ME 423: FLUIDS ENGINEERING

Gas Pipeline Hydraulics

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Pipeline Economics

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10.2 CAPITAL COSTS

The capital cost of a pipeline project consists of the following major components:

- Pipeline
- Compressor stations
- Mainline valve stations
- Meter stations
- Pressure regulator stations
- SCADA and telecommunication
- Environmental and permitting
- Right of way acquisitions
- Engineering and construction management

In addition, there are other costs such as allowance for funds used during construction (AFUDC) and contingency. Each of the preceding major categories of capital cost will be discussed next.

10.2.1 Pipeline

The pipeline cost consists of those costs associated with the pipe material, coating, pipe fittings, and the actual installation or labor cost. In Chapter 6, we introduced a simple formula to calculate the weight of pipe per unit length. From this and the pipe length, the total tonnage of pipe can be calculated. Given the cost per ton of pipe material, the total pipe material cost can be calculated. Knowing the construction cost per unit length of pipe, we can also calculate the labor cost for installing the pipeline. The sum of these two costs is the pipeline capital cost.

Using Equation 6.11 for pipe weight, the cost of pipe required for a given pipeline length is found from

$$PMC = \frac{10.68(D-T)TLC \times 5280}{2000} \tag{10.2}$$

where

PMC = pipe material cost, \$
L = length of pipe, mi
D = pipe outside diameter, in.
T = pipe wall thickness, in.
C = pipe material cost, \$/ton

Table 10.1 Typical Pipeline Installation Costs

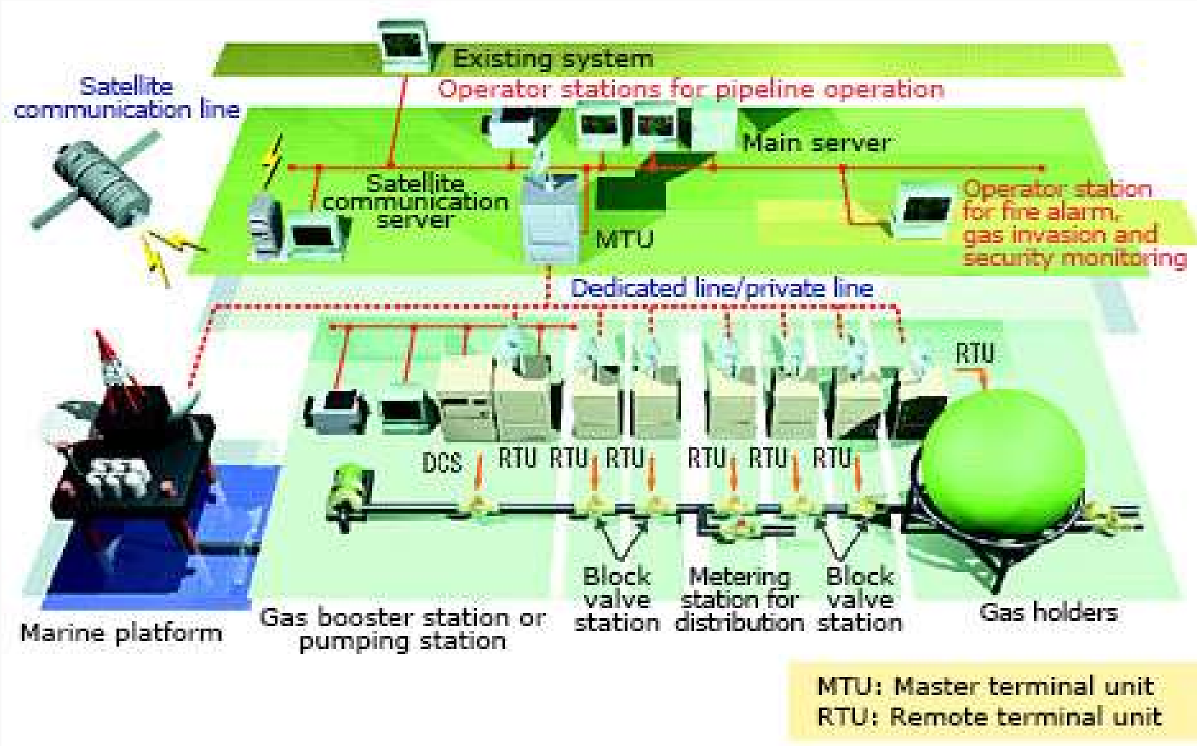
Pipe Diameter, in.	Average Cost, $/in.-dia/mi
8	18,000
10	20,000
12	22,000
16	14,900
20	20,100
24	33,950
30	34,600
36	40,750

Table 10.2 Cost Breakdown for a Typical Natural Gas Pipeline Project

Description			Million $
1	Pipeline	~ 50%	160.00
2	Compressor stations		20.00
3	Mainline valve stations		1.20
4	Meter stations		1.20
5	Pressure regulator stations		0.10
6	SCADA and telecommunications	2 to 5%	5.48
7	Environmental and permitting	10 to 15%	21.90
8	Right of way acquisiton	6 to 10%	14.60
9	Engineering and construction management	15 to 20%	36.50
10	Contingency	10%	26.10
	Sub-Total		287.08
11	Working capital		5.00
12	AFUDC	5%	14.35
	Total		306.43

SCADA

Supervisory Control and Data Acquisition (SCADA)



O & M

10.3 OPERATING COSTS

Once the pipeline, compressor stations, and ancillary facilities are constructed and the pipeline is put into operation, there will be annual operating costs over the useful life of the pipeline, which might be 30 to 40 years or more. These annual costs consist of the following major categories:

- Compressor station fuel or electrical energy cost
- Compressor station equipment maintenance and repair costs
- Pipeline maintenance costs, such as pipe repair, relocation, aerial patrol, and monitoring
- SCADA and telecommunication
- Valve, regulator, and meter station maintenance
- Utility costs, such as water and natural gas
- Annual or periodic environmental and permitting costs
- Lease, rental, and other recurring right of way costs
- Administrative and payroll costs

Compressor station costs include periodic equipment maintenance and overhaul costs. For example, a gas turbine–driven compressor unit may have to be overhauled every 18 to 24 months. Table 10.3 shows the annual operating cost of a typical gas pipeline.

Table 10.3 Annual Operating Cost of a Typical Gas Pipeline

Description		$ per year
1	Salaries	860,000
2	Payroll overhead (20%)	172,000
3	Admin and general (50%)	516,000
4	Vehicle expense	72,800
5	Office expenses (6%)	92,880
6	Misc materials and tools	100,000
7	Compressor station maintenance	
8	Consumable materials	50,000
9	Periodic maintenance	150,000
10	ROW payments	350,000
11	Utilities	150,000
12	Gas control	100,000
13	SCADA contract install and maintenance	200,000
14	Internal corrosion inspection ($750,000/3 years)	250,000
15	Cathodic protection survey	100,000
	Total O&M	3,163,680

DETERMINING ECONOMIC PIPE SIZE

For a particular pipeline transportation application, there is an economic or optimum pipe diameter that will result in the lowest cost of facilities. For example, a pipeline that requires 100 MMSCFD gas to be transported from a source location to a destination location may be constructed of a wide range of pipe materials and diameters. We may choose to use NPS 14, NPS 16, or NPS 18 pipe or any other pipe size for this application. Using the smallest-diameter pipe will cause the greatest pressure drop and the highest HP requirement for a given volume flow rate. The largest pipe size will result in the lowest pressure drop and, hence, require the least HP. Therefore, the NPS 14 system will be the lowest in pipe material cost and highest in HP required. On the other hand, the NPS 18 system will require the least HP but considerably more pipe material cost due to the difference in pipe weight per unit length. Determining the optimum pipe size for an application will be illustrated in the next example.

DETERMINING ECONOMIC PIPE SIZE

Example 3

A gas pipeline is to be constructed to transport 150 MMSCFD of natural gas from Dixie to Florence, 120 mi away. Consider three pipe sizes—NPS 14, NPS 16, and NPS 18—all having 0.250 in. wall thickness. Determine the most economical pipe diameter, taking into account the pipe material cost, cost of compressor stations, and fuel costs. The selection of pipe size may be based on a 20-year project life and a present value (*PV*) of discounted cash flow at 8% per year. Use $800 per ton for pipe material and $2000 per installed HP for compressor station cost. Fuel gas can be estimated at $3 per MCF.

The following information from hydraulic analysis is available:

NPS 14 pipeline: Two compressor stations, 8196 HP total. Fuel consumption is 1.64 MMSCFD.

NPS 16 pipeline: One compressor station, 3875 HP. Fuel consumption is 0.78 MMSCFD.

NPS 18 pipeline: One compressor station, 2060 HP. Fuel consumption is 0.41 MMSCFD.

$$PV = \frac{R}{i}\left(1 - \frac{1}{(1+i)^n}\right) \tag{10.1}$$

where

PV = present value, $

R = series of cash flows, $

i = interest rate, decimal value

n = number of periods, years

Solution:

See class note