.

However, as Q' is given and we also know that this point has to be located on the pipeline characteristic, we know that $H' = 20 + 1125 \times 0.05^2 = 22.81[m]$. Thus, the parameter of the affine parabola is $a = H'/Q'^2 = 9125$.

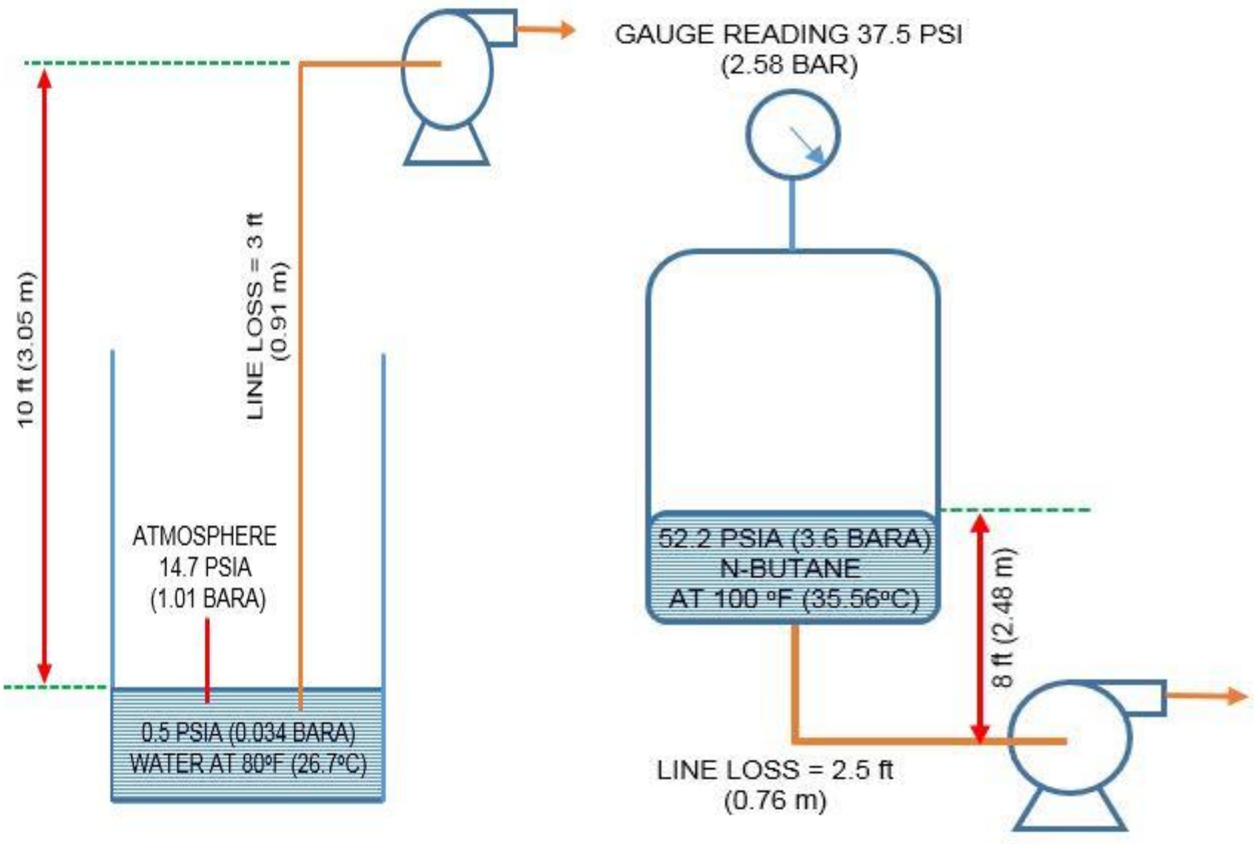
Q^* is given by the intersection of the affine parabola and the original pump characteristic: $H_{ap}(Q^*) = H_{pump}(Q^*)$, which gives $Q^* = 0.06148[m^3/s]$ with $H^* = 34.5[m]$.

Now we can employ affinity between Q^* and Q':

$$n' = n^* \frac{Q'}{Q^*} = 1470 \times \frac{0.05}{0.06148} = 1195.5[rpm]$$

and just for checking the calculation

$$H' = H^* \left(\frac{n'}{n^*}\right)^2 = 34.5 \times \frac{1195.5^2}{1470^2} = 22.81[m].$$



NPSHA of pump – suction lift

NPSHA of pump – at boiling point
SG of n-butane at 100 deg F = 0.56

NPSHA = Hatmp.+/- Hs – Hf – Hvap.

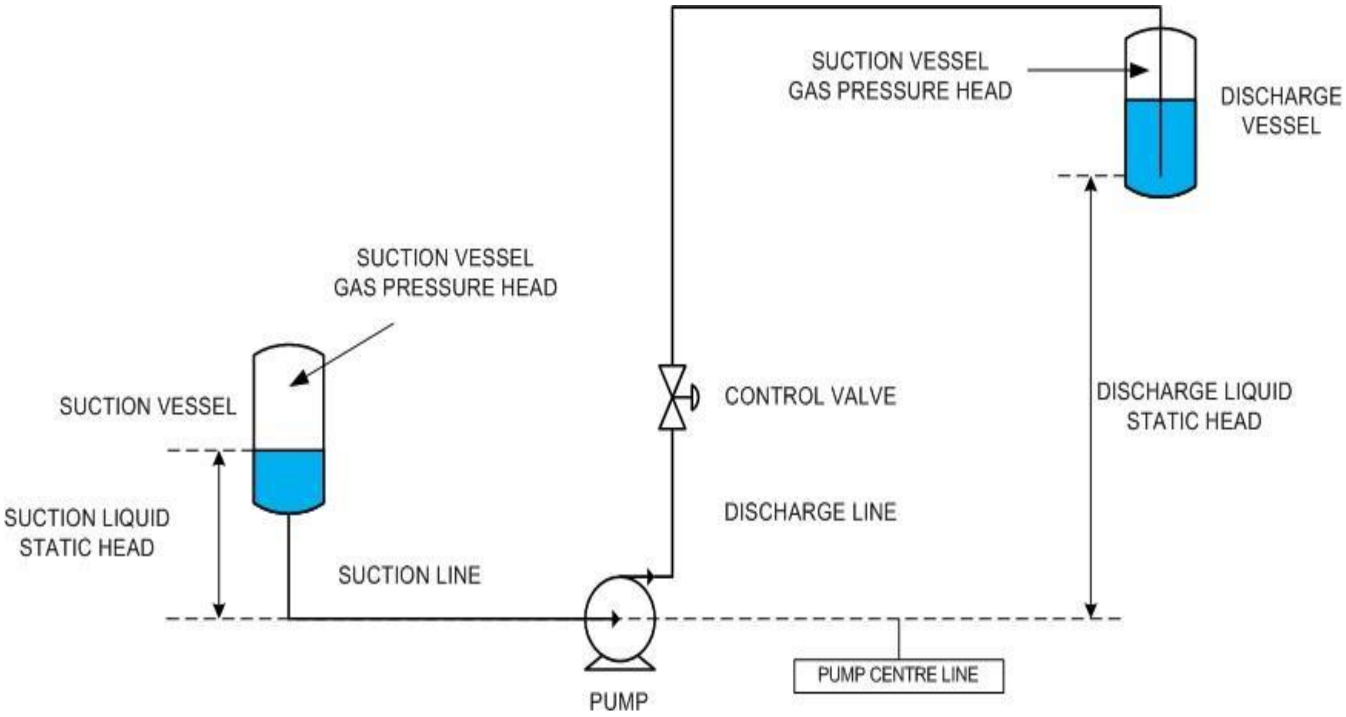
https://engineeringunits.com/net-positive-suction-head-calculator/?utm_content=cmp-true

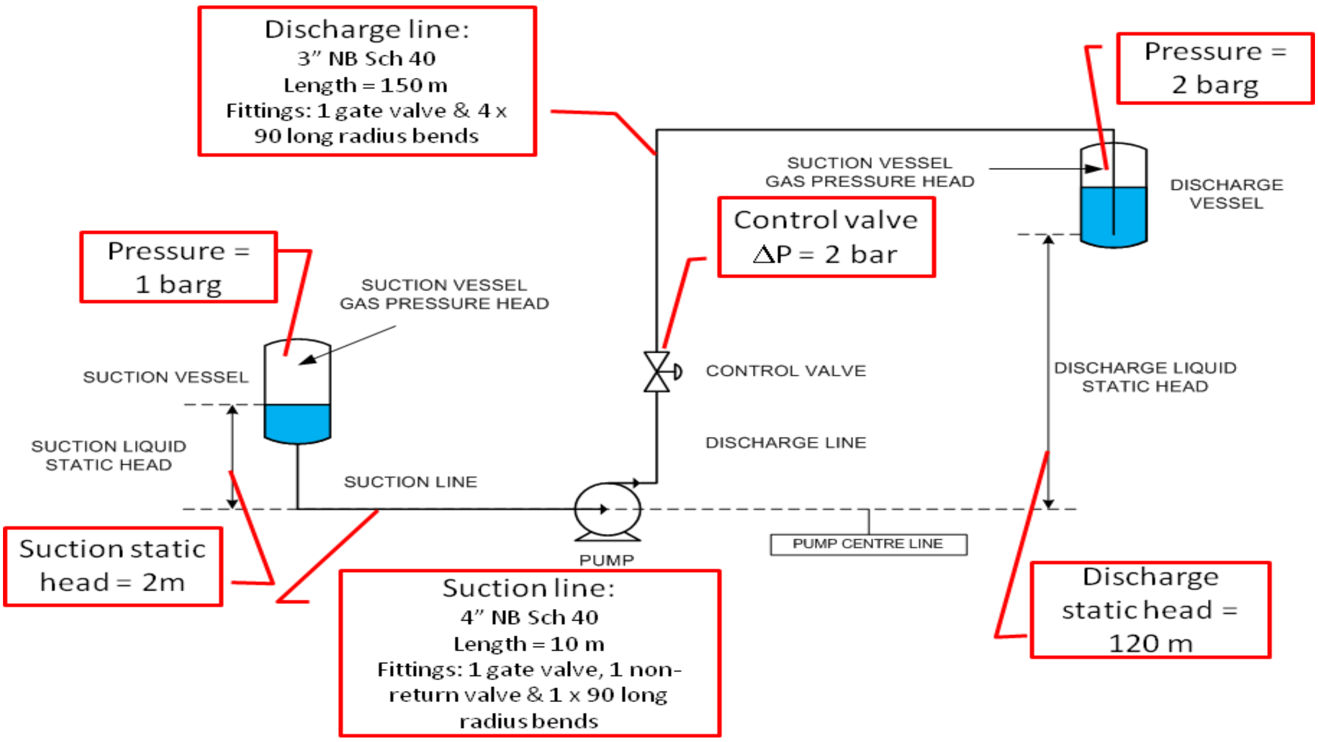
http://www.pressure-drop.com/Online-Calculator/index.html

NPSH Calculations

Input Data	
API	36
c.P.	3
Vapor pressure, psi	10
Atmp. Pressure, psi	14.7
Height above pump, ft	20
1000 bbl/d	2.0
Length, km	0.003
I.D., in.	2.992
Rough. (E), in.	0.005

Output Results	
Flow Velocity, ft/s	2.6620
E/I.D.	0.001671
sp.gr.	0.8448
Re	17363.9
F	0.0302
Hf, psi	0.048
Hf, ft water	0.111
NPSHA, ft oil	32.72
NPSHA, ft water	27.64





Calculator

PUMP DETAILS

Pump tag number		P-001	
Suction vessel tag number		V-001	
Discharge vessel tag number		V-002	
Barometric pressure	P_{atm}	1.013	bara
NPSH available margin	H_{margin}	0	m
Pump efficiency	η	70%	

FLUID PROPERTIES

Fluid		Water	
Phase		Liquid	
Flowrate	m	30000	kg/hr
Density	ρ	998	kg/m3
Viscosity	μ	1	cP
Vapour pressure	P_{vap}	0.023	bara

VESSEL GAS PRESSURES

Suction vessel gas pressure	$P_{suc.\_vessel}$	1	barg
Discharge vessel gas pressure	$P_{dis.\_vessel}$	2	barg

STATIC HEADS

Suction static head	$H_{suc.\_static\_head}$	2	m
Discharge static head	$H_{dis.\_static\_head}$	120	m

PIPELINES

		Suction Line	Discharge Line	
Pipe nominal diameter		4	3	inch
Pipe schedule		Sch 40	Sch 40	
Pipe internal diameter	d	102.26	77.92	mm
Pipe length	L	10	150	m
Absolute roughness	e	0.046	0.046	mm

OUTPUTS

Volumetric flow rate Q 30.060 m3/hr

		Suction Line	Discharge Line	
Relative roughness	e:d	0.00045	0.00059	
Flow area	A	0.00821	0.00477	m2
Velocity	u	1.02	1.75	m/s
Reynolds No.	Re	103758	136170	
Flow regime		turbulent	turbulent	
Friction factor	f	0.02011	0.02010	
Pipe velocity head loss	K_{pipe}	1.966	38.695	
Fittings total velocity head loss	$K_{fittings}$	1.724	2.152	
Frictional pressure loss	$\Delta P_{friction}$	0.02	0.62	bar
Frictional head loss	$H_{friction}$	0.19	6.38	m

Pump suction pressure	$P_{suction}$	2.19 bara
Pump suction head	$H_{suction}$	22.37 m
Pump discharge pressure	$P_{discharge}$	15.39 bara
Pump discharge head	$H_{discharge}$	157.16 m
Net positive suction pressure available	P_{NPSHA}	2.17 bara
Net positive suction head available	NPSHa	22.13 m
Pump total differential pressure	ΔP_{pump}	**13.20 bar**
Pump total differential head	H_{pump}	**134.79 m**
Pump absorbed power	E	**15.74 kW**

Results of above calculations may be confirmed through either of followinglinks:

https://www.swagelok.com/en/toolbox/cv-calculator

https://experttoolsonline.com/danfoss/orifice_calculator

https://www.efunda.com/formulae/fluids/calc_orifice_flowmeter.cfm

https://www.omnicalculator.com/physics/coefficient-of-discharge

Power Calculations:

https://inventory.powerzone.com/resources/centrifugal-pump-power-calculator/%3Aflu%3DGPM%3Apru%3DHEAD%20FT%3Apu%3DHP

http://irrigation.wsu.edu/Content/Calculators/General/Required-Water-Pump-HP.php

Required Compressor Horsepower

https://www.engineeringtoolbox.com/horsepower-compressed-air-d_1363.html

Input Data		Output Results	
T1, F	60	Compression Ratio	34.014
K	1.35	Cp, J/kg/K	1107
P1, psi	14.7	Gas, cfm	36791.50
P2, psi	500	Gas, kg/s	21.250
Gas sp.gr.	1	Theoretical Power, HP	9731.847
No. of Comp. stages	3	Total Required HP	12721.37
Gas million SCMD	1.5		
Eff. of Gas Comp., %	85		
Eff. of Driving Motor, %	90		

Heater Duty
https://www.advantageengineering.com/fyi/288/advantageFYI288.php

Input Data		Output Results	
Million BTU/hr.	0.75	Delta Temp., C	15.6
API	10.0	Mega Watt	0.220
Specific Heat, BTU/lb/F	1.00	Billion Joule/hr.	0.791
Delta Temp., F	60	gpm	25.0
Heater Eff., %	100	gallon/hr.	1498.4
		Lit./min.	94.5
		m3/hr.	5.7
		1000 bbl/d	0.856
		Required Diesel Lit./day	502.90
		Required Diesel bbl/d	3.16
		Required Gas, 1000 ft3/d	16.364
		Required crude oil, bbl/d	3.268

https://www.enggcyclopedia.com/2011/09/problem-solving-heat-exchanger-tubeside-pressure-drop-calculation/

Input Data		Output Results	
Mass Flow Rate, kg/hr.	2000.0	cm3/s	562.303
Fluid Density, Kg/m3	988.0	V, cm/s	110.9720
Visc., c.P.	0.53	Re	52544.59
Pipe Diameter (D), in.	1	f	0.0261
Roughness (E), mm	0.045	Total Hf, cm (per single tube)	22.5583
Tube Length, m	3.5	Total Hf, psi (per single tube)	0.3166
No. of tubes	1	Total Hf, bar (per single tube)	0.0218

Heat exchanger tube side pressure drop calculation

Calculate the tube side pressure drop for the following heat exchanger specification,

Process fluid = water

Inlet pressure = 4 barg

Inlet temperature = 50^0C

Outlet temperature = 30^0C

Tubeside flowrate = 50000 kg/hr

Number of tubes = 25

Tube ID (internal diameter) = 1 inch

Tube length = 3.5 m

Total volumetric flow = 50000 kg/hr ÷ 988.0 kg/m^3 = 50.61 m^3/hr Volumetric flow in each 1" tube = 50.61 ÷ 25 = 2.02 m^3/hr Pressure loss per unit length of the tube is then calculated using EnggCyclopedia's pressure drop calculators for pipes and tubes. This calculator is based on Darcy-Weisbach equation.

Pressure loss across a single tube (ΔP/L) = 6.17 bar/km

SINGLE PHASEFLOW INPUTS		
W – Mass flow capacity	2000	kg/h
ρ – Density of fluid	988	kg/m^3
μ – Viscosity of fluid (either liquid or gas)	0.53	cP
PIPE SPECIFICATIONS		
e – Effective roughness of the pipe	0.045	mm
d – Nominal diameter of the pipe	1	inches
sch – pipe schedule	STD	
Calculate pressure loss	Reset	
RESULTS		
Fluid Velocity	1.110	m/s
Volumetric flow	2.02	m^3/hr
Reynold's No.	52557.9	
Pressure loss	6.1715	bar/km

Tube length (L) = 3.5 m

Tubeside pressure drop (ΔP) = 6.17 × 3.5 / 1000 = 0.0216 bar

Another alternative is to directly use EnggCyclopedia's Heat Exchanger Tube side Pressure Drop Calculator. All the inputs given in the sample problem statements are given to the calculator and pressure drop across the tubeside is calculated as output. This calculator uses the same basic steps discussed above and hence the answer also matches with the figure above (0.0216 bar) . The following image is a snapshot of this direct calculation of tubeside pressure drop.

Exchanger tubeside pressure drop

Tubeside inputs		
Total tubeside mass flow	50000	kg/hr
Tubeside Density	988	kg/m^3
Tubeside Viscosity	0.53	cP
Number of tubes	25	
Total tube length (accounting for all tube passes)	3.5	m
Tube nominal diameter	1	inches
Tubeside roughness	0.045	mm
Calculate pressure drop	Reset	
Results		
Tubeside pressure drop	0.0216	bar

Course Coordinator

Mari Nakintu, Tel: +971 2 30 91 714, Email: mari1@haward.org