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Gas Transmission System

Guidelines To Codes & Specifications

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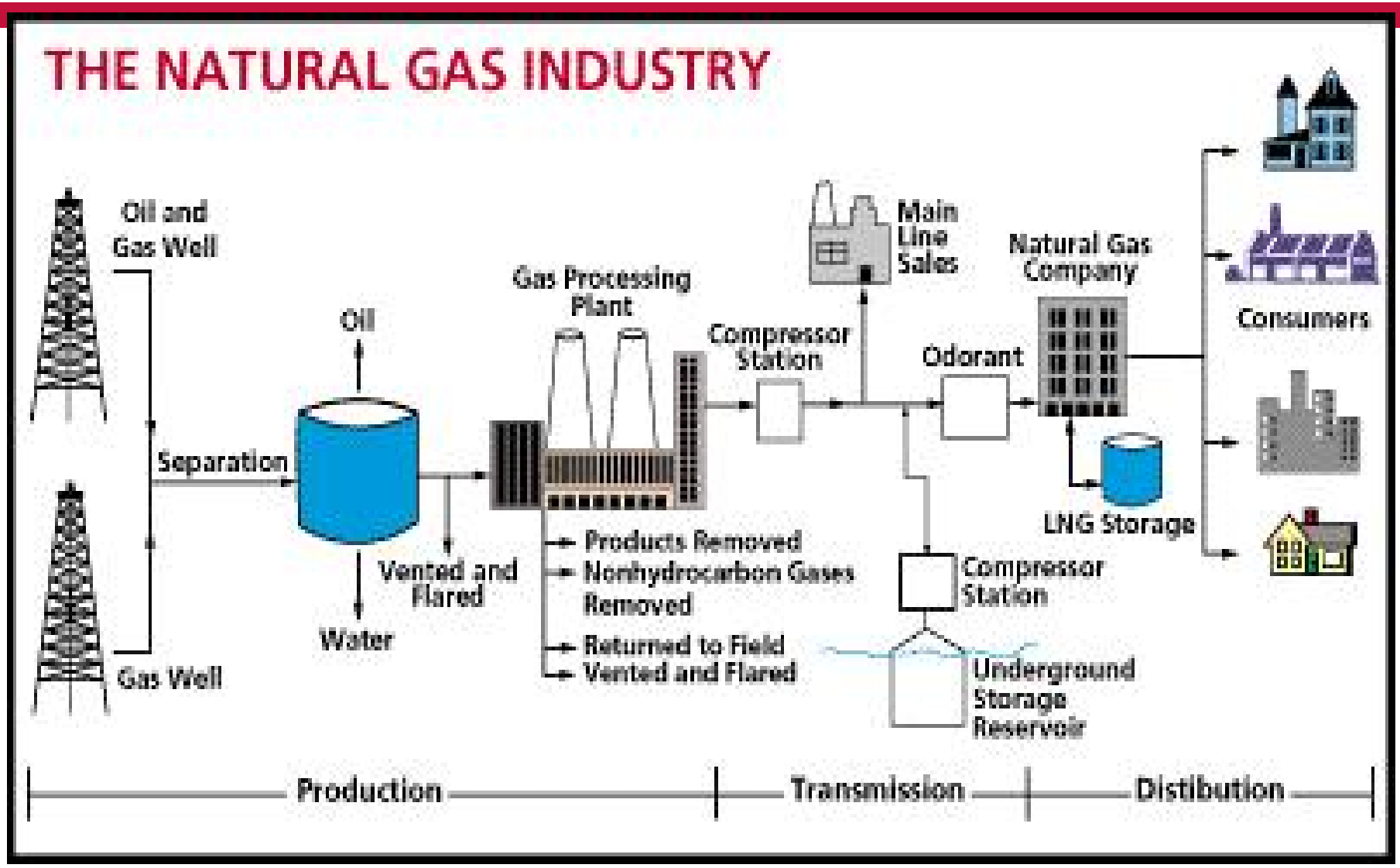

Pipeline Quality Gas

- Ownership of Standard Pipeline quality gas transfers from upstream production companies to mid stream transmission pipeline operator at downstream flange of Gas Treatment plant
- Online chromatographs record and monitor the gas composition and heating value.

Pipeline Quality Gas

Characteristics & Components	Limit	
Wobbe Index	Minimum /Maximum	46.6 / 52 MJ per cubic meter
Carbon Dioxide	Maximum	3.0 mole %
Oxygen	Maximum	0.2%
Hydrogen Sulfide	Maximum	5.7 mg per cubic meter
Total Sulfur	Maximum	50 mg per cubic meter
Water Content	Maximum	Dew point 0ºC at the highest MAOP in the relevant transmission system (in any case, no more than 112.0 mg/m3)
Hydrocarbon Dew Point	Maximum	10 degrees Celsius between the pressures of 1000 kPag and 10,000 kPag
Total Inert Gas	Maximum	7 mol %

Transmission System

- Transmission system :

Gas transmission pipelines, compressors stations, mixing stations and custody transfer metering stations along the pipelines and terminals

  - Supervisory Control and Data Acquisition (SCADA)
  - The pipelines may be a common carrier (open access) or a contract carrier (merchant pipeline)

Design Basics

- Safety of pipeline and the public
- Design is specific to nominated fluid (gas, oil, water, etc.).
- Route selection considers the existing and planned land use and environmental needs
- The fitness of the design for the purposes of the pipeline and other associated equipment.
- Engineering calculations for known load cases and probable conditions (weather, seismic).

Design Basics

- Stress, strains, displacements, and deflection limits of materials
  - Materials for pressure containment are required to meet standards and be traceable
  - Fracture control plan to limit fast fractures is required.

Standard Design Code Of Gas Transmission System

- **ASME 831.8-2003 (Revision 01 ASME 831.8-1999)/ *IGEM/TD/1 Edition 5 Communication 1735 are preferred standards for Steel pipelines and associated installations for high pressure gas transmission***
- **ASME CODE FOR PRESSURE PIPING, 802.11** Code the design, fabrication, installation, inspection and testing of pipeline facilities used for the transportation of gas. It also covers safety aspects of the operation and maintenance of those facilities,safety aspects of the operation and maintenance

Design Basics

- Preliminary Tests To Meet Conditions
  - Pressure must be positively controlled and limited.
  - Pipeline integrity testing is planned for implementation before commissioning of pipeline.
  - For natural gas pipelines, the likelihood, extent and consequences of the formation of condensates and hydrates in the pipeline is established.
  - Prevention or mitigation measures are planned to be put in place to ensure safe operation and integrity of the pipeline.

Design Steps

- Right of way (ROW) Selection
- Shortest possible route with the least barriers and impediments from topography maps.
- Topography and terrain conditions, difficult crossings and soil conditions, accesses for construction and operation of the system are taken into account.

Design Steps

- Optional routes are identified, EIA, social impact (SIA) and] RA are conducted to finally select the ROW.
- Supply conditions required for sizing the pipeline
  - Maximum volume of gas that requires to be transported
  - Maximum pressure that the pipeline has to be operated
  - Temperature and quality of gas to be transported
  - Minimum pressure required at destinations

Design Basics

- ANSI Class # 600 Classification or equivalent for transmission pipeline: maximum allowable operating pressure[MAOP] of 1440 PSIA (98 atm).
- ANSI Class #900 for high pressure Raw Gas gathering pipelines
- Classifications dictate the specifications of line pipes, valves , flanges and fittings for the pipeline.
- Transmission pipelines must be buried underground unless unavoidable.
- Main line valve stations and scarper stations are usually above ground installations

- Simplified Modified Panhandle Equation can be used as a thumb rule to design the transmission pipeline.
- $Q=0.00123(di)^{2.53}\ [p_1^2-p_2^2/L]^{0.51}$

  Q = PIPELINE Capacity in MMCFD

  di = Line pipe internal diameter in inches

  P1= Maximum pressure at delivery point from gas field in PSIA

  P2=Minimum pressure at receipt point of distribution system in PSIA

  L = Length of the pipeline in miles

Design Basics

- After selecting pipe line size and ROW, a detailed route survey identifies special points (road, river, waterway, rail track and special section crossings).
- Soil survey ascertains the requirements for buoyancy control and the nature of coating and cathodic protection for corrosion control

Materials Selection: Line Pipe

- Line pipes: carbon/carbon manganese steel pipe, API spec 5L, ISO 3183, ASTM A53, ASTM A106 and ASTM A 524.
  - Pipe for use in accordance with these standards shall not have an Specified Minimum Yield Stress (SMYS) greater than 555 Mpa (X80).

Materials Selection: Line Pipe

Standards Used for Pipeline Components

- **Corrosion Resistant Alloys (for sour gas service):** API SPEC 5LC and API 5LD
- **Fiber glass:** API SPEC 15LR ,API 15HR,or ISO 14692 -1 and ISO 14692-2
- **Pipeline Assemblies:** Elements of a pipelines are assembled from pipe that complies with a nominated standard and pressure
- **Station Piping:** AS 4041,ASME B31.3

- **Valves:** ASME B 16.34, API Spec 6D , API Std 600, API Std 603, ASTM A 350, BS 5351, MSS SP -25, MSS SP -67.
- **Induction Bends:** ISO 15590-1, ASME B16.49
- **Flanges:** ASME B 16.5, ASME B 16.21, ANSI B 16.47 ,MSS SP-6,MSS SP-44
- **Gaskets**: ASME B 16.21 ,BS 3381.
- **Bolting**: AS2528, ANSI B18.2.1 ,ASME B16.5, ASTM A 193, ASTM A 194, ASTM A 307 , ASTM A 320, ASTM A 325, ASTM A 354 , ASTM A 449

Determination of Pipe thickness

- The following equation applies for determining pipe thickness.

  $t=fPR/S$

Where

t=thickness of the pipe

f=factor of safety (usually 0.6)

P=internal pressure the pipe has to sustain

R=mean radius of the pipe

S= Specified Minimum Yield Stress (SMYS) of the pipe

Pipe Coating

- Line pipes are hollow cylinders.
- When buried underground in the presence of subsurface water, pipes can tend to float due to buoyancy effect.
- To counteract buoyancy, pipelines can be:
  - coated in concrete after application of anticorrosive coating or
  - weighted with concrete saddle weights after burial.

Formula for Calculating Buoyancy Control

- For uncoated pipe:

$$(B) = D/3[D-32t]+11t^2$$

- For coated pipe:

$$(B) = E/3\,(D-32t) + T1D\,[63-W_c/48]$$

- Where:
- D=outside diameter of pipe, in.
- T=wall thickness of pipe, in
- T_1=thickness of concrete coating, in.
- W_c=weight o f concrete, lb/ft^3

Bends

- Pipelines are not straight. To fit into pipeline profile bends are used wherever required .
- 5 D bends of standard angles are fabricated from the same steel as used in pipe in the factory. These are known as fire bends/ hot bends . These are of 12 ½ , 15, 25, 30, 45 , 60 and 90 degrees.
- If other bends are required, these are fabricated at pipeline construction sites . These are called field bends.

Valves

- As a safety measure, during operation of long distance transmission pipelines, line break valves are installed at prescribed intervals.
- These valves are located at places which have easy access facilitating required routine and emergency maintenance.
- Valve stations are usually above ground and have manual and remote operation facilities.

- Remote control valves have line break facilities and are filled with gas over oil actuators.
- Command of the valves from the SCADA control center is conveyed through Remote Terminal Units (RTUs).
- Transmission systems use API 6D top entry/ side entry welded body/ forged body double block and bleed line valves.
- Tees, elbows, flanges and fillings follow ANSI #600 standard.

Scrapper Stations

- Every transmission pipeline must have scrapper launcher and receiver stations at either end. For a long distance pipeline, such stations are set up after every 90-100 KM.
- Scrappers are used for swabbing, cleaning, gauging, hydrostatic testing of pipelines.
- Scrapper stations are also used for routine on-stream scrapping and metal loss surveys (intelligent scrapping) of the pipeline.

Standard Codes For Construction
Welding

- Welding is the major activity of pipeline construction .
- Transmission pipelines unless unavoidable is buried underground at prescribed cover
- All pipe joints are welded following API 1104 or equivalent welding codes .
- All welds are 100% radiographed by X Ray /Gamma Ray or Automatic Ultrasonic Method.

Pipe Coating

- Mild steel pipes require anti corrosion coating
- NACE Standard is followed for coating .
- Coal Tar Enamel Coating , Fusion Bonded Epoxy Coating , PE (double layer of 3 Layer) , Yellow Jacket are standard coating methods.
- In swampy areas for buoyancy control Concrete coating / Saddle Weights / Mechanical Anchors are used a s required

Special Points

- Roads , Rail , Rivers , Waterways , Swampy Areas , Valve Stations , Scarper Stations are Special points are Vulnerable points .
- Special Construction Procedures apply in their construction .
- These are constructed by special crew and tied to the main line after construction .
- These special points come under patrolling and vigilance during operation of the pipeline .

Cleaning ,Swabbing and Gauging

- Constructed sections of the pipelines are cleaned , swabbed and gauged by driving pigs with compressed air
- Cleaning takes up most of the undesirable elements that may have entered the pipelines during construction
- Swabbing mops out moisture and water
- Gauging maps the internal diameter of the pipeline

Hydro testing & Commissioning

- Cleaned and gauged pipeline is filled with water having pH value of 7.0 and free of corrosive materials.
- Compact filling is done to remove air and pipe is pressurized to about 1.44 times of the maximum allowable operating pressure.
- During this process, the tightness test is carried out to detect leaks.
- For strength tests, the pressure is held in line for 24 hours and monitored through installation of three-pen chart recorder.

Quality Control

- Strict quality control and quality assurance must be ensured at every stage of pipeline construction.
- A poorly constructed pipeline will create nightmare for the pipeline operator.
- All as-built documentations must be properly recorded and made readily available for operator to make required operation and maintenance plans.