GAS PROPERTIES CALCULATION SHEET

MIXED GAS

INPUT GIVEN CONDITION OR QUANTITY IN RED COLOR CELLS

A. Partial gas composition given in % mole Gas name : Synthesis Gas

Pressure, p =	27.55	bar A	Temperature, t =	36	^{o}C , T =	309	^{o}K

Designation	Gas component						Total	Note
	CH_4	H_2	N_2	Ar	H_2O			
MWi	16.042	2.02	28.02	39.94	18.02		-	Table 1.
MMi	-	-	-	-	-		-	
% mole (Mi)	0.737	73.225	25.500	0.303	0.235		100	
MCpi	36.53	28.8	29.18	20.79	33.58		-	Table 1.
p_{CR-i}	46.40	13	33.9	48.6	221.2		-	Table 1.
T_{CR-i}	191.10	33.3	126.7	151.1	647.8		-	Table 1.
0.01 . (%M_i).(MW_i)	0.118	1.479	7.145	0.121	0.042		8.906	Total = MW
0.01 . (%M_i).($p_{CR\,i}$)	0.342	9.519	8.645	0.147	0.519		19.172	Total = pcr , equation A.8
0.01 . (%M_i).($T_{CR\,i}$)	1.409	24.384	32.309	0.457	1.520		60.079	Total = T_{CR} , equation A.9
0.01x (%M_i.MCp_i)	0.269	21.089	7.441	0.063	0.079		28.941	Total = MCp
p_{red} = p / p_{CR}	-	-	-	-	-	-	1.437	p_{red} = p / pcr
T_{red} = T / T_{CR}	-	-	-	-	-	-	5.143	T_{red} = T / Tcr
k	-	-	-	-	-	-	1.403	Equation A.7, k = MCp/(MCp-8.314)
R	-	-	-	-	-	-	0.934	R = 8.314 / MW
Z	-	-	-	-	-	-	1.020	Fig. 8 and fig. 9.
DS	-	-	-	-	-	-	9.550	Equation A.10
DSn	-	-	-	-	-	-	0.397	DS_n = 101.3 / (273 x R)

Flowrate conversion at above condition

If flowrate given in :	**kgmol/hr**		**If flowrate given in :**	**Nm^3/hr**	
Molecular flow, G_{mol}	600	kgmol/hr	Normal flow, Q_n	13430	Nm^3/hr
Normal flow, Q_n	13443.6	Nm^3/hr	Molecular flow, G_{mol}	599.39	kgmol/hr
Actual flow, Q	559.50	m^3/hr	Actual flow, Q	558.93	m^3/hr
Mass flow, G	5343.45	kg/hr	Mass flow, G	5338.06	kg/hr
If flowrate given in :	**kg/hr**		**If flowrate given in :**	**m^3/hr**	
Mass flow, G	5340	kg/hr	Actual flow, Q	560	m^3/hr
Molecular flow, G_{mol}	599.61	kgmol/hr	Normal flow, Q_n	13455.6398	Nm^3/hr
Normal flow, Q_n	13434.88917	Nm^3/hr	Molecular flow, G_{mol}	600.54	kgmol/hr
Actual flow, Q	559.14	m^3/hr	Mass flow, G	5348.25	kg/hr

General notes :

1. Alll black cell contain formula for calculation.
2. Just blank or fill " - " for unnecessary gas component column
3. Fill data in the last column for more gas column component . Copy black cell in left column and paste it in the last column

B. Partial gas composition given in kgmol/hr Gas name : Synthesis Gas

Pressure, p =	27.55	bar A	Temperature, t =	36	^{o}C, T =	309	^{o}K

Designation	Gas component						Total	Note
	CH_4	H_2	N_2	Ar	H_2O			
MWi	16.042	2.02	28.02	39.92	18.02		-	Table 1.
MMi (kgmol/hr)	29.920	2970.9	1034.6	12.3	9.5		4057.220	Total = MM = Σ(MMi)
Supporting row	4057.220	4057.220	4057.220	4057.220	4057.220	4057.220	4057.220	Don't delete this row
% mole (Mi)	0.737	73.225	25.500	0.303	0.234		100	Mi = 100 x Mmi / MM
MCpi	36.53	28.8	29.18	20.79	33.58		-	Table 1.
p_{CR-i}	46.40	13	33.9	48.6	221.2		-	Table 1.
T_{CR-i}	191.10	33.3	126.7	151.1	647.8		-	Table 1.
0.01 . (%M_i).(MW_i)	0.118	1.479	7.145	0.121	0.042		8.906	Total = MW
0.01 . (%M_i).($p_{CR\,i}$)	0.342	9.519	8.645	0.147	0.518		19.171	Total = pcr , equation A.8
0.01 . (%M_i).($T_{CR\,i}$)	1.409	24.384	32.309	0.458	1.517		60.077	Total = T_{CR} , equation A.9
0.01x (%M_i.MCp_i)	0.269	21.089	7.441	0.063	0.079		28.941	Total = MCp
p_{red} = p / p_{CR}	-	-	-	-	-	-	1.437	p_{red} = p / pcr
T_{red} = T / T_{CR}	-	-	-	-	-	-	5.143	T_{red} = T / Tcr
k	-	-	-	-	-	-	1.403	Equation A.7, k = MCp/(MCp-8.314)
R	-	-	-	-	-	-	0.934	R = 8.314 / MW
Z	-	-	-	-	-	-	1.020	Fig. 8 and fig. 9.
DS	-	-	-	-	-	-	9.551	Equation A.10
DSn	-	-	-	-	-	-	0.397	DS_n = 101.3 / (273 x R)

Flowrate conversion at above condition

If flowrate given in :	kgmol/hr	
Molecular flow, G_{mol}	4057.22	kgmol/hr
Normal flow, Q_n	90905.8	Nm^3/hr
Actual flow, Q	3783.34	m^3/hr
Mass flow, G	36133.14	kg/hr

General notes :

1. Alll black cell contain formula for calculation.
2. Just blank or fill " - " for unnecessary gas component column
3. Fill data in the last column for more gas component. Copy black cell in left column and paste it in the last column
4. Don't delete supporting row (yellow cell)

CH4	H2	N2	H20
36	36	36	36
36.64	28.82	29.18	33.57

C. Partial gas composition given in kg/hr

Gas name : Synthesis Gas

Pressure, p =	27.55	bar A	Temperature, t =	36	^{o}C, T =	309	^{o}K

Designation	Gas component						Total	Note
	CH_4	H_2	N_2	Ar	H_2O			
MWi	16.042	2.02	28.02	39.94	18.02		-	Table 1.
Gi (kg/hr)	480	6000	29000	490	170		36140	Total = G
MMi (kgmol/hr)	29.92	2970.30	1034.98	12.27	9.43		4056.896	Total = G_{mol}
Supporting row	4056.896	4056.896	4056.896	4056.896	4056.896	4056.896	4056.896	Don't delete this row
% mole (Mi)	0.738	73.216	25.512	0.302	0.233		100	
MCpi	36.64	28.82	29.18	20.79	33.57		-	Table 1.
p_{CR-i}	46.40	13	33.9	48.6	221.2		-	Table 1.
T_{CR-i}	191.10	33.3	126.7	151.1	647.8		-	Table 1.
0.01 . (%M_i).(MW_i)	0.118	1.479	7.148	0.121	0.042		8.908	Total = MW
0.01 . (%M_i).($p_{CR\,i}$)	0.342	9.518	8.648	0.147	0.514		19.170	Total = pcr , equation A.8
0.01 . (%M_i).($T_{CR\,i}$)	1.409	24.381	32.323	0.457	1.506		60.077	Total = T_{CR} , equation A.9
0.01x (%M_i.MCp_i)	0.270	21.101	7.444	0.063	0.078		28.956	Total = MCp
p_{red} = p / p_{CR}	-	-	-	-	-	-	1.437	p_{red} = p / pcr
T_{red} = T / T_{CR}	-	-	-	-	-	-	5.143	T_{red} = T / Tcr
k	-	-	-	-	-	-	1.403	Equation A.7, k = MCp/(MCp-8.314)
R	-	-	-	-	-	-	0.933	R = 8.314 / MW
Z	-	-	-	-	-	-	1.020	Fig. 8 and fig. 9.
DS	-	-	-	-	-	-	9.553	Equation A.10
DSn	-	-	-	-	-	-	0.398	DS_n = 101.3 / (273 x R)

Flowrate conversion at above condition

Flowrate given in :	kg/hr	
Mass flow, G	36140	kg/hr
Molecular flow, G_{mol}	4056.90	kgmol/hr
Normal flow, Q_n	90898.58	Nm^3/hr
Actual flow, Q	3783.04	m^3/hr

General notes :

1. Alll black cell contain formula for calculation.
2. Just blank or fill " - " for unnecessary gas component column
3. Fill data in the last column for more gas component. Copy black cell in left column and paste it in the last column
4. Don't delete supporting row (yellow cell)

Gas or Vapor Name	Hydrocar - bon Refer. Symbols	Chemical formula	MW (kg/kgmol)	k at 15.5 °C	Critical condition		MCp (kJ/kgmol.°K)		
					p_{CR} (bar A)	T_{CR} (°K)	at 0 °C	at 100 °C	at 197 °C
Acetylene	C_2 =	C_2H_2	26.04	1.24	62.4	309.4	42.16	48.16	53.17
Air (dry)		N_2+O_2	28.97	1.4	37.7	132.8	29.05	29.32	-
Ammonia		NH_3	17.03	1.31	112.8	406.1	34.65	37.93	-
Argon		Ar	39.94	1.66	48.6	151.1	20.79	20.79	20.79
Benzene		C_6H_6	78.11	1.12	49.2	562.8	74.18	103.52	-
Iso-Butane	iC_4	C_4H_{10}	58.12	1.1	36.5	408.3	89.75	116.89	141.88
n-Butane	nC_4	C_4H_{10}	58.12	1.09	38	425.6	93.03	117.92	141.04
Iso-Butylene	iC_4 _	C_4H_8	56.1	1.1	40	418.3	83.36	104.96	124.87
Butylene	nC_4 _	C_4H_8	56.1	1.11	40.2	420	83.4	105.06	-
Carbon Dioxide		CO_2	44.01	1.3	74	304.4	36.04	40.08	43.7
Carbon Monoxide		CO	28.01	1.4	35.2	134.4	29.1	29.31	29.63
Chlorine		Cl_2	70.91	1.36	77.2	417.2	35.29	35.53	35.9
Coke Oven Gas [1]		-	10.71	1.35	28.1	109.4	31.95	34.21	-
n-Decane	nC_{10}	$C_{10}H_{22}$	142.28	1.03	22.1	619.4	218.35	280.41	-
Ethane	C_2	C_2H_6	30.07	1.19	48.8	305.6	49.49	62.14	74.37
Ethyl Alcohol		C_2H_5OH	46.07	1.13	63.9	516.7	69.92	81.97	-
Ethyl chloride		C_2H_4Cl	64.52	1.19	52.7	460.6	59.61	70.16	-
Ethylene	C_2 _	C_2H_4	28.05	1.24	51.2	283.3	40.9	51.11	60.55
Flue Gas [1]		-	30	1.38	38.8	146.7	30.17	30.98	-
Helium		He	4	1.66	2.3	5	20.79	20.79	20.79
n-Heptane	nC_7	C_7H_{16}	100.2	1.05	27.4	540.6	161.2	202.74	239.8
n-Hexane	nC_6	C_6H_{14}	86.17	1.06	30.3	508.3	138.09	174.27	206.88
Hydrogen		H_2	2.02	1.41	13	33.3	28.67	29.03	29.25
Hydrogen Sulfide		H_2S	34.08	1.32	90	373.9	33.71	35.07	36.88
Methane	C_1	CH_4	16.04	1.31	46.4	191.1	34.5	40.13	44.64
Methyl Alcohol		CH_3OH	32.04	1.2	79.8	513.3	42.67	55.32	-
Methyl Chloride		CH_3Cl	50.49	1.2	66.7	416.7	45.6	49.82	-
Natural Gas [1]		-	18.82	1.27	46.5	210.6	34.66	39.54	-
Nitrogen		N_2	28.02	1.4	33.9	126.7	29.1	29.31	29.46
n-Nonane	nC_9	C_9H_{20}	128.25	1.04	23.8	596.1	197.07	253.1	-
Iso-Pentane	iC_5	C_5H_{12}	72.15	1.08	33.3	461.1	112.09	145.56	-
n-Pentane	nC_5	C_5H_{12}	72.15	1.07	33.7	470.6	115.21	145.94	173.96
Pentylene	C_5 _	C_5H_{10}	70.13	1.08	40.4	474.4	102.11	130.37	-
n-Octane	nC_8	C_8H_{18}	114.22	1.05	25	569.4	176.17	226.17	-
Oxygen		O_2	32	1.4	50.3	154.4	29.17	29.92	30.78
Propane	C_3	C_3H_8	44.09	1.13	42.5	370	68.34	88.68	107.71
Propylene	C_3 ..	C_3H_6	42.08	1.15	46.1	365.6	60.16	75.7	90.54
Blast Furnace Gas [1]		-	29.6	1.39	-	-	29.97	30.64	-
Cat Cracker Gas [1]		-	28.83	1.2	46.5	286.1	46.16	57.31	-
Sulphur Dioxide		SO_2	64.06	1.24	78.7	430.6	38.05	40	45.7
Water Vapor		H_2O	18.02	1.33	221.2	647.8	33.31	34.07	34.9

Note : For MCp, use linier interpolation to determine MCp at other temperature.

MCp as function of temperature. Copy this cells and paste at upper the table and fill red cell, example on table C.

dry air
25
29.125

NH3
30
35.634

H2
34
28.81

CO2
100
40.08

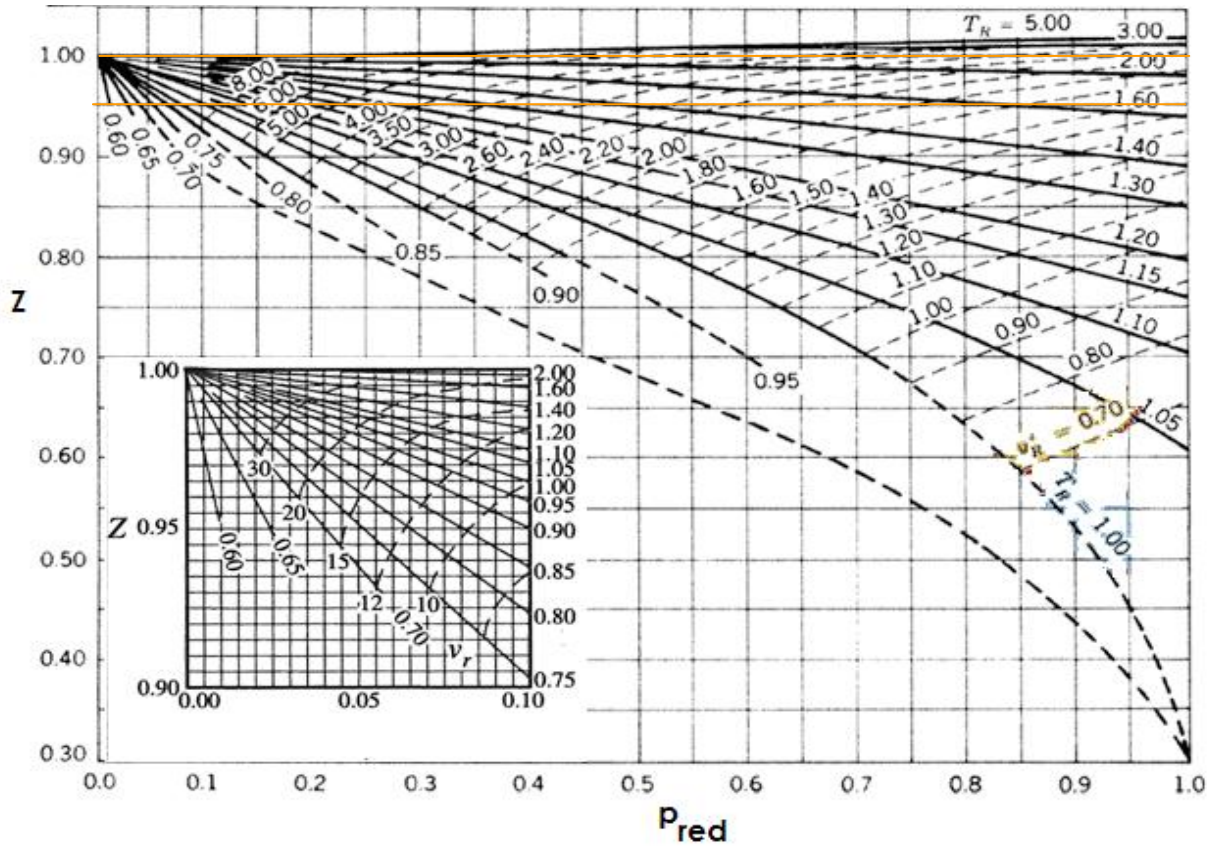
ethane
25
52.65

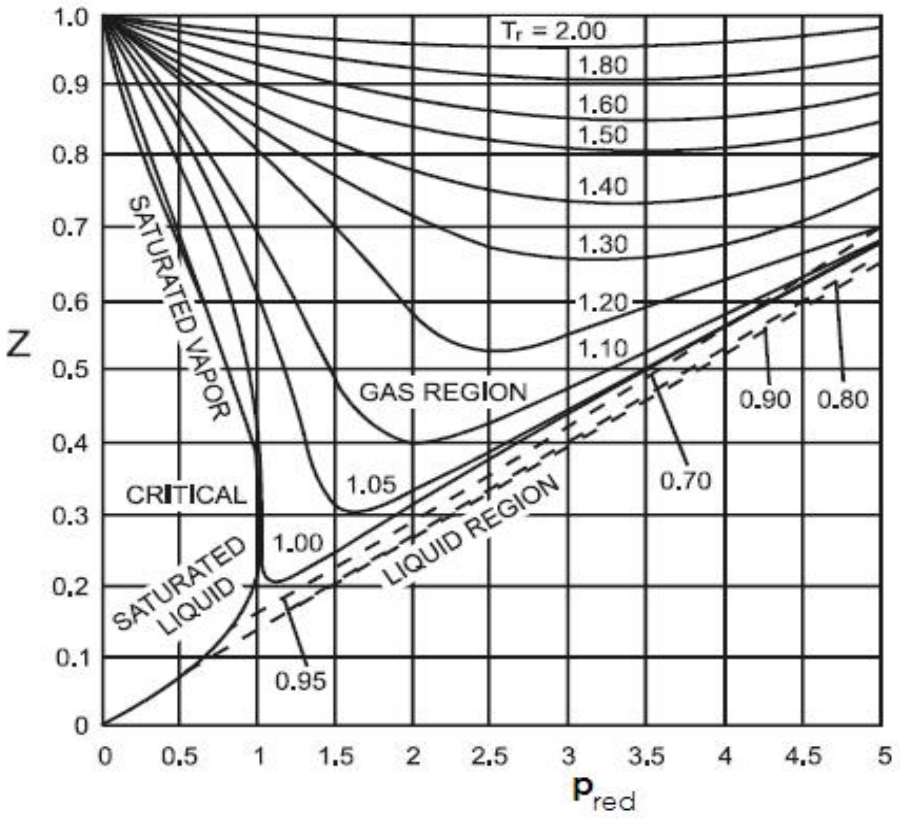
CH4
55
37.73

N2
65
29.24

O2
30
29.38

H20
32
33.54


Z
p_{red}
T_R = 5.00
3.00
2.00
1.60
1.40
1.30
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
v_r
30
20
15
12
10


Z
p_{red}
T_r = 2.00
1.80
1.60
1.50
1.40
1.30
1.20
1.10
1.05
1.00
0.95
0.90
0.80
0.70
SATURATED VAPOR
GAS REGION
CRITICAL
SATURATED LIQUID
LIQUID REGION
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5