Design, Construction, and Operation of Petroleum Pipelines

Course Number: ME-02-601

PDH: 12

Approved for: AK, AL, AR, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, VT, WI, WV, and WY

State Board Approvals

Florida Provider # 0009553 License #868
Indiana Continuing Education Provider #CE21800088
Maryland Approved Provider of Continuing Professional Competency
New Jersey Professional Competency Approval #24GP00025600
North Carolina Approved Sponsor #S-0695
NYSED Sponsor #274

How Our Written Courses Work

This document is the course text. You may review this material at your leisure before or after you purchase the course.
After the course has been purchased, review the technical material and then complete the quiz at your convenience.
A Certificate of Completion is available once you pass the exam (70% or greater). If a passing grade is not obtained, you may take the quiz as many times as necessary until a passing grade is obtained).
If you have any questions or technical difficulties, please call (508) 298-4787 or email us at admin@PDH Pro.com.

Module 1: Introduction

Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the scale, economic impact, and diverse geographic reach of the U.S. liquid petroleum pipeline network.
- **Identify** the physical characteristics and volatility of various liquid hydrocarbons to determine appropriate transport protocols.
- **Select** appropriate steel grades and system components, such as tankage and pump stations, based on product requirements and yield strength.

Executive Summary: The U.S. liquid petroleum pipeline industry is a vital economic driver consisting of 200,000 miles of infrastructure that transports 66% of domestic petroleum at a significantly lower cost than marine, rail, or truck alternatives.

U.S. Pipeline Network

The U.S. liquid petroleum pipeline industry is large, diverse, and vital to the nation's economy. Comprised of approximately **200,000 miles of pipe** in all fifty states, these lines carried more than 40 million barrels per day in 2001.

Industry Economic Impact

- Pipelines represent about **17% of all freight** transported in the U.S., but only 2% of the nation's freight bill.
- Approximately **66% of domestic petroleum transport** occurs by pipeline.
- The cost to move a barrel of gasoline from Houston to New York Harbor is only **3¢ per gallon**.

Network Characteristics

- Pipelines range in size from small diameters up to **48 inches**.
- Mainline pipe is nearly always buried, while pump stations remain above ground.
- Crude oil infrastructure includes **55,000 miles of trunk lines** (8 to 24 inches) and **30,000 to 40,000 miles of gathering lines** (2 to 6 inches).
- Refined products pipelines cover **95,000 miles** nationwide, varying from 8 to 42 inches in diameter.

Fluids Handled

Liquid pipelines carry a diverse range of materials, from crude oil production to refined petroleum products and petrochemical feedstocks.

Table 1.2-1 Characteristics of Liquid Hydrocarbons

Type	Characteristics
Type 1(a): liquefied gases (liquefied petroleum gas, ethylene, propylene)	• Highly volatile • Gas at ambient conditions; maintained at high pressures
Type 1(b): very light grade oils (gasoline)	• Highly volatile • Evaporates quickly, often completely within 1 to 2 days
Type 2: light grade oils (jet fuels, diesel, No. 2 fuel oil, light crude)	• Moderately volatile • Will leave residue (up to one-third of spill amount) after a few days • Moderately soluble, especially distilled products
Type 3: medium grade oils (most crude oils)	• About one-third will evaporate within 24 hours • Typical water-soluble fraction 10−100 ppm • May penetrate substrate and persist • May pose significant cleanup-related impacts
Type 4: heavy grade oil (heavy crudes, No. 6 fuel oil, bunker C)	• Heavy oils with little or no evaporation • Water-soluble fraction typically less than 10 ppm • Heavy surface contamination likely • Highly persistent; long-term contamination possible • Weathers very slowly; may form tar balls • May sink in water, depending on product density • May pose significant cleanup-related impacts • Low acute toxicity relative to other oil types
Type 5 low API fuel grade oils (heavy industrial fuel oils)	• Neutrally buoyant or may sink • Weathers slowly; sunken oil has little potential for evaporation • May accumulate on bottom under calm conditions and smother subtidal resources • Sunken oil may be resuspended during storms, providing a chronic source of shoreline oiling • Highly variable and often blended with oils • Blends may be unstable, and the oil may separate when spilled • Low acute toxicity relative to other oil types

Checkpoint Quiz

1. **What percentage of domestic petroleum transport (by ton-mile) is handled by pipelines?**
   a) 17%
   b) 28%
   c) 66%
   d) 95%

Answer: (c). Approximately two-thirds of domestic petroleum movement occurs through the pipeline network, making it the primary transport mode.

2. **Which hydrocarbon characteristic identifies Type 1(b) oils?**
   a) Neutrally buoyant or may sink
   b) Evaporates quickly, often within 1 to 2 days
   c) Typical water-soluble fraction 10−100 ppm
   d) High persistence and tar ball formation

Answer: (b). Type 1(b) oils like gasoline are highly volatile and dissipate rapidly under ambient conditions.

3. **In an impressed-current corrosion control system, how long do buried components typically last?**
   a) 5 to 10 years
   b) 10 to 15 years
   c) 20 to 25 years
   d) 40 to 50 years

Answer: (c). Components in impressed-current systems are designed for long-term service and generally do not require replacement for at least two decades.

Module 2: Pipeline Design

Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the primary engineering parameters and product qualities that dictate pipeline diameter, wall thickness, and station spacing.
- **Identify** the regulatory and industry standards (ASME, API, NACE) required to ensure system safety and integrity.
- **Analyze** the technical challenges of colocation, specifically focusing on electrical interference and environmental hazards in shared corridors.

Executive Summary: Pipeline design is an iterative process that balances throughput requirements and fluid properties against topographic constraints and rigorous safety codes to establish a system's Maximum Allowable Operating Pressure (MAOP).

Factors Influencing Pipeline Design

General Pipeline Design Considerations

The design phase establishes performance objectives and engineering parameters. Critical steps include:

- Determining required **throughput** (volume or pounds per unit time).
- Identifying **origin and destination** points.
- Assessing product properties like **viscosity** and **specific gravity**.
- Mapping the **topography** of the route.
- Establishing the **Maximum Allowable Operating Pressure (MAOP)**.
- Performing hydraulic calculations for pipe diameter, wall thickness, yield strengths, and pump station horsepower.

Safety

Safety is achieved through the application of DOT Office of Pipeline Safety (OPS) regulations.

- **Quality Control:** Continuous monitoring via metering and **SCADA** systems.
- **Workforce:** Safety results from strictly adhering to standard operating procedures and OSHA regulations.

- **Process Safety:** Very specific procedures are developed for activities representing significant hazards.

Industry Codes and Standards

ASME, API, and NACE International maintain the standards for construction, operation, and maintenance.

Core Standards Summary

- **Line Pipe Manufacture:** 4 API standards.
- **Cathodic Protection:** 8 NACE standards.
- **Welding:** 15 AWS and 1 API standards.
- **Pipeline Integrity:** API RP 1129.
- **Wall Thickness:** API Standard B31.G.

Pipeline Coating

Corrosion-resistant coatings are applied to inhibited chemical oxidation.

- **Interior Coatings:** Used for corrosion resistance and to reduce frictional losses, lowering energy requirements.
- **Bedding Material:** Sand or gravel tamping (12 to 18-inch lifts) protects the pipe from mechanical damage and stabilizes it against seismic shifts.

Figure 2.1-1: Coating Newly Installed Pipe for Corrosion Control (Source: Photo courtesy of Corrosion Control Products Co. Reproduced with permission.)

Purchase this course to see the remainder of the technical materials.