POTENTIAL NATURAL GAS PIPE LINE AT RESIDENTIAL COLLEGE UNIT (UMP): FUTURE DEVELOPMENT

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ABSTRACT

The consumption of energy has increased as result of rapid economic growth in Malaysia. Realizing the importance of energy, natural gas can be alternative energy source which is more effective and cheap compared to electricity. The main objective of this project is to design the distribution line of natural gas to all residential college units (UKK) at Universiti Malaysia Pahang (UMP) located at Gambang, Kuantan. UMP is located near to gas service station, approximately 500 m. With the existing gas service station in Gambang, it is convenient way to tap the natural gas at future point to UMP. Currently, student's cafeteria using LPG bulk storage for cooking and it is not continuously supply and can disturb their production. Besides that, student also have water heater in their hostel, thus it will affect the electricity bill for every month. Cox's equation has been used to estimate the pressure drop as stated in MS 930 and ASME B31.8. As a result, the total pressure drop from the source to load consumer is below 15% which is acceptable for designing pipeline. The 2 and 3 inches Medium Density polyethylene (MDPE) pipe is use for distribution line construction. Lastly, Plan Design Management System (PDMS) has been used to draw the pipeline in 3D. As the conclusion, natural gas can reduce about 50% the utilities cost compare to electricity

ABSTRAK

Permintaan terhadap tenaga semakin meningkat disebabkan oleh pembangunan ekonomi yang pantas di Malaysia. Menyedari kepentingan tenaga, gas asli boleh dijadikan sumber tenaga alternatif yang di mana mempunyai lebih efektif dan murah berbanding tenaga elektrik. Objektif utama projek ini ialah untuk mereka sistem pengagihan gas asli ke semua Unit Kolej Kediaman (UKK) di Universiti Malaysia Pahang (UMP) yang terletak di Gambang, Kuantan. UMP terletak berhampiran dengan stesen servis gas asli, dalam anggaran 500m. Dengan kewujudan stesen servis gas asli di Gambang, ini menjadi kepastian untuk mengambil gas asli daripada punca di UMP. Pada masa ini, kafeteria pelajar masih menggunakan tong penyimpanan LPG untuk memasak dan tong-tong ini tidak dihantar berterusan dan akan mengganggu produksi mereka. Selain itu, para pelajar juga mempunyai pemanas air di asrama mereka, maka ini boleh mengakibatkan kenaikan bil elektrik untuk setiap bulan. Formula Cox telah digunakan untuk mengira kejatuhan tekanan seperti yang telah diwartakan dalam MS930 dan ASME B31.8. Keputusannya, jumlah kejatuhan tekanan daripada punca ke pengguna adalah dibawah 15%, yang dimana diterima untuk mereka sistem pempaipan. 2 dan 3 inci paip Polyethylene Berketumpatan Sederhana (MDPE) digunakan dalam membuat sistem pengagihan gas asli ini. Akhir sekali, Plan Design Management System (PDMS) telah digunakan untuk melukis sistem pempaipan dalam bentuk 3 Dimensi. Kesimpulannya, gas asli dapat mengurangkan 50% kos penggunaan tenaga berbanding elektrik.

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LIST OF SYMBOLS

^{o}C	-	Degree Celsius
^{o}F	-	Degree Fahrenheit
m	-	meter
mm	-	millimeter
%	-	percent
Q	-	Flow of fluid between nodes
P	-	Pressure
L	-	Length
SG	-	Specific gravity
psi	-	Pound square per inch
kpa abs	-	kilo Pascal absolute
psig	-	Pound square per inch (gauge)
bar	-	bar
mmH_2O	-	Millimeter of water
kWh	-	Kilowatts per hour
BTU	-	British Thermal Unit
Sm^3	-	Standard meter square
hr	-	hour
SDR	-	Standard Dimension Ratio
PN	-	Pressure Nominal
PE	-	Polyethylene
MDPE	-	Medium Density Polyethylene
LPG	-	Liquefied Petroleum Gas
3D	-	3 dimension
H_2S	-	Sulphuric acid
CO_2	-	Carbon Dioxide

N_2	-	Nitrogen
CH_4	-	Methane
C_2H_6	-	Ethane
C_3H_8	-	Propane
C_4H_{10}	-	Butane
km	-	Kilometer

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CHAPTER 1

INTRODUCTION

1.1. Background of study

Nowadays, the natural gas demand as a fuel to generate electricity is increasing due to abundance resources compared to other fuel, environmental friendly (clean burning), efficiency and low cost compared to other fuel or electricity. On the other hand, for example in term of transmission line, the electric power in current from the power plant will loss and need a generator to power up the current to make sure the current is supplied to customer. So, it is more expensive because of the cost to generate the current. For natural gas, the gas will flow through the transmission line without having a loss of load. With using the natural gas, it will reduce the pollution and increase the consciousness and responsibility to the environment in our country. It is important to consider the environment to make sure we have the brighter future towards sustainable development for our country (T. H. Oh, 2009).

Natural gas is not only can generate electricity, it also can use for water heating and boiling, cooking, drying, production of steam and so on. It is suitable for household, commercial, and industrial utilizations. Many new and improved application of natural gas have been in the market. The function of these applications depends on the equipment and alternative fuel cost, and local regulatory condition (M. Z. Jaafar, 2003).

1.2. Problem statement

Universiti Malaysia Pahang has four student hostels which are divided into for residential college unit 1, 2, and 3. For student cafeteria, currently using the LPG bulk storage for cooking and it is not continuously supply like natural gas. In that case they need to order if the LPG is finish. It will slow the production of their food. Other than that, students also have a water heater in their hostel. Thus, it will affect the electricity bill for every month.

1.3. Objectives of the project

The objective of this project is:

1. To design the distribution line of natural gas to all residential college unit

1.4. Scope of study

1. Load demand

   Accommodate for 3 unit hostel and 2 unit students cafeteria.
2. The network piping calculation can be made by calculations the loads of consumption using a certain formula and also determine the classification of polyethylene pipe construction.
3. The PDMS software is used to draft and draw pipelines in 3 dimensions (3D).

1.5. Rational and significance

1.5.1 Rational

The usage of Natural Gas will affect the cost of the electricity bill every month. It also can produce cleaner environment due to the clean combustion.

1.5.2 Significance

The natural gas price is cheaper and the efficiency is up to 90% to power compare to other fuel.

CHAPTER 2

LITERITURE RIVIEW

2.1 Introduction to gas system

Natural gas are found in the earth's crust together with crude oil located thousands feet from the ground. These reservoirs only would exist in a certain location depending on the geological of the earth itself. In that case, this is the most challenging task in the petroleum industry. There are three major activities to find the reservoir such as geological survey, geophysical survey and exploratory drilling (A. Roley, 1997).

After the area of the reservoir is located, a drilling facility is built at the location. Then, reaching the gas deposits requires drilling through layers of sand, silt and rock. The raw gas is pumped from the underground to the surface. Untreated natural gas usually contains undesirable components such as H_2S, CO_2, N_2 and water vapor. Field processing of natural gas implies the removal of this component or reduced to acceptable concentration (A. Roley, 1997).

Then the natural gas will be piped to the gas processing plant (GPP) to finish clean the gas. This to make sure that the gas arriving to the customer will burn efficiently and clean. When the gas is clean, it will distributed to the compressor station to make sure the gas can arrive to the customers. It about 100 km, that we need the compressor station to reduce the pressure drop in the pipe line (A. Roley, 1997).

The gas wills transmitted to the city gate to reduce the pressure about 20 psi. It has to pass through an odorant facility to add distinctly unpleasant smell because natural gas has no colour, taste or smell. This is a safety to ensure that we can detect a gas leak or when a burner is accidentally left on without burning (A. Roley, 1997).

Lastly, it will distribute to the service station and district station. Finally, it transported to commercial, residential and industrial area at lower pressures via the distribution and reticulation pipelines.

2.2 Properties of natural gas

Natural gas is considered a fossil fuel and consists of methane (CH_4). It may also contain ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}) and others. It has certain properties that enable its use for industrial or domestic purpose, such as, contains non-poisonous ingredients that when inhaled gets absorbed into our body. It is also tasteless and colourless and when it mixed with suitable amount of air and ignited, it will burn with clean blue flame. It is considered as the cleanest burning fuels and producing carbon dioxide and water as same as breathing. Natural gas is lighter than air (SG_{NG}=0.6, SG_{air}=1.0), and tends to disperse into the atmosphere (A. Roley, 1997).

Natural gas only ignites when there is an air and gas mixture and the percent of natural gas is between 5 to 15 percent. A mixture containing less or greater, natural gas would not ignite. Natural gas contains very small quantities of nitrogen (N_2), carbon dioxide (CO_2), sulfur components and water. It leads to the formation of a pure and clean burning product that is efficient to transport (Gas Malaysia Sdn Bhd).

It is the cleanest burning fossil fuel available that can leads to a cleaner environment. It can help improve the quality of the air and water. Natural gas burns to produce no harmful pollutants and is a highly reliable fuel for domestic use.

2.3 Distribution system

Main service and meters are required to distribute gas to make sure the customer continuously get the natural gas. The design of the new systems and addition to and renewals of existing systems is a branch of the gas engineering. The main objective of a good design is to supply the market demand of any customer in the system with minimum cost and follow the safety practices.

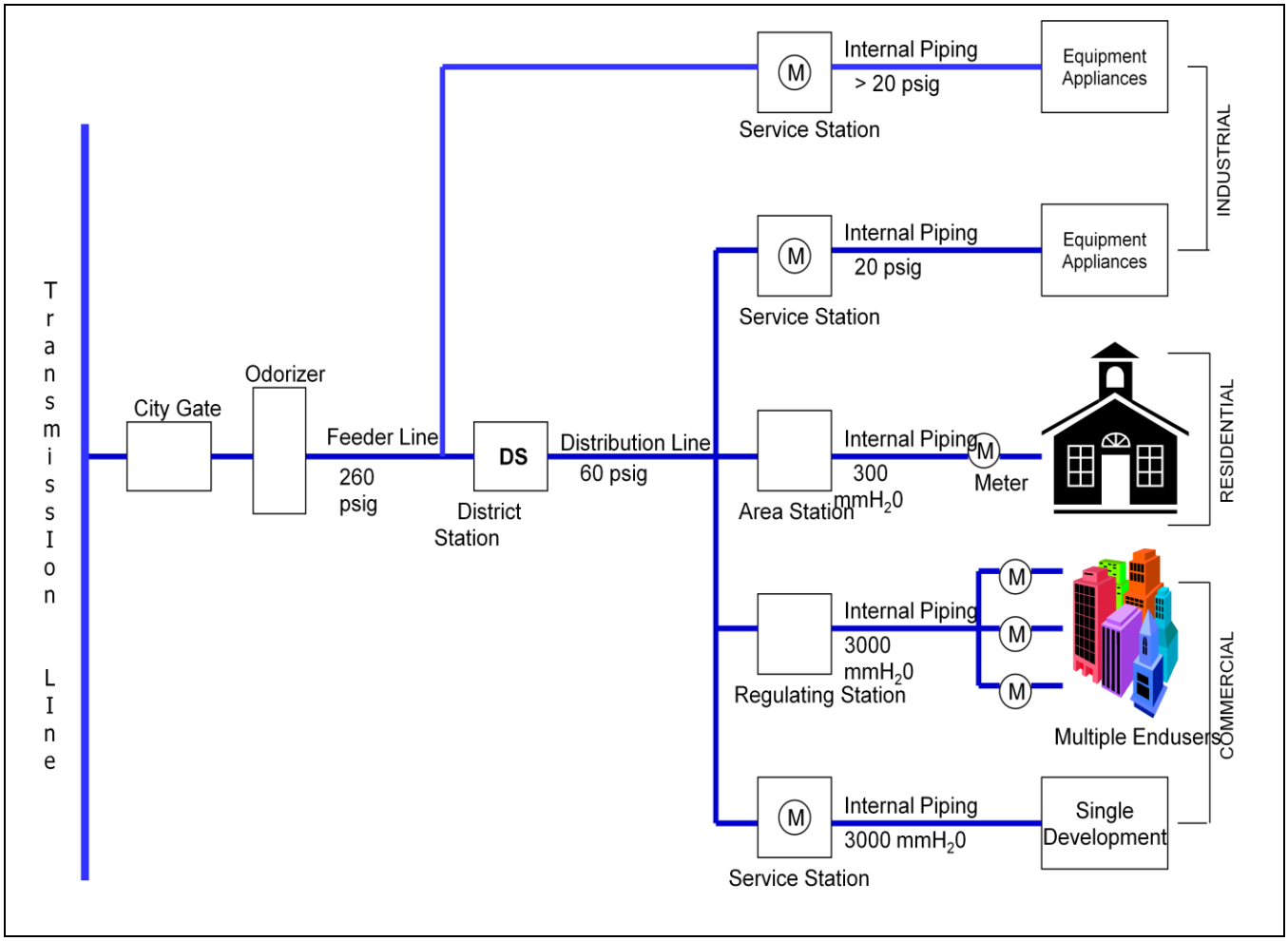

Figure 2.1: Natural gas Distribution system (Zulkefli Y., 2008)

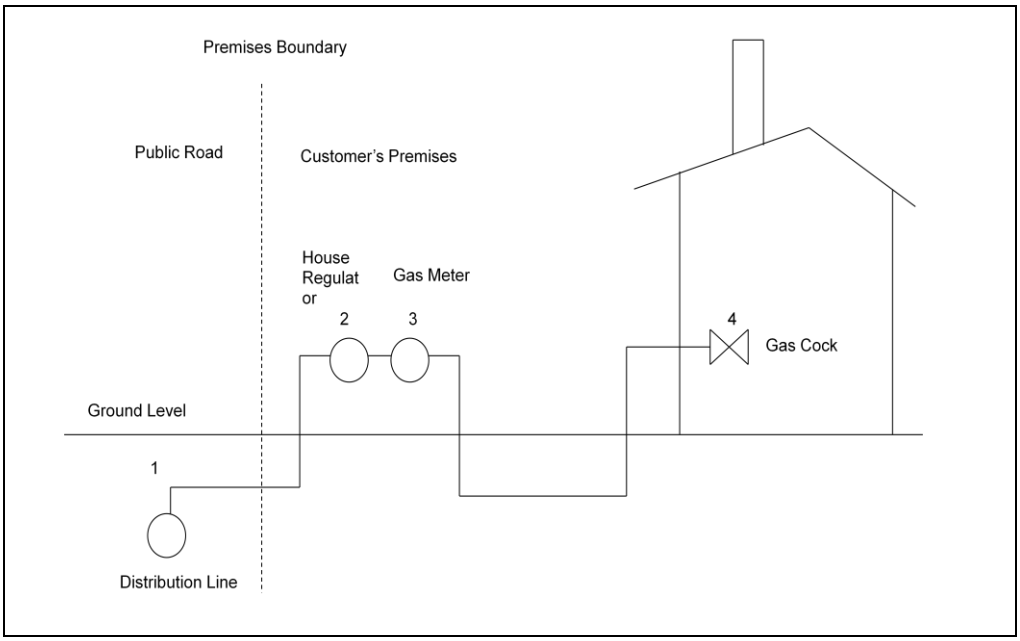

Figure 2.2: Typical residential distribution line for single floor house (Zulkefli Y., 2008)

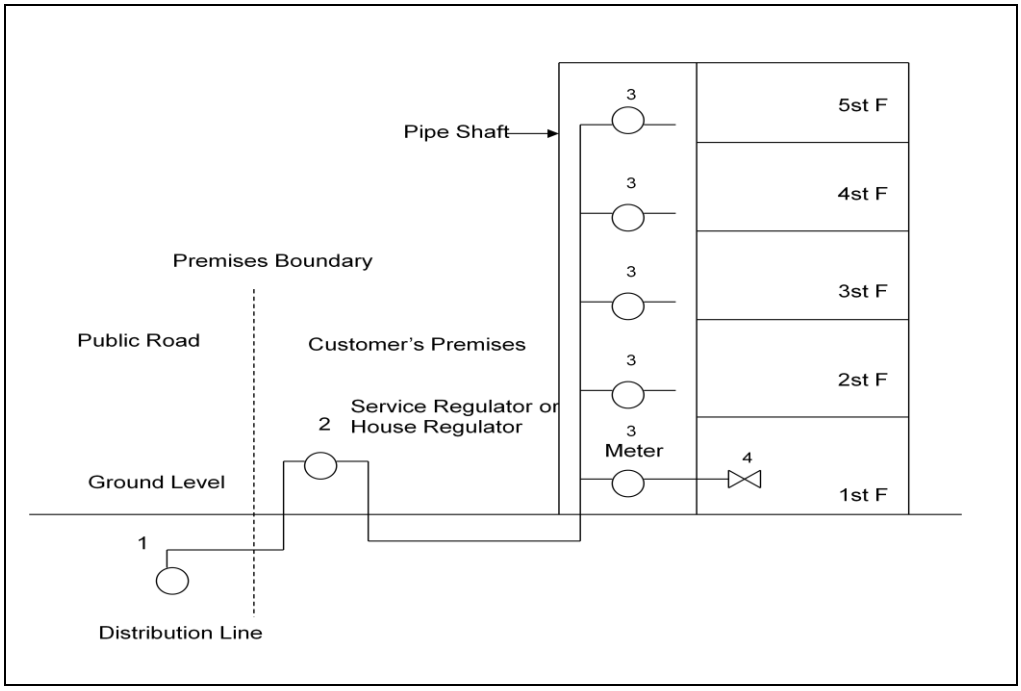

Figure 2.3: Typical residential distribution line for multi-floor house(Zulkefli Y., 2008)

To make this happen is too able to offer adequate gas service economically to any customer within the service. Distribution systems that fail to provide such service reflects upon the engineering design practices of utility involved.

Cox's equation is used for designing gas pipeline systems which are for distribution purposes. The inlet pressure must be more than 29.4 kPag.

Cox's equation:

$$Q = K\sqrt{\frac{(P_1^2 - P_2^2)D^5}{SL}}$$

$$P_2 = \sqrt{P_1^2 - \frac{sQ^2L}{K^2D^5}}$$

Where:

Q_s = Flow of fluid between the nodes (Sm^3/hr)

S = Specific gravity

P_i = Absolute pressure (kPa abs)

D = Pipe inner diameter (mm)

L = Pipe length between the nodes (m)

2.3.1 Design of Pipeline

There are some steps must be done before the pipeline can be done. These steps is a simple guidelines which already be done from the previous engineer that dealt with pipeline project (Cornell et. al., 1959).

First, make a market survey for the usage of the natural gas and prospects for growth. Then, choose the suitable pipe size and operating pressure for the pipeline. After that, materials selections and pipe specifications must be suitable for the environment that the pipeline is constructed. For example, ASTM D 2513 (Thermoplastic Gas Pressure Pipe), ASTM A 106 (steel pipe) and EN 1057 (Copper Pipe).

Then, get the map and select a best pipeline route. It must consider of roads, railways, river or buildings to make sure that the pipeline route is safe from damage or harm others. From the selected route, the total cost can be estimated from the bill of materials that being used. The cost is important to make sure that the pipeline is suitable to construct.

Before start the construction, the convenience and necessity certificate and right of way to make the pipeline from the authority to make sure the pipeline is in public land. Then, begin the construction survey to provide the properties of the land. After that, the construction begins.

Lastly, after the pipeline construction is finish, the pipeline is then subjected to a test such as hydrostatic test which used to validate the integrity of the pipeline before it can be placed into service. The purpose of this test are to ensures that the pipeline can withstand expected operating pressures, eliminate any defect that might threaten the ability of the pipeline to sustain maximum operating pressure and to show that the pipeline is free from any defects.

For routing process, some factors need to consider earlier before any project will begin which are maps and survey. For maps, this is where the area between supply & delivery should be examined and determines either the route is possible or not to choose so that the selected route free from any constraints and other problem that will arise.

After that, then the visual survey will undergo to examined and to get the analysis for the selected route which is to avoid any obstacles that may face such as congested underground plant, unstable structures, natural ground level altered, subsidence or side slip, running ground or gravel; traffic loaded routes, aggressive soil, close to cathodic protection systems or stray DC earth current, direct underneath overhead cables, and lastly, internal piping, through circulating duct, chimney, gas vent, ventilatin duct, enclosed staircase, elevator shaft, electricity, facility room excessive vibration area, corrosive areas, concrete slab, soil partition.

Piping systems and supports must be designed for strength and structural integrity in addition to meeting flow, pressure drop, and pump power requirements. Consideration must be given to stresses created by the following such as internal pressure, static forces due to weight of the piping and the fluid, dynamic forces created by moving fluids inside the pipe, and external loads caused by seismic activity, temperature changes installation procedures, or other application-specific conditions.

2.4 Materials and Equipments Selections

2.4.1 Materials

For the safety regulations of pipeline, there are many listed materials which are qualified for natural gas service. It is important to choose suitable material for the pipe line for the safety for which condition the materials is intended to used such as climate, location area and standard that been use for the construction of the pipe. For example, for plastic pipe, the common standard that been used are ASTM D 2513 (Thermoplastic Gas pressure Pipe, Tubing, and Fittings) and ASTM D 2517 (Reinforced Epoxy Resin Gas Pressure Pipe and Fittings) (ASME, 2003).

It is important to check the marking of the material when purchasing material for natural gas pipeline system use to help identify whether the materials is qualified for gas service. Threaded pipe are not allow to be used in the underground installation.

Pipe material that should be used in natural gas steel, copper or polyethylene and the materials should comply with the specifications that have been approved by Suruhanjaya Tenaga, such as:

1. ASTM A106 or API 5L Grade B for steel pipe
2. EN 1057 for copper pipe
3. ASTM D 2513 or ISO 4437 for polyethylene pipe.

The common materials that been used is carbon steel because of no limitations of piping pressures due to its good mechanical properties. Besides that, medium or high density polyethylene pipes can be used above and underground with the operating pressure not exceeding 60 psig. Copper pipe can be only be used in vapour phase system only with operating system not exceeding 20 psig. Plastic pipe or tubing shold be protected from damage such as crushing, piercing, or exposure to direct sunlight.

Corrosion or rust can happen to the steel pipe from exposure to moisture in the air, but the process can be strongly affected by exposure to a certain substances. Corrosion of metals is an electrochemical process, which electrical circuit where the exchange of electron is conducted by chemical reactions in part of the circuit. These chemical reactions occur at the surface of steel exposed to the electrolyte. Oxidation reactions occur at the surface of the anode and

reduction reactions occur at the surface of the cathode. To prevent this to happen, we need to use protective coatings and cathodic protection.

2.4.2 Equipments

A valve cannot be used for operating conditions that exceed the applicable pressure-temperature rating. The valve will be marked with the maximum working pressure and never operate the valve exceed the maximum pressure. The maximum working ratings are applicable at temperature from -20^{o}F to 100^{o}F (6.7^{o}C to 37.8^{o}C). Metal valves usually be marked with symbols "WOG" (water, oil, gas). That means it suitable for water, oil, or gas service. The valves must be rated for at least 100psig.

The manufacturer's trademark must be included on the valve, so the operators must maintain the manufacturer's manuals which consist of installation, operation, and maintenance procedures for each type of valve in the gas system. This procedures and manuals should be references in the operations and maintenance plan. Plastic valves must comply with the appropriate industry standard. It also must compatible with the plastic pipe used in the natural gas system.

For each flanges must be meet the minimum requirement accorded in the Standards and Act and Regulations. The operators can verify the flange by checking the markings on the flanges. The markings are similar with valves.

There are much kind of gas regulators and overpressure equipment for use in the gas pipeline system. The equipment must have a suitable size to ensure that overpressure or low-pressure conditions do not occur in the gas system. A qualified person must make the installation. It is important to get the manufacturer's operation and maintenance instructions for each type of regulator and relief valve used in the pipeline system.

There are also other additional equipment to operate natural gas system such as pipe-to-soil meters, pipe locators, gas leak detection equipment and industry publications. That means the operator also must pay attention before make the installation.

2.4.3 Polyethylene (PE) Pipes

In recent years, since the introduction of polyethylene (PE) pipes in late 1960s, it's been becoming increasingly popular in natural gas distribution network. For example, in North America, 90% of natural gas distribution pipeline use plastic pipe and 99% of it are PE pipes. PE pipe become more popular due to lower material, installation, and maintenances cost, good corrosion resistances, lower friction at the interface, light in weight, and great capacity to accommodate displacements compare to steel pipe.