

Case Histories *(High Pressure Line Pipe)*

Line Pipe - High Pressure

Application	High Pressure Water and CO ₂ Injection Line Pipe, 1992
Location	Dollarhide Field, West Texas
Product	2", 2500 psi Aliphatic Amine Line Pipe, 8rd Integral Joint connection
Quantity	22,000 feet
Service Conditions	Began 1992 on 17 Injection Wells, 1997 converted 5 wells to CO ₂ . The remaining 2 well continued water injection. 2001- Converted 5 wells on CO ₂ back to water 2002 - Converted same 5 wells back to CO ₂ 2003 - Converted all 17 wells to 100% CO ₂
Conditions: CO₂	Flow Rate: 500,000 to 1,000,000 cubic feet per day Pressure: 1900 psi Temperature: 70°F - 80°F
Conditions: Water	Flow Rate: 300 to 400 barrels per day Pressure: 2000 psi Temperature: 70°F - 80°F

Line Pipe - High Pressure

Application	Flow Lines, 2004
Location	Kazakhstan
Product	<u>Oil Line Service</u> 12"- 1000 psi STAR Super Seal (4,980 meters) 10"- 500 psi STAR Super Seal (1,080 meters) 8"- 1500 psi 8rd Aliphatic Integral Joint (8,631 meters) 3 1/2"- 1500 psi Aliphatic Amine Integral Joint (545 meters) <u>Water Line Service</u> 10"- 1250 psi STAR Super Seal (8,266 meters) 8"- 1500 psi 8rd Aliphatic Amine Integral Joint (6,900 meters) 6"- 1500 psi 8rd Aliphatic Amine Integral Joint (1,885 meters) 3 1/2"- 1500 psi 8rd Aliphatic Amine Integral Joint (545 meters)

Line Pipe - High Pressure

Application	Fiberglass flowlines proved effective for replacing corroded carbon steel
Location	Norman Wells, Alberta Canada (75 miles south of the Arctic Circle)
Product	3" and 4", 2000 psi Aliphatic Amine Line Pipe, Integral Joint connection
Quantity	5 Miles
Service Conditions	STAR Series 2000 was used to replace carbon steel pipe that was in service only 3 years.

Line Pipe - High Pressure

Application	High Pressure Water Injection Line Pipe
Location	Kurten, Texas
Product	1½" (2 ⅜" EUE 8rd) through 4" (5½" OD 8rd) 4000 psi Line Pipe, Threaded and Coupled
Quantity	57,000 feet 1½" (2 ⅜") 29,000 feet 2" (2 ⅞") 19,600 feet 2½" (3 ½") 17,200 feet 3" (4 ½") 19,700 feet 4" (5 ½")
Service Conditions	Installation date 1984 Buried 3 feet deep Fresh water injection Candidate for CO ₂ injection Operating pressure 3200 psi Operating temperature 140°F
CO₂ Test	The project started in October of 1981 and ended August 1984. The test consisted of 4 injector wells and one INSTALLATION producer. Three of the injection wells were completed with steel line pipe, which corroded causing problems and the fourth well was 2" 3500 psi STAR fiberglass pipe. The STAR pipe has operated trouble free to this date. The four wells are still injecting fresh water into the Woodbine C sands. The 100% CO ₂ was injected at 2800 to 2900 lbs as a liquid, with a operating temperature of 150°F maximum at a rate of 20 to 750 barrels per day. The CO ₂ was injected a total of eight different times for periods of one week to four months at a time during the 35 month project. The fresh water used in this pilot was injected at the same pressure with a operating temperature of 130°F at 40 to 260 barrels per day. The project was cancelled due to the cost of CO ₂ and the break through into other sands.

Line Pipe - High Pressure

Application	High Pressure Fiberglass Water Injection System Replaces Steel
Location	Big Wells, Texas
Product	2" 2000 psi and 2500 psi Injection Line Pipe
Quantity	Since 1978, virtually all injection lines have been replaced. Originally a 2000 psi product was used, but since then the operating pressure has increased to 2100 psi, the field began to use the 2500 psi product about 1987.
Service Conditions	Injection Pressure 2100 psi Operating Temperature 100°F Maximum Produced Water, 4-13 PPM H ₂ S, Oxygen content 0 to .3 PPM
Observation	There has been concern in the industry over the long-term lifetime of fiberglass line pipe operating at or above the manufacturer's rating. In 1987 a 2" 2000 psi sample was provided by the customer from this system that was eight years old. The sample was evaluated and found to show no significant change in the ultimate weep pressure or elastic properties from new production pipe.

Line Pipe - High Pressure

Application	High Pressure Water/CO ₂ Injection (WAG) and Flow Lines
Location	Camirick Field - Perryton, Texas
Product	Flow Lines: 3" 1000 psi, Aliphatic Amine Line Pipe 4" 1000 psi, Aliphatic Amine Line Pipe 6" 500 and 1000 psi, Aliphatic Amine Line Pipe
Quantity	80,000 feet
Service Conditions	Operating Pressure: 250 psi (500 Series pipe) 600 psi (1000 Series pipe) Operating Temperature: 100°F
Product	Water/CO ₂ Injection: 3", 4" and 6" 2000 psi, Aliphatic Amine Line Pipe
Quantity	100,000 feet
Service Conditions	Operating Pressure: 1300 psi (2000 Series pipe) Operating Temperature: 110°F
Observation	Water/CO ₂ Injection (WAG) - A method used to boost oil production in existing oil fields by injecting alternating water and gas (carbon dioxide) into injection wells resulting in extending the production life of the field. NOV Fiber Glass Systems has been replacing and installing new fiberglass line pipe since 2000 with Aliphatic Amine line pipe.

Line Pipe - High Pressure

Application	High Pressure Fiberglass Line Pipe selected for two South Louisiana waterfloods
Location	Denheim Springs, Louisiana
Product	2" (2 7/8") 3000 psi Line Pipe - 40,000 feet 4" (5 1/2") 3000 psi Line Pipe - 44,000 feet Various 2 7/8" and 5 1/2" 3000 psi STAR Fiberglass Fittings
Service Conditions	Year of installation 1985; Salt water injection system Operating Pressure 1800 psi; Operating Temperature Ambient
Location	2" (2 7/8") 4000 psi Line Pipe - 28,000 feet 4" (5 1/2") 4000 psi Line Pipe - 28,000 feet Various 2 7/8" and 5 1/2" 4000 psi STAR Fiberglass Fittings
Service Conditions	Year of installation 1986 Buried under 3 feet of cover All the fittings were thrust blocked Salt water injection service Operating Pressure 1500 psi Operating Temperature Ambient

Line Pipe - High Pressure

Application	Fiberglass Water Injection System
Location	Welch, Texas
Product	2" 2500 psi Line Pipe 3" 2500 psi Line Pipe
Quantity	More than 100,000 Feet combined footage installed since 1991
Service Conditions	Produced Water Injection Operating Pressure 1400 psi Operating Temperature 80°F Maximum

Line Pipe - High Pressure

Application	High Temperature Multi-Phase Flowlines
Location	Harmattan - Alberta, Canada
Product	2", 2 1/2", 3", 4", and 6" 800 psi to 1250 psi Line Pipe
Quantity	Ongoing project started in 1994, up to 40,000 meters in service
Service Conditions	Operating Pressure 800 psi to 1250 psi Operating Temperature 180°F

Line Pipe - High Pressure

Application	High Temperature Multi-Phase Flowlines
Location	Simonette - Alberta, Canada
Product	3", 4", and 8" psi Line Pipe
Quantity	Ongoing project started in 1992, up to 22,000 meters installed
Service Conditions	Operating Pressure 800 psi Operating Temperature 180°F

Line Pipe - High Pressure

Application	Fire Water Line
Location	Oman - October 1992
Product	6" 800 psi Line Pipe, Threaded and Coupled - 560 Feet 8" 800 psi Line Pipe, Threaded and Coupled - 4000 Feet Various Star Fiber Glass Fittings
Service Conditions	Fire Water/Foam Solution Piping, Test Pressure 363 psi Design Operation Pressure 235 psi Operating Temperature 180°F

Line Pipe - High Pressure

Application	Fiberglass Line Pipe Battles H ₂ S and CO ₂ Corrosion
Location	Near Red Deer, Alberta Canada
Product	3" 800 psi Line Pipe - 50,000 Feet 4" 2000 psi Line Pipe - 12,000 Feet 6" 1250 psi Line Pipe - 42,000 Feet
Service Conditions	Flow Lines 400 psi at 120°F Injection Lines 1400 psi at 120°F Produced Oil and Water H ₂ S and traces of CO ₂ are present

Line Pipe - High Pressure

Application	Water Injection Systems began in mid 1992
Location	Oklahoma City, Oklahoma Airport
Product	3500 psi Line Pipe, 8rd
Quantity	2" 3500 psi Line Pipe - 40,000 Feet 2 1/2" 3500 psi Line Pipe - 40,000 Feet 3 1/2" 3500 psi Line Pipe - 100,000 Feet 4" 3500 psi Line Pipe - 25,000 Feet
Service Conditions	Water Injection System Operating Pressure 1750 psi Operating Temperature 100°F

Line Pipe - High Pressure

Application	Produced Saltwater Injection System
Location	Friendswood, Texas
Product	3" 2000 psi Line Pipe, Integral Joint
Quantity	60,000 Feet installed in 1991, 10,000 Feet installed in November 1993
Service Conditions	Produced Saltwater Operating Pressure 1500 psi Operating Temperature 110 to 120 Degrees

Line Pipe - High Pressure

Application	Injection Trunk Line
Location	N. Cowden, Texas
Product	8", 10" & 12" Tested to 1400 psi Super Seal Line Pipe
Service Conditions	Operating Pressure: 1100 - 1200 psi Operating Temperature: 90°F

Line Pipe - High Pressure

Application	Water Injection with H ₂ S
Location	Fittstown, Oklahoma (East Fitts Field)
Product	4", 6" & 8" 2000 psi Aliphatic Amine Line Pipe 200,000 total footage installed
Service Conditions	Operating Pressure: 1960 psi Operating Temperature: 115°F H ₂ S: 0.2 Dissolved PH: 5.8

Line Pipe - Natural Gas

Application	Production Flowlines
Location	Freer, Texas
Product	3" and 4" 1500 psi Line Pipe (Standard Design)
Quantity	Ongoing project, more than 150,000 feet of 3" and 30,000 feet of 4" Pipe and Fittings
Service Conditions	Natural Gas with CO ₂ present Operating Pressure 900 psi Operating Temperature 110°F

Line Pipe - Natural Gas

Application	Gas Production Flowlines
Location	Big Wells, Texas
Product	3 1/2" 2000 psi Line Pipe, Integral Joint
Quantity	7,500 Feet and 4,800 Feet
Service Conditions	Operating Pressure 1800 psi Shut-In Pressure 2000 psi Operating Temperature 80°F Produced Gas, Water and Condensate 1% H ₂ S (9 PPM), Chlorides (120,000 PPM)

Line Pipe - Natural Gas

Application	Sour Gas Production Flowlines inserted inside steel
Location	Grand Prairie - Alberta, Canada
Product	3" 2000 psi Line Pipe
Service Conditions	Natural Gas with 28% H ₂ S Operating Pressure 1400 psi Operating Temperature 150°F

Line Pipe - Natural Gas

Application	South Texas Field solves H ₂ S and CO ₂ Corrosion and Erosion problem installed in 1993
Location	Zapata, Texas
Product	2", 2 1/2", 3", and 4" 1500 psi Line Pipe More than 50,000 feet of 2" More than 120,000 feet of 3" More than 50,000 feet of 4"
Service Conditions	Natural Gas Production Lines; 5 to 6% CO ₂ ; Operating Pressure 110°F to 190°F 1000 to 1200 psi Gas Production 10 MCFD; Condensate 400 BPD Velocity 60 to 70 feet/second; sales line pressure - 980 psi Produced Water H ₂ S (5 PPM) Operating Pressure 970 psi Operating Temperature 90°F
Erosion Test Line	The 2" steel line (double extra heavy) was being replaced on a regular basis due to corrosion and erosion problems. The line contains 90° elbows which further enhanced the erosion problems. Currently, the fiberglass line pipe has outlasted the steel 3 times. Flow rate 3.2 MCFD Operating Temperature 110°F to 120°F; Operating Pressure 1000 psi; Traces of 20 to 40 Grit Sand.

Line Pipe - Natural Gas

Application	Onshore Gas Field uses FRP to fight corrosion problems
Location	Rehden, Germany
Product	3" 800 psi Line Pipe IJ
Quantity	7,300 Feet (2,200 meters) Installed January 1995
Service Conditions	Natural Gas Water Condensate (Waco Saltwater) Design Pressure 232 psi (16 Bar) Operating Pressure 14.5 to 232 psi (1 to 16 Bar) Operating Temperature 176°F (80°C) Working Temperature 140°F (60°C)

Line Pipe - Natural Gas Production with CO₂

Application	Flowline installed in 1991
Location	Fowlerton, Texas
Product	2 1/2" and 3" 1500 psi Line Pipe
Service Conditions	Operating Pressure 650 psi Operating Temperature 100°F to 110°F

Line Pipe - Produced Gas and CO₂

Application	Flowline Installed in 1992
Location	Edinburg, Texas
Product	2 1/2" 2000 psi Line Pipe
Service Conditions	Operating Pressure 850 psi Operating Temperature 120°F

Line Pipe - Produced Gas and H₂S

Application	Buried Flowing installed in 1988
Location	Staffhorst, Germany
Product	4" 1500 psi Line Pipe, Threaded and Coupled
Quantity	1500 Meters
Service Conditions	Operating Pressure 40 Bar (580 psi)

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