Polytropic Head for a Centrifugal Compressor

SI Units:

$$H_{poly} = \frac{8314}{MW} \times T_1 \times Z_{avg} \times \left(\frac{n}{n-1} \right) \times \left[\left(\frac{P_2}{P_1} \right)^{(n-1)/n} - 1 \right]$$

where:

H_{poly} =	Polytropic head, N-m/kg
MW =	molecular weight of the gas, kg/kg-mol
T_1 =	Absolute temperature at inlet conditions, K
Z_{avg} =	Average compressibility factor, dimensionless
	= $(Z_1+Z_2) / 2$
Z_1 =	Compressibility factor at inlet conditions, dimensionless
Z_2 =	Compressibility factor at discharge conditions, dimensionless
P_1 =	Inlet pressure in absolute units, kPaa or bara
P_2 =	Discharge pressure in absolute units, kPaa or bara
n =	polytropic exponent

US Customary units

$$H_{poly} = \frac{1545}{MW} \times T_1 \times Z_{avg} \times \left(\frac{n}{n-1} \right) \times \left[\left(\frac{P_2}{P_1} \right)^{(n-1)/n} - 1 \right]$$

H_{poly} =	Polytropic head, ft-lb_f/lb_m
MW =	molecular weight of the gas, lb/lb-mol
T_1 =	Absolute temperature at inlet conditions, R
Z_{avg} =	Average compressibility factor, dimensionless
	= $(Z_1+Z_2) / 2$
Z_1 =	Compressibility factor at inlet conditions, dimensionless
Z_2 =	Compressibility factor at discharge conditions, dimensionless
P_1 =	Inlet pressure in absolute units, psia
P_2 =	Discharge pressure in absolute units, psia

Centrifugal Compressor Performance

SI Units

Impeller Flow Coefficients

$$\phi = \frac{V_{inlet}}{u_2 \times d_2^{\,2}}$$

where:

ϕ = impeller flow coefficient, dimensionless

V_{inlet} = compressor inlet volume flow in m^3/s

u_2 = impeller tip speed in m/s

d_2 = impeller diameter in m

Note: Impeller flow coefficients shall be within the 0.01 to 0.12 range

Impeller Stage Head Coefficients

SI Units

$$\mu = \frac{H_{poly}}{u_2^{\,2}}$$

where:

μ = Head Coefficient, dimensionless

H_{poly} = Polytropic head **per stage**, N-m/kg

Note: Impeller stage head coefficients shall be within the 0.4 to 0.55 range. For preliminary calculations an initial value of 0.48 is recommended.

Approximate Rotational Speed

SI Units

$$N = \frac{u_2 \times 60}{\pi \times d_2}$$

where:

N = approximate rotational speed, rpm

US Cust Units

$$\phi = \frac{V_{inlet} \times 144}{u_2 \times d_2^{\,2}}$$

ϕ = impeller flow coefficient, dimensionless

V_{inlet} = compressor inlet volume flow in ft^3/s

u_2 = impeller tip speed in ft/s

d_2 = impeller diameter in inch

US Cust Units

$$\mu = \frac{H_{poly} \times 32.2}{u_2^{\,2}}$$

μ = Head Coefficient, dimensionless

H_{poly} = Polytropic head **per stage**, $ft\text{-}lb_f/lb_m$

US Cust Units

$$N = \frac{u_2 \times 60 \times 12}{\pi \times d_2}$$

N = approximate rotational speed, rpm

Project No.:
Description:
Date:

SI Units

Inputs:

Inlet Pr., P_1	**2.068**	bar(abs)
Inlet Temp., T_1	**40**	°C
Disch. Pr., P_2	**6.89**	bar(abs)
Mass flow, M	**136,078.0**	kg/h

=Input Values
=Calculated Values

Calculations:

Component	mole fraction	Component Critical Press., kPa (abs)	Pseudo-Critical Press., P_{pc}, kPa (abs)	Component Critical Temp., K	Pseudo-Critical Temp., T_{pc}, K	Component Molecular Wt.	Pseudo-Molecular wt., MW	Specific Heat at const. press., $C_{p,}$ kJ/kg-K	Pseudo-Specific Heat at const. press., $C_{p,}$ kJ/kg-K
Ethane	**0.05**	4,880	244.0	305.41	15.27	30.07	1.50	1.7053	0.0853
Propane	**0.8**	4,240	3,392.0	369.77	295.82	44.097	35.28	1.6242	1.2994
n-Butane	**0.15**	3,784	567.6	425.1	63.77	58.123	8.72	1.6514	0.2477
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
	1		**4,203.6**		**374.85**		**45.50**		**1.632**

Inlet compressibility factor, Z_1 =	**0.972**		(Calculated from "**Comp. Factor SI**" worksheet)
Specific Heat Ratio, $\kappa_1 = C_p / C_v$	**1.126**		$C_p/(C_p-(8.314 / MW))$
Inlet volume flow **@P_1&T_1**, Q_1	**36,581.45**	m^3/h	$M*0.08314*(T_1+273.15)*Z_1 / P_1*MW$

Table 1
Typical Centrifugal Compressor Frame Data

Frame	Nominal Inlet Volume flow		Nominal Polytropic head		Nominal Polytropic efficiency (%)	Nominal Rotational Speed (RPM)	Nominal Impeller Diameter	
	English (ICFM)	Metric (m^3/h)	English (ft-lb_f/lb_m)	Metric (N-m/kg)			English (inch)	Metric (mm)
A	1,000-7,000	1,700-12,000	10,000	30,000	76	11,000	16	406
B	6,000-18,000	10,000-31,000	10,000	30,000	76	7,700	23	584
C	13,000-31,000	22,000-53,000	10,000	30,000	77	5,900	30	762
D	23,000-44,000	39,000-75,000	10,000	30,000	77	4,900	36	914
E	33,000-65,000	55,000-110,000	10,000	30,000	78	4,000	44	1,120
F	48,000-100,000	82,000-170,000	10,000	30,000	78	3,300	54	1,370

(Table reproduced from page 234 of "Pipeline Rules of Thumb Handbook" by E.W. McAllister, 3rd Ed., Gulf Publishing Company, Houston,TX)

***Note*: Nominal polytropic head values have been calculated using the "Chart" worksheet and not referred from Table 1**

Frame Selection	C		(Select from Table 1 based on inlet volume flow)
$H_{poly-nom}$ =	**25,227**	N-m / kg	(from polynomial equation from **"Chart SI"** worksheet)
η_{poly} =	**77**	%	(From Table 1)
N_{nom} =	**5,900**	rpm	(FromTable 1)

Pr. Ratio, r_P =	3.33		P_2/P_1
n/(n-1) =	6.88		$(\kappa_1/(\kappa_1-1))*\eta_{poly}$
T_2 =	373.02	K	$T_1*(r_P)^{(n-1)/n}$ (compressor discharge temperature)
	99.9	°C	

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Discharge compressibility factor, Z_2 =	**0.941**	(Calculated from "**Comp. Factor SI**" worksheet)
Average Compressibility, Z_{avg} =	**0.956**	$(Z_1+Z_2)/2$

Average κ-value

The inlet κ value is generally used for polytropic head calculations. The polytropic head equation is insensitive toκ-value (and therefore n-value) within the limits that κ normally varies during compression. This is because any multiplier in the polytropic head equation tends to balance corresponding errors in the (n-1)/n exponent.

Thus,

$\kappa_{avg} = \kappa_1$ =	1.126		
Polytropic Head, H_{poly} =	**71,971**	N-m/kg	(For equation refer "Head eqn" sheet)

Number of Stages

Definition of Stage *: For the purpose of this spreadsheet, a stage is defined as an impeller-diffuser pair. A series of stages will comprise a 'section' or 'process stage' between which there is no intercooling or loss or gain in flow (i.e. no sidestreams, bypassing or injection) & whose rotational speeds are in fixed ratio to each other.*

DEP 31.29.40.10-Gen. *: "Single section compressors with in-line impeller arrangements shall have no more than 9 impellers per casing. Two section compressors shall have no more than 8 impellers per casing. Compressors with one side-stream shall have a maximum of 7 impellers per casing, for each additional sidestream one additional impeller less in order to have sufficient space for adequate mixing of main & side streams."*

Thus number of stages =	2.9	$(H_{poly}/H_{poly\text{-}nom})$
	3	(Round-up to the next whole integer if calculated stages **>X**.2 & round-down if **≤ X**.2, where **X** = a whole integer)
Calculated polytropic head per stage =	**23,990** N-m/kg	

Rotational Speed

N_{nom} =	**5,900**	rpm	
Actual rotational speed =	**5,754**	rpm	$N_{nom}*((H_{poly}/H_{poly\text{-}nom}*\text{No. of Stages})^{0.5})$

Shaft Power, P_{shaft}

Gas Power Requirement, P_{gas} =	3,533.1	kW	$M*H_{poly}/(3.6E+6*\eta_{poly})$

Table 2

Approximate Mechanical Losses as a Percentage of Gas Power Requirement

Gas Power Requirement		Mechanical Losses, L_m,
English (hp)	Metric (kW)	%
0-3,000	0-2,500	3
3,000-6,000	2,500-5,000	2.5
6,000-10,000	5,000-7,500	2
10,000+	7,500+	1.5

(Table reproduced from page 236 of "Pipeline Rules of Thumb Handbook" by E.W. McAllister, 3rd Ed., Gulf Publishing Company, Houston,TX)

Mechanical Losses for given example:

L_m =	**2.5**	%	(Table 2)
	88.3	kW	

Shaft power requirement is sum of gas power requirement and mechanical losses. Thus

P_{shaft} =	3,621.4	kW
	3,622	kW

Summary of Results:

Polytropic Head, H_{poly} =	**71,971**	N-m/kg
No. of Stages =	**3**	
Discharge Temperature, T_2	**99.9**	°C
Rotational Speed =	**5,754**	rpm
Shaft Power, P_{shaft} =	**3,622.0**	kW

Data Table reproduced from: "GPSA Engineering Data Book, 11th Edition-SI, 1998"

Component	Critical Pressure, kPa (abs)	Critical Temperature, K	Molecular Weight	Specific Heat at constant pressure, C_p, KJ/kg-K
Methane	4,599	190.56	16.043	2.204
Ethane	4,880	305.41	30.07	1.7053
Propane	4,240	369.77	44.097	1.6242
Isobutane	3,640	407.82	58.123	1.6164
n-Butane	3,784	425.1	58.123	1.6514
Isopentane	3,381	460.35	72.15	1.6071
n-Pentane	3,365	469.65	72.15	1.6233
Neopentane	3,199	433.71	72.15	1.632
n-Hexane	3,030	506.4	86.177	1.6151
n-Heptane	2,740	539.2	100.204	1.6074
n-Octane	2,490	568.4	114.231	1.6026
n-Nonane	2,280	594.7	128.258	1.599
n-Decane	2,100	617.7	142.285	1.5962
Carbon Dioxide	7,374	304.11	44.01	0.83294
Hydrogen Sulfide	8,963	373.37	34.082	0.99794
Oxygen	5,043	154.59	32	0.91673
Nitrogen	3,398	126.21	28.0134	1.0395
Water	22,064	647.1	18.01	1.8617
Sulfur Dioxide	7,884	430.8	64.065	0.61942
Air	3,771	132.43	28.9625	1.004

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U. S. Customary Units

Inputs:

Inlet Pr., P_1	**30**	psia		=Input Values
Inlet Temp., T_1	**104**	°F		=Calculated Values
Disch. Pr., P_2	**100**	psia		
Mass flow, M	**300,000.0**	lb/h		

Calculations:

Component	mole fraction	Component Critical Press., psia	Pseudo-Critical Press., P_{pc}, psia	Component Critical Temp., R	Pseudo-Critical Temp., T_{pc}, R	Component Molecular Wt.	Pseudo-Molecular wt., MW	Specific Heat at const. press., C_p, Btu/lb-°F	Pseudo-Specific Heat at const. press., C_p, Btu/lb-°F
Ethane	**0.05**	707	35.3	549.92	27.50	30.069	1.50	0.4088	0.0204
Propane	**0.8**	616	492.4	665.92	532.74	44.096	35.28	0.3897	0.3118
n-Butane	**0.15**	551	82.6	765.55	114.83	58.122	8.72	0.39649	0.0595
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
		0	0.0	0	0.00	0	0.00	0	0.0000
	1		**610.4**		**675.06**		**45.50**		**0.392**

Inlet compressibility factor, Z_1 =	**0.972**		(Calculated from "**Comp. Factor US**" worksheet)
Specific Heat Ratio, $\kappa_1 = C_p / C_v$	**1.125**		$C_p/(C_p-(1.986 / MW))$
Inlet volume flow **@P_1&T_1**, Q_1	**21,538**	ft^3/min	$M*10.73*(T_1+460)*Z_1 / P_1*MW*60$

Table 1
Typical Centrifugal Compressor Frame Data

Frame	Nominal Inlet Volume flow		Nominal Polytropic head		Nominal Polytropic efficiency (%)	Nominal Rotational Speed (RPM)	Nominal Impeller Diameter	
	English (ICFM)	Metric (m^3/h)	English (ft-lb_f/lb_m)	Metric (N-m/kg)			English (inch)	Metric (mm)
A	1,000-7,000	1,700-12,000	10,000	30,000	76	11,000	16	406
B	6,000-18,000	10,000-31,000	10,000	30,000	76	7,700	23	584
C	13,000-31,000	22,000-53,000	10,000	30,000	77	5,900	30	762
D	23,000-44,000	39,000-75,000	10,000	30,000	77	4,900	36	914
E	33,000-65,000	55,000-110,000	10,000	30,000	78	4,000	44	1,120
F	48,000-100,000	82,000-170,000	10,000	30,000	78	3,300	54	1,370

(Table reproduced from page 234 of "Pipeline Rules of Thumb Handbook" by E.W. McAllister, 3rd Ed., Gulf Publishing Company, Houston,TX)

***Note*: Nominal polytropic head values have been calculated using the "Chart" worksheet and not referred from Table 1**

Frame Selection	C		(Select from Table 1 based on inlet volume flow)
$H_{poly-nom}$ =	**8,442**	ft-lb_f / lb_m	(from polynomial equation from **"Chart US"** worksheet)
η_{poly} =	**77**	%	(From Table 1)
N_{nom} =	**5,900**	rpm	(FromTable 1)

Pr. Ratio, r_P =	3.33		P_2/P_1
n/(n-1) =	6.91		$(\kappa_1/(\kappa_1-1))*\eta_{poly}$
T_2 =	671.36	R	$T_1*(r_P)^{(n-1)/n}$ (compressor discharge temperature)
	211.4	°F	

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Approved By:

Discharge compressibility factor, Z_2 =	**0.941**	(Calculated from "**Comp. Factor US**" worksheet)
Average Compressibility, Z_{avg} =	**0.956**	$(Z_1+Z_2)/2$

Average κ-value

The inlet κ value is generally used for polytropic head calculations. The polytropic head equation is insensitive toκ-value (and therefore n-value) within the limits that κ normally varies during compression. This is because any multiplier in the polytropic head equation tends to balance corresponding errors in the (n-1)/n exponent.

Thus,

$\kappa_{avg} = \kappa_1$ =	1.125		
Polytropic Head, H_{poly} =	**24,089**	ft-lb_f / lb_m	(For equation refer Head eqn sheet)

Number of Stages

Definition of Stage *: For the purpose of this spreadsheet, a stage is defined as an impeller-diffuser pair. A series of stages will comprise a 'section' or 'process stage' between which there is no intercooling or loss or gain in flow (i.e. no sidestreams, bypassing or injection) & whose rotational speeds are in fixed ratio to each other.*

DEP 31.29.40.10-Gen. *: "Single section compressors with in-line impeller arrangements shall have no more than 9 impellers per casing. Two section compressors shall have no more than 8 impellers per casing. Compressors with one side-stream shall have a maximum of 7 impellers per casing, for each additional sidestream one additional impeller less in order to have sufficient space for adequate mixing of main & side streams."*

Thus number of stages =	2.9		$(H_{poly}/H_{poly\text{-}nom})$
	3		(Round-up to the next whole integer if calculated stages **>X**.2 & round-down if **≤ X**.2, where **X** = a whole integer)
Calculated polytropic head per stage =	**8,030**	ft-lb_f / lb_m	

Rotational Speed

N_{nom} =	**5,900**	rpm	
Actual rotational speed =	**5,754**	rpm	$N_{nom}*((H_{poly}/H_{poly\text{-}nom}*\text{No. of Stages})^{0.5})$

Shaft Power, P_{shaft}

Gas Power Requirement, P_{gas} =	4,740.0	hp	$M*H_{poly}/(1.98E+6*\eta_{poly})$

Table 2

Approximate Mechanical Losses as a Percentage of Gas Power Requirement

Gas Power Requirement		Mechanical Losses, L_m,
English (hp)	Metric (kW)	%
0-3,000	0-2,500	3
3,000-6,000	2,500-5,000	2.5
6,000-10,000	5,000-7,500	2
10,000+	7,500+	1.5

(Table reproduced from page 236 of "Pipeline Rules of Thumb Handbook" by E.W. McAllister, 3rd Ed., Gulf Publishing Company, Houston,TX)

Mechanical Losses for given example:

L_m =	**2.5**	%	(Table 2)
	118.5	hp	

Shaft power requirement is sum of gas power requirement and mechanical losses. Thus

P_{shaft} =	4,858.5	hp
	4,859	hp

Summary of Results:

Polytropic Head, H_{poly} =	**24,089**	ft-lb_f / lb_m
No. of Stages =	**3**	
Discharge Temperature, T_2	**211.4**	°F
Rotational Speed =	**5,754**	rpm
Shaft Power, P_{shaft} =	**4,859.0**	hp

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Checked By:
Approved By:

Data Table reproduced from: "GPSA Engineering Data Book, 12th Edition-FPS, 2004"

Component	Critical Pressure, psia	Critical Temperature, ˚F	Molecular Weight	Specific Heat at constant pressure, C_p, Btu/lb-˚F
Methane	667	-116.66	16.042	0.52725
Ethane	706.6	89.92	30.069	0.4088
Propane	615.5	205.92	44.096	0.3897
Isobutane	527.9	274.41	58.122	0.39709
n-Butane	550.9	305.55	58.122	0.39649
Isopentane	490.4	369	72.149	0.38311
n-Pentane	488.8	385.8	72.149	0.38882
Neopentane	463.5	321	72.149	0.39126
n-Hexane	436.9	453.8	86.175	0.38696
n-Heptane	396.8	512.9	100.202	0.38566
n-Octane	360.7	564.2	114.229	0.38446
n-Nonane	330.7	610.8	128.255	0.38358
n-Decane	304.6	652.2	142.282	0.38294
Carbon Dioxide	1,070	87.76	44.01	0.19875
Hydrogen Sulfide	1,306.5	212.81	34.082	0.23811
Oxygen	731.4	-181.43	31.9988	0.21894
Nitrogen	492.5	-232.53	28.0135	0.24829
Water	3,200.1	705.1	18.0153	0.44476
Sulfur Dioxide	1,143	315.48	64.065	0.14735
Air	551.9	-220.97	28.9586	0.23992

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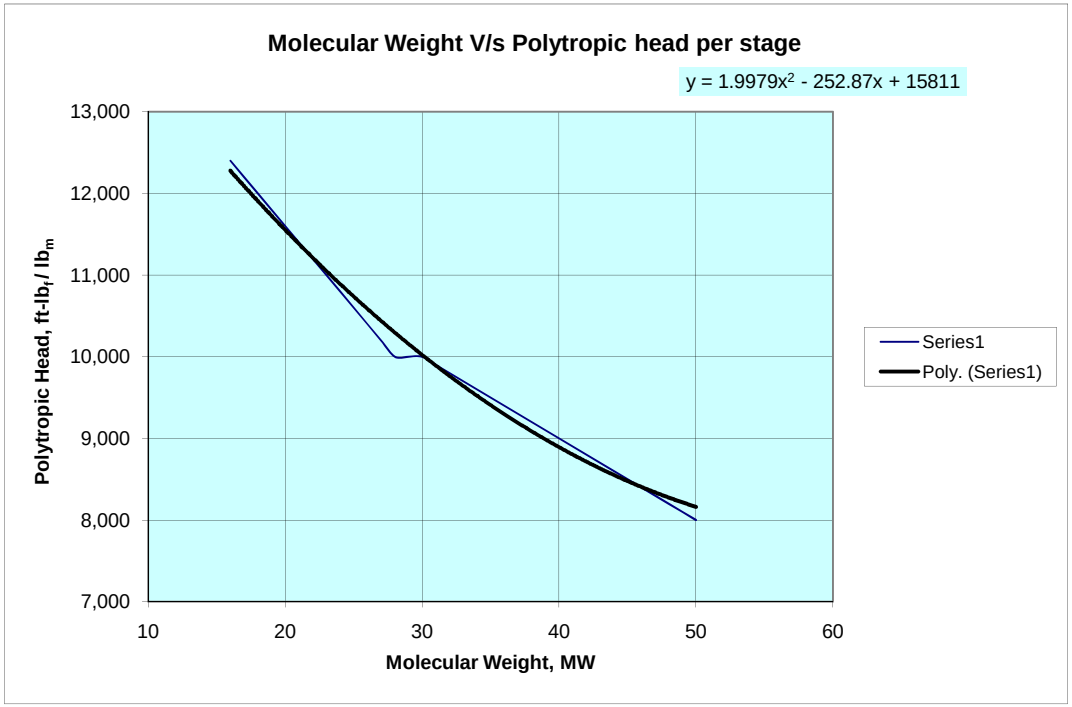
Molecular Weight, MW	Polytropic head per stage, ft-lb_f/lb_m	Calculated head per eqn., ft-lb_f/lb_m	Error % for tabulated and eqn. values
16	12,400	12,277	-1.00
17	12,200	12,090	-0.90
18	12,000	11,907	-0.78
19	11,800	11,728	-0.61
20	11,600	11,553	-0.41
21	11,400	11,382	-0.16
22	11,200	11,215	0.13
23	11,000	11,052	0.47
24	10,800	10,893	0.86
25	10,600	10,738	1.30
26	10,400	10,587	1.80
27	10,200	10,440	2.35
28	10,000	10,297	2.97
29	10,000	10,158	1.58
30	10,000	10,023	0.23
31	9,900	9,892	-0.08
32	9,800	9,765	-0.36
33	9,700	9,642	-0.60
34	9,600	9,523	-0.80
35	9,500	9,408	-0.97
36	9,400	9,297	-1.10
37	9,300	9,190	-1.18
38	9,200	9,087	-1.23
39	9,100	8,988	-1.23
40	9,000	8,893	-1.19
41	8,900	8,802	-1.10
42	8,800	8,715	-0.97
43	8,700	8,632	-0.78
44	8,600	8,553	-0.55
45	8,500	8,478	-0.26
46	8,400	8,407	0.08
47	8,300	8,339	0.48
48	8,200	8,276	0.93
49	8,100	8,217	1.45
50	8,000	8,162	2.03



"To determine the number of stages (using the impeller and diffuser defined as the stage), assume 10,000 ft-lb_f/lb_m of head per stage. This value can be used if the molecular weight is in the range of 28 to 30. For other molecular weights, this initial value must be modified. As a rule of thumb, lower the head per stage by 100 ft-lb_f/lb_m for each unit increase in molecular weight. Conversely, raise the allowable head per stage 200 ft-lb_f/lb_m for a unit decrease in molecular weight. The rule of thumb gives the best results for a molecular weight range of 2 through 70. Because this sizing procedure is being used only to establish the rough size of the compressor, the upper range may be extended with some loss in accuracy." **- Page 196, Compressors: Selection and Sizing, 3rd Edition, by Royce N. Brown**

Revision: 0
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Checked By:
Approved By:

This sheet is applied for the "Polytropic Head US Cust" worksheet

Calculations for Inlet Compressibility Factor, Z_1 using Redlich-Kwong Equation of State

Molecular Weight, M	45.50	g/g-mol
Pseudo-Critical Temp., T_c:	375.04	°K
Pseudo-Critical Press., P_c:	41.53	atmA
Inlet temperature, T_1	313.33	°K
Inlet Pressure, P_1	2.041	atmA

Constants Used:

Gas Constant, R: 0.08206 L*atm/g-mol*°K

Calculated Parameters:

Reduced Temperature, T_r	0.835	(T/T_c)
Reduced Pressure, P_r	0.049	(P/P_c)

Equations:

A^2 =	0.03293
B =	0.00510
q =	-0.02781
r =	0.00017
f =	-0.30553
g =	-0.06497
C =	0.00000
D =	IRRELEVANT
E1 =	IRRELEVANT
φ =	0.02948
E =	IRRELEVANT
z1 =	0.97156
z2 =	0.00879
z3 =	0.01965
z0 =	IRRELEVANT
z =	**0.972**

Calculations for Discharge Compressibility Factor, Z_2 using Redlich-Kwong Equation of State

Molecular Weight, M	45.50	g/g-mol
Pseudo-Critical Temp., T_c:	375.04	°K
Pseudo-Critical Press., P_c:	41.53	atmA
Discharge temperature, T_2	372.98	°K
Discharge Pressure, P_2	6.805	atmA

Constants Used:

Gas Constant, R: 0.08206 L*atm/g-mol*°K

Calculated Parameters:

Reduced Temperature, T_r	0.995	(T/T_c)
Reduced Pressure, P_r	0.164	(P/P_c)

Equations:

A^2 =	0.07100
B =	0.01427
q =	-0.05653
r =	0.00101
f =	-0.27681
g =	-0.05624
C =	0.00001
D =	0.31222
E1 =	0.02581
φ =	IRRELEVANT
E =	0.29553
z1 =	IRRELEVANT
z2 =	IRRELEVANT
z3 =	IRRELEVANT
z0 =	0.94108
z =	**0.941**

Revision: 0
Prepared By:
Checked By:
Approved By:

SI Units

Inputs

Head Coefficient, μ	0.48	dimensionless	(Recommended Value)
Calc. Polytropic Head per Stage, H_{poly}	23,990	N-m/kg	(Calculated value from '**Polytropic Head SI**' worksheet)
Impeller diameter	762	mm	(Refer Table 1 on '**Polytropic Head SI**' worksheet)

Calculations

Impeller tip Speed, u_2	223.6	m/s
Approx. Rotational Speed, N	5,603	rpm

US Customary Units

Inputs

Head Coefficient, μ	0.48	dimensionless	(Recommended Value)
Calc. Polytropic Head per Stage, H_{poly}	8,030	ft-lb_f / lb_m	(Calculated value from '**Polytropic Head US Cust**' worksheet)
Impeller diameter	30	inch	(Refer Table 1 on '**Polytropic Head US Cust**' worksheet)

Calculations

Impeller tip Speed, u_2	733.9	fps
Approx. Rotational Speed, N	5,607	rpm