Case Histories *(Downhole Tubing and Casing)*

Downhole Casing

Application New San Andreas Water Injection Wells completed with Fiberglass Casing

Location Bennet Ranch near Denver City, Texas

Product 5 ½" 2000 psi Casing, Threaded and Coupled

Quantity 20 Wells completed since 1987
500 feet to 1500 feet (150-455 mts) of Fiberglass Casing used in the pay area of each well

Service Conditions Total depth 5200 feet (1585 mts) average, cemented in place with DV tool. Jet perforated, 2 to 4 shots per foot, hollow carrier 10 to 13 gram select fire charges. Water Injection Pressure 1400 psi. Water contains polysulfide and ironsulfide, gradient 0.43. Reservoir Pressure 2600 psi. Bottom Hole Injection Pressure 3550 psi, Bottom Hole Temperature 55°F to 105°F (13-40°C) cup type packers set in some of the fiberglass. Certain wells were installed with CRA joint above fiberglass for packer setting. Steel ran above CRA or fiberglass.

Downhole Casing

Application Fiberglass Tubing successfully repairs corroded 4 ½" Steel Casing

Location Near Eagle Pass, Texas

Product 2 ⅞" 2500 psi Tubing, Threaded and Coupled with special O.D. turned down collars

Quantity 42 Wells completed in 1991, 36 wells completed in 1992

Service Conditions Approximately 1300 to 1700 feet (395-515 mts) ran top to bottom in each well. Water Injection 1000 psi, Injection Temperature 85°F (29°C), Bottom Hole Temperature 110°F (43°C). The pipe is sandblasted and cemented in place. Inflatable packers used in first 42 wells, used two joints of steel on the bottom, the steel was perforated. The 36 wells completed in 1992 were installed using a polished bore receptacle with a latch instead of an inflatable packer. A special dement shoe was used on these 32 wells and the liner was stopped above the original perforations. This saved the cost of two joints of steel tubing, perforating and acidizing.

Downhole Casing

Application Fiberglass Casing and Liners in service up to 20 years

Location Denver City, Texas

Product 3 ½" & 4 ½" 2000 psi Tubing, Threaded and Coupled (used for liner repair of corroded steel casing)
5 ½" 2000 psi Casing, Threaded and Coupled (used in new wells at the bottom of a steel string)

Quantity 350 Injection Wells completed since 1971 at the Denver Unit
The fiberglass is ran through the corrosive pay area

Service Conditions Total well depth 5200 feet (1580 mts), 500 feet to 1500 feet (150-455 mts) of fiberglass cemented in place and perforated. CO_2 and Water Wag System began in 1984. CO_2 Surface Injection 1800 psi, Water Injection Pressure 1400 psi. Bottom Hole Temperature 55° F to 105° F (13-40°C).

Downhole Casing

Application	High Temperature Observation Well Casing
Location	Dubia - October 1992
Product	5 ½" 2000 psi Casing, Threaded and Coupled
Quantity	416 feet (125 mts)
Service Conditions	Observation Well Offshore Total Depth 9,305 feet (2836 mts) Fiberglass Casing from 9,134 feet to 8,718 feet (2784-2657 mts) Bottom Hole Temperature 235°F (113°C) Cemented to Surface Wireline Tools

Downhole Casing

Location	Japan - September 1993
Product	7" 2000 psi Casing, Threaded and Coupled ACT
Service Conditions	Oil and Gas Production Total Depth 6,090 feet (1856 mts) 13 ⅜" Steel Surface Casing 1,410 feet (430 mts) Fiberglass Casing ran from 1,410 feet to 6,090 feet (430-1856 mts) 41 degree deviation cemented from 4,055 feet to Surface (1236 mts) Perforated 7" Fiberglass Casing with Wire Screen ran from 4,055 to 6,090 feet (1236-1856 mts)

Downhole Casing

Application	Special sized Carbon Fiber Coupling's increase liner size while maintaining performance
Location	Oosaka, Japan
Product	5 ½" 1500 psi Casing OD 5.80" Carbon Fiber Coupling - 1,420 Feet (433 mts) 7" 1500 psi Casing combination Tapered String cemented in place - 1,260 Feet (384 mts)
Service Conditions	Installed in September 1993

Downhole Casing

Application	Special sized Carbon Fiber Coupling's increase liner size while maintaining performance
Location	Welch, Texas
Product	4" 2000 psi Liner Pipe with 4.60" O.D. 4" EUE 8rd Carbon Fiber Couplings, Cemented in place Ran inside Corroded Steel 5½" Casing
Service Conditions	Installed in January 1992 2 ⅜" J55 Steel Tubing ran inside Fiberglass Liner

Downhole Tubing

Application	Fiberglass Tubing solves corrosion problem in Bravo Dome CO_2, Production Field
Location	Near Clayton, New Mexico
Product	2 ⅜", 2 ⅞", 3 ½" & 4 ½" 2000 psi Tubing, Threaded and Coupled
Quantity	236 Wells completed since 1986 Approximately 542,800 feet (165,500 mts) combined footage Individual Well footage runs 2,000 to 2,800 feet (600-800 mts) 2 Wells completed with 4 ½" Tubing
Service Conditions	Production Pressure 300 psi Maximum Bottom Hole Pressure 410 psi Operating Temperature 70-80°F (21-27°C) Production 100% Wet CO_2 Prior to installing fiberglass tubing, the steel tubing was being pulled for corrosion related problems every 6 to 9 months. Currently, they do not trip wells for tubing corrosion problems.
Packer	Permanent Set, Retrievable, Set with Fiberglass Tubing
Lubricant	Teflon Based
Fiberglass Casing	In December 1988, 3,000 feet (915 mts) of 5 ½" Star 2000 psi Casing was installed in an open hole completion and cemented in place. The test consist of producing CO_2 directly through the casing. The need for a packer and tubing has been eliminated. The hole size, casing size and well head size have all been reduced therefore, further reducing expenses. The test well continues to produce CO_2 successfully at this time. May through August 1993, installed 56 strings of 4 ½" 2000 psi Casing in new drilled tubingless production wells 2,350 feet (715 mts) deep to surface. May through August 1995 installed 1 string of 9 ⅝" 2000 psi Casing, 240 feet (70 mts) to surface, 32 strings of 5½" 2000 psi Casing installed 2,350 feet (715 mts) to surface in new drilled tubingless production wells. Ran 160 to 200 feet (50-60 mts) of steel casing at the bottom of the string. Currently 97% of the field has been converted to fiberglass.

Downhole Tubing

Application	Special sized Carbon Fiber Coupling's increase liner size while maintaining performance
Location	Sundown, Texas
Product	4" 2000 psi Liner Pipe with 4.60" O.D. 4" EUE 8rd Carbon Fiber Couplings, Cemented in place Ran inside Corroded Steel 5 ½" Casing
Service Conditions	Installed in 1992 and 1993 2 ⅜" J55 Steel Tubing ran inside Fiberglass Liner

Downhole Tubing

Application	West Texas Waterflood Uses Fiberglass Tubing
Location	Seminole, Texas
Product	2 3/8" 2000 psi Tubing, Threaded and Coupled
Quantity	52 Wells completed in 1987, 44 Wells completed in 1989, total 576,000 feet (175,500 mts)
Service Conditions	Salt Water Injection Tubing; Pacer depth 6000 feet (1825 mts); Operating temperature 114°F (45°C) Maximum Injection pressure 1550 to 1700 psi; 2 3/8" Fiberglass Landing Sub (2 7/8" O.D.)
Packer	Permanent type, retrievable with an on/off tool. Packer set with steel work string.

Downhole Tubing

Application	Antrium Gas Production Wells completed with Fiberglass Tubing
Location	Northern Michigan
Product	1 1/2" 1500 psi Tubing, Integral Joint Pressure rating 1500 psi Collapse rating 1500 psi Tensile rating 5000 lbs (2260 kg) Star Advanced Composite Thread (ACT) 1.90" EUE 8rd Longform
Service Conditions	The tubing depth is approximately 1,500 feet (450 mts) deep. There are several types of lift systems utilized. They are self flowing, gas lifted, plunger lifted and rod pump. The well head temperatures are 60°F (15°C). Numerous wells have been successfully tripped. The Star Advanced Composite Thread (ACT) has proven to be a consistent performer.
Production	Gas Lift Pressure 25 to 100 psi; Well Head temperature 60°F (15°C); Bottom Hole temperature 60°F (15°C) Production contains up to 900 PPM H_2S and 4 to 9% CO_2; Production rate 10,000 MCF to an estimated 200,000.

Downhole Tubing

Application	Fiberglass Tubing in Rod Pump Production Well with CO_2
Location	Edgerly, Louisiana
Product	2 3/8" 2000 psi Tubing, Threaded and Coupled
Quantity	There are 10 Wells with depths of 2,100 feet to 2,450 feet (640-745 mts). The first well was installed in February 1988 and are still in operation
Service Conditions	The tubing is anchored. Three clip on hard rubber or nylon rod guides were used on each rod. The wells are produced with a 2 1/2" to 3 1/4" barrel and a 74" to 86" stroke at a rate of 10 to 13.5 strokes per minute. These wells have been repeatedly pulled due to corrosion. The majority of the original tubing is still in service with very few joints being replaced due to rod wear.

Downhole Tubing

Application	Water Injection Wells
Location	Whiteface, Texas
Quantity	40 Wells completed in 1992
Service Conditions	Average depth to Packer 4,750 feet (1450 mts) ER6 Guiberson with on/off tool Set with work string BH temperature 75°F to 80°F (24-26°C) Injection pressure 1500 to 1800 psi Static level full

Downhole Tubing

Application	Produced Water Injection Wells
Location	Friendswood, Texas
Quantity	13 Disposal Wells started 1990, 5 Injection Wells started 1989
Disposal Well	Packer depth 4,500 to 4,700 feet (1350-1425 mts) 3 1/2" 1500 psi Tubing, Threaded and Coupled in 5 1/2" Casing 4 1/2" 1500 psi Tubing, Threaded and Coupled in 7" Casing Wellhead temperature 100°F (38°C) Injection pressure 650 to 700 psi Shut-in pressure 800 psi
Injection Well	Packer depth 5,700 feet (1730 mts); Product 2 7/8" 2000 psi & 2500 psi Tubing, Threaded and Coupled Wellhead temperature 100°F (38°C); Bottom Hole temperature 150°F (65°C) Injection pressure 1250 to 1300 psi; Shut-in pressure 1500 psi
Wire Lining	All wells were installed with a profile nipple. Wire line activities are normal procedures.
Packers	Guiberson Uni 6, Nickel Plated Wetted Parts; Right hand release on/off tool

Downhole Tubing

Application	Chemical Waste Disposal Wells
Location	Bishop, Texas - 1984, 1987 ,1990
Quantity	7" 2000 psi Tubing 7" 1500 psi Couplings (8.40" O.D.)
Service Conditions	Permanent packers 4,107 to 4,137 feet (1250-1260 mts) Injection pressure 100 psi Well head differential pressure 800 psi Ambient injection temperature BH Temperature 140°F (60°C) BPD injection rate 300 to 650

Downhole Tubing

Application	Fiberglass Injection Tubing
Location	Holland
Product	4 1/2" 1500 psi Tubing, Threaded and Coupled - (Coupling O.D. Standard)
Quantity	11 Wells ran in 1991 7 Wells ran in early 1992 Approximately 50,000 feet (15,240 mts) total
Service Conditions	Packer depth 2,900 to 3,300 feet (880-1005 mts) Wellhead Pressure: 900 psi Wellhead Temperature: 75°F (23°C) Injection Temperature: 75°F to 150°F (23°-65°C) Bottom Hole Temperature: 125°F (50°C) Fiberglass Swage: 4 1/2" x 2 7/8" Polished Bore Receptacle: 2.13" - 3.63" - 4.00" Landed with Ball-Wivel Hanger. Seal bore will travel from +10 and -30 inches from neutral point depending on injection pressure and temperature.
Application	Oil-Produced with Gas Lift
Gas Lift	Well depth ±3000 feet (900 mts), 3 1/2" 2000 psi. Standard gas lift mandrels Wellhead Pressure at Annulus: 870 psi Wellhead Temperature: 70°F (20°C) Bottom Hole Temperature: 125°F (50°C) Polished Bore Receptacle: 3.25" Seal bore at producing +12 inches from neutral.

Downhole Tubing

Application	Fiberglass Tubing in South Texas Gas Lift Production and Salt Water Injection Wells
Location	Refugio and Taft, Texas
Product	2 3/8", 2 7/8", and 3 1/2" 2000 psi (Some 2500 psi) Tubing, Threaded and Coupled
Service Conditions	Packer depth 4,000 to 5,000 feet (1200-1500 mts) Bottom Hole Temperature 140°F to 150°F (60-65°C)
Gas Lift Production	Wells have 3 to 5 mandrels each Lift Pressure 1000 psi Production Pressure 100 psi Maximum Production up to 2000 to 3000 BPD Maximum Production 92 to 99% Salt Water 1/2 % CO_2 no H_2S Static Level 1000 feet (300 mts)
Salt Water Injection	Injection Pressure 1000 psi to 1500 psi Maximum Gas Lift Mandrels ran for back washing in some wells Static level full

Downhole Tubing

Application	Fiberglass Tubing
Location	Kuwait - 1996
Product	2 3/8" 2000 psi Tubing, Threaded and Coupled
Quantity	3,000 feet (915 mts)
Service Conditions	Maximum Bottom Hole Temperature: 160°F (70°C) Wellhead Temperature: 100°F (38°C) Wellhead Pressure: 1200 psi Depth: 3,200 feet (975 mts) Flow Rate: 800-1000 BPD
Pump	Free hanging REDA submersible 100HP

Downhole Tubing

Application	Fiberglass Tubing replaces highly corrosive well
Location	Kuwait - 1997
Product	3 1/2" 2000 psi Tubing, Threaded and Coupled
Quantity	3,240 feet (990 mts)
Service Condition	Maximum Bottom Hole Temperature: 170°F (75°C) Maximum Wellhead Pressure: 1000 psi Wellhead Temperature: 100°F (38°C) Operating Pressure: 110 psi Depth: 3,598 feet (2000 mts) Oil Production Flow Rate: 1200 BPD
Pump	Free hanging REDA submersible 150HP - Stainless Steel Weight: 800 lbs (363 kg)

Downhole Tubing

Application	Water Injection
Location	Kuwait - 2002
Product	4" 3000 psi Tubing, Threaded and Coupled
Quantity	7,000 feet & 7,300 feet (2130 mts & 2225 mts)
Service Conditions	Maximum Bottom Hole Temperature: 150°F (65°C) Maximum Wellhead Pressure: 1700 psi Wellhead Temperature: 100°F (38°C) Depths: 6,822 feet (2080 mts) 7,222 feet (2200 mts)

Downhole Tubing

Application	Salt Water Disposal Well
Location	Wingate Field - Attica, Kansas - 1998
Product	2 3/8" 2000 psi Tubing, Threaded and Coupled
Quantity	3,809 feet (1160 mts)
Service Conditions	Operating Pressure: 100-200 psi

5 1/2" lockset packer with on-off tool set at 3089 feet (1160 mts) with approximately 522 feet (159 mts) of 2 3/8" Tubing below packer

Downhole tubing was installed in 1998 and pulled in 2009 because of casing integrity failure and reinstalled.

Downhole Tubing

Application	Production Well
Location	Kador F-1 & D-4 Field - Stinnett, Texas - 2009
Product	2 3/8" 3000 psi Tubing, Integral Joint
Quantity	3,100 feet (945 mts) 3,237 feet (986 mts)
Service Condition	Operating Pressure: 150 psi Operating Temperature: Ambient
Pump	60 HP submersible pump moving approximately 300 bpd.

North America
17115 San Pedro Ave. Suite 200
San Antonio, Texas 78232 USA
Phone: 210 477 7500

South America
Avenida Fernando Simoes
Recife, Brazil 51020-390
Phone: 55 31 3501 0023

Europe
P.O. Box 6, 4190 CA
Geldermalsen, The Netherlands
Phone: 31 345 587 587

Asia Pacific
No. 7A, Tuas Avenue 3
Jurong, Singapore 639407
Phone: 65 6861 6118

Middle East
P.O. Box 17324
Dubai, UAE
Phone: 971 4881 3566

www.fgspipe.com • fgspipe@nov.com

NOV Fiber Glass Systems

CH2002 October 2009