Maharashtra Multi Distributors Ltd.™
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Technical Data

All the technical data you need to know is here for your reference. We have gleaned this information over the past 25 years from various sources / publications for your convenience

LIQUIFIED PETROLEUM GAS (LPG)

The term LPG applies to a mixture of light hydrocarbons derived from petroleum which are gaseous at ambient temperature and atmospheric pressure, however can be condensed to liquid state at ambient temperature by application of moderate pressure. LPG available in India is normally a mixture of commercial butane and propane, with composition as per the following.

COMPOSITION	(% volume)
Propane	27.5%
ISO butane	14.7%
N. Butane	55.7%
CS	2.0%
Liquid Density @ 15ºC	0.562
Vapour Pressure @ 100ºC	83 kg/cm^2

CALORIFIC VALUES OF VARIOUS SOLID AND LIQUID FUELS

	KCal/kg	Btu/lb	
Wood (dry)	4400	8,000-9,000	
Lignite	4900	9,000-13,000	
Coal	3800	12,000-13,000	
Coke	6600	12,000-12,750	
Diesel	10300	19,300	
Light Fuel Oil	9500	17,800	
Heavy Fuel Oil	10000	18,750	
Petrol	11400	21,300	
Kerosene	10550	19,700	
LPG			
Btu/lb	21,300	Kcal/lb	5,368
Btu/kg	46,800	Kcal/kg	11,400
Btu/ft^3	3,200	Kcal/ft^3	806
Btu/litre	122	Kcal/litre	308
Max. Temp. in Air	2000°C	Kcal/mt^3	30,600
Max. Temp. in Oxygen	2800°C		
Ignition Temperature	461°C		

TECHNICAL DATA

Calorific Value	: Kcal / Kg (Btu / Lb)
	: Kcal / Litre of Vapour (Btu / Cft of Vapour)
Specific Gravity	: Liquid (Water = 1)
	: Vapour (Air = 1)
Specific Volume	: Litres of Vapour / Kg of Liquid
	: Cft of Vapour / Lb of Liquid

CONVERSION FACTORS FOR DIFFERENT UNITS

Heat Unit:	1 Kcal	= 3.97 B.T.U. (British Thermal Unit)
Pressure:	1 kg / cm^2	= 14.22 Pounds / Sq. Inch
	1 Atmosphere	= 760 mm of Mercury
		= 29.92 Inches of Mercury
	300 mm Water	= 30 gm / cm^2
	Column	= 11.81 Inches Water Column
		= 0.43 / Sq. Inch

TECHNICAL INFORMATION ABOUT CONNECTIONS

The valves in the LPG installations play a vital part in the system since the material is handled under high pressure conditions. Decades ago, the oil companies used a hand wheel operated valve on their cylinders. The valve used to have left male threads at the outlet where the regulator used to be connected. When LPG came to be drawn under high pressure, a flexible high pressure connection with a suitable coupling arrangement used to be screwed on to the outlet. This developed into a standard connection and came to be termed as 'Male Cylinder Valve' (MECV) connection.

ABBREVIATIONS:

The following abbreviations are used in this catalogue.

Cu - Copper or Compression fitting

B.S.P.T.M.	-	British Standard Pipe Taper Male
B.S.P.T.F.	-	British Standard Pipe Taper Female
B.S.P.P.M.	-	British Standard Pipe Parallel Male
B.S.P.P.F.	-	British Standard Pipe Parallel Female
M.E.C.V.	-	Male European Cylinder Valve (Left hand)
F.E.C.V.	-	Female European Cylinder Valve (Left hand)

With the advancement in technology, the MECV valves with left hand threads were replaced by the Self Closing (SC) 'Click on type' valve. Yet several installations continue to use the left hand threaded connection where high pressure LPG is involved.

The threads in these valves conform to the British Standard Pipe (B.S.P.) threads. These are of two types :

1) Taper threads used for direct pressure tight joints on lines.
2) Parallel threads or fastening threads (B.S.P.-F) generally used for fastening. There are also the compression type threads where flexible connections are to be provided

LEFT HAND PARALLEL THREAD

Specifications for the LPG burners, fittings, accessories and allied equipment are given in the imperial system with their equivalence, where possible in the metric system.

Technical Data

PHYSICAL PROPERTIES OF LPG

BOILING POINT AND VAPOUR PRESSURE

Normal boiling points of pure propane and butane are :

Propane	n-Butane	Isobutane
-42° C	-0.5° C	-12° C

From the user's point of view, a high vapour pressure is an advantage and therefore LPG should contain as much propane as possible. IS : 4576 specifies the maximum permissible vapour pressure of LPG at 65°C to be 16.87kg/cm^2 gauge (17.6 bar absolute). Assuming that butane is entirely n-butane, the upper limit of propane in LPG is 60% by weight. Usually, LPG contains 27.5% propane and the balance is largely butane with small quantities of ethane, ethylene, pentane and pentene.

VAPORISATION

In one of the most common methods of storage and handling, LPG is held under pressure at near ambient temperature. At 30°C, this pressure would be in the region of 4.7 to 6.4 bar gauge depending upon compositions. If there is a leak, the escaping liquid would be exposed to atmospheric pressure and maximum temperature which the liquid can have at this pressure is its normal boiling point, e.g. -42 °C in the case of propane and -0.5 °C in the case of butane. Therefore, the escaping liquid will undergo a large drop in temperature. If propane at 30°C leaks to atmosphere, the temperature of the liquid will drop to -42 °C.

Heat available from within the liquid as a result of this cooling is used up in instantaneously vaporising a part of the liquid. This phenomenon of instantaneous vaporisation of a part of the liquid is known as flashing of the liquid. When pressurised LPG is released to atmosphere, the proportion of liquid, which vaporises due to flashing amounts to 20% to 40% depending upon the composition of the liquid.

The vapour generated due to flashing and the remaining liquid will be at the normal boiling point temperature of the liquid. This low temperature will cause cooling of the ambient temperature and condensation of moisture in the air. The resultant walling around leakage source indicates that a leakage is taking place.

In a second method of storing LPG, Refregerated Storage, less common though, the pressure in the storage tank is practically atmospheric. Under refrigeration, at a temperature at which the vapour pressure of the liquid is nearly equal to the atmospheric pressure. Any leakage in this case does not cause any flash vaporisation because the liquid is already at its normal boiling point. If the spillage occur on the ground, the liquid will spread under gravity and vaporisation will occur by supply of heat from the ground. If the spillage occurs on water, water underneath the LPG layer will freeze and the latent heat of freezing of the water will supply the heat requirement for LPG vaporisation.

Thus contrary to flashing, vaporisation in the case of a refrigerated liquid spillage will occur at a rate determined by the rate of heat supply to spill from the underlying ground or water.

DENSITY

Liquid LPG is immiscible with water and its density is 535 kg/m^3 at 30 ºC. Therefore, any water present in a pressurised LPG tank at room temperature settles as a bottom layer. This water can be drained by opening the outlet at the bottom of the tank provided the valve is closed before the interface reaches the valve.

The density of LPG vapour is 1.7 times that of air. Therefore, any LPG vapour released to atmosphere will form a heavy cloud at ground level. This is an important property to be borne in mind in modeling the dispersion of LPG vapour.

MELTING OR FREEZING POINT

LPG can exist as a liquid over a wide range of temperatures. The lowest temperature in the range at which liquid assumes the solid state is known as the melting point. It is such a low temperature that it is not encountered in normal operations / handling and, therefore does not have any practical significance.

BOILING POINT

A The temperature at which the vapour pressure of a liquid becomes equal to the external pressure is its boiling point. This temperature differs for the same liquid under different pressures. The normal boiling point is the temperature at which the vapour pressure reaches 760 mm of Mercury or one atmosphere.

B The boiling point of LPG presently marketed is very nearly 0 ºC. At temperatures near 0 ºC or at sub-zero temperatures, the pressure inside the container will be almost the same as atmospheric pressure. Therefore, this product cannot be used at places where the ambient temperature is near or sub-zero.

SENSIBLE PROPERTIES

Colour (Sight) : Like air LP gases are colourless, therefore, they cannot be seen. However, when liquid LPG is released from a container or a pipe it vapourises almost immediately. This produces a cooling of the surrounding air and may cause water vapour in the air to condense, freeze and become visible. In this way, LPG leak may be detected even though the gas itself is invisible.

Odour (Smell) : LPG is distinctively odourised to give warning in case of leakage. LPG is generally odourised by adding mercaptans. Its smell is detectable in air at concentrations down to 1/5th of the lower limit of flammability. In other words, it can be smelt sufficiently before it becomes dangerous enough to catch fire.

Ignition Temperature : For the combustion process or burning of LPG to occur it is necessary that an ignition source is applied. The flammable mixture of LPG vapour and air will not ignite or explode unless the ignition source is present. The source may be a spark, flame or heated material possessing sufficient heat to equal or exceed the required ignition temperature, which is in the range of 410 ºC to 580 ºC.

Calorific Value : Calorific value is defined as the amount of heat produced by complete combustion of unit mass of the fuel. It is expressed in kcal / kg The calorific value of LPG is very high and uniform which makes it an ideal fuel.

Technical Data

MOLECULAR WEIGHT, ATMOSPHERIC BOILING POINT, CRITICAL CONDITION

Property	Propane	N-Butane	Isobutane	Commercial Propane	Commercial Butane
Molecular Weight	44.097	58.124	58.124	44	58
Boiling Point, 1 atm, °C	-42.045	–0.50	–11.72	–45	–0.7
Critical Temp. °C	96.67	152.03	134.99	–95	150
Critical Pressure, atm.	41.94	37.47	36	–40	–35
Critical Volume, 1 Lt. / Mole	0.203	0.255	0.263	–0.20	–0.26

CALORIFIC VALUE AND WOBBE NUMBER

Calorific Value	Propane	N-Butane	Isobutane	Commercial Propane	Commercial Butane
Kcal / Kg.	11945	11740	11715	11900	11800
Kcal / m^3	23700	30600	30500	24000	30200
Wobbe Number	19100	21290	21180	19200	21000

MATERIAL IDENTIFICATION AND USE

(This is as per normal LPG supplied by the oil companies)

Chemical Name : Commercial Mixture Butane and Propane.

UN No. : 1075

Chemical Identity : Hydrocarbons C3H8 and C4H10 (Mixture).

Use of Product : Multi faceted energy use

Hazardous Ingredients of : EAC (HAZCHEM) 2 WE

Material Physical State : Liquid & Gas (When Pressurised)

Odour and appearance : Odourless / Colour less

Specific Gravity : 0.525 to 0.58 at 15ºC

Vapour Pressure : 16.87 Kg. / cm^2 at 65ºC

Vapour Density : Butane 2.703 Kg/NM^3
Propane 2.099 Kg/NM^3

Evaporation Rate : - 2ºC Temp. in deg C for 95% by Volume at 760 mm-kg

Boiling Point : Butane - 0.5ºC Propane - 42.1ºC

Freezing Point (CD) : - 137ºC - 187ºC

Solubility : Insoluble in water at 20ºC.

Density (g /ml) : 0.565 @ 15ºC

Coefficient of water / Oil distribution : 0.565 @ 15ºC

CONVERSION FROM VARIOUS FUELS TO LPG

Fuel	Cal Value in K Cal / Kg.	Efficiency %	Equivalent LPG requirement in Kgs. LPG Kgs. Unit.
FO	9500	60	600 kg - 1000Ltrs FO
LSHS	10300	65	650 kg - 1000Ltrs. LSHS
LDO	9500	60	600 kg - 1000Ltrs. LDO
WOOD	4400	40	175 kg - 1000Kgs. of wood
COAL	3800	40	150 kg - 1000Kgs. of Coal
LPG	11400	95	

FIRE AND EXPLOSION HAZARD OF LPG

Flammability : Gas at 1.8% to 9% mixture with air is inflammable.

Means of Extinction : Dry Chemical Powder type Fire Extinguishers, Carbon dioxide, Water spray.

Lower Explosive Limit : 1.8% (% by volume)

Upper / Higher Explosive Limit : 9.0% (% by volume)

Auto Ignition Temperature : 461ºC

Flamability Classification : 2

Hazardous product of Combustion: Carbon Monoxide, Carbon Dioxide.

Sensitivity to static discharge :High

Routes of entry :Inhalation acute

Effects :Giddiness

COMMON PROPERTIES OF COMMERCIAL LPG

(Vapour at 1 atmosphere, 15.5°C) as per oil company records

	Commercial Propane	Commercial Butane	LPG
Density lb/ft^3 kg/m^3	0.115 2.0	0.155 2.6	0.142 2.26
Specific Volume ft^3/lb mt^3/kg	8.6 0.5	6.5 0.38	7.10 0.45
Specific Gravity (Air = 1)	1.5	2.0	1.7
Specific Heat Btu/Lb (kcal/kg) CP CV	0.38 0.34	0.39 0.35	0.39 0.35
Calorific Value, Nett Btu / ft^3 Kcal/mt^3	2,300 22,600	3,000 29,000	3,200 30,600

IMPORTANT CONVERSION FACTORS

Pressure 1 lb/in ABS = 27.68 in W.C. = 2.307 FT W.C.
= 0.070306 kg/cm^2

Energy 1Btu = 2.93 x 10.4 kwh = 0.251996 Kcal.
1 kcal = 1.1628 x 10.3 kwh = 3.9683 Btu

Withdrawal rate of LPG from 19 kg cylinder should not exceed 0.5 kg/hr as it may cause drop in pressure of LPG inside cylinder.

Books Used For Reference While Preparing This Catalogue

1 ISI - 6044 Part 1 - 2000
2 ISI - 6044 Part 2 - 2001
3 OISD - 162 - 1995
4 Handbook on Industrial & Commercial LPG
5 Technical Ref. Matheson Gas Data Book
6 Gas Engineers Handbook.
7 Gas cylinder rules 2004
8 Safety in the Installation & use of gas system & appliances
9 Industrial & Commercial gas installation practice

COMPARISON OF LPG AND ELECTRICAL ENERGY

1 KW = 860 K Cal

1 Kg of LPG = 11,400 kcal

1 KW Electricity = Rs. 8.00

1 KW of LPG = as under

a) at domestic rate of LPG = Rs. 350 /14.2 kg =
Rs. 1.85 ps. (Rs. 24.64/ Kg)

b) at commercial rate of LPG = Rs. 1,200 / 19 kg.
Rs. 4.76 ps. (Rs. 63.15/ Kg)

After assessing the requirement of LPG we can offer supply of LPG either in 19 kg / 33 kg / 47.5 kg or in bulk. The minimum area required for bulk installation is given below :

AREA REQUIREMENT FOR BULK INSTALLATION

SI	Water Capacity of vessel (In liters)	Minimum distance from line of adjoining property or group of building not associated with storage and operation		Minimum distance between vessels	
		Aboveground Vessel	Underground or above ground vessel covered with earth (mound)	Above ground vessel	Underground or above ground vessel covered with earth (mound)
	Not above 2000	5 meters	3 meters	1 meters	1 meter
	Above 2000 but not above 7500	10 meters	3 meters	1 meters	1 meter
	Above 7500 but not above 10000	10 meters	5 meters	1 meters	1 meter
	Above 10,000 but not above 20,000	15 meters	7.5 meters	1.5 meters	1 meter
	About 20,000 but not above 40,000	20 meters	10 meters	2 meters	1 meter
	About 40,000 but not above 3,50,000	30 meters	15 meters	2 meters or ¼th of the sum of diameter of adjacent vessel or half the diameter of the two adjacent vessels, which ever is greater	1 meter
	Above 3,50,000 but not above 4,50,000	40 meters	15 meters		1 meter
	Above 4,50,000 but not above 7,50,000	60 meters	15 meters		1 meter
	Above 7,50,000 but not above 38,00,000	90 meters	15 meters		1 meter
	Above 38,00,000	120 meters	15 meters		1 meter

- The ground should be fairly leveled.
- The licenced area mentioned should be clearly measured.
- Approach road for truck should be available.
- No open fire such as furnace should be next to the yard.
- Electric or Telephone cables should not pass over the allocated area.
- Water of 50,000 ltrs. Should be available for fire fighting pumps.
- Power requirement of minimum 25 KW should be available.

LP GAS: AN EXCEPTIONAL ENERGY

For many years, LP Gas has played a valuable role in meeting the world's energy needs. In the future, LP Gas has the opportunity to enhance this role because of its obvious benefits as an efficient and cleaner fuel as well as its immediate contributions to delivering real greenhouse gas emissions reductions.

Global awareness about rising energy costs, the reliability of energy supplies, health and climate change are encouraging nations to make choices and LP Gas can be the solution in many applications and regions of the world. LP Gas is therefore a healthy fuel option compared to some traditional fuels used in both the developing world, where negative health consequences caused by indoor air pollution is a grave problem, and in the developed world in congested, built-up cities. The World LP Gas Association (WLPGA) demonstrates these clear benefits of LP Gas, a cleaner and modern energy through its activities and interaction with its stakeholders every day.

LP Gas unique properties allow it to be used everywhere:

PORTABLE

LP Gas can be transported, stored, and used virtually anywhere in the world. It does not require a fixed network and will not deteriorate over time.

CLEAN

LP Gas is very clean burning and has lower greenhouse gas emissions than any other fossil fuel when measured on a total fuel cycle. Originating mainly from natural gas production, it is also non-toxic and will not contaminate soil or aquifers in the event of a leak.

ACCESSIBLE

LP Gas can be accessible to everyone everywhere today without major infrastructure investment. Nothing needs to be invented and there are enough reserves to last many decades.

EFFICIENT

LP Gas is cost-effective, since a high proportion of its energy content is converted into heat. LP Gas can be up to five times more efficient than traditional fuels, resulting in less energy wastage and better use of our planet's resources.

CONVENIENT

LP Gas is a multi-purpose energy. There are more than a thousand applications, from cooking, heating, air conditioning and transportation, to cigarette lighters and even the Olympic torch.

LP Gas is a derivative of two large energy industries: natural gas processing and crude oil refining.

When natural gas is drawn from the earth, it is a mixture of several gases and liquids. Methane, which is sold by gas utilities as “natural gas” constitutes about 90 percent of this mixture. Of the remaining 10 percent, 5 percent is propane and 5 percent is other gases such as butane and ethane. Before natural gas can be transported or used, the LP Gases (which are slightly heavier than methane, the major component of natural gas) are separated out. Depending on the ”wetness” of a producing gas field, gas liquids generally contain 1%-3% of the unprocessed gas stream. Some LP Gases are also trapped in crude oil. In order to stabilise the crude oil for pipeline or tanker distribution, these “associated” or ”natural gases” are further processed into LP Gas. Worldwide, gas processing is a source of approximately 60% of LP Gas produced.

In crude oil refining the LP Gases are the first products produced on the way to making the heavier fuels such as diesel, jet fuel, fuel oil, and gasoline. Roughly 3% of a typical barrel of crude oil is refined into LP Gas although as much as 40% of a barrel could be converted into LP Gas. Worldwide, crude oil refining is the source for the other roughly 40% of LP Gas supplies although the ratio between gas processing and refining varies among regions.

LP Gas production from these sources is a natural derivative. That means production of LP Gas is assured since the primary motive for gas processors and refiners is to produce fuels other than LP Gas but first the LP Gases are produced. Although tied to the production of natural gas and crude oil, LP Gas has its own distinct marketing advantages and can perform nearly every fuel function of the primary fuels from which it is derived.

LP Gas plays a valuable role in meeting the world's energy needs. In the future LP Gas has the opportunity to enhance this role by also helping to combat climate change.

The clean burning nature of LP Gas makes it an ideal substitute for solid fuels in domestic cooking and heating applications. Household solid fuel use, overwhelmingly concentrated in developing countries, accounts for up to 30% of black carbon emissions worldwide according to some statistics. Switching to LP Gas could lower global greenhouse gas emissions as well as help to diminish deforestation thus preserving the trees needed to maintain a global climatic equilibrium and combat climate change.

LP Gas used in combination with renewable sources can improve energy reliability while reducing the overall life-cycle costs. LP Gas is portable, making it a perfect complement to distributed renewable energy sources such as solar, wind and wave energy (and soon fuel cells), thereby reducing our reliance on centrally produced electricity.

LP Gas produces lower greenhouse gas emissions compared to conventional energy supplies in every application it is used, from stationary applications such as water heating, space heating, cooking and industrial boilers to transportation applications. Any industry can switch to clean-burning LP Gas as a means to meet greenhouse gas targets.

LP Gas can claim to be ahead of its time, for its clean-burning, low-carbon advantage is available at once, so that even using today's technology, most industries can exceed Kyoto greenhouse gas reduction targets by switching to LP Gas. In most cases LP Gas can make major and immediate contributions to delivering real greenhouse gasses emissions reductions.

PRESSURE BUILDING INFORMATION FOR CO_2

The following information is based on liquid withdrawn from the tank being pressurised with saturated liquid at 285-295 psig. For everypound of liquid CO_2 drawn, 0.0536 pounds of gas will need to be put back into the tank to maintain the tank pressure.

700 lbs. Of liquid withdrawn	37.52 lbs. Pressure required
1000 lbs.Of liquid withdrawn	53 lbs. Pressure required
5000 lbs.Of liquid withdrawn	268 lbs. Pressure required
BTU per lb. of pressure built	120 BTU

NOTE : If the customer is using gas off the top of the tank, the pressure build unit will have to deliver the same number of pounds of gas being used. A straight 1 to 1 ratio is required.

TRIM HEATER INFORMATION FOR CO_2

BTU required to heat 1 Lb. Of CO_2 gas at 1 degree = 0.2040445

Example : 500 lbs of gas per hour heated at 60 degrees 500 x 60x 0.2040445 = 6121.33 BTU or 1.79 kilowatts

ENGINEERING DATA FOR CO_2

BTU per kilowatt : 3412
BTU per pound of steam : 1000
BTU per pound of water per degree : 1
BTU required to vaporise 1 pound of CO_2 : 120
BTU required to vaporise 1 pound of water : 960

Note : One pound of steam = one pound of water. Average heat required to vaporise one pound of CO_2 to 70 degrees farenheit = 135 BTU

The steam pressure does not affect these numbers. The steam pressure affects the sizing of the steam train and the condensate return system. Lower pressure steam will require a larger steam train and condensate system.

LOW TEMPERATURE PHYSICAL PROPERTIES OF GASES

			Normal Boiling Point			Critical Point		Triple Point (or Melting Point)			
Name	Formula	Molecular Weight	Temp. °F	Liquid Density lb/ft.^{3}	Latent Heat BTU1 lb-mole	Temp. F	Pressure PSIA	Temp. F	Pressure PSIA	Specific Heat (Cp at 6°F, 14.7 PSIA) = BTU/lb mole F	Gas Density at 60°F 14.7 PSIA lb/ft^3
Acetylene	C_2H_2	26.04	-119.2†	38.7†	9180†	96.0	906	-114.6	17.4	10.4	0.0692
Air	(1)	28.97	-317.9	54.6	2556					6.86	0.0763
Ammonia	NH_3	17.03	-28.1	42.6	10037	270.3	1639	-108.0	8.81×10^{-1}	8.44	0.0454
Argon	Ar	39.94	-302.6	87.5	2804	-187.6	705	-308.9	9.99	4.90	0.1054
Carbon Dioxide	CO_2	44.01	-109.3†	97.5†	10854†	87.9	1071	-69.9	75.1	8.78	0.1165
Carbon Monoxide	CO	28.01	-311.9	49.3	2597	220.4	508	-337.1	2.23	6.84	0.0738
Carbonyl Sulphide	COS	60.07	-58.3	73.0	7961	221.0	896	(-271.8)		9.74	0.1550
Chlorine	Cl_2	70.91	-29.3	97.4	8780	291.2	1118	-149.8	2.02×10^{-1}	8.05	0.1888
Deuterium	D_2	4.03	-417.3	10.7	540	-390.8	239	-426.0	2.48	6.84	0.0106
Ethane	C_2H_6	30.07	-127.6	33.8	6315	90.1	708	-297.9	1.20×10^{-4}	12.37	0.0797
Ethylene	C_2H_4	28.05	-154.8	35.2	5826	49.1	735	-272.5	1.70×10^{-2}	10.2	0.0742
Fluorine	F_2	38.00	-306.6	93.8	2815	-200.2	808	(-363.3)		7.35	0.1010
Freon-12	CCl_2F_2	120.92	-21.6	92.9	8592	233.6	597	(-252.4)		17.34	0.324
Freon-13	$CClF_3$	104.47	-114.6	95.0	6670	83.9	561	(-294.0)		15.75	0.278
Freon-14	CF_4	88.01	-198.4	122.4	5160	-49.9	542	-299.2	1.70×10^{-2}	14.32	0.232
Freon-22	$CHClF_2$	86.48	-41.4	88.2	8704	204.8	716	(-256.0)		13.11	0.233
Helium	He	4.00	-452.1	7.80	396	-450.2	33	-455.8*	7.35×10^{-11}	4.89	0.0105
Hydrochloric Acid	HCl	36.46	-120.9	74.3	6948	124.5	1199	(-173.7)		6.77	0.0968
Hydrogen	H_2	2.02	-423.0	4.43	389	-399.8	188	-434.5	1.044	6.76	0.0053
Hydrogen Sulphide	H_2S	34.08	-75.4	60.0	8033	212.7	1307	-122.0	3.36	8.05	0.0908
Krypton	Kr	83.70	-244.0	135.0	3884	-82.8	796	-250.9	10.62	4.89	0.2190
Methane	CH_4	16.04	-258.6	26.5	3519	-116.6	670	-296.5	1.69	8.44	0.0424
Methyl Chloride	CH_3Cl	50.49	-11.5	62.2	9293	289.6	967	-144.0	1.27	9.79	0.1352
Neon	Ne	20.18	-410.7	74.9	748	-379.7	395	-415.4	6.27	4.89	0.0532
Nitric Oxide	NO	30.01	-241.0	79.3	5953	-137.2	945	-263.6	3.16	6.96	0.0791
Nitrogen	N_2	28.02	-320.5	50.4	2405	-232.6	491	-345.9	1.82	6.85	0.0739
Nitrogen Trifluoride		NF_2	71.01	-199.2	96.0	4984	-38.7	657	(-343.3)	1.77×10^{-5}	-
0.1901											
Nitrous Oxide	N_2O	44.02	-127.2	76.8	7110	97.7	1054	-131.6	12.74	9.02	0.1168
Oxygen	O_2	32.00	-297.3	71.2	2932	-181.1	737	-361.8	2.10×10^{-2}	6.89	0.0844
Ozone	O_3	48.00	-169.4	101.8	6174	10.2	791	(-314.5)		-	0.1262
Propane	C_3H_8	44.09	-43.7	36.2	8076	206.2	617	-305.8	8.39×10^{-11}	17.08	0.1175
Propylene	C_3H_6	42.08	-53.8	37.5	7925	197.4	667	-301.0	2.44×10^{-8}	15.01	0.1089
Sulphur Dioxide	SO_2	64.06	13.9	89.3	10728	315.0	1142	-103.8	2.43×15^{-1}	9.42	0.1715
Xenon	Xe	131.30	-163.0	191.0	5436	61.9	847	-169.2	11.82	4.89	0.3451

(1) Approximate Composition of Dry Air (in Mole Percent)78.09 N2, 20.95 O2, 0.93 A, 0.03 CO2
† Denotes sublimation and solid density *(Lambda) Point

Maharashtra Multi Distributors Ltd.

www.mahamulti.com

Technical Data

SPECIFICATIONS OF GASES

Product	Formula	Molecular weight (lb/lb mol)	Critical Temp (F)	Critical Prossure	Critical Density (lb/ft^3)	Boilling point 1atm (F)	Heat of Vaporization at BP (Btu/lb)	Mealting point (F)	Vapor Pressure (psig)	Heat of Vaporization (Btu/lb)	Liquid Density (lb/ft^3)	Gas Density (lb/ft^3)	Specific Volume (ft^3/lb)	Specific Gravity (Air=1.0)	Specific Heat, Cp (btu/lb mol °F)
Acetyience	C_2H_2	26.04	95.97	906.0	14.39	-118.4	352.5	-113.35	640.0	126.2	24.9	0.068	14.76	0.905	10.60
Air	—	28.96	—	—	—	-317.8	87.8	—	—	—	—	0.081	12.39	1.00	6.96
Ammonia	NH_3	17.03	270.13	1636.00	14.67	-28.1	590.3	-107.91	129.1	510.0	38.0	0.044	22.49	0.593	8.66
Argon	Ar	39.95	-188.37	705.77	33.17	-302.2	69.4	-308.79	—	—	—	0.103	9.7	1.380	4.98
Arsine	AsH_3	77.94	221.82	957.30	37.44	-80.5	92.1	-178.48	220.5	70.2	84.1	0.204	4.91	2.718	9.27
Boron Trichloride	BCl_3	117.17	353.84	561.30	16.80	54.50	87.8	-160.6	19.9	85.9	82.7	0.303	3.30	4.045	14.9
Boron Trifluoride	BF_3	67.81	9.95	723.02	36.90	-148.5	109.3	-199.7	—	—	—	0.1745	5.73	2.32	12.1
Bromine Trifluoride	BrF_3	136.90	622.00	----	—	260.6	134.1	47.8	0.13	134.1	—	—	—	4.72	15.9
Butane	C_4H_{10}	58.12	305.93	549.93	14.20	31.2	165.9	-217.03	31.3	157.1	36.0	0.155	6.44	2.072	23.81
Carbon Dioxide	CO_2	44.01	87.89	1071.00	29.20	-109.3	246.3	-69.97	853.5	63.2	47.6	0.114	8.74	1.527	8.91
Carbon Monoxide	CO	28.01	-220.41	507.00	18.79	-312.6	92.1	-337.09	—	—	—	0.072	13.80	0.967	6.97
Chlorine	Cl_2	70.91	291.20	1118.40	35.79	-29.3	123.7	-149.73	100.2	109.0	88.8	0.186	5.38	2.479	8.19
Chlorine Trifluoride	ClF_3	92.45	308.30	838.0	37.5	53.2	115.7	-105.4	21.5	125.5	—	0.2381	4.20	3.18	—
Deuterium	D_2	4.03	-390.80	241.5	4.2	-417.24	130.9	-425.97	—	—	—	0.0104	96.15	0.139	6.97
Diborane	B_2H_6	27.67	62.1	580.8	10.4	-135.1	230.3	-264.8	—	—	—	0.0712	14.05	0.95	8.64
Dichlorosilane	SiH_2Cl_2	101.01	348.8	678.2	28.9	46.9	—	-187.6	24.2	—	—	0.2602	3.84	3.47	—
Disttane	Si_2H_6	62.22	303.53	746.96	21.1	6.3	147.8	-206.7	49.3	—	—	—	—	—	—
Ethane	C_2H_6	30.07	90.42	707.90	12.70	-127.4	210.1	-297.85	560.5	85.0	20.9	0.078	12.76	1.046	12.61
Ethyl chloride	C_2H_5Cl	64.51	369.0	754.2	20.1	54.09	165.0	-213.52	20.26	161.8	55.8	0.167	5.99	2.23	14.97
Ethylene	C_2H_4	28.05	49.10	736.00	14.17	-154.6	207.5	-272.45	—	—	—	0.073	13.71	0.974	10.27
Fluorine	F_2	38.00	-199.91	756.40	35.81	-306.8	74.8	363.41	—	—	—	0.098	10.17	1.312	7.49
Halocarbon-23	CHF_3	70.01	78.66	701.42	32.21	-115.9	104.7	-247.32	631.6	30.5	63.2	0.182	5.48	2.436	12.34
Halocarbon-116	C_2F_6	138.02	67.5	432.2	38.0	-108.76	50.4	-149.3	—	—	—	0.361	2.77	4.82	25.12
Helium	He	4.00	-450.31	32.99	4.33	-452.1	8.8	----	—	—	—	0.0103	96.71	0.138	4.98
Hydrogen	H_2	2.016	-399.95	190.75	1.88	-422.97	195.3	-434.5	—	—	—	0.005	191.98	0.070	6.88
Hydrogen Chloride	HCl	36.46	124.52	1199.20	26.22	-121.1	190.6	-173.63	612.1	108.5	56.9	0.095	10.55	1.266	7.16
Hydrogen Fluoride	HF	20.01	370.4	940.5	18.2	67.14	161.0	-118.43	15.54	161.0	59.9	0.199	5.02	1.858	—
Hydrogen Sulfide	H_2S	34.07	212.81	1306.47	21.77	-76.5	235.9	-121.99	261.4	180.8	48.9	0.0893	11.20	1.192	8.27
Iodine Pentafluoride	IF_5	221.90	573.23	742.00	57.34	220.1	70.3	48.98	0.4	81.4	200.1	—	—	—	41.99
Krypton	Kr	83.80	-82.8	798.0	57.4	-244.0	46.35	-251.3	—	—	—	0.2172	4.60	2.90	4.95
Methane	CH_4	16.04	116.17	673.09	10.10	-258.6	219.5	296.45	—	—	—	0.042	24.06	0.555	8.55
Methyl Chloride	CH_3Cl	50.49	290.84	964.00	22.04	-11.2	184.1	-143.86	74.1	163.7	56.8	0.133	7.54	1.771	9.98
Neon	Ne	20.18	-379.75	384.89	30.15	-410.9	36.9	-415.50	—	—	—	0.0521	19.18	0.696	4.97
Nitrogen	N_2	28.01	-232.45	492.34	19.40	-320.5	85.6	-345.91	—	—	—	0.072	13.81	0.967	6.96
Nitrogen Trifluoride	NF_3	71.00	-38.5	646.9	34.1	-200.3	70.1	-340.2	—	—	—	0.1843	5.43	2.46	12.8
Nitrous Oxide	N_2O	44.01	97.61	1053.27	28.61	-127.4	160.2	-131.60	754.6	71.7	49.5	0.114	8.74	1.528	9.15
Octafluoropane	C_3F_8	188.02	161.38	386.06	39.20	-34.1	45.2	-233.84	114.0	34.0	81.5	0.498	2.01	6.652	35.55
Oxygen	O_2	32.00	-181.82	729.10	26.80	-297.7	91.5	361.93	—	—	—	0.083	12.08	1.105	7.02
Phosphine	PH_3	34.00	124.9	947.9	18.8	-125.9	177.3	-208.8	607.4	—	—	0.0890	11.23	1.19	8.87
Phosphorus Pentafluoride	PH_5	125.97	292.1	492.3	38.96	-120.1	58.7	-136.8	414.7	—	—	0.323	3.10	4.31	----
Propane	C_3H_8	44.10	206.57	617.57	13.70	-43.7	183.0	305.82	124.9	147.1	31.1	0.116	8.62	1.548	17.61
Propylene	C_3H_5	42.08	197.53	666.27	14.51	-53.8	188.3	301.43	152.5	146.0	32.1	0.110	9.05	1.475	15.46
Silane	SIH_4	32.12	25.8	702.5	15.1	-160.9	164.6	301.0	—	—	—	0.0838	11.9	1.12	10.23
Silicon Tetrachoride	$SICl_4$	169.89	453.0	521.1	32.5	135.68	70.5	-94.0	3.89	75.6	92.2	—	—	—	—
Silicon Tetrafluoride	SiF_4	104.08	6.53	539.30	42.66	-138.6	64.6	-124.24	—	—	—	0.271	3.69	3.615	17.58
Sulfur Dioxide	SO_2	64.06	315.53	1142.00	32.78	13.9	167.5	-103.92	49.7	155.0	84.7	0.168	5.94	2.249	9.78
Sulfur Hexafluride	SF_6	146.05	114.03	545.20	46.04	-83.0	48.5	-58.92	312.9	28.2	86.1	0.382	2.61	5.105	22.81
Sulfur Tetrafluoride	SF_4	108.1	195.6	—	—	40.7	105.3	-184.9	154.7	—	—	0.278	3.60	3.71	—
Tetrafluoromethane	CF_4	88.00	-50.19	543.16	39.06	-198.5	58.5	-298.46	—	—	—	0.228	4.38	3.050	14.46
Tungsten Hexafluoride	WF_6	297.84	337.7	619.3	81.6	62.5	38.1	35.62	17.3	37.7	216.2	0.800	1.25	10.674	29.01
Xenon	Xe	131.30	61.88	847.08	68.65	-162.6	41.4	-169.37	—	—	—	0.341	2.93	4.558	5.02

Technical Data

CARBON DIOXIDE	Lb.	Ton	kg	Cubic ft.	Cubic meter	Gallon	Litre	Cubic ft. Solid
1 pound	1.0	0.0005	0.4536	8.741	0.2294	0.11806	0.4469	0.010246
1 ton	2000.0	1.0	907.2	17483	458.8	236.1	893.9	20.49
1kilogram	2.205	0.0011023	1.0	19.253	0.5058	0.2603	0.9860	0.226
1 scf gas	0.1144	not available	0.05189	1.0	0.02628	0.013508	0.05113	0.0011723
1nm3 of gas	4.359	0.00218	1.9772	38.04	1.0	0.5146	1.948	0.04468
1 gallon liquid	8.470	0.004235	3.842	74.04	1.9431	1.0	3.785	0.08678
1 litre liquid	2.238	0.0011185	1.0151	19.562	0.5134	0.2642	1.0	0.02293
1 cu.ft solid	97.56	0.0488	44.25	852.8	22.38	11.518	43.60	1.0

Note : Scf (Standard Cubic Feet) of gas measured at one atmosphere and 70ºF. Nm3 (Normal Cubic Metre) of gas measured at one atmosphere and zero degrees centigrade. Liquid is measured at 21.42 atmosphere and 1.7ºF. Solid measured at -109.25ºF. All values rounded of to nearest significant numbers.

WEIGHT AND VOLUME EQUIVALENT TABLES FOR INDUSTRIAL GASES

OXYGEN Weight		Volume of Liquid †			Volume of Gas*		HELIUM Weight		Volume of Liquid †			Volume of Gas*	
Pound	Kilo grams	Cu. Ft.	Litres	Imp. Gallons	Cu. Ft.	Cubic Metres	Pounds	Kilo grams	Cu. Ft.	Litres	Imp. Gallons	Cu. Ft.	Cubic Metres
1.0000	0.4540	0.01400	0.397	0.08743	11.850	0.3356	1.0000	0.4540	0.12810	3.625	0.79730	94.870	2.6870
2.2050	1.0000	0.03090	0.873	0.19230	26.060	0.7380	2.2050	1.0000	0.28300	8.015	1.77200	192.100	5.4400
71.1400	32.3000	1.00000	28.320	6.23200	842.900	23.8700	7.7910	3.5320	1.00000	28.320	6.23200	739.200	20.9300
2.5120	1.1400	0.03530	1.000	0.22010	29.770	0.8431	0.2751	0.1251	0.03530	1.000	0.22010	26.100	0.7392
11.4200	5.1850	0.16050	4.544	1.00000	135.300	3.8320	1.2510	0.5680	0.16050	4.544	1.00000	118.700	3.3690
8.4400	3.8320	0.11860	3.359	0.73900	100.000	2.8320	1.0540	0.4746	0.13430	3.802	0.83700	100.000	2.8320
2.9800	1.3520	0.04188	1.186	0.26090	35.310	1.0000	0.3722	0.1693	0.04790	1.359	0.29910	35.310	1.0000

NITROGEN Weight		Volume of Liquid †			Volume of Gas*		ARGON Weight		Volume of Liquid †			Volume of Gas*	
Pound	Kilo grams	Cu. Ft.	Litres	Imp. Gallons	Cu. Ft.	Cubic Metres	Pounds	Kilo grams	Cu. Ft.	Litres	Imp. Gallons	Cu. Ft.	Cubic Metres
1.0000	0.4540	0.01980	0.561	0.12320	13.540	0.3834	1.0000	0.4540	0.01140	0.324	0.06890	9.491	0.2686
2.2050	1.0000	0.04370	1.238	0.27230	29.850	0.8454	2.2050	1.0000	0.02520	0.713	0.15180	20.900	0.5924
50.4500	22.9100	1.00000	28.320	6.23200	683.000	19.3400	87.0900	39.5400	1.00000	28.320	6.23200	826.500	23.4600
1.7820	0.8090	0.03530	1.000	0.22010	24.120	0.6825	3.0760	1.3970	0.03530	1.000	0.22010	29.190	0.8267
8.0990	3.6770	0.16050	4.544	1.00000	109.700	3.0940	13.9800	6.3470	0.16050	4.544	1.00000	132.700	3.7580
7.3900	3.3540	0.14660	4.143	0.91120	100.000	2.8320	10.5400	4.7460	0.12060	3.413	0.75200	100.000	2.8320
2.6080	1.1830	0.05181	1.467	0.32170	35.310	1.0000	3.7220	1.6900	0.04240	1.242	0.27360	35.310	1.0000

AIR Weight		Volume of Liquid †			Volume of Gas*		HYDROGEN Weight		Volume of Liquid †			Volume of Gas*	
Pound	Kilo grams	Cu. Ft.	Litres	Imp. Gallons	Cu. Ft.	Cubic Metres	Pounds	Kilo grams	Cu. Ft.	Litres	Imp. Gallons	Cu. Ft.	Cubic Metres
1.0000	0.4540	0.01830	0.518	0.11400	13.100	0.3718	1.0000	0.4540	0.22610	6.400	1.40900	188.400	5.3410
2.2050	1.0000	0.04040	1.144	0.25180	28.880	0.8178	2.2050	1.0000	0.49820	14.107	3.10900	416.200	11.7800
54.5600	24.2100	1.00000	28.320	6.23200	714.600	20.2400	4.4320	2.0430	1.00000	28.320	6.23200	834.500	23.6100
1.9270	0.8749	0.03530	1.000	0.22010	25.240	0.7115	0.1565	0.0711	0.03530	1.000	0.22010	29.480	0.8350
8.7600	3.9770	0.16050	4.544	1.00000	114.700	3.2480	0.7116	0.3230	0.16050	4.544	1.00000	134.000	3.7920
7.6300	3.4640	0.13960	3.952	0.86980	100.000	2.8320	0.5308	0.2411	0.13850	3.921	0.86300	100.000	2.8320
2.6940	1.2230	0.04931	1.396	0.30690	35.310	1.0000	0.1874	0.0852	0.04240	1.201	0.26440	35.310	1.0000

†Liquid volumes are calculated for normal boiling point at atmospheric pressure. *Gas volumes are calculated for standard conditions of 60ºF and pressure of 14.7 psi.

Maharashtra Multi Distributors Ltd.
www.mahamulti.com

Technical Data

METRIC MEASURES

LENGTH

1 millimetre (mm)		=0.0394 in
1 centimetre (cm)	= 10 mm	=0.3937 in
1metre (m)	= 100 cm	= 1.0936 yd
1 kilometre (km)	= 1,000 m	= 0.6214 mile

AREA

1 sq cm (cm^2)	= 100 mm^2	= 0.1550 in^2
1 sq metre (m^2)	= 10,000 cm^2	= 1.1960 yd^2
1 hectare (ha)	= 10,000 m^2	= 2.4711 acres
1sq km (km^2)	= 100 hectares	= 0.3861 $mile^2$

Volume / Capacity

1 cu cm (cm^3)		= 0.0610 in^3
1 cu decimetre (dm^3)	= 1,000 cm^3	= 0.0353 ft^3
1 cu metre (m^3)	= 1,00 dm^3	= 1.3080 yd^3
1 litre (l)	= 1 dm^3	= 1.76 pt
		= 2.113 US pt
1 hectolitre (hl)	= 100 l	= 22 gal
		= 26.418 US gal

MASS (Weight)

1 milligram (mg)		= 0.0154 grain
1 gram (g)	= 1,000 mg	= 0.0353 oz
1 metric carat	= 0.2g	= 3.0865 grains
1 kilogram (kg)	= 1,000 g	= 2.2046 lb
1 tonne (t)	= 1,000 kg	= 0.9842 ton
		= 1.1023 short ton

IMPERIAL AND US MEASURES

LENGTH

1 inch (in)		= 2.54 cm
1 foot (ft)	= 12 in	= 0.3048m
1 yard (yd)	= 3 ft	= 0.9144 m
1 furlong		= 201 m
1 mile	= 1,760 yd	= 1.6093 km
1 int nautical mile	= 2,025.4 yd	= 1.852 km

AREA

1 sq inch (in^2)		= 6.4516 cm^2
1 sq foot (ft^2)	= 144 in^2	= 0.0929 m^2
1 sq yard (yd^2)	= 9ft^2	= 0.8361 m^2
1 acre	= 4,840 yd^2	= 4046.9 m^2
1 sq mile ($mile^2$)	= 640 acres	= 2.590 km^2

VOLUME / CAPACITY

1 cu inch (in^3)		= 16.387 cm^3
1 cu foot (ft^3)	= 1,728 in^3	= 0.0283 m^3
1 cu yard (yd^3)	= 27 ft3	= 0.7647 m^3
1 fluid ounce (fl oz)		= 28.413 ml
1 pint (pt)	= 20 fl oz	= 0.5683 ltr
1 gallon (gal)	= 8 pt	= 4.546 ltr
1 fluid ounce (fl oz)		= 2.957 cl
1 liquid pint (pt)	= 16 fl oz	= 0.4732 l
1 liquid quart (qt)	= 2 pt	= 0.946 l
1 gallon (gal)	= 4 qt	= 3.7853 l
1 dry pint		= 0.5506 l
1 bushel (bu)	= 64 dry pt	= 35.238 l

IMPERIAL AND US MEASURES

MASS (Weight)

1 ounce (oz)	= 437.5 grains	= 28.35 g
1 pound (lb)	= 16 oz	= 0.4536 kg
1 stone	= 14 lb	= 6.3503 kg
1 hundred weight (cwt)	= 112 lb	= 50.802 kg
1 ton	= 20 cwt	= 1.016 t

FORCE

Pound:force lbf	1lbf	= 4.45 Newton
Ton:force tonf	1tonf	= 9.96 Kilonewton

PRESSURE

1psig	= 9.89 kilopascal
1 atmosphere	= 101 kilopascal
1 ton/sq.inch	= 15.4 megapascal
1 inch of Hg	= 33.9 mega pascal

METRIC CONVERSION

To convert to metric, multiply by the factor shown. To convert from metric, divide by the factor.

LENGTH

miles: kilometres	1,6093
yards: metres	0.9144
feet: metres	0.3048
inches: millimetres	25.4
inches: centimetres	2.54

AREA

square miles: square kilometres	2.59
square miles: hectares	258.999
acres: square metres	4046.86
acres: hectares	0.4047
square yards: square metres	0.8361
square feet: square metres	0.0929
square feet: square centimetres	929.03
square inches: square millimetres	645.16
square inches: square centimetres	6.4516

VOLUME

cubic yards: cubic metres	0.7646
cubic feet: cubic metres	0.0283
cubic feet: cubic decimetres	28.3168
cubic inches: cubic centimetres	16.3871

CAPACITY

bushels: cubic metres	0.568
gills: litres	0.142
fluid ounces: cubic centimetres	28.4131
fluid ounces: millimetres	28.41
US gallons: litres	3.785
quarts: litres	1.137
pints: litres	0.568
gills: litres	0.142
fluid ounces: cubic centimetres	28.4131
fluid ounces: millilitres	28.41

Technical Data

METRIC CONVERSION

To convert to metric, multiply by the factor shown. To convert from metric, divide by the factor.

VELOCITY

miles per hour: kilometres per hour	1.6093
feet per second: metres per second	0.3048
feet per minute: metres per second	0.0051
feet per minute: metres per minute	0.3048
inches per second: millimetres per second	5.4
inches per minute: millimetres per second	0.4233
Inches per minute: centimetres per minute	2.54

MASS

tons: kilogrammes	1016.05
tons: tonnes	1.0160
hundred weights: kilogrammes	50.8023
centals: kilogrammes	45.3592
quarters: kilogrammes	12.7006
stones: kilogrammes	6.3503
pounds: kilogrammes	0.4536
ounces: grammes	28.3495

ENERGY & POWER

1 BTU	= 1.06 kilojoules
1 Therm	= 106 megajoules
1 kilowatt	= 3.6 megajoules
1 Hp	= 0.746 kilowatt

MASS PER UNIT AREA

tons per square mile: kilogrammes per hectare	3.923
pounds per square foot: kilogrammes per square metre	4.882
ounces per square foot: grammes per square metre	305.152
Fuel consumption gallons per mile: litres per kilometre	2.825
miles per gallon: kilometres per litre	0.354

US MEASURES

1 US dry pint	= 33.60 in3	= 0.5506 l
1 US liquid pint	= 0.8327 imp pt	= 0.4732 l
1 US gallon	= 0.8327 imp gal	= 3.785 l
1 short cwt	= 100 lb	= 45.359 kg
1 short ton	= 2,000 lb	= 907.19 kg

DENSITY

tons per cubic yard: kilogrammes per cubic metre	1328.94
pounds per cubic foot: kilogrammes per cubic metre	16.0185
pounds per cubic inch: grammes per cubic centimetre	27.6799
pounds per gallon: kilogrammes per litre	0.0998

WEIGHTS AND MEASURES

UK (imperial)units*

LENGTH

12 inches	=	1 foot
3 feet	=	1 yard
22 yards	=	1 chain
10 chains	=	1 furlong
5,280 feet	=	1 mile
1,760 yards	=	1 mile
8 furlongs	=	1 mile

Nautical

6 feet	=	1 fathom
100 fathoms	=	1 cable length
6,080 feet	=	1 nautical mile

SPEED

15 mph	=	22 feet per second
1 knot	=	1 nautical mph

AREA

144 sq. inches	=	1 sq. foot
9 sq. feet	=	1 sq. yard
4.840 sq. yards	=	1 acre
640 acres	=	1 sq. mile

VOLUME

1.728 cu. inches	=	1 cu. foot
27 cu. feet	=	1 cu. yard
5.8 cu. feet	=	1 bulk barrel shipping
1 register ton	=	100 cubic feet

WEIGHTS AND MEASURES

UK (imperial)units*

CAPACITY

8 fluid drachms	=	1 fluid ounce
5 fluid ounces	=	1 gill
4 gills	=	1 pint
2 pints	=	1 quart
4 quarts	=	1 gallon
2 gallons	=	1 pack
4 packs	=	1 bushel
8 bushels	=	1 quarter
36 gallons	=	1 bulk barrel

WEIGHT, avoirdupois

437 ½ grains	=	1 ounce
16 drams	=	1 ounce
16 ounces	=	1 pound
14 pounds	=	1 stone
28 pounds	=	1 quarter
4 quarters	=	1 hundred weight
2,240 pounds	=	ton
20 hundred weights	=	1 ton

*A gradual change to the metric system is taking place in the United Kingdom.

WEIGHTS AND MEASURES

Metric Units

LENGTH

10 angstrom	=	1 nanometre
1.000 nanometres	=	1 micrometre
1.000 micrometres	=	1 millimetre
10 millimetres	=	1 centimetre
10 centimetres	=	1 decimetre
1.000 millimetres	=	1 metre
100 centimetres	=	1 metre
10 decimetres	=	1 metre
10 metres	=	1 dekametre
10 dekametres	=	1 hectometre
10 hectometres	=	1 kilometre
1.000 kilometres	=	1 megametre

Nautical

1.852 metres	=	1 international nautical mile

AREA

100 sq. millimetres	=	1 sq. centimetre
100 sq. centimetres	=	1 sq. decimetre
100 sq. decimetres	=	1 sq. metre
100 sq. metres	=	1 are
10,000 sq. metres	=	1 hectare
100 acres	=	1 hectare
100 hectares	=	1 sq. kilometre

VOLUME

1.000 cu. millimetres	=	1 cu. centimetre
1.000 cu. centimetres	=	1 cu. decimetre
1.000 cu. decimetres	=	1 cu. metre
1.000 cu. metres	=	1 cu. dekametre
1.000 cu. dekametres	=	1 cu. hectometre

CAPACITY

10 millilitres	=	1 centilitre
10 centilitres	=	1 decilitre
10 decilitres	=	1 litre
1 litre	=	1 cu. decimetre
10 litres	=	1 dekalitre
10 dekalitres	=	1 hectolitre
10 hectolitres	=	1 kilolitre
1.000 litres	=	1 kilolitre
1 kilolitre	=	1 cu. metre

WEIGHT (Mass)

1.000 milligrams	=	1 gram
10 grams	=	1 dekagram
10 dekagrams	=	1 hectogram
10 hectograms	=	1 kilogram
100 kilograms	=	1 quintal
1000 kilograms	=	1 tonne

Technical Data

COMMON UNITS OF HEAT

1 BTU	=	0.252 kcal
1 BTU	=	107.7 kgm
1 BTU/sec.	=	1.055 kW
1 BTU/lb	=	0.5556 kcal/kg.
1 BTU/cu ft	=	8.900 kcal/m^3
1 BTU/sq.ft. h	=	2.71 kcal / m^{2}h
1 BTU/sq.ft.h ºF	=	4.886 kcal/m^{2}h ºC
1 BTU/ft h ºF	=	1.49 kcal/m h ºC
1 BTU in/sq. ft. hr. ºF	=	0.124 kcal/m h ºC
1 BTU/lb ºF	=	1.001 kcal/kg ºC
1 BTUcu.ft ºF	=	16.2 kcal/m^3 ºC
1 kcal	=	3.968 BTU
1 kgm	=	0.00930 BTU
1 kW	=	0.948 BTU/sec.
1 kcal/kg	=	1.80 BTU/lb
1 kcal/m^3	=	0.112 BTU/cu.ft
1 kcal/m^2 h	=	0.369 BTU/sq.ft.h.
1 kcal/m^{2}h ºC	=	0.205 BTU/sq ft. h ºF
1 kcal/m h ºC	=	0.67 BTU/ft h ºF
1 kcalm/h ºC m^2	=	8.07 BTU in/sq ft g ºF
1 kcal/kg ºC	=	0.999 BTU/lb ºF
1 kcal/m^3 ºC	=	0.0624 BTU/cu ft ºF

CONVERSION OF PRESSURE UNITS

	PSI	Kg/cm^2	Atmo-sphere	Bar	mm WC	Pascal	Pieze
PSI	1	0.07031	0.06804	0.069	703.1	6896	6.895
Kg/cm^2	14.223	1	0.9678	0.981	10000	98087	98.08
Atmosphere	14.69	1.033	1	1.0133	10330	101325	101.32
Bar	14.5	1.019	0.986	1	10200	100000	100
mm WC	14.223×10^{-4}	1.0×10^{-4}	96.78×10^{-6}	9.81×10^{-5}	1	9.808	98.40×10^{-4}
Pascal	145×10^{-6}	10.19×10^{-6}	9.869×10^{-6}	10^{-5}	0.1019	1	0.001
Pieze	0.145	0.01019	0.00986	0.01	102	1000	1

PRESSURE CONVERSION TABLE

From \ To	Mbar	psi	In H_2O	In Hg	MmHg	Pa(Nm^{-2})	Atm
Mbar	1.00	0.015	0.40	0.03	0.75	100	9.87×10^{-4}
psi	68.93	1.00	27.66	2.04	51.70	6892.86	0.07
in H_2O	2.49	0.036	1.00	0.074	1.87	249.38	2.46×10^{-3}
in Hg	33.78	0.49	13.59	1.00	25.40	3386.53	0.03
mm Hg	1.33	0.019	0.54	0.39	1.00	133.32	1.32×10^{-3}
Pa(Nm^{-2})	1×10^{-2}	1.45×10^{-4}	4.01×10^{-3}	2.95×10^{-4}	7.5×10^{-3}	1.00	9.87×10^{-6}
atm	1013.25	14.70	406.64	29.92	760	10132.5	1.00

METHOD TESTING CHART

	Soap Bubbles	Air Pressure	Air Flow	Tracer Gas	Pressurised Water
Does method locate leaks?	YES	NO	NO	YES	YES
Is method quantitative?	NO	YES	YES	YES	NO
Is test cycle fast ?	NO	YES	YES	YES	YES
Is the result operator dependant?	YES	NO	NO	NO	YES
Any size restriction on test component?	NO	YES	NO	NO	NO
Does test affect sample?	YES	NO	NO	NO	YES
Can method be automated?	NO	YES	YES	YES	NO
Is statistical analysis possible?	NO	YES	YES	YES	NO

Technical Data

CHARCTERISTICS OF FUEL OILS

PROPERTIES	Fuel Oils		
	F.O.	L.S.H.S.	L.D.O.
Density (Approx., kg / lit at 15°C)	0.89-0.95	0.88-0.98	0.85-0.87
Flash Point, (°C)	66	93	66
Pour Point (°C)	20	72	12 (Winter) 18 (Summer)
G.C.V. (kcal.kg)	9,500	10,300	9,500
Sediment, % Wt. Max.	0.25	0.25	0.10
Sulphur Total, % Wt. Max.	4.00	1.00	1.80
Water Content, % Vol Max.	1.00	1.00	0.25
Ash, % Wt. Max	0.10	0.10	0.02

TYPICAL COMPOSITIONS OF FUEL

FUELS	Percentage Combustion							NCV
	C	H_2	S	N	O_2	H_2O	ASH	KCAL/KG
Wood	45.60	3.96	0.07	0.45	37.45	9.33	3.14	4400
Lignite	52.21	3.83	0.88	0.46	17.06	18.39	7.17	4900
Coal-4000	44.03	3.10	0.32	0.82	4.77	3.84	43.13	3800
Coal-4500	48.92	3.79	0.51	1.00	5.36	6.04	34.38	4250
Coal-5500	59.38	3.15	0.38	1.04	4.86	6.00	25.19	5300
Husk	36.14	3.70	0.08	0.46	29.34	8.92	19.40	3100
Bagasse	40.94	4.58	0.04	0.23	36.65	10.53	7.03	3550
F.O.	84.00	11.00	3.50	-	-	1.00	0.50	9500
L.D.O	85.50	11.50	3.00	-	-	-	-	9500
L.S.H.S.	86.70	11.80	1.00	-	-	0.50	-	10300
L.P.G. 1 #	81.50	17.00	-	-	-	1.50	-	11400
N. GAS $	66.00	23.00	-	-	-	1.50	-	6300

NOTE:

1. The above compositions can very widely depending on the mine, location, source etc.
2. Solid fuels in air dried condition.

\# L.P.G. is assumed to be composed of (by volume) 10-40% of Propane and 70-60% of Butane. Density - 2.32 KG/NM^3.

$ Natural Gas is assumed to be composed of (by volume) 76% of Methane, 10% of Ethane, 2% of Propane, 6% of CO^2 and 4% of N^2. Denisity - 0.83kg/NM^3.

CONVERSION OF ENERGY UNITS

	kg	kcal	Joule	KW/Hour	HP/Hour
kg	1	0.00235	9.81	0.27×10^{-5}	0.365×10^{-5}
kcal	427	1	4179	0.001161	0.001556
Joule	0.102	0.000239	1	27.77×10^{-8}	37.23×10^{-8}
KW/Hour	366,973	860	$3,600 \times 10^{3}$	1	1.3411
HP/Hour	273,745	642.5	2,685,500	0.74565	1

CONVERSION OF TEMPERATURES

$$°C = \frac{(°F-32)5}{9}$$

The number in the centre of the 3 columns can be converted from F into by reading to the left and from C into F by reading to the right. For a difference of temperature, use the following formulae directly, without making use of the table.

$$D°F = D°C\frac{9}{5} \qquad D°C = D°F\frac{5}{9}$$

°C		°F	°C		°F	°C		°F
-90	-130	-202	-37.8	-36	-32.8	-21.11	-6	21.2
-87.2	-125	-193	-37.2	-35	-31	-20.56	-5	23
-84.4	-120	-184	-36.7	-34	-29.2	-20	-4	24.8
-81.7	-115	-175	-36.1	-33	-27.4	-19.44	-3	26.6
-78.9	-110	-166	-35.6	-32	-25.6	-18.89	-2	28.4
-76.1	-105	-157	-35	-31	-23.8	-18.33	-1	30.2
-73.3	-100	-148	-34.4	-30	-22	-17.78	0	32
-70.6	-95	-139	-33.9	-29	-20.2	-17.22	1	33.8
-67.8	-90	-130	-33.3	-28	-18.4	-16.67	2	35.6
-65	-85	-121	-32.8	-27	-16.6	-16.11	3	37.4
-62.2	-80	-112	-32.2	-26	-14.8	-15.56	4	39.2
-59.4	-75	-103	-31.7	-25	-13	-15	5	41
-56.7	-70	-94	-31.1	-24	-11.2	-14.44	6	42.8
-53.9	-65	-85	-30.6	-23	-9.4	-13.89	7	44.6
-51.1	-60	-76	-30	-22	-7.6	-13.33	8	46.4
-48.3	-55	-67	-29.4	-21	-5.8	-12.78	9	48.2
-45.6	-50	-58	-28.9	-20	-4	-12.22	10	50
-45	-49	-56.2	-28.3	-19	-2.2	-11.67	11	51.8
-44.4	-48	-54.4	-27.8	-18	-0.4	-11.11	12	53.6
-43.9	-47	-52.6	-27.2	-17	1.4	-10.56	13	55.4
-43.3	-46	-50.8	-26.7	-16	3.2	-10	14	57.2
-42.8	-45	-49	-26.1	-15	5	-9.44	15	59
-42.2	-44	-47.2	-25.56	-14	6.8	-8.89	16	60.8
-41.7	-43	-45.4	-25	-13	8.6	-8.33	17	62.6
-41.1	-42	-43.6	-24.44	-12	10.4	-7.78	18	64.4
-40.6	-41	-41.8	-23.89	-11	12.2	-7.22	19	66.2
-40	-40	-40	-23.33	-10	14	-6.67	20	68
-39.4	-39	-38.2	-22.78	-9	15.8	-6.11	21	69.8
-38.9	-38	-36.4	-22.22	-8	17.6	-5.56	22	71.6
-38.3	-37	-34.6	-21.67	-7	19.4	-5	23	73.4

CONVERSION OF POWER UNITS

	kg / sec	kcal/sec	Kilowatt	HP	Ch
kg / sec	1	0.00234	0.00981	0.0131	0.0133
kcal/sec	427	1	4.17	5.59	5.67
Kilowatt	101.97	0.239	1	1.341	1.359
HP	76	0.178	0.746	1	1.014
Ch	75	0.176	0.736	0.986	1

Technical Data

WATER-HEATING DATA

TECHNICAL DATA

1 Btu = heat required to raise 1 lb of water 1°F
1 kilowatt hour = 3413 Btu
1 kilowatt hour = 860 kcal/hr

$$kWh = \frac{\text{Gals. X Temp. Rise °F}}{\text{3413 x Efficiency}}$$

$$KW = \frac{\text{Gals. X Temp. Rise °F}}{\text{3413 x Efficiency x Time in hours}}$$

$$\text{Gals/hour} = \frac{\text{kW x 3413 x Efficiency}}{\text{Temperature Rise in °F x 10}}$$

$$\text{Time in hours} = \frac{\text{Gals. x 10 x Temp. Rise °F}}{\text{3413 x Efficiency x kW}}$$

1 kilogram calorie = heat required to raise 1 litre of water 1°C
1 litre = 1000 cm^3
1 kilowatt hour = 860 kilogram calorie/hr

$$kWh = \frac{\text{Litres x Temp. Rise °C}}{\text{860 x Efficiency x Time in hours}}$$

$$\text{Litres/hr.} = \frac{\text{kW x 860 x Efficiency}}{\text{Temperature Rise in °C}}$$

$$\text{Time in hours} = \frac{\text{Litres x Temp. Rise °C}}{\text{860 x Efficiency x kW}}$$

Approximate efficiencies : Lagged container 0.9 to 0.95
Unlagged container 0.8 to 0.85

Example. 22 gallons, 90°F. rise, 0.8 Efficiency.

$$kWh = \frac{22 \times 10 \times 90}{3413 \times 0.8} = 7.26$$

Example 100 litres, 50°C. rise, 0.8 Efficiency

$$kWh = \frac{100 \times 50}{860 \times 0.8} = 7.26$$

CONVERSION FACTORS

1 Calorie = 4.186 Joules
1 Btu = 252 Calories = 1055 Joules
1 Btu = 778 ft lbf.
1 kWh = 3.6 Megajoules
1 kWh = 3415 Btu = 2.6552 x 10^6 ft lbf.
1 Joule M 0.73 ft lbf.

1 Radian = $\frac{180°}{p}$, Or 2p radians = 1 revolution

WATER DATA

1 gallon = 277 cubic inches
1 gallon of fresh water = 10 lb
1 cubic foot = 6.23 lb
1 galon = 4.54 litres
1 litre = 0.22 gallons
1 litre of fresh water = 1kg
1 cm^3 of fresh water = 1 g
1 ft head of water = 0.433 lbf/in^2 = 2985 N/m^2
1 lbf/in^2 = 27.71 inches head of water

Water expands approximately 4 per cent when heated from cold to boiling.

VOLUME HEAT REQUIREMENT

m^3× Specific heat × difference in temperature = mass × cp × Dt = kwh
kwh × 860 = kcal/hr.

LPG will ignite at 2% air, NG will ignite at 15% air
Flow calculation for vapour

$$Q = \frac{114\ (a^2)\sqrt{\Delta P \times 1.7}}{2} \quad \text{(sp. gr. of LPG)}$$

Q = m^3 / hr = volume

$$a = \text{area} = \frac{\pi d^2}{4} = .785 \times dia^2 \text{ in cm}$$

ΔP = difference in pressure kg/cm^2

Normal flow 1" pipe at 1 kg/cm^2 = 300 Kg
2" pipe at 1 kg/cm^2 = 1200 Kg

CONVERSION TABLES

Linear			Area		
Inches		Centimetres	Sq. Inches		Sq. Centimetres
.393700	1	2.54000	.15500	1	6.45160
.787402	2	5.08000	.31000	2	12.90320
1.181102	3	7.62000	.46500	3	19.35480
1.574803	4	10.16000	.62000	4	25.80640
1.968504	5	12.70000	.77500	5	32.25800
2.362205	6	15.24000	.93000	6	38.70960
2.755906	7	17.78000	1.08500	7	45.16120
3.149606	8	20.32000	1.24000	8	51.61280
3.543307	9	22.86000	1.39500	9	58.06440
Yards		Metres	Sq. Feet		Sq. Metres
1.093613	1	.91440	10.76391	1	.09290
2.187226	2	1.82880	21.52782	2	.18580
3.280839	3	2.74320	32.29173	3	.27870
4.374452	4	3.65760	43.05564	4	.37160
5.468065	5	4.57200	53.81955	5	.46450
6.561678	6	5.48640	64.58346	6	.55740
7.655291	7	6.40080	75.34737	7	.65030
8.748904	8	7.31520	86.11128	8	.74320
9.842517	9	8.22960	96.87519	9	.83610
Miles		Kilometres	Sq. Yards		Sq. Metres
.621371	1	1.60934	1.19599	1	.83613
1.242742	2	3.21869	2.39198	2	1.67226
1.864113	3	4.82803	3.58797	3	2.50839
2.485484	4	6.43738	4.78396	4	3.34452
3.106855	5	8.04672	5.97995	5	4.18065
3.728226	6	9.65606	7.17594	6	5.01678
4.349597	7	11.26541	8.37193	7	5.85291
4.970968	8	12.87475	9.56792	8	6.68904
5.592339	9	14.48410	10.76391	9	7.52517
Power					
Horsepower		Kilowatts	Acres		Hectares
1.341022	1	.7457	2.47105	1	.40469
2.682044	2	1.4914	4.94210	2	.80938
4.023066	3	2.2371	7.41315	3	1.21407
5.364088	4	2.9828	9.88420	4	1.61876
6.705110	5	3.7285	12.35525	5	2.02345
8.046132	6	4.4742	14.82630	6	2.42814
9.387154	7	5.2199	17.29735	7	2.83283
10.728176	8	5.9656	19.76840	8	3.23752
12.069198	9	6.7113	22.23945	9	3.64221

METRIC MULTIPLES AND SUBMULTIPLES

Prefix name	*Prefix symbol*	*Factor by which the unit s multiplied*	*Description*
pico	p	0000000000001	one UK billionth* US trillionth
nano	n	0000000001	one UK milliardth, US billionth
micro	u	0000001	one millionth
milli	m	0001	one thousandth
centi	c	001	one hundredth
deci	d	01	one tenth
deca (or deka)	da	10	ten
hecto	h	100	one hundred
kilo	k	1000	one thousand
myria	my	10000	ten thousand
mega	M	1000000	one million
giga	G	1000000000	one UK milliard, US billion
tera	T	1000000000000	one UK billion*, US trillion

*The definition of one billion as a thousand million is becoming increasingly common in the United Kingdom and continental Europe.

Technical Data

CONVERSION TABLES

Area

Sq. Miles		Sq. Kilometres
.38610	1	2.58999
.77220	2	5.17998
1.15830	3	7.76997
1.54440	4	10.35996
1.93050	5	12.94995
2.31660	6	15.53994
2.70270	7	18.12993
3.08880	8	20.71992
3.47490	9	23.30991

Capacity

Gallons		Litres
.21997	1	4.54609
.43994	2	9.09218
.65991	3	13.63827
.87988	4	18.18436
1.09985	5	22.73045
1.31982	6	27.27654
1.53979	7	31.82263
1.75976	8	36.36872
1.97973	9	40.91481

Volume

Cu. Feet		Cu. Metres
35.31467	1	.02832
70.62934	2	.05664
105.94401	3	.08496
141.25868	4	.11328
176.57335	5	.14160
211.88802	6	.16992
247.20269	7	.19824
282.51736	8	.22656
317.83203	9	.25488

Weights

Ounces		Grams
.035274	1	28.349523
.070548	2	56.699046
.105822	3	85.048569
.141096	4	113.398092
.176370	5	141.747615
.211644	6	170.097138
.246918	7	198.446661
.282192	8	226.796184
.317466	9	255.145707

Cu. Yards		Cu. Metres
1.30795	1	.76455
2.61590	2	1.52910
3.92385	3	2.29365
5.23180	4	3.05820
6.53975	5	3.82275
7.84770	6	4.58730
9.15565	7	5.35185
10.46360	8	6.11640
11.77155	9	6.88095

Pounds		Kilograms
2.204622	1	.453592
4.409244	2	.907184
6.613866	3	1.360776
8.818488	4	1.814368
11.023110	5	2.267960
13.227732	6	2.721552
15.432354	7	3.175144
17.636976	8	3.628736
19.841598	9	4.082328

Capacity

Pints		Litres
1.75976	1	.56826
3.51952	2	1.13652
5.27928	3	1.70478
7.03904	4	2.27305
8.79880	5	2.84131
10.55856	6	3.40957
12.31832	7	3.97783
14.7808	8	4.54609
15.83784	9	5.11435

Tons*		Kilograms
.000984	1	1016.0469
.001968	2	2032.0938
.002952	3	3048.1407
.003936	4	4064.1876
.004920	5	5080.2345
.005904	6	6096.2814
.006888	7	7112.3283
.007872	8	8128.3752
.008856	9	9144.4221

*1 metric ton = 1,000 kg.

CAPACITIES OF CONTAINERS

Rectangular to obtain capacity in gallons	Multiply Length x Breadth x Height (all in inches) and divide by 277.	$\frac{inch^3}{227}$
Capacity in litres	Multiply Length x Breadth x Height (all in cm) and divide by 1000.	$\frac{cm^3}{1000}$
Cylindrical to obtain capacity in gallons	Multiply Height x Diameter x Diameter (all in inches) and divide by 350.	$\frac{inch^3}{350}$
Cylindrical capacity inlitres	Multiply Height x Diameter x Diameter (all in cm) x 0.7854 and divide by 1000.	$\frac{cm^3}{1000} \times 0.7854$

PROPERTIES OF WATER BETWEEN 0°C AND 220°C

Temp °C	Steam Pressure Absolute kg/cm^2	Specific Weight kg/m^3 x 103	Specific Volume m^3/kgx10^{-3}
000	0.006228	0.9998	1.0002
010	0.012513	0.9996	1.0004
020	0.023830	0.9982	1.0018
030	0.043250	0.9956	1.0044
040	0.075200	0.9922	1.0079
050	0.125780	0.9880	1.0121
060	0.203100	0.9832	1.0171
070	0.317700	0.9777	1.0226
080	0.482900	0.9718	1.0290
090	0.174900	0.9653	1.0359
100	1.033200	0.9583	1.0435
110	1.460900	0.9510	1.0515
120	2.024500	0.9431	1.0603
130	2.754400	0.9348	1.0697
140	3.685000	0.9261	1.0798
150	4.854000	0.9169	1.0906
160	6.302000	0.9074	1.1021
170	8.076000	0·8973	1·1144
180	10·225000	0·8869	1·1275
190	12.800000	0.8760	1.1415
200	15.857000	0.8647	1.1565
210	19.456000	0.8528	1.1726
220	23.659000	0.8403	1.1900

CALORIFIC VALUE OF FUELS*

Fuel	(In Btu / lb)	(in K. Cal / Kg.)
Commercial Propane	22,300	11,900
Commercial Butane	21,900	11,700
Acetylene	22·400	11·950
Hydrogen	63,500	34,000
Natural Gas	11,800	6,300
Furnace Oil	17,800	9,500
Light Diesel Oil	17,800	9,500
High speed Diesel	17,800	10,300
Kerosene	19,700	10,550
Petrol	21,300	11,400
Charcoal	13,000	6,950
Coal	7,100	3,800
Coke	12,300	6,660
Fire Wood	8,200	4,400
Lignite	9,200	4900
LPG	21,300	11,400

*Depends on quality

Technical Data

TABLE OF INTERNATIONAL GAUGES

No. of Gauge	British			U. S.		
	S.W.G. mm	B.W.G. mm	B.G. SHEETS mm	B.S.G. mm	S.W.G. mm	B.S.G. SHEETS mm
5/0	10.972	12.7	14.943	—	10.935	—
4/0	10.160	11.532	13.757	11.684	10.000	11.684
3/0	9.449	10.795	12.7	10.405	9.208	10.404
2/0	8.839	9.652	11.308	9.266	8.407	9.266
0	8.229	8.636	10.068	8.255	7.785	8.252
1	7.620	7.62	8.971	7.348	7.188	7.348
2	7.010	7.213	7.993	6.544	6.668	6.543
3	6.401	6.579	7.122	5.829	6.19	5.827
4	5.893	6.045	6.35	5.189	5.723	5.189
5	5.385	5.588	5.652	4.621	5.258	4.62
6	4.877	5.156	5.032	4.115	4.877	4.115
7	4.470	4.572	4.48	3.665	4.496	3.665
8	4.064	4.191	3.988	3.263	4.115	3.264
9	3.658	3.759	3.55	2.906	3.767	2.096
10	3.251	3.404	3.175	2.588	3.429	2.588
11	2.946	3.048	2.827	2.303	3.061	2.304
12	2.642	2.769	2.517	2.052	2.68	2.778
13	2.337	2.413	2.24	1.828	2.324	1.829
14	2.032	2.108	1.994	1.628	2.032	1.628
15	1.829	1.829	1.775	1.45	1.829	1.45
16	1.626	1.651	1.588	1.29	1.588	1.29
17	1.422	1.473	1.412	1.151	1.372	1.151
18	1.219	1.245	1.257	1.024	1.207	1.024
19	1.016	1.067	1.118	0.912	1.041	0.912
20	0.914	0.889	0.996	0.812	0.884	0.813
21	0.814	0.814	0.886	0.723	0.806	0.724
22	0.711	0.711	0.794	0.644	0.726	0.643
23	0.610	0.635	0.707	0.573	0.655	0.574
24	0.559	0.559	0.629	0.511	0.584	0.511
25	0.508	0.508	0.56	0.455	0.518	0.455

ATOMIC WEIGHTS OF ELEMENTS

ELEMENT	Atomic Number	Symbol	Atomic Weight	ELEMENT	Atomic Number	Symbol	Atomic Weight
Actinium	89	Ac	226.00	Mercury	80	Hg	200.61
Aluminium	13	Al	26.97	Molybdenum	42	Mo	95.95
Antimony	51	Sb	121.76	Neodymium	60	Nd	144.27
Silver	47	Ag	107.88	Neon	10	Ne	20.183
Argon	18	A	39.944	Nickel	28	Ni	50.69
Arsenic	33	As	74.91	Niton or Radon	86	NtorRn	222.00
Nitrogen	7	N	14.008	Gold	79	Au	197.20
Barium	56	Ba	137.36	Osmium	76	Os	190.20
Bismuth	83	Bi	209.00	Oxygen	8	O	16.00
Boron	5	B	10.82	Palladium	46	Pd	106.70
Bromine	35	Br	79.916	Phosphours	15	P	30.98
Cadmium	48	Cd	112.41	Platinum	78	Pt	195.23
Calcium	20	Ca	40.08	Lead	82	Pb	207.21
Carbon	6	C	12.01	Potassium	19	K	39.096
Celtium	72	Ct	178.60	Praseodymium	59	Pr	140.92
Cerium	58	Ce	140.13	Proto-actinium	91	Pa	231.00
Cesium	55	Cs	132.91	Radium	88	Ra	226.05
Chlorine	17	Cl	35.457	Rhenium	75	Re	186.31
Chromium	24	Cr	52.01	Rhodium	45	Rh	102.91
Cobalt	27	Co	58.94	Rubidium	37	Rd	85.48
Colombium	41	Cb	92.91	Ruthenium	44	Ru	101.70
Copper	29	Cu	63.57	Samarium	62	Sa	150.43
Dysprosium	66	Ds	162.46	Scandium	21	Sc	45.10
Erbium	68	Er	167.20	Selenium	34	Se	78.96
Tin	50	Sn	118.70	Silicium	14	Si	28.06
Europium	63	Eu	152.00	Sodium	11	Na	22.997
Iron	26	Fe	55.86	Sulphur	16	S	32.06
Fluorine	09	F	19.00	Strontium	38	Sr	87.63
Gadolinium	64	Gd	156.90	Tantalum	73	Ta	180.88
Gallium	31	Ga	69.72	Tellurium	52	Te	127.61
Germanium	32	Ge	72.60	Terbium	65	Tb	159.20
Glucinium (1)	4	Gl	9.02	Thallium	81	Ti	204.39
Helium	2	He	4.003	Thorium	90	Th	232.12
Holmium	67	Ho	163.50	Thullium	69	Tm	169.40
Hydrogen	1	H	1.008	Titanium	22	Ti	47.90
Indium	49	In	114.76	Tungsten	74	WorTu	183.02
Iodine	53	I	126.92	Uranium	92	U	238.07
Iridium	77	Ir	193.10	Vanadium	23	V	50.95
Krypton	36	Kr	83.70	Xenon	54	X	131.30
Lanthanum	57	La	138.92	Ytterbium	70	Yb	173.04
Lithium	3	Li	6.94	Yttrium	39	Y	88.92
Lutesium	71	Lu	174.99	Zinc	30	Zn	65.38
Magnesium	12	Mg	24.32	Zirconium	40	Zr	91.22
Manganese	25	Mn	54.93				

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PHYSICAL PROPERTIES OF METALS

Material	Sp. wt. at 20^{0}C	Melting Point ^{0}C	Boiling Point ^{0}C	Sp. heat at – 50^{0}C Kcal/kg ^{0}C	Thermal Conductivity at temperature t: Kcal m hr ^{0}C	t^{0}C	Material	Sp. wt. at 20^{0}C	Melting Point ^{0}C	Boiling Point ^{0}C	Sp. heat at – 50^{0}C Kcal/kg ^{0}C	Thermal Conductivity at temperature t: Kcal m hr ^{0}C	t^{0}C
Mild Steel	7.65	1,400	--	0.144	39.4	20	Manganese	7.2	1,247	2,032	0.121 1	--	-
Aluminium	2.7	660	2,270	0.212 2	174	0	Mercury	13.6	–38.83	356.9	0.332 5	5.4	18
Antinomy	6.7	630.5	1,645	0.052	15.9	0	Molybdenum	10.22	2,625	4,540	0.064 7	126	0
Silver	10.5	960.5	1,927	0.005 8	365	20	Nickel	8.9	1,455	2,340	0.108 6	51.5	18
Barium	3.59	710	1,537	--	--	--	Gold	19.3	1,063	2,600	0.031 6	254	0
Bismuth	9.8	271	1,560	0.03	6.82	0	Platinum	21.45	1,773	4,300	0.032	60.2	10
Bronze	8.7	900	--	--	51	20	Lead	11.34	327.4	1,740	0.039	30.2	2
Cadmium	8.64	320.9	767	0.549	80.3	0	Potassium	0.85	63.5	762.2	0.192 1	85.1	0
Calcium	1.55	810	1,439	10.149	--	--	Silicium	2.326	1,430	2,355	0.1712	72.2	30
Carbon (graphite)	2.227	3,845	3,927	0.31	--	--	Sodium	0.954	97.8	880	0.297	121	0
Chromium	7.188	1,765	2,660	0.12 8	77.3	100	Sulphur	2.07	112.8	444.55	0.175 1	00.181	0
Cobalt	8.9	1,490	2,900	0.104 1	--	-	Strontium	2.577	770	1,366	0.055	--	--
Copper	8.94	1,083	2,336	0.092 8	333	18	Tantalum	16.6	3,027	>4,100	0.033	48	20
White Tin	7.3	231.85	2,260	0.053 8	56.5	20	Crystalline Tellurium	6.27	449.8	989.8	0.048 7	--	--
Iron	7.9	1,535	Varying	0.109 6	58.1	18	Thallium	11.85	302	1,457	0.032 6	33.6	0
Wroght Iron	7.78	2,100	according to	--	45	20	Thorium	11.7	(1,827)	(>3,000)	0.027 6	--	--
White Cast Iron	7.4 to 7.8	1,100	Composition	0.129 8	--	-	Titanium	4.5	1,725	>3,000	0.112 5	--	--
Gray Cast Iron	6.7 to 7.1	1,225		--	48	0	Tungsten	19.3	3,370	(6,700)	0.037 5	149	99.8
Brass	8.600	900	--	0.094	83.5	0	Uranium	18.97	1,090	(3,500)	0.061 9	--	--
Lithium	0.530	186	1,336	1,092	60.2	0	Vanadium	6.015	1,715	--	0.115 3	--	--
Magnesium	1.736	650	1,110	0.246 9	137	50	Zinc	7.14	419.44	907	0.093 8	96	20

WEIGHT OF COPPER AND ALUMINIUM STRIPS KGS/FT.

Thickness / Width		1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	½"	5/8"	3/4"
1 / 2"	Al	0.0165	0.033	0.050	0.066	0.084	0.100	0.132	0.165	0.200
1 / 2"	Cu	0.058	0.116	0.0174	0.232	0.290	0.348	0.464	0.580	0.696
3 / 4"	Al	0.025	0.050	0.075	0.100	0.125	0.150	0.200	0.250	0.300
3 / 4"	Cu	0.087	0.174	0.261	0.348	0.435	0.522	0.696	0.870	1.044
1"	Al	0.033	0.066	0.099	0.132	0.165	0.200	0.265	0.330	0.400
1"	Cu	0.116	0.232	0.348	0.464	0.580	0.690	0.928	1.160	1.380
1 1 / 4"	Al	0.042	0.084	0.126	0.168	0.210	0.252	0.336	0.420	0.500
1 1 / 4"	Cu	0.145	0.290	0.435	0.580	0.725	0.870	1.160	1.450	1.740
1 1 / 2"	Al	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.500	0.600
1 1 / 2"	Cu	0.174	0.348	0.522	0.696	0.870	1.044	1.392	1.740	2.088
2"	Al	0.066	0.132	0.198	0.264	0.330	0.396	0.528	0.660	0.792
2"	Cu	0.232	0.464	0.690	0.928	1.160	1.380	1.856	2.320	2.760
2 1 / 2"	Al	0.084	0.168	0.252	0.336	0.420	0.500	0.672	0.840	0.100
2 1 / 2"	Cu	0.290	0.580	0.870	1.160	1.450	1.740	2.320	2.900	3.480
3"	Al	0.100	0.200	0.300	0.400	0.500	0.600	0.800	1.000	1.200
3"	Cu	0.348	0.696	1.044	1.392	1.740	2.088	2.784	3.480	4.176
4"	Al	0.132	0.264	0.396	0.528	0.660	0.792	1.056	1.320	1.600
4"	Cu	0.464	0.928	1.380	1.856	2.320	2.760	3.712	4.640	5.520
5"	Al	0.168	0.336	0.504	0.672	0.840	0.100	1.345	1.680	2.000
5"	Cu	0.580	1.160	1.740	2.320	2.900	3.480	4.640	5.800	6.960
6"	Al	0.200	0.400	0.600	0.800	1.000	1.200	1.600	2.000	2.400
6"	Cu	0.696	1.392	2.088	2.784	3.480	4.176	5.568	6.960	8.352

Technical Data

WEIGHT OF ALUMINIUM SHEET

S.W.G	Inch	Millimeters	Kg/sq.ft
3/ 8"	0.375	9.53	2.400
5 / 16"	0.312	7.93	1.995
1 / 4"	0.250	6.36	1.596
3 / 16"	0.187	4.75	1.197
10 gz	0.128	3.25	0.816
1 / 8"	0.125	3.18	0.798
18 gz	0.048	1.22	0.307
19gz	0.040	1.02	0.255
20gz	0.036	0.914	0.230
21 gz	0.032	0.813	0.205
24 gz	0.022	0.559	0.141

WEIGHT OF M.S. ANGLES (EQUAL SIZE)

Size in mm	Weight in kg/mtr	Size in mm	Weight in kg/mtr
20x3	0.90	45x6	4.00
25x3	1.10	50x3	2.30
25x5	1.80	50x5	3.80
30x3	1.40	50x6	4.50
35x5	2.60	75x5	5.70
35x6	3.00	75x6	6.80
40x3	1.80	75x8	8.90
40x5	3.00	75x10	11.00
40x6	3.50	100x6	9.20
45x3	2.10	100x8	12.10
45x5	3.40	100x10	14.90

WEIGHT OF M.S PLATES

Mm	Kg/sq.mtr
2	15.70
4	31.40
6	47.10
8	62.80
10	78.50
12	94.20

WEIGHT OF M.S SHEETS

S.W.G	Thickness in mm	Kg/sq.mtr
10	3.15	24.75
14	2.00	15.70
16	1.60	12.55
18	1.25	9.80
19	1.12	8.80
20	1.00	7.85
21	0.90	7.05
24	0.63	4.95

WEIGHT OF M.S CHEQUERED PLATES

MM	Kg/sq.mtr
5	42.40
6	56.10
8	65.90
10	79.30
12	103.70

WEIGHT OF S.S SHEET/PLATE

S.W.G	Thickness in mm	Kg/sq.mtr
	8.00	64.00
	5.00	44.00
	4.00	32.00
10	3.15	26.00
14	2.00	16.00
16	1.60	12.00
18	1.25	10.00
19	1.12	9.04
20	1.00	8.00
21	0.90	7.04
24	0.63	5.04

WEIGHT OF ROUND AND SQUARE STEEL BAR/FT. OF 10 GZ HOLLOW

Size	Weight in kgs (Round)	Weight in kgs (Square)
⅛"	0.0190	0.0241
3⁄16"	0.0427	0.0545
¼"	0.078	0.0963
5⁄16"	0.1185	0.1512
⅜"	0.1702	0.2170
½"	0.3028	0.3859
⅝"	0.4731	0.6026
¾"	0.6820	0.8688
1"	1.210	1.542
1¼"	1.894	2.410
1½"	2.720	3.470
2"	4.850	6.170

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Technical Data

PRESSURE OF GAS AT DIFFERENT TEMPERATURE

	ARGON	HELIUM	HYDROGEN	NITROGEN	OXYGEN
MOL. VOL, LITER/MOL	0.15961	0.18471	0.18445	0.16917	0.15819
CONTENTS, CU. M.	6.91	6.16	5.99	6.53	6.98
TEMPERATURE °C	Pressure Kg/cm²	Pressure Kg/cm²	Pressure Kg/cm²	Pressure Kg/cm²	Pressure Kg/cm²
0	132	136	136	133	132
2	133	137	137	134	133
4	134	138	138	135	134
6	136	139	139	137	136
8	137	140	140	138	137
10	139	141	141	139	138
12	140	142	142	140	140
14	141	143	143	142	141
15	142	144	144	142	142
16	143	144	144	143	143
18	144	145	145	144	144
20	145	146	146	146	145
22	147	147	147	147	147
24	148	148	148	148	148
25	149	149	149	149	149
28	151	151	151	151	151
30	152	152	152	152	152
32	153	153	153	153	153
34	155	154	154	155	155
36	156	155	155	156	156
38	157	156	156	157	158
40	159	157	157	158	159
42	160	158	158	160	160
44	161	159	159	161	162
46	163	160	160	162	163
48	164	161	161	163	164
50	165	162	162	165	166
52	167	163	163	166	167
54	168	164	164	167	168
56	170	165	165	169	170
58	171	166	166	170	171
60	172	167	167	171	172
62	174	168	168	172	174
64	175	169	169	174	175
66	176	170	170	175	176

PHYSICAL PROPERTIES OF CERTAIN LIQUIDS

LIQUIDS	Specific Weight kg / m³	Specific Heat kcal / kg °C	Thermal Conductivity kcal / hr. m °C
Acetic Acid 100%	1050	0.49	0.148
Sulphuric Acid 5%	1030	0.95	0.445
Sulphuric Acid 10%	1070	0.92	0.445
Sulphuric Acid 15%	1100	0.98	0.445
Nitric acid 10%	1050	0.90	0.445
Nitric acid 20%	1120	0.81	0.445
Ethyl Alcohol 100%	700	0.65	0.150
Hydrochloric Acid 10%	1050	0.75	-
Asphalt	1100-1500	0.22-0.40	0.640
Aniline	1020	0.50	0.148
Benzene	730 -780	0.45	0.137
Cellulose	1300-1600	0.32	0.030
Vulcanised Rubber	1100	0.42	0.148
Dowtherm A	995	0.63	0.118
Ether	736	0.50	0.117
Water	1000	1.00	0.510
Gasoline	700 - 750	0.53	0.116
Gelatin	1100	0.90	-
Glycerine	1250	0.58	0.245
Coal Tar	1200	0.35	-
Cotton Oil	950	0.47	0.148
Machine Oil	920	0.40	0.148
Olive Oil	920	0.47	0.146
Melted Paraffin	890	0.70	0.208
25% Solution NaCl	1180	0.63	0.416
25% Solution CaCl	1240	0.65	0.416
Carbon Tetrachloride	1600	0.20	0.159
Turpentine	860	0.42	0.100

Note: All the properties give above are at 30 °C

Technical Data

MECHANICAL PROPERTIES OF SOME COMMON METALS AND ALLOYS

MATERIAL	Working Stress kg/mm²			Ultimate Stress kg/mm²			Modulus of elasticity kg/mm²	
	Tension	Compression	Shear	Tension	Compression	Shear	Longitudinal	Transversal
Extra mild steel	8	8	4	35-40	35-40	20	20,000	8,000
Mild steel	9	9	4.5	40-45	40-45	23	20,000	8,000
Semi-mild steel	11	11	5.5	50-55	50-55	28	20,000	8,000
Semi -hard steel	13	13	6.5	60-65	60-65	33	20,000	8,000
Hard steel	15	15	7.5	70-75	70-75	38	22,000	8,800
Very hard steel	17	17	8.5	80-85	80-85	43	22,000	8,800
Extra hard steel	20	20	10	90-100	90-100	50	22,000	8,800
Cast steel	30	30	15	130	130	65	27,500	11,000
Cast aluminium	5	5	2.5	20	—	10	6,750	2,700
Rolled aluminium	4	4	2	25	—	13	7,500	3,000
Bronze	2	2.5	2	25	—	12	6,000	2,400
Aluminium bronze	12	12	6	60	60	30	12,000	4,800
Pure rolled copper	3	6.5	1.5	21	—	11	11,000	4,400
Non-annealed copper wire	6	6	3	40	—	20	13,000	5,200
Hard state duralumin	9	9	7.5	50	50	40	7,500	3,000
Normal duralumin	7.5	7.5	4	43	43	22	7,500	3,000
Annealed duralumin	4	4	2	23	23	12	7,500	3,000
Tin	0.6	0.6	0.3	3.5	3.5	2	3,200	1,280
White cast iron	3	9	3	15	90	15	10,000	4,000
Grey cast iron	2.5	7	2.5	12.5	75	12.5	10,000	4,000
Cast brass	3	3	3	13	70	13	8,000	3,200
Rolled brass	3	3	1.5	20	—	10	6,500	2,600
Non - annealed brasswire	6	6	3	50	—	25	10,000	4,000
Lead	0.2	0.2	0.1	1.35	5	0.7	500	200
Lead wire	0.25	0.25	0.12	2.2	—	1.1	700	280
Zinc	1.5	1.5	1.75	5.5	—	3	9,500	3,800

WEIGHT OF STACKED SUBSTANCES (in Bulk) - kg/m³

Clay, gravel (dry)	1,800	Coal	770 to 860
Clay, gravel (wet)	2,000	Stacked Books	850
Oats	350 to 500	Lime and sand mortar	1,700 to 1,800
Bananas	250	Eggs in case	3,600 pieces/m³
Beetroot	570 to 650	Domestic garbage	200 to 250
Wheet	700 to 800	Barley	530 to 750
Coffee	720	Paper	720
Wood Coal	150 to 200	Ouarry Stone	200 to 2,700
Coke	360 to 530	Planks	700 to 720
Pressed Cotton	390	Pears & Plums	350
Unpressed Cotton	200	Apples	300
Flour	500 to 600	Potatoes	650 to 700
Pressed cotton thread	200	Sand, lime (dry)	1,600
Hay and Straw	100 to 120	Sand, lime (wet)	2000
Manure	750 to 950	Rye	600 to 800
Ice	670	Salt	745 to 785
Granite	2,500 to 3050	Tobacco	420
Beans, peas, Lentils	710 to 850	Wet Pear	600
		Sheet glass	2,600

CONDUCTIVITY OF CONSTRUCTION MATERIALS

MATERIAL	Specific Weight kg/m³	Conductivity Kcal/m h °C Temperature of material 10 °C			
		Dry State	Partitions	External Walls	Damp Walls
Light brick	1,200	0.22	-	-	-
Normal brick	1,800	0.50	-	-	-
Walls of light brick	1,200	0.29	0.35	0.42	0.48
Walls of normal brick	1,800	0.52	0.62	0.75	0.86
Limestone	2,000	0.65	1.01	1.17	1.4
Sandstone	2,400	0.93	1.44	1.67	2
Slate perpendicular to strata	2,700	1.3	1.4	1.5	1.8
Slate parallel to strata	2,700	2.0	2.2	2.4	3.0
Mortar, lime, cement	1,800	0.44	0.58	0.72	0.85
Plaster coat	1,200	0.37	0.48	0.6	0.8
Plaster siabs	1,000	0.23	0.3	0.37	0.5
Grit concrete	2,000	0.55	0.85	1.0	1.25
Compact reinforced concrete	-	0.9	1.2	1.4	1.6
Light aggregate concrete	1,000	0.16	0.24	0.28	0.33
Cellur Concrete	1,000	0.32	0.5	0.58	0.69
Isolated isorel	400	0.039	0.044	0.045	0.047

Technical Data

CONDUCTIVITY OF MATERIAL

MATERIAL	Specific Weight kg / m^3	Conductivity (K) Kcal/hr m °C	At °C
IS-8 Bricks	2200	1.032-1.204	1,000
Hysil Bolcks	260	0.096	500
Mineral Wool (Rock)	100-150	0.082-0.103	300
Mineral Wool (Slag)	240-300	0.069-0.086	300
Mineral wool (Glass)	150-300	0.070-0.082	300
Fibre Glass	400	0.059	10
Cork Plate	300	0.047	10
Asbestos (Wools)	300	0.047	10
Asbestos (Felt)	800	0.11	10
Asbestos (Plated Goods)	1,600	0.2	10
Sand	1,600	0.23	10
Gravel	2,000	0.33	10
Asphalt	2,150	0.8	10
Bitumen	1,050	0.14	10
Tiles	-	0.6	10
Cardboard	700	0.12	10
Ramming Mass (70% Al)	2,600 (Dry)	1.35-1.4	800
33% Alumina Fireclay	2,200	0.55	800
49% Alumina Fireclay	2,350	1.16	800
62% Alumina Fireclay	2,550	1.35	800
78% Alumina Fireclay	2,600	1.40	800

INSULATION

The table below gives reccommended insulation thickness in mm, required for different pipe sizes and different operating / fluid temperatures.

CONDUCTIVITY OF MATERIAL

Pipe dia (NB) mm	Operating / fluid temperatures					
	90	150	200	260	315	375
25	25	25	25	25	40	40
40	25	25	25	25	50	50
50	25	25	25	25	50	50
80	25	25	40	40	50	65
100	25	25	40	40	50	65
150	25	25	40	40	65	75
200	25	40	40	40	65	75
250	40	40	40	40	65	75
300	40	40	40	40	65	75
Flat	40	40	50	50	65	75

PLEASE NOTE: [1]Insulation material assumed is Glass wool having thermal conductivity 0.045 kcal / hr m °C @ 100 °C and average density about 80 - 100 kg m^3 [2] The surface temperature after insulation is 55-60 °C. [3] Insulation upto 65 mm should be in single layer and above 65 mm multi layer. e.g. for 80 mm two layer of 40 mm each; for 90 mm inner layer of 40 mm and outer of 50 mm.

COMBUSTION REACTIONS

		Water in Vapour form	Water in Liquid form
Carbon	$C + O_2 + 4N_2 = CO_2 + 4N_2$	+97.6 kcal	
--			
Sulphur	$C + ½O_2 + 2N_2 = CO + 2N_2$	+183.6 kcal	
--	$S_2 + 2O_2 + 8N_2 = 2SO_2 + 8N_2$		
Hydrogen	$S_2 + 3O_2 + 12N_2 = 2SO_3 + 12N_2$	+58.2 kcal	(+69.1) kcal
Carbon	$H_2 + 1/2O_2 + 2N_2 = 2N_2 + H_2O$		
Monoxide	$CO + 1/2O_2 + 2N_2 = CO_2 + 2N_2$	+68.2 kcal	
Methane	$CH_4 + 2O_2 + 8N_2 = CO_2 + 8\ N_2 + 2\ H_2O$	+192.5 kcal	(+214.3) kcal
Ethylene	$C2H_4 + 3O_2 + 12\ N_2 = 2CO_2 + 12\ N_2 + 2\ H_2O$	+319.7 kcal	(+341.5) kcal
Acetylene	$C_2H_2 + 5/2O2 + 10N_2 = 2\ CO2 + 10\ N2 + 4\ H_2O$	+304.8 kcal	(+315.7) kcal
Propane	$C_3H_3 + 5O_2 + 20N_2 = 3CO_2 + 20N_2 + 4\ H_2O$	+485.1 kcal	(+528.7) kcal
Butane	$C_4H_{10} + 3/2O_2 + 26N_2 + 4CO_2 + 26N_2 + 5H_2O$	+625.7 kcal	(+680.2) kcal

EQUIVALENT LENGTH (M) FOR ADDITIONAL PRESSURE DROP DUE TO VALVES AND BENDS % WISE

Pipe Dia (NB) Medium	Gate Valve	Angle Valve	Globe Valve	Std. T	Bend 90°	Bend 45°
10	0.099	2.79	5.33	1.116	0.434	0.230
15	0.122	3.30	6.44	1.369	0.483	0.277
25	0.204	5.04	9.81	2.180	0.763	0.436
40	0.314	7.53	14.65	2.930	1.130	0.628
65	0.515	12.36	24.03	4.806	1.716	1.030
80	0.605	14.52	28.23	5.646	2.016	1.200
100	0.788	18.91	36.77	7.354	2.626	1.576
125	0.975	23.39	45.48	9.097	3.249	1.950
150	1.167	27.99	54.43	10.885	3.888	2.333

Technical Data

% WISE PRESSURE DROP DURING FLOW AT DIFFERENT CFM AND PRESSURE										
CFM	SystemPress (PSIG)	½"	¾"	1"	1½"	2"	3"	4"	5"	6"
10	50	0.67	0.16	-	-	-				
	100	0.38	-	-	-	-				
	150	0.26	-	-	-	-				
	200	0.20	-	-	-	-				
50	50	-	3.42	0.97	0.12	-				
	100	8.2	1.93	0.55	-	-				
	150	5.7	1.35	0.38	-	-				
	200	4.37	1.03	0.29	-	-				
100	50		-	3.7	0.40	0.11				
	100		7.53	2.09	0.24	-				
	150		5.25	1.44	0.17	-				
	200		4.02	1.12	0.13	-				
150	50		-	-	0.94	0.26				
	100		-	4.6	0.53	0.15				
	150		11.5	3.20	0.37	0.10				
	200		8.85	3.46	0.28	-				
200	50		-	-	1.63	0.46				
	100		-	8.05	0.92	0.26				
	150		-	5.61	0.64	0.18				
	200		15.6	4.30	0.49	0.14				
250	50			-	2.54	0.70				
	100			-	1.44	0.40				
	150			8.87	1.00	0.28				
	200			6.72	0.77	0.21				
300	50			-	3.62	1.01	0.13			
	100			-	2.05	0.57	-			
	150			12.6	1.43	0.40	-			
	200			9.66	1.09	0.31	-			
500	50				-	2.67	0.36			
	100				5.59	1.51	0.20			
	150				3.89	1.05	0.14			
	200				2.98	0.81	0.11			
600	50				-	3.81	-			
	100				8.00	2.15	-			
	150				5.55	1.50	-			
	200				4.26	1.05	-			
750	50				-	-	0.78	0.20		
	100				-	-	0.44	0.11		
	150				-	-	0.30	-		
	200				-	-	0.23	-		
1000	50				-	-	1.34	0.34	0.11	
	100				-	5.9	0.76	0.19	-	
	150				9.8	4.12	0.53	0.14	-	
	200				7.5	3.16	0.41	0.10	-	
1500	50					-	2.98	0.75	0.24	
	100					-	1.68	0.43	0.13	
	150					9.17	1.17	0.30	-	
	200					7.02	0.90	0.23	-	
2000	50					-	5.29	1.32	0.42	0.16
	100					-	2.99	0.75	0.24	-
	150					16.3	2.08	0.52	0.16	-
	200					12.5	1.60	0.40	0.13	-
2500	50					-	-	2.04	0.64	0.25
	100					-	4.67	1.16	0.36	0.14
	150					-	3.26	0.80	0.25	0.10
	200					19.4	2.50	0.62	0.19	-
3000	50						-	2.91	0.91	0.36
	100						6.71	1.64	0.51	0.20
	150						4.68	1.14	0.36	0.14
	200						3.58	0.88	0.27	0.11
4000	50						-	5.15	1.60	0.62
	100						11.9	0.90	0.90	0.35
	150						8.31	2.02	0.63	0.25
	200						6.36	1.55	0.48	0.19
5000	50						-	-	2.47	0.97
	100						-	4.5	1.40	0.55
	150						13.0	3.14	0.97	0.38
	200						9.95	2.40	0.75	0.29
7500	50						-	-	-	-
	100						-	-	-	-
	150						-	-	-	-
	200						-	-	-	-

INTENSITY OF DRAFT FOR METALLIC CHIMNEYS (Draft in mm Wg at 27°C and 760 mm of Hg.)											
Average Temp. in chimney °C	Induced Draft per m height z	*(Useful) Height of chimney in meter									
		3	5	7.5	10	15	20	30	40	50	60
120	0.277	0.83	1.38	2.07	2.77	4.15	5.5	8.3	11.0	13.8	16.6
140	0.317	0.95	1.58	2.37	3.17	4.75	6.3	9 .5	12.6	15.8	19.0
160	0.360	1.08	1.80	2.70	3.60	5.40	7.2	10.8	14.4	18.0	21.6
180	0.395	1.18	1.97	2.96	3.95	5.92	7.9	11.8	15.8	19.7	23.7
200	0.425	1.27	2.11	3.18	4.25	6.36	8.5	12.7	17.0	21.1	25.5
220	0.458	1.37	2.29	3.43	4.58	6.87	9.1	13.7	18.3	22.9	27.4
240	0.486	1.45	2.43	3.64	4.86	7.29	9.7	14.5	19.4	24.3	29.1
260	0.515	1.54	2.57	3.86	5.15	7.72	10.3	15.4	20.6	25.7	30.9
280	0.535	1.60	2.67	4.01	5.35	8.02	10.7	16.0	21.4	26.7	32.1
300	0.557	1.67	2.78	4.17	5.57	8.35	11.1	16.7	22.2	27.7	33.4
320	0.577	1.73	2.88	4.32	5.77	8.65	11.5	17.3	23.0	28.8	34.6
340	0.599	1.80	3.00	4.49	5.99	8.98	11.9	17.9	23.9	29.9	35.9

(1) For other barometric pressures (b), draft = $Z \frac{b}{760}$

(2) Since the loss of temperature per m height of chimney is approx 0.5°C, average temperature of chimney = Foot temperature – ¼ chimney height

(3) Useful (*) height above the plane of earth, for instance above the grating level.

GAS PRESSURE VS. TEMPERATURE			
Temperature°C	Propane Kg/cm^2	Butane Kg/cm^2	LPG
16	6.25	1.5	4
25	6.75	2	5
32	8.5	3	6
40	10	3.5	7
47	11	4	9
55	13	5.5	11
65	17	8	15

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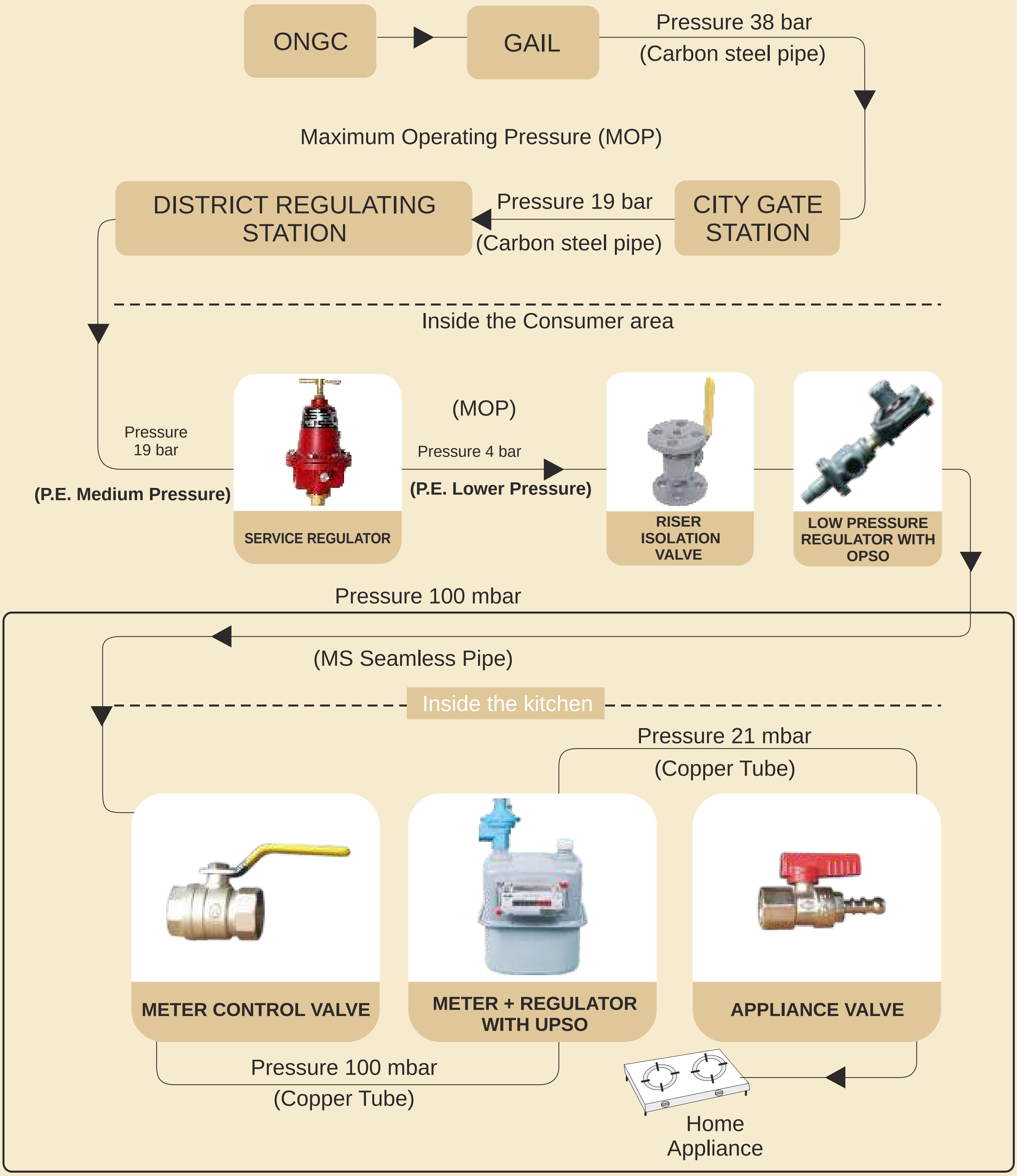
Technical Data

Gas Transmission & Distribution System
All pressures indicated are Maximum Operating Pressure (MOP)



Technical Data

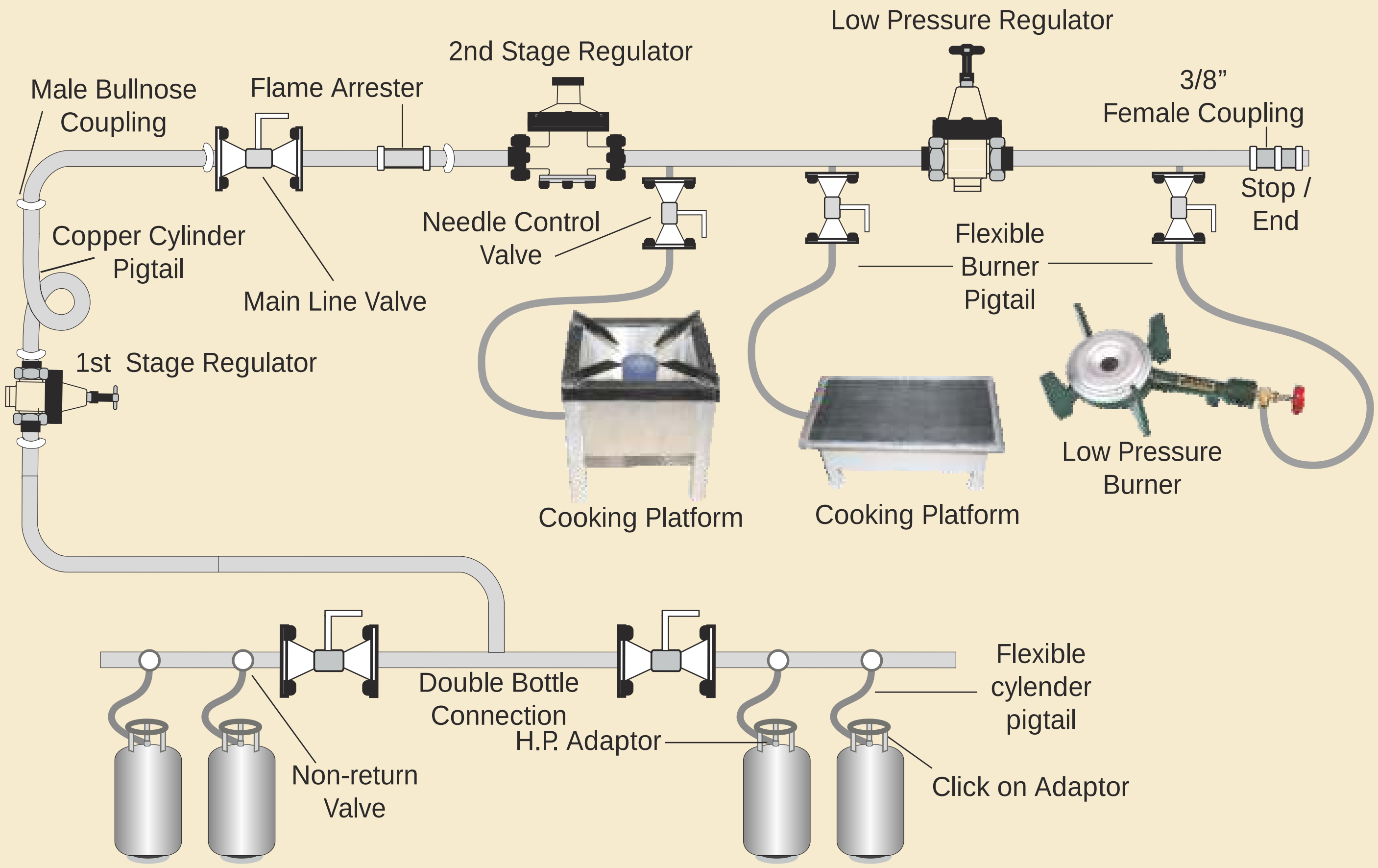
NATURAL GAS Daily Average Gas Analysis Test Report (MNGL)				
Sampling / Receipt & Testing for reference purpose only		For the Day :	06-Dec-06 Time: 0600	07-Dec-06 Time: 0600
Source	URAN- TROMBAY LINE		Location	ONGC URAN
Sr. No.	Comp #		Gas Composition (Mole %)	
1	Hexane (C6+)		0.02368	
2	Nitrogen (N2)		0.29929	
3	Methane (C1)		94.69242	
4	Carbon Dioxide (CO2)		0.11622	
5	Ethane (C2)		2.98684	
6	Propane (C3)		1.20651	
7	I - Butane (IC4)		0.23932	
8	N - Butane (NC4)		0.30222	
9	I - Pentane (IC5)		0.07095	
10	N - Pentane (NC5)		0.06250	
11	Total		100.000	
12	Gross Calorific Value (Kcal/M3)		9509.240	
13	Net Calorific Value (Kcal/M3)		8578.530	
14	Specific Gravity		0.59459	

MERITS OF USAGE OF LPG

- High calorific value
- Perfect combustion is possible with stoichiometric ratios of gas and air and it's not necessary to provide excess air
- No sulphur content (only few parts approx. 0.5 ppm)
- System based on modern technology, hence the fuel efficiency is more (approx. 95%)
- Simple equipment, achieves a homogenous mixture of air and gas, not necessary to elaborate atomizing / swirling devices as in case of liquid fuels.
- Clean and safe system.
- LPG is safer to use. The exclusive range of lpg in air is between 1.8% and 9%. With leaner or richer mixtures, it does not even burn.
- Environmental friendly-fuel and operating system
- Minimum running and operating cost
- Chances of pilferage is nil.
- Assured uninterrupted supply.
- Operational/temperature loss is nil.
- LPG is easy to handle and totally 'safe'.

Technical Data

SCHEMATIC DIAGRAM TO SHOW AN IDEAL INSTALLATION (COMMERCIAL)



Shown above is a schematic drawing of an ideal installation as per Indian Standard IS 6044. At the very start S.C. Valve Adapter with inbuilt non-return valve are used to fit onto the cylinder [note the 2 side screw flow adjustment device is illegal as it is not an adapter & ruins cylinder valves]. The adapter is link to the manifold by means of a re-inforced flexible cylinder pigtail. Manifolds come in either staggered or standard formation to suit the space available where the cylinder are stored. At all points in time cylinders whether empty or full must be connected to the system. This is why manifolds are sold in sets of 2 arms, 1 online & 1 in reserve. After the 2 manifolds are connected a primary stage regulator must be used to reduce the pressure in the line ahead to a maximum of 2kgs/cm^2 [or 30psi]. Choosing a regulator is important as the flow requirement of the entire system must not exceed what the regulator can deliver. Outside the cylinder storage side and in each room in which gas is used an emergency valve has to be provided. It is good practice to use second stage regulators in each room so that pressure stability can be maintained to the burners downstream of the second stage regulators. Finally, even though an appliance might have it’s own controls, each tapping point, from where gas is being drawn, must be terminated in a needle control valve on the line prior to it’s connection with the burner or appliance. By following these few rules together with others laid down in the Indian Standard IS 6044 a safe installation can be assured.

While carrying out commercial and industrial installations it is very necessary to install excellent quality safety products, regulators, governors, flashback arrestors, filters, slam shut off valves and excess flow check valves. An ideal installation will be complete in all respects provided most points mentioned in ISI 6044 Part I 2000, Part II 2001, OISD - 162 1995, Gas Cylinder Rules 2004 and the British Standards pertaining to

A) Safety in installation and use of gas systems and appliances
B) Industrial and commercial gas installation practice