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SAMSUNG ENGINEERING CO., LTD.

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1. INTRODUCTION

Fuel is used for the production of heat for process applications, for the generation of steam in process and utility plants and for driving machinery.

Fuel systems include facilities for collection, preparation storage and the distribution of fuel to users. The most commonly used fuels are hydrocarbon mineral oils and hydrocarbon gas.

In many process plants it is usual to rely on a single imported fuel such as a specific fuel oil or natural gas for supplying principal energy requirements.

In oil refineries the fuel system is usually more complex. Alternative fuels are usually available at most fired heaters, except in reforming or hydrotreating units where the process produces a surplus of suitable gaseous fuel. It is common practice to burn either fuel gas or fuel oil as a base and to use the other material to trim the heat requirement of the refinery. Many furnaces and boilers are equipped with combination burners suitable for gas or oil and may be controlled using either fuel.

Fuels are required to drive large items of machinery through gas turbines which may use a liquid or gas fuel or have a dual fuel system.

Diesel engines are used generally for driving essential or emergency equipment which would be required during an electric power failure or steam failure.

Gas and gasoline fueled spark ignition engines are rarely used in process plants and their fuel systems are not discussed in this manual.

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2. FUEL SELECTION

In most process plants the fuel to be used is generally determined by the resources available in the area and is stipulated by the purchaser. Natural gas and heavy fuel oil are the most commonly used fuels in many plants with diesel fuel being used as back-up for essential users.

The selection of an oil refinery fuel for burning in process furnaces and boilers is based on economic considerations which may vary throughout the life of the refinery. By-product materials which cannot be sold readily have the lowest value and are used as plant fuel but additional fuel may be required to meet requirements.

Consequently, depending on the refinery processing scheme, the fuel system will vary from plant to plant and may comprise two or three separate fuel systems such as gas, heavy oils and LDF (light distillate fuel).

2.1 FUEL OIL

Liquid fuel delivered to most process plants will usually be of a given fixed composition, frequently conforming to a recognized commercial fuel oil specification.

Liquid materials commonly diverted to refinery burner fuel include vis-breaker tar, FCC decanted oil, vacuum tower bottoms, lube oil extracts and waxes and any other material for which there is no market or which cannot be blended into marketable products.

Thus the properties of refinery fuel oil may vary over a wide range.

2.2 FUEL GAS

Gaseous fuel for most process plants will usually be natural gas or pipeline gas of fairly constant known composition.

Gases diverted to oil refinery fuel are those which are not processed to marketable products and frequently include hydrogen, hydrogen sulfide and hydrocarbon gases of the paraffin and olefin series to C4 and heavier.

2.3 FUEL PROPERTIES

In general the physical properties of fuels and their components, both liquid and gaseous, may be obtained from the literature e.g.:

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1. Technical Data on Fuel – Spiers
2. API Project 44 "Selected Values of Properties of Hydrocarbons and Related Compounds"
3. API Technical Data Book
4. Modern Petroleum Technology – Institute of Petroleum.

Figures 1 and 2 may be used to derive the physical properties of petroleum fractions used as fuel oils. However, since most fuels are complex mixtures the particular properties pertaining to a given plant should be obtained from the purchaser.

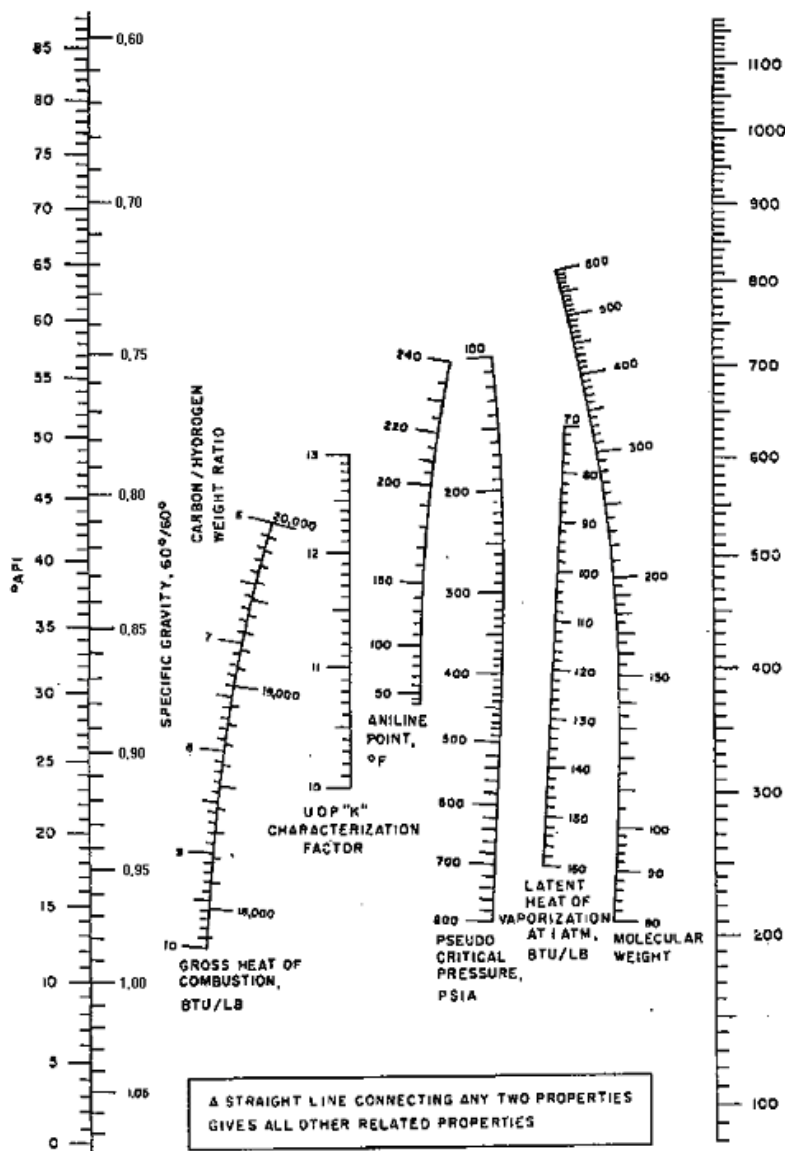


Fig – 1 Related Properties of Petroleum Fractions

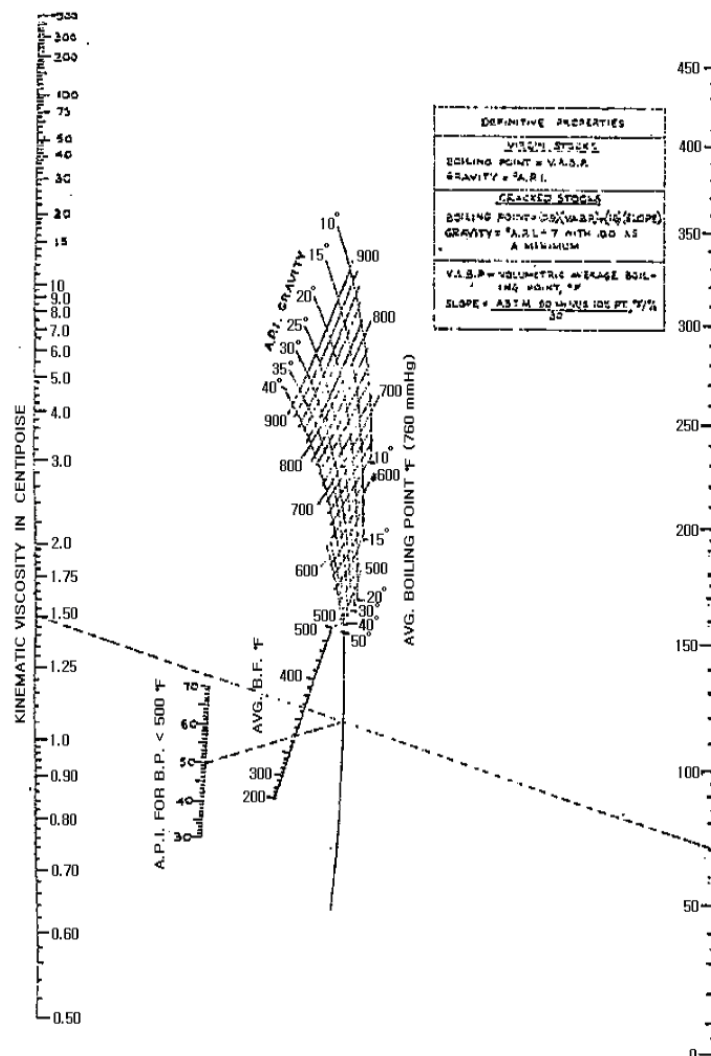


Fig - 2 Viscosity of Liquid Petroleum Fractions

Properties required for specifying fuel oil systems include:

- (1) Density (Specific gravity or API gravity)
- (2) Viscosity, preferably at two given temperatures to allow viscosity at any temperature to be estimated.
- (3) Pour point.
- (4) Flash point (PMCC, COC, Tag etc).

For specifying combustion equipment, the sulfur content, calorific value and carbon/hydrogen ratio are desirable, together with an analysis of trace elements.

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The following are typical examples for refinery fuel oil and fuel gas:

(1) Refinery Fuel Oil

Flowing material: Refinery Fuel Oil
 Gravity: 23° API
 Flowing Temperature: 140–170°F
 Viscosity at flowing temperature: 400–200 SSU
 Pour Point: 55°F
 Calorific Value: (gross) 19000 BTU/lb.
 Flash Point, PMCC: 150°F
 C/H weight ratio: (Fig 1) 7.4
 Sulfur, % wt: 1.1
 Metallic elements: Vanadium 379 ppm
 Calcium 7 ppm
 Lead 4 ppm
 Sodium 6 ppm
 Potassium 3 ppm
 Magnesium 1200 ppm

(2) Refinery Fuel Gas

Flowing material: Refinery Fuel Gas
 Available pressure: 50 psig (normal)
 60 psig (maximum)
 Calorific Value: (gross) 1200–1800 Btu/SCF
 Composition: (give detailed analyses for range to be used including H₂S and other sulfur compounds, nitrogen, CO₂ etc)

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3. FURNACE FUEL OIL SYSTEM

3.1 GENERAL

Fuel oil systems are designed to ensure a constant regulated supply of oil to the burners of process furnaces and utility boilers. The systems include equipment for storage, pumping, heating and distribution of oil at suitable pressure, temperature and viscosity to ensure that atomization and efficient burning are possible.

Heating is often required to reduce viscosity or to keep liquid any wax which is present in the fuel. Heavy oils may, therefore, need to be heated in the storage tank and/or a tank outflow heater to permit transfer from the tank to the pump suction and to avoid plugging of filters and lines.

IP standard 230/69 defines a pumpability test for fuel oils which indicates that viscosity in operating systems should not generally exceed 6 poise, and minimum storage temperature in tanks equipped with outflow heaters should not allow viscosity in the tank to exceed 25 poise.

Further heating of the oil is frequently necessary to facilitate oil atomization at the burners and may be carried out anywhere between the pump discharge and the burners, using a common steam heater or individual heaters for each plant.

A typical plant fuel oil system is shown in Figure 3.

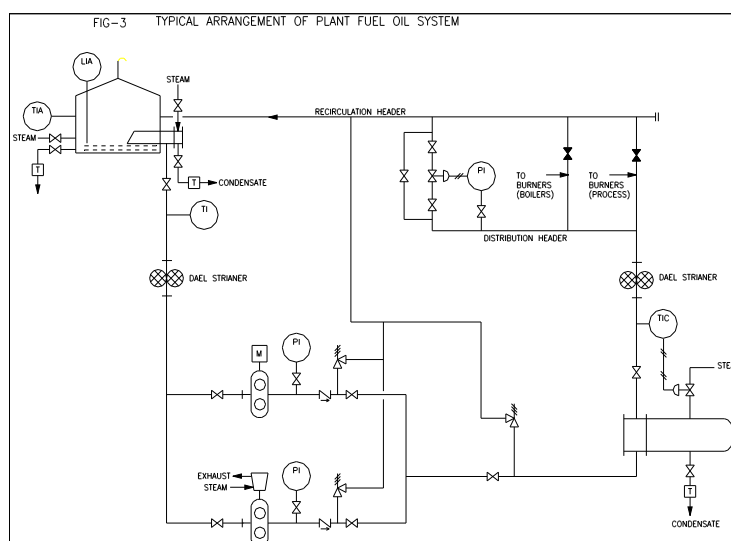


Fig - 3 Typical Arrangement of Plant Fuel Oil System

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In a centralized fuel oil system, oil is drawn from storage and heated to lower the viscosity to the value required at the burners. The oil is distributed to all plant users via a ring main system to ensure an adequate continuous supply, and to ensure the correct physical conditions at the burners an excess of fuel is supplied to the distribution header.

The excess, which amounts to about 25% of the maximum consumption is recirculated to storage.

The ultimate aim in fuel oil system design is to ensure that the supply of fuel to each burner does not vary when operational changes occur at other furnaces supplied by the system.

Individual plant systems are preferred by some operators, the on-plot fuel oil tanks being filled periodically from off-site tankage via bunkering pump and line (Figure 4).

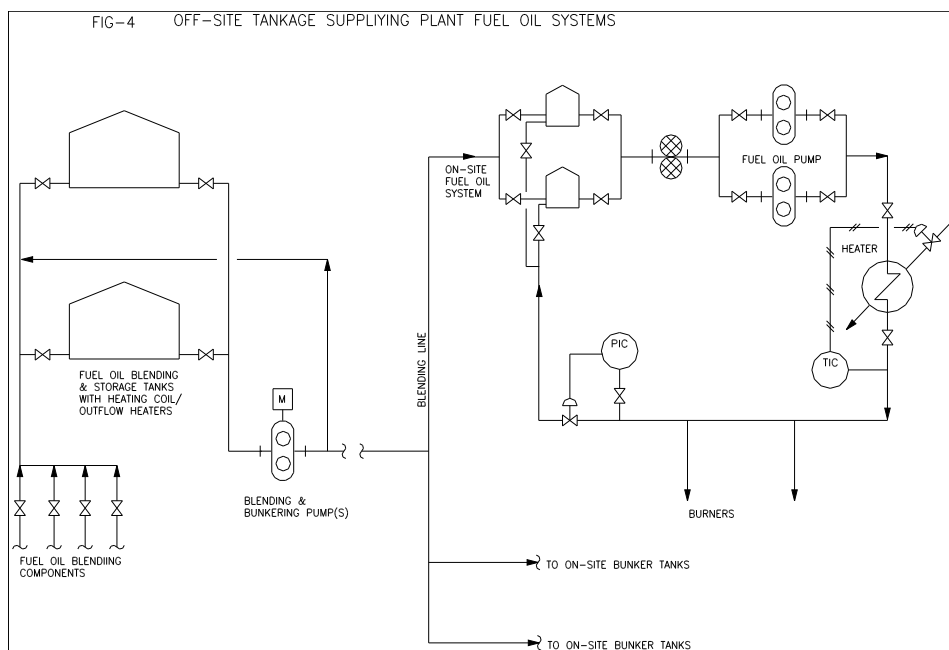


Fig - 4 Off-Site Tankage Supplying Plant Fuel Oil System

3.2 STORAGE

Usually two fuel oil tanks should be provided to allow for one tank to be filled or blended while the other is used.

In oil refineries it is often necessary to blend refinery fuel oil in bulk so two large tanks are provided each having a capacity for at least 5 days supply at normal firing rates.

For on-site systems two tanks are provided with 24-36 hours capacity; one tank is refilled from

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bulk storage while the other is used. Consumption data for accounting purposes are then derived from tank dips.

The tanks should be cone roofed, usually fitted with internal heaters and/or outflow heaters as required by the viscosity of the fuel oil. In some plants, the heaters are seldom operated at maximum capacity as recirculation flows maintain the temperature high enough to ensure pump suction.

Tanks should be insulated and pipework should be heat traced and insulated. Tanks should be provided with an atmospheric vent, gauge hatch, roof and shell manway(s), level indicator and alarm, temperature indicator, separate nozzles for inlet, pump suction and recirculation.

A pressure/vacuum breather valve should be provided in place of the atmospheric vent if the tank contents are to be heated above their flash point.

Water draw-off valves should be provided if there is a likelihood of wet fuel oil being supplied. In this case a temperature alarm should also be provided and tank temperature should be limited to a maximum of 200°F to avoid the possibility of boil-over due to vaporization of water in the bottom of the tank. Alternatively the tank should be held above 260°F to ensure that water cannot exist at the bottom of a full tank.

Fuel oil tanks are insulated for personnel protection (above 150°F) or for heat conservation depending on the normal operating temperature.

3.3 PUMPING AND HEATING

The temperature of the fuel oil must be maintained at a suitable level to ensure adequate pump suction conditions. The temperature in the tank or out of the outflow heater may be automatically controlled, but manual control is usually adequate. The temperature of the fuel oil at the burners must be accurately controlled to ensure correct viscosity and is usually automatically controlled.

A fuel oil set, comprising the pumps, heaters and controls may be purchased as a single package mounted on a common base plate or may be purchased as separate items. The fuel oil set is commonly installed in the utility plant, with the fuel tankage adjoining.

Oil must be delivered to the burners at a suitable pressure for control and atomization, depending on the type of burners used, and should be advised by the burner supplier. To provide this pressure, and to allow for distribution and control losses, oil should be distributed from the fuel oil set at a pressure of up to 25 psi or more above the required burner pressure. (See

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also Section 3.4)

The temperature at which oil is discharged from the fuel oil set depends on the viscosity required at the burners. Viscosities required by various types of burners should be advised by the burner suppliers but are around the following values:

- | | |
|---|----------|
| (1) Low pressure, air-fuel atomization | 10 cs |
| (2) Pressure atomization | 20 cs |
| (3) Rotary cup | 25 cs |
| (4) High pressure air-steam atomization | 30-40 cs |

The design capacity of the fuel oil pumping and heating equipment should be equal to 125% of design requirements of the plant based on simultaneous firing at design rate by all users, thus allowing 25% of oil pumped to be recirculated. Pumps will usually be of a rotary type, suitable for viscous material and giving a steady output.

A stand-by pump should be provided, which starts automatically on failure of the duty pump. At least one pump should be steam driven and any electric motor driven pumps should be connected to the emergency power distribution system unless alternative fuel systems are available for essential users.

Fuel oil heaters are usually steam heaters of the fixed tube sheet type. A spare heater is usually provided in centralized systems.

Coarse dual filters of about 1/16" mesh are provided upstream of pumps to intercept dirt and sludge while finer strainers are provided before the burners to remove carbon particles etc.

3.4 PIPING

Pump suction lines should be sized for a pressure drop not exceeding 0.3 psi per 100 ft. The suction line should be at least as large as the pump suction nozzle.

Discharge piping and recirculation lines should be sized for a pressure drop of 1 to 2 psi 100 ft.

Separate nozzles should be provided at tankage for fuel oil make-up, recirculation and pump suction lines.

All piping is usually heat traced and insulated and is kept separate from atomizing steam lines.

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The fuel oil pump discharge pressure should be specified so that with compatible piping arrangements the pressure at burners is about:

- (1) 150 psig (or higher) for pressure atomizing burners.
- (2) 15 to 20 psi below the atomizing medium pressure for steam or high pressure air atomizing burners.
- (3) 3 to 15 psi below the atomizing medium pressure for intermediate pressure air/fuel atomizing burners.
- (4) 30 inch water gauge below the atomizing medium pressure for low pressure air/fuel atomizing burners.

An allowance of 25–30% of the total system pressure drop must be made for the main firing control valve (furnace outlet temperature control valve, steam pressure control valve, etc).

Atomizing steam requirements are in the range 0.2 to 0.5 pounds per pound of fuel oil, values around 0.25 lb/lb being suitable for most heavy fuels.

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4. FUEL GAS SYSTEMS

4.1 GENERAL

Fuel gas systems should provide a supply to utility boilers, process furnaces, gas turbines and gas engines at constant regulated pressures and fairly constant calorific value. If the fuel gas is natural gas it may also be the principal feed to a chemical plant.

Plant fuel gas systems may include collection piping, mixing vessel, knock-out vessels, pressure controls and distribution piping. Liquefied gas may be provided as a stand-by fuel, but is seldom necessary when fuel oil is provided as an alternative fuel. In some refinery designs a vaporizing facility may be provided for disposing of excess or off-specification LPG.

A typical fuel gas system is shown in Figure 5 which would serve an oil refinery or petrochemical complex.

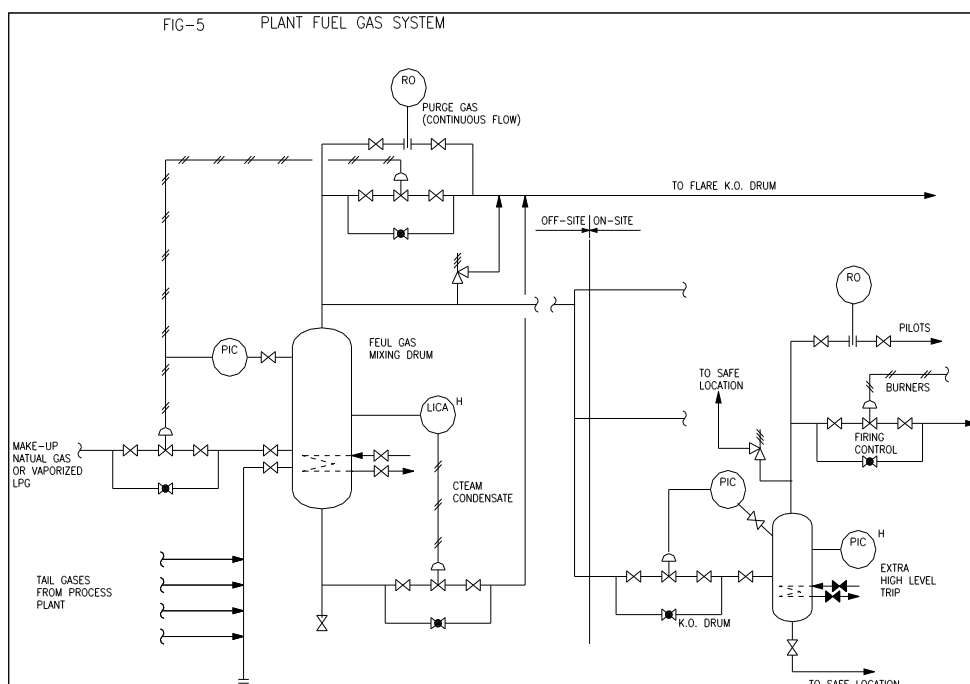


Fig - 5 Plant Fuel Gas System

Tail gases from process units is collected by a header system into a mixing drum kept at constant pressure. Make-up natural gas or revaporized LPG can be added to the mixing drum, either to maintain pressure (as shown) or to maintain calorific value using a flow control valve. The mixing drum may be provided with a steam heating coil and/or a gas condensate liquid level control valve depending on the dew point of the mixed gases at the set pressure and the ambient

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temperature at the site.

The mixed gas is distributed to on-site users at a controlled pressure; a continuous flow is provided to purge the flare system and excess gas is released to flare via a pressure control valve.

The on-site systems are supplied from the pressure controlled mixing drum through a suitable piping system, typically to a fuel gas knock-out drum. The knock-out drum may be provided with an inlet pressure control valve, a heating coil, a high liquid level alarm and an extra high liquid level trip which will extinguish the burners if there is a danger of liquid carry over. Pilot burners should be supplied separately.

The safety precautions required depend largely on the dew point of the fuel gas at operating pressure and the minimum ambient temperature expected. Generally the line from the knock-out drum to the burners and the pilots should be heat traced and insulated if the fuel gas contains significant amounts of C4 hydrocarbons.

4.2 MIXING DRUM

Gas may be supplied from the mixing drum to the fuel gas distribution header at any practical pressure, typically this is in the range 30–60 psig. Fuel gas is supplied to headers to furnace and boiler burners at the pressure required by the burner manufacturers, typically 10–30 psig. The difference in pressure between the mixing drum and the burner controls is available for piping distribution and control valve losses.

Gas turbines require fuel gas to be supplied at a pressure in the range of 125–225 psig, and often require an independent source of supply; eg. natural gas, or a fuel gas booster compressor should be used.

Gas engines also require fuel gas at a pressure of 125–225 psig; additionally a low sulfur content fuel should be provided to minimize valve spring and engine failures.

The fuel gas mixing drum should be sized for a design flow equal to the simultaneous design requirements of all normal gas users in the plant. Gas will be properly mixed if the mixing drum is large enough to separate all liquid droplets from the gas; thus the general criteria for sizing knock-out drums may be applied.

The vessel should be fitted with mixing baffles and a steam coil for revaporizing gas condensate. A liquid level control valve for releasing gas condensate to the flare knock-out drum (or other suitable location) should be provided if large quantities of liquid hydrocarbon condensate

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accumulation are anticipated.

4.3 PIPING

The sizing of piping between the mixing drum and plant on-site facilities depends largely on the system pressure and the available pressure drop. Generally off-site piping may be sized for a pressure drop of 0.5 to 1.0 psi per 100 ft and on-site piping for 0.2 to 0.5 psi per 100 ft.

Lines to isolated burners such as flare pilots may require heat tracing in cold climates and depending on fuel gas dew point. Fuel gas lines from furnace knock-out drums to the burners should be heat traced and lagged if significant quantities of C4 or heavier hydrocarbons are present in the fuel gas.

Climatic conditions and possible heavy hydrocarbon entrainment should also be considered in establishing the need for heat tracing.

Condensate separated in knock-out drums should be disposed of to the flare knock-out drum or other safe place via a closed system.

Knock-out drums should be located as near as practicable to the burners, and gas lines to the burners are heat traced if condensation is at all likely. The portion of piping after the final firing control valve should be heat traced if the final expansion of the fuel gas to the burners is likely to produce a temperature low enough to result in condensation.

4.4 START-UP FUEL

When the normal fuel gas is produced as a by-product of operating processes, provision must be made for start-up using an alternative fuel gas such as natural gas or revaporized LPG if dual fuel systems (oil and gas) are not provided. Use of commercial LPG will normally necessitate heat tracing of fuel gas lines after the final knock-out drum at each user.

Table-2 ASTM Gas Turbine Fuel Oil Specifications

DESIGNATION * / GRADE OF GAS TURBINE FUEL OIL	FLASH	POUR	WATER	CAR- BON RESI- DUE UN	ASH	DISTILLATION		GAYBOLT SEC "		KINEMATIC VISC cS "			GRAV	Na+K	Ca	Pb	Mg/V	S	
	POINT	POINT	& SOLU- %VOL	% BUI- TOM %	%WT	TEMP 90% PT		UNIVERSAL	FUROL	@ 100 F	@ 122 F	ITY	ppm	ppm	ppm	ppm	WEIGHT	%WT	
	(°F)	(°F)				(°F)	(°F)	@ 100 F	@ 122 F	(38°)	(50°)	, API	WT	WT	WT	WT	RATIO		
	MIN	MAX	MAX	MAX	MAX	MIN	MAX	MIN	MAX	MAX	MIN	MAX	MAX	MIN	MAX	MAX	MAX	MIN	MAX
No.1 - GT* VOLATILE DISTILLATE FOR GAS TURBINES THAT BURNS CLEANER THAN No.2 - GT	100 OR LEGAL (38)	0 (-18°)	0.05	0.15	0.1	- (215)	550 (288)	- (34.4)	-	1.4	2.5	-	35	2	5	5	5	-	0.5 OR LEGA
No.2 - GT - DISTILLATE FUEL OR LOW ASH AND MEDIUM VOLATILITY	100 OR LEGAL (38)	20 (-7°)	0.10	0.35	0.1	540 (282)	675 (357)	(32.8)	(45)	2.0	5.8	-	30	2	5	5	5	-	0.7 OR LEGA
No.3 - GT* - LOW ASH/ VOLATILITY FUEL THAT MAY CONTAIN RESIDUAL COMPOUNDS	130 OR LEGAL (54)	-	1.0	-	0.3	-	-	45	-	300	(5.8)	-	(638)	-	2*	5*	10*	5	-
No.4 - GT - LOW VOLATILITY FUEL CONTAINING RESID- UAL COMPONENTS & MORE V THAN No.3 - GT	150 OR LEGAL (66)	-	1.00	-	-	-	-	45	-	300	(5.8)	-	(638)	-	500	10'	10'	5	3.0*

a. No.1 - GT CORRESPONDS IN GENERAL TO SPECIFICATION D-396 No.1 FUEL & CLASSIFICATION D-975 No.1 - D DIESEL FUEL IN PHYSICAL PROPERTIES
No.2 - GT CORRESPONDS IN GENERAL TO SPECIFICATION D-396 No.2 FUEL & CLASSIFICATION D-975 No.2 - D DIESEL FUEL IN PHYSICAL PROPERTIES
No.3 - GT & No.4 - GT VISCOSITY RANGE BRACKETS SPECIFICATION D-396 No.4, No.5 (LIGHT), No.5 (HEAVY) AND No.6 & CLASSIFICATION
D-975 No.4 - D DIESEL FUEL, WHICH MAY BE SUPPLIED PROVIDED METALS COMPOSITION REQUIREMENTS ARE MET.

b. VISCOSITY VALUES IN PARENTHESES () ARE FOR INFORMATION ONLY AND ARE NOT LIMITING.

c. RECOGNISING THE NECESSITY OF ADDITIONAL REQUIREMENTS FOR CERTAIN TYPES OF GAS TURBINES, THE FOLLOWING MAY BE SPECIFIED
FOR No.1 - GT FUEL: LUMINOUSITY No. MIN = 40; THERMAL STABILITY TEST FOR 5 HOURS AT 250 F. PREHEATER TEMPERATURE, 350 F
FILTER TEMPERATURE AND AT A FLOW RATE OF 6 lb/h; FILTER PRESSURE DROP, MAX = 12" OF Hg; PREHEATER DEPOSIT CODE, MAX = 2.

d. FOR COLD WEATHER OPERATION, THE POUR POINT SHOULD BE SPECIFIED 10° F BELOW THE AMBIENT TEMPERATURE AT WHICH THE TURBINE IS
TO BE OPERATED, EXCEPT WHERE FUEL OIL HEATING FACILITIES ARE PROVIDED. WHEN A POUR POINT LESS THAN 0° F IS SPECIFIED FOR
No.2 - GT, THE MINIMUM VISCOSITY SHALL BE 1.8 cS (32.0 SUS) AND THE MINIMUM 90% POINT SHALL BE WAIVED.

e. FOR GAS TURBINES OPERATING BELOW 1200 F MAX GAS TEMPERATURE. THE LIMITATIONS ON V, Na+K, AND Ca MAY BE WAIVED,
PROVIDED THAT A SILICON-BASE ADDITIVE, OR EQUIVALENT, IS USED. THE SPECIAL REQUIREMENTS COVERING THE ADDITION OF
AND THE TYPE OF ADDITIVE SHALL BE SPECIFIED BY MUTUAL AGREEMENT BETWEEN PURCHASER AND SELLER.

f. WHERE WATER WASHING FACILITIES ARE AVAILABLE AT THE POINT OF USE, THESE REQUIREMENTS MAY BE WAIVED BY MUTUAL AGREEMENT
BETWEEN THE PURCHASER AND SELLER.

g. SPECIAL REQUIREMENTS COVERING THE ADDITION OF AND THE TYPE OF MAGNESIUM - CONTAINING ADDITIVE, OR EQUIVALENT, TO BE
USED SHALL BE SPECIFIED ONLY BY MUTUAL AGREEMENT BETWEEN THE PURCHASER AND SELLER.

h. FOR PRODUCTS OUTSIDE THE U.S.A. THE MAXIMUM SULPHUR LIMIT SHALL BE 1.0% WT.

i. LEGAL REQUIREMENTS TO BE MET.

ASTM - DETAILED REQUIREMENTS FOR GAS TURBINE FUEL OILS
- REF: ASTM PROPOSED SPECIFICATIONS FOR GAS TURBINE FUEL OILS - APPENDIX VI: D-2-1968
(ASTM STANDARDS, PART 17, JAN 1967, Page 1127)

Table-3 ASTM Diesel Fuel Oil Specifications

GRADE OF DIESEL FUEL OIL	FLASH POINT	POUR POINT	WATER & SEDIMENT %VOL	CARBON RESIDUE ON 10% REDUCED PRESSURE	ASH %WT	DISTILLATION TEMPERATURES °F(°C)		VISCOSITY @ 100°F KINEMATIC cS OR (S.U.S. sec)		\$ %WT	Cu STRIP CORROSION	CETANE NUMBER
	°F (°C)	°F (°C)										
	MIN	MAX	MAX	MAX	MAX	MIN	MAX	MIN	MAX	MAX	MAX	MIN
No.1 - D. VOLATILE DISTILLATE FUEL OIL FOR ENGINES IN SERVICE REQUIRING FREQUENT SPEED & LOAD CHANGES	100 OR LEGAL (37.8)	b	TRACE	0.15	0.01	-	550 (287.8)	1.4	2.5 (34.14)	0.50	No.3	40
No.2 - D. DISTILLATE FUEL OF LOWER VOLATILITY FOR ENGINES IN INDUSTRIAL & HEAVY MOBILE SERVICE	125 OR LEGAL (51.7)	b	0.05	0.35	0.01	540° (282.2)	640 (338)	20° (32.8)	4.3 (40.1)	0.50 ^a	No.3	40 ^c
No.4 - D. FUEL OIL FOR LOW AND MEDIUM SPEED ENGINES	130 OR LEGAL (54.4)	b	0.05	-	0.10	-	-	5.8 (45)	26.4 (125)	2.0	-	40 ^c

a. TO MEET SPECIAL OPERATING CONDITIONS, MODIFICATIONS OF INDIVIDUAL LIMITING REQUIREMENTS MAY BE AGREED UPON BETWEEN PURCHASER, SELLER AND SUPPLIER.

b. FOR COLD WEATHER OPERATION, THE POUR POINT SHOULD BE SPECIFIED 10°F BELOW THE AMBIENT TEMPERATURE AT WHICH THE ENGINE IS TO BE OPERATED, EXCEPT WHERE FUEL OIL HEATING FACILITIES ARE PROVIDED.

c. WHEN POUR POINT LESS THAN 0°F IS SPECIFIED, THE MINIMUM VISCOSITY SHALL BE 1.8 cS (32.0 SUS) AND THE MINIMUM 90% POINT SHALL BE WAIVED.

d. FOR ALL PRODUCTS OUTSIDE THE USA THE MAXIMUM SULPHUR LIMIT SHALL BE 1.0% WT.

e. WHERE CETANE NUMBER BY METHOD D613, "TEST FOR IGNITION QUALITY OF DIESEL FUELS BY THE CETANE METHOD," IS NOT AVAILABLE, ASTM METHOD D976, "CALCULATED CETANE INDEX OF DISTILLATE FUELS" MAY BE USED AS AN APPROXIMATION. WHERE THERE IS DISAGREEMENT, METHOD D613 SHALL BE THE REFEREE METHOD.

f. LOW ATMOSPHERIC TEMPERATURES AS WELL AS ENGINE OPERATION AT HIGH ALTITUDES MAY REQUIRE USE OF FUELS WITH HIGHER CETANE RATINGS.

ASTM - LIMITING REQUIREMENTS FOR DIESEL FUEL OILS *

- REF: ASTM STANDARD CLASSIFICATION OF DIESEL FUEL OILS. ASTM DESIGNATION: D975-68 (ASTM STANDARDS, PART 17, JAN 1969, Page 316)

SEE ALSO B.S.2869 & REF Be FOR BRITISH SPECIFICATIONS.

U.S.A. STANDARD 211.205-1968.

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A wide range of fuels can be used; however, the majority of liquid fuel fired turbines operate on light distillate. The only acceptable way to burn the heavier fuels (No 3 and 4 GT) is to limit, by pretreatment, the metals content (Particularly Vanadium and Sodium). Pretreatment would typically include desalting for sodium, potassium and calcium content reduction and the addition of a suitable compound, eg. magnesium sulfate or sulphonate, to counter the effect of vanadium.

Fuel filtration is required to protect fuel pumps and nozzles; generally 5 micron filtration is required for mechanical and low pressure air atomization system while 25 micron filtration is adequate for high pressure air atomization.

Viscosity limits are stipulated to provide a minimum viscosity for fuel pump and controller lubrication and a maximum for adequate fuel atomization. Fuel oil preheating is required for heavy distillate and heavier fuels, and air assisted atomization is used.

Each liquid fueled gas turbine installation should be provided with its individual fuel oil set, specified in detail by the gas turbine vendor and supplied as economics dictate from a central turbine fuel bunkering system comprising tanks, pumps and, if necessary, heaters.

5.2 FUEL GAS SPECIFICATIONS

Typical requirements for gas turbine fuel gas are:

- (1) Pressure: 125–225 psig
- (2) Solid contaminants: 30 ppm maximum, but 0.3 ppm (max) larger than 10 microns.
- (3) Water: 0.25% maximum, above saturation.
- (4) Hydrocarbons: No condensation upon a 20°F temperature drop (i.e. at least 20 °F above hydrocarbon dew point).
- (5) Heating value: 300–5000 Btu/SCF
- (6) Variation in heating value: 10% max for selected fuel.
- (7) Flammability limits: upper to lower 2.2:1, minimum.
- (8) Sulfur: 30 ppm max for units with exhaust heat recovery.
- (9) Alkali metals in the presence of Sulfur: 5 ppm equivalent alkali metal sulfate.

Sour gas systems for turbines require a fuel gas filter located as closely to the machine as possible, with alloy pipe being used downstream of the filter.

A number of gas fueled gas turbines may be supplied from an adequately sized fuel gas header with pressure regulation installed to meet the requirements of individual machines. Each machine should be supplied with its own filtration and knock-out facilities.

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6. DIESEL ENGINE FUEL

Diesel engines in process plants are generally used for emergency services such as stand-by fire-water pump or instrument air compressor, auxiliary power generator, etc.

6.1 FUEL TANKS

Diesel engines are provided with a small local tank, sized to hold sufficient fuel for a prescribed duration. The tank may be filled from a central tank and pump or from a road tanker, drums, etc. depending on size and frequency of filling.

The fuel tank is elevated to provide a few feet head above the fuel injection pump. The stroke of these pumps, may be so small that they cannot be relied upon to draw fuel from a lower level. The tank elevation should not be so high as to overcome the spring on the pump valves when the engine is not in use.

6.2 TANK FITTINGS

Gauge glasses should be avoided as they are likely to break due to vibration. However, if they are used, weighted cocks should be fitted so that they are normally closed and vibration will not cause them to open.

A spring loaded cock should be used for tank water draw-off and the fuel pipe should be set proud of the tank bottom which is sloped towards the water draw-off valve.

6.3 ESTIMATION OF DIESEL FUEL CONSUMPTION

A 2-stroke diesel engine, with a 65% mechanical efficiency and a 34% thermal efficiency requires about 10 kg/kw day useful fuel inventory. A 4-stroke diesel engine requires rather less, having a higher mechanical efficiency of about 75%.

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7. NATURAL GAS

Natural gas supplied as feed stock or fuel to a process plant is usually of pipe line quality. This means that the natural gas has been treated by the supplier for removal of liquids, solids and most undesirable gaseous components such as CO₂, H₂S and other sulfur compounds.

During transmission from the treating plant to the consumer it is likely that residual H₂S, in trace amounts, will attack the transmission line piping to form iron sulfide which can be carried forward to the consumer. Hence filters are required at the gas reception facility when the gas is to be used as fuel and more sophisticated equipment, such as a water washing venturi scrubber, may be necessary to prevent build-up of sulfides on the first stages of feed gas centrifugal compressors.

Natural gas may be supplied to consumer plants at almost any pressure up to or even above 1000 psig. For use within a process complex it may be necessary to reduce the pressure to several convenient levels and provide metering facilities for each stream (See Figure 6).

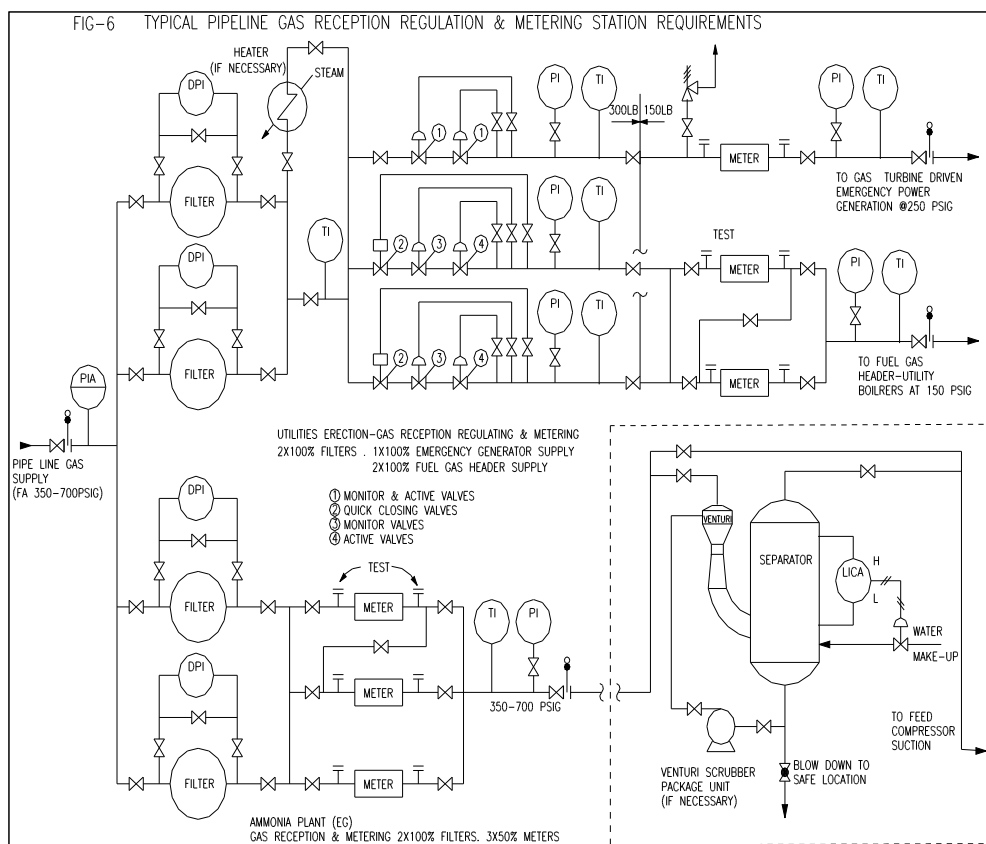


Fig - 6 Typical Pipeline Gas Reception, Regulating and Metering Station Requirements

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9. 작 성 내 력

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