

the weak pump becomes hard to start, unreliable in operation.

All burners and fuel-oil pumping equipment require strainers in the suction line to protect them from foreign matter. Perforated-metal or wire-mesh strainer baskets serve for residual oils. It is also customary to install a discharge strainer after the oil has passed through preheating equipment, especially for mechanical-atomizing burners.

Return Lines. Fuel-oil pumps are usually rated to deliver at least up to 1.5 times the burning rate. On so-called one-pipe installations where there's only a suction line, excess oil is diverted from the discharge line back to the suction side of the pump. The customary and preferred procedure is to run a return line back to the storage tank so all excess flows back to tank.

For residual oil this return circulation is highly important. This excess oil already has been preheated and its return to storage raises the over-all temperature at the storage tank, making pumping easier. The return line provides the further advantage of venting the piping system without the aid of special venting valves required with one-pipe designs.

Return-line pipe sizes are usually made the same as for the suction line. When return line rises above the burner on its way to the storage tank a check valve goes in near the burner hinge but there should be no other valves, shut-offs or obstructions. Where there's more than one tank, and you need to install valves in the return line to divert oil to either tank, insert a relief valve in the bypass line.

Valves. Oil supply lines from storage to burner must carry readily accessible shutoff valves of approved type near each burner and close to gravity and pressure supply tanks. Usually they go in on each side of the oil strainers and on the discharge and suction side of oil pumps. If there is one on the discharge side of an oil pump an approved pressure-relief valve should go in to return surplus oil to the tank or bypass it around the pump.

Further, approved automatically operated valves designed to shut off oil in case of breakage of the oil supply line are smart where burners are not equipped to prevent abnormal discharge of oil at the burner. Anti-siphon valves once required by NBFU for this kind of service are no longer a necessity and should not be put in unless local regulations demand it.

A good tight suction line with a check valve near the burner gives a very good guarantee that the suction line will stay filled and the pump will not lose its prime.

Preheating Oil. All No. 6 fuel oils and most No. 5's have to be preheated for efficient handling and combustion. How closely oil temperature, and hence viscosity at the burner, must be controlled depends on atomizing method. For mechanical-atomizing burners, recommended viscosity is 150 ssu at 100 F. Temperature to produce this viscosity depends on the fuel oil used. The Navy rule puts temperature at 125 F plus the saybolt furol viscosity of 122 F. Rotary cup burners handle oils of viscosities up to 300 ssu, while steam- or air-atomizing burners permit an even wider range.

There is a danger of vapor locking in the suction side of an oil pump if all preheating is done before the pump. Top temperature in the suction line should be of the order of 80 to 110 F and no more. For simplicity's sake, many installations have all their preheating on the discharge side of the pump. But often, especially in cold climates, some preliminary preheating has to be done at the storage-tank stage.

Preheaters, or fuel-oil heaters as they are often called, may use steam, hot water or electricity as a heating medium. Electricity serves best for starting up a cold plant.

Preheaters using steam or hot water are of shell-and-tube arrangement with the oil passing through the tubes and the heating medium passing through the shell over the tubes, or vice versa. High-pressure steam plants use steam almost entirely.

But because this steam has a high temperature and can cause coking of the oil and rapid fouling of the heater, thermostatic regulators should go in the steam line supplying the heater, with the thermostatic bulb put in the oil discharge line. As a further safeguard, a magnetic steam valve in the steam line before the regulator opens when the burner starts and shuts when it stops to prevent a build-up of hot steam within the preheater and attendant extreme temperature rise in the standing oil within the heater.

Where steam supply pressures run above 50 psi a reducing valve to bring it down to 25 psi is good operating practice. The heater installation runs larger and, hence costs more but it returns solid advantages in the way of reduced operating costs, less coking of oil, better regulation of oil discharge temperature, greater service and longer life of the fuel-oil heater.

Insulation. Since temperature plays so important a part in the handling and combustion of fuel oil, thorough and efficient insulation of all piping heaters, etc., is a sensible move.

Materials like 85% magnesia, mineral wool, or asbestos air-cell do a good job on in-plant piping, with plastic cement taking care of the various pipe fittings. Hairfelt and tar paper are often used for underground piping. Frequently the fuel-oil suction line, return line and steam or hot water supply and return lines to the storage-tank heating coil are wrapped together as one bundle.

How to handle gas economically and safely

A major difference between gas and the solid and liquid fuels is that gas storage is almost invariably the responsibility of the supplier and storage at the consumer's premises is rare. Such large-scale storage of the gas, and away from most important gas lines, natural gas, is relatively new.

Tremendous expansion of natural gas use into fields like house heating, has led to a demand that varies seasonally as well as hour to hour. But gas fields and transmission systems can't be operated economically at widely varying rates. As a result, gas is made available at the source at reasonably constant rates, as close as possible to capacity ratings of the lines.

Underground Storage. With virtually no gas-storage facilities in consumer plants, the problem of maintaining high and economical transmission rates in spite of widely varying consumer demand has been solved to an increasing extent by underground storage. In 1952, close to 150 large storage projects, with total capacity of about 1,000,000 MMcf were in operation from New York to California, Michigan to Texas. In the Appalachian region alone there are more than 100, with combined capacity exceeding 600, MMcf. More are planned.

Such underground storages have been developed from depleted or partially depleted gas fields, oil fields, abandoned noncommercial gas fields and formerly untested water sands. Some of extremely large — the Oakford storage field of New York State Natural Gas Corp (near Jeannette, Pa.) with 1,000,000 Mcf.

Gas Properties. The natural-gas pipeline company customarily conditions the gas to give it qualities and properties that make it more transportable and more desirable to the consumer. Methane and ethane constitute the bulk of the combustibles, methane varying in volume from 60 to 100%. Ethane, propane, butane, hexane, etc., follow in decreasing percentages.

Carbon dioxide and nitrogen form the bulk of the inert portion. Carbon dioxide ranges from a trace, to 100% in some Rocky Mountain area wells, while nitrogen averages out at about 10% by volume for the various U. S. fields. Helium also occurs in natural gas but is, usually less than 1%.

Some gas fields produce gas containing hydrogen sulfide and the various sulfur compounds known as mercaptans. A gas with hydrogen sulfide is known as a "sour" gas, while one without it is a "sweet" gas. When

hydrogen sulfide shows up in a gas it may be from a trace to 10 or 15% by volume. For each 1% H₂S by volume you can figure about 0.1 lb of sulfur per 100 cu ft. Usually, gas when produced is saturated with water vapor at prevailing pressure, temperature.

The gas-transmission company conditions the product by (1) removing water and liquid hydrocarbons (2) taking out hydrogen sulfide and inert gases (3) removing dirt and foreign

matter. An odorant is added for safety. The gas reaching the customer is thus nearly all pure fuel and his problem is reduced to delivering this fuel safely to firing units. An example from the setup of a large user (Powell, Nov. 1951, pp 90-94) gives an idea of what is involved.

Typical Large System. A typical large-scale user of natural gas gets supply from a pipeline at 100 psi, through a 22-in. line connecting to a

RECOMMENDED PRACTICES FOR INDUSTRIAL GAS PIPING

■ **LOCATION.** Be sure piping is located with safety in mind. Avoid putting it under floors, in unventilated crawl spaces or concealed in solid masonry. If you have to, enclose it in a larger pipe, sealed but provided with means for leak inspections at the inner end of the casing.

Never lay gas piping in cinder fill. Protect buried steel pipe against corrosion by suitable coating, or cathodic means.

Remember that many gases, particularly manufactured, contain moisture. Whether above or below ground, piping should not be exposed to freezing temperatures.

■ **MATERIALS.** Standard-weight (ASA Schedule 40) steel pipe is acceptable and generally used since pressures are relatively low, usually below 25 psi.

In smaller pipe sizes, fittings are screwed type, made of malleable iron, cast or forged steel. Larger sizes (4-in. and over) often use cast-iron fittings but welding fittings and welded or gland-type joints have become quite general. For the latter, check your local gas supplier for gland materials resistant to the gas they furnish.

■ **SIZING.** Estimate maximum rate of gas consumption (cu ft per hr) by dividing equipment input rating in Btu's per hr by the Btu per cu ft of the gas supplied. Load diversity may be figured in, but best practice usually designs pipe for maximum rating, so there is room for growth and changes in specific gravity or heating value of the gas supplied.

Allowable pressure loss from meter to point of use under maximum gas demand can be selected by allowing either 0.5-in. water, or 10% of initial pressure, whichever is greater.

Equivalent pipe length to use in determining pressure loss is taken as actual length plus equivalent length allowances for fittings shown in Table XIV, *Piping Handbook*, 4th ed.

■ **INSTALLATION RULES.** Never weaken the building structure by such shortcuts as notching beams to install piping. Never hang, strap or otherwise support gas piping from other piping or electrical conduit.

Securely fasten and support gas piping with hooks, straps, bands or hangers spaced at intervals no greater than: 8 ft for 1/4- and 1-in. pipe, 10 ft for 1 1/4-in. or larger pipes in horizontal runs; at every floor level for 1 1/4-in. or larger vertical pipes.

Grade piping with a pitch of at least 1 in. in 50 ft and provide a drip at any low point where condensate could collect. Allow for expansion bends or gland-type couplings in long runs of 4-in. or larger piping. Expansion bends should follow usual good practice for radius, uniformity of curvature, uniformity of wall thickness. Locate gland-type couplings where they can be readily inspected and maintained. (Turn page)



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