Baker Hughes

Engineering Guide – Composite Pipe by Baker Hughes

Baker Hughes

Composite Pipe by Baker Hughes is a continuous, spoolable, reinforced thermoplastic pipeline system that is designed and manufactured to provide high-pressure, corrosion-free operation. Typical oil and gas applications include production gathering, enhanced oil recovery (EOR), saltwater disposal (SWD), transmission, injection, and distribution. Other industries, such as mining, have discovered unique opportunities to utilize composite pipe to overcome severe problems such as acidic and erosive applications. The advantages of composite pipe include:

- Rapid installation
- Corrosion-resistant operation
- Long continuous lengths
- Improved flow characteristics
- Lightweight

Composite pipe is manufactured at a state-of-the-art facility in Houston, Texas. The facility is capable of manufacturing multi-layer coextruded liner pipe, tape line winding, as well as cover layer extrusion. Polymer raw materials are kept onsite in silos to eliminate downtime in manufacturing and allow for efficient production planning. The facility houses its chiller water system which gives precise control of the pipe production cooling process. The manufacturing facility, which drives rapid development of pipe products and specialty testing, also includes onsite research and development staff and equipment. This proximity allows for fast communication between development and production operations.

DESIGN OVERVIEW

Composite pipe has been designed according to API Specification 15S: Spoolable Reinforced Plastic Linepipe. The pipe consists of

- a multi-layer design that includes a hydrocarbon resistant liner, which acts as a barrier or bladder,
- reinforced thermoplastic tape that provides pipe strength, and
- a UV and abrasion-resistant outer jacket for added durability.

Composite pipe is available in sizes ranging from 4" up to 8" with pressures ranging from 750 psi to 2250 psi, and reel lengths up to 2,160 ft depending on the size and reel capacity.

Composite pipe liner and cover materials are selected based on temperature and chemical compatibility required. HDPE is used for temperatures up to 150°F (65°C), and PERT is used for temperatures up to 180°F (82°C). Both PE materials are designated PE4710 per ATSTM D3350. The liner can also be manufactured with a PA or PPS barrier layer for additional chemical and permeation resistance.

QUALITY

Baker Hughes is committed to delivering consistent quality throughout the design, qualification, manufacturing, and installation of Composite pipe. Product quality assurance starts with an array of inline sensors continuously monitoring the manufacturing process. Using multiple types and several sensors at various stages of pipe manufacture, the equipment continuously monitors several process parameters and uses machine intelligence to identify and automatically correct deviations, minimizing manufacturing defects. Offline sampling and destructive testing such as burst, fiber tensile break tests, and cross-sectional inspections of the laminate and liner provide complete assurance of product quality to meet the needs of challenging applications.

The Baker Hughes quality management system is compliant with the requirements of ISO 9001 and API Q1. A Certificate of Quality Assurance is available upon request to customers before shipment, which summarizes the results from all quality assurance tests required by Baker Hughes quality systems.

END FITTINGS AND COUPLINGS

Composite pipe proprietary end fittings and couplings are a robust and reliable design that can be installed in 15-30 minutes. The fittings are composed of a stem and ferrule design and are installed with a single step swaging process. This process compresses the ferrule into plastic deformation and anchors the fitting to the pipe creating a leak-proof seal between the inner layer of the pipe and the stem of the fitting. Composite pipe end fittings utilize NPT threads, API/ASME Lap Flanges, or weld prepared (beveled) ends for connections to surface equipment or infrastructure. Tee, wye, etc. connection points are constructed with multiple Composite pipe end fittings and can be preconstructed or constructed in the field to meet the customer's requirements.

Composite pipe end fittings and couplings are designed to meet the requirements of API 15S including the elevated temperature test for long-term performance and the temperature cycling test for suitability across the installation and operating temperature ranges. The end fittings and couplings are specifically designed to the pipe size, temperature, and pressure ratings.

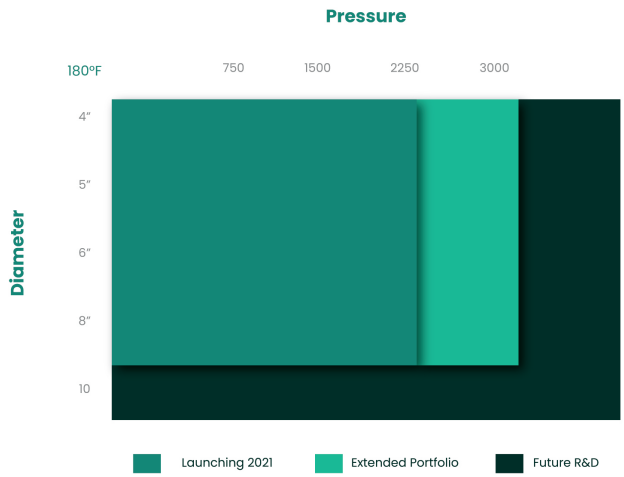
Composite pipe end fittings and couplings are designed with the following material with coating options available per fluid composition and corrosion resistance requirements.

- Carbon steel with Zinc chromate coating: non-corrosive applications
- Carbon steel with FBE coating (stem only)
- Carbon steel with PPS coating (stem only)
- Stainless steel 316
- Stainless steel Duplex 2205

Corrosion of metallic materials is a complex phenomenon and driven by many factors including fluid composition, CO2, H2S, water content, chloride concentration, temperature, and pressure. The Baker Hughes Application Engineering team can assist in making a material recommendation based on in-house testing, published literature, and industry standards.

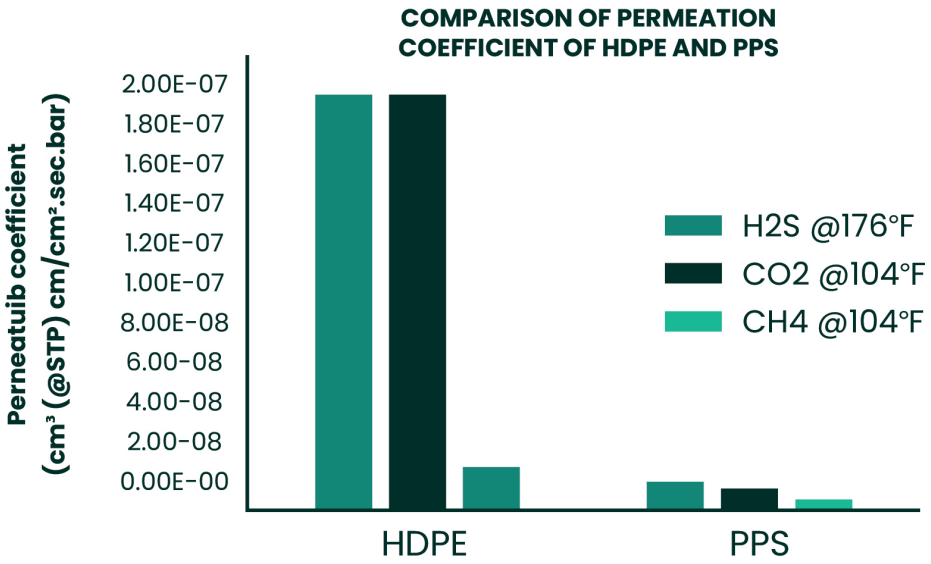
LONG TERM HYDROSTATIC STRENGTH (PRESSURE RATING)

The pressure rating, or long-term hydrostatic strength, is determined by qualification regression testing at the maximum rated temperature as per the API 15S Specification. The chart below shows the rated pressures and sizes for composite pipe products as determined by regression testing and product variant tests. The design life of the pipe is specified as a minimum of 20 years. Using industry-standard design factors, the MOP is rated for all types of fluid and does not require a derate for any typical oilfield service including hydrocarbons, gas, and produced water.



CHEMICAL COMPATIBILITY

Composite pipe is uniquely designed to handle a variety of chemicals and fluids. The liner is offered with a coextruded PA or PPS barrier layer which provides superior resistance to permeation of gases (up to 40 times lower than HDPE) and prevents absorption and breakdown of the pipe from chemicals such as acids, BTEX's, and other light hydrocarbons. The liner is fully compatible with methanol and alcohols which are typically used to prevent freezing in winter climates.



Due to the reinforcement layer being isolated from the bore fluid, and protected from external hazards by the jacket, the strength of the line is not affected by most chemicals. However, Baker Hughes Engineering can guide the compatibility of specific chemicals upon request.

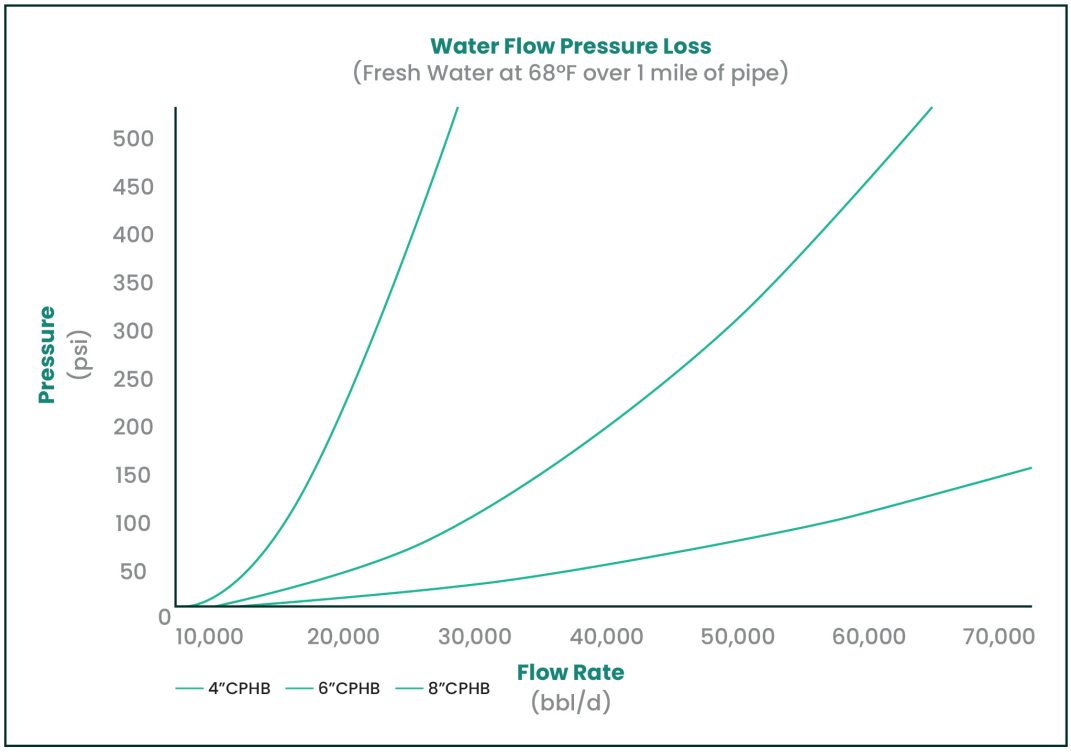
PRESSURE CYCLING AND VIBRATION

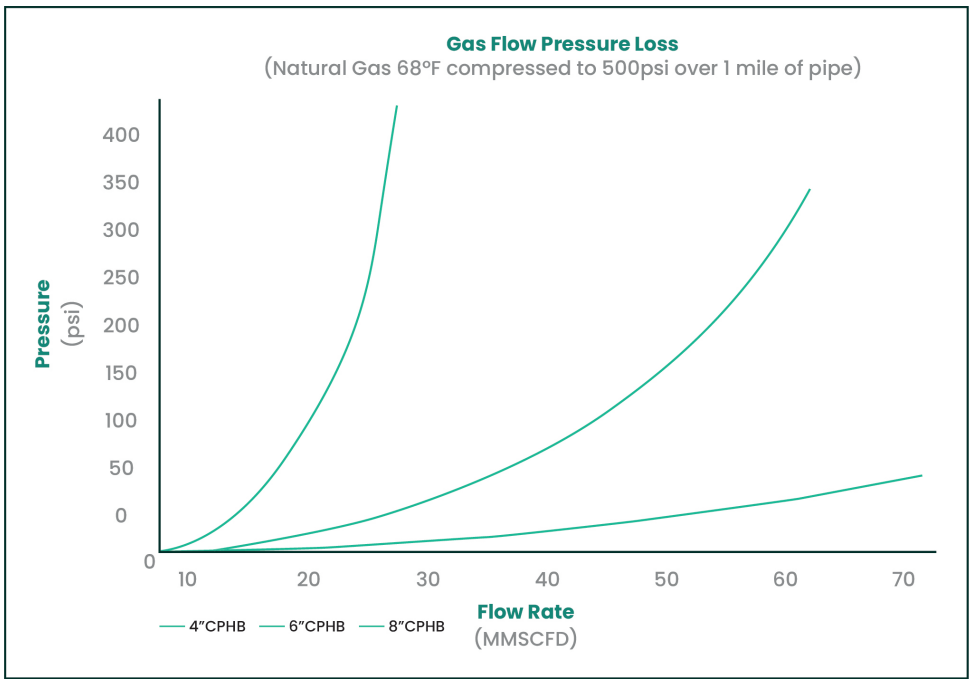
Pressure cycling caused by different pumps or on/off cycles during operation is generally not a concern when using composite pipe. The glass fiber thermoplastic tape reinforcement is designed to be resilient to cyclic loading and abrasion caused by pressure and external movement or vibration. All pump types produce pressure variations. When using high-pressure positive displacement pumps, such as triplex or duplex, an advised standard precaution includes utilizing properly sized pulsation dampeners.

In places where high vibration is expected, the pipeline should be restrained from any unwanted movement and isolated from objects that could abrade the pipe over time. Contact Baker Hughes Engineering for guidance about any concerns regarding pressure cycles or vibration.

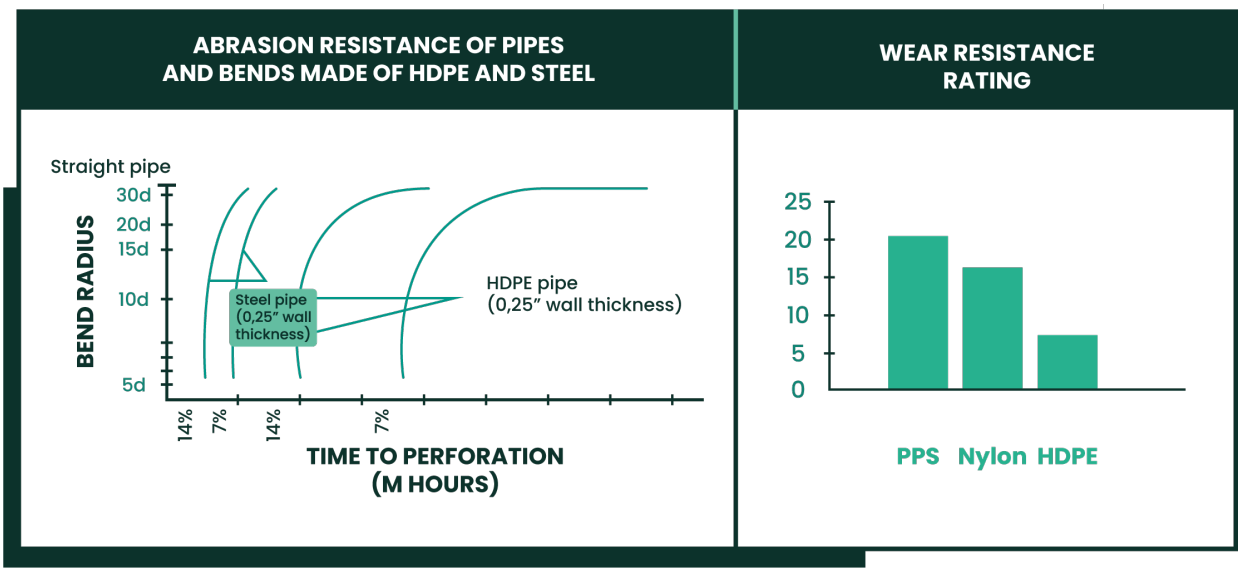
FLOW CHARACTERISTICS AND EROSION

Composite pipe has a very smooth bore which produces favorable flow and reduced frictional losses compared to other pipe materials such as steel. Due to the non-metallic materials used, the roughness will not change over time due to corrosion which means minimal changes to the flow capabilities of the line over its useable lifetime. The roughness value for Composite pipe is 0.00006 in (0.015 mm) for use in friction loss calculations. The graph below shows pressure drop comparisons for the 4", 6", and 8" composite pipe over varying flow rates for both water and gas applications.





Erosion and abrasive flow are generally not a concern with composite pipe, because the non-metallic materials used will have less abrasive material loss than steel under the same flow conditions. Many variables can change the severity of erosive flows such as particle size and flow velocity. However, a sufficient flow velocity should be maintained to keep suspended particles from dropping out of the carrying fluid. Where severe erosion is a concern, it is recommended to test the specific operating conditions for compatibility.



PIGGING

Pigging can aid in removing blockages and deposits that may form inside the line. When pigging composite pipe, Baker Hughes recommends using a bullet nose bare foam pig, of low (1.2 lbs/ft3) or medium (2.0 lbs/ft3) density. No rigid body pigs of any kind can be used with CPBH products. Other flexible pigs such as urethane cup and disk pigs, or small body smart pigs with flexible cups, could also be safely used. Contact Baker Hughes Engineering for additional information.

HOT OILING

Hot oiling can aid in removing paraffin obstructions in pipelines and minimize the potential for plugging or buildup in the line when pigging alone may not be adequate. Hot oiling injects solvents such as diesel fuel, or BTEX's at elevated temperatures into the pipeline to heat the paraffin and help melt it into solution. The usual treatment time is 2-8 hours and is often performed annually but may be more frequent depending upon the severity of the paraffins in the line. Hot oiling does not have a long-term effect on composite pipe products and can be safely performed at any temperature and pressure within the product's rated limits. Baker Hughes does not support operation above the maximum allowable operating temperature.

PARAFFINS AND ASPHALTENES

Paraffins and asphaltenes can form when the fluids in the pipe change temperatures and pressures. These solids form when they can precipitate out of the fluid when the temperature falls below the liquid cloud point or wax precipitation temperature (WPT). Controlling the precipitation is done using higher temperatures or chemicals to keep the solids in solution. composite pipe is compatible with various types of chemicals used for injection and paraffin control as well as being able to handle temperature up to 180°F.

If paraffin formation cannot be suitably hindered, the precipitated substances may adhere to the pipe wall causing buildup and blockage. Composite pipe has a very smooth bore which reduces the ability of the precipitates and asphaltenes to adhere to the pipe.

The PA and PPS lined options further reduce the ability for these substances to build up and adhere to the liner as they are dissimilar materials to the hydrocarbon-based paraffins and asphaltenes.

UV PROTECTION

Composite pipe is manufactured with a continuous CV white-colored jacket to protect the pipe and resist solar heating when used in surface applications. A titanium dioxide (TiO2) UV stabilizer is included in the jacket masterbatch to provide suitable resistance for the entire 20-year design life. Any discoloration is cosmetic and will not affect the performance of the pipe which can continue to be used up to the full pressure and temperature ratings.

STATIC DISCHARGE

Composite pipe is comprised of non-conductive materials and acts as an electrical insulator. Applications, where dry gasses and non-polar liquids are present, may generate a static charge inside the pipe. Standard maintenance and operating procedures should be followed when working with non-conductive pipe and dissipation of static electricity including the use of proper PPE. Discharge of static electricity in the presence of flammable gases or liquids may cause an explosion or fire and result in injury or property damage.

Information on the handling of static electricity in non-conductive pipelines can be found in OSHA's Hazard Information Bulletin dated September 30, 1988.

INSTALLATION

Composite pipe installation and handling methods follow most standard RTP practices. Composite pipe design produces longer continuous lengths per reel of pipe and makes it one of the most flexible RTP's on the market which reduces installation costs and time. For proper Composite pipe installation and handling techniques, reference the Composite pipe Installation and Handling Manual which is available upon request.

COMPOSITE PIPE BY BAKER HUGHES INSTALLATION MANUAL

Composite pipe shall be installed using the recommended practices and procedures outlined in the Composite Pipe by Baker Hughes Installation and Handling Manual.

The Manual is a controlled document that contains detailed installation practices for properly trained and authorized personal. Baker Hughes offers training for customers and contractors to be able to properly and safely install composite pipe.

PULL-THROUGH REHABILITATION

Pipeline rehabilitation is a cost-effective way to eliminate replacing problematic pipelines or repurposing abandoned pipelines instead of fully constructing new infrastructure. Pipeline rehabilitation is the process of pulling new pipe (typically a spoolable composite pipe) through a problematic line or an abandoned line to lessen construction costs and reduce the time needed to resume production. When utilizing Baker Hughes products, typically equivalent flow rates are achieved when compared to the original host pipe. These optimal flow rates are achieved because of better flow coefficients, with additional operational advantages such as corrosion, chemical, bacterial, paraffin resistance, etc. from composite pipe technology.

ENGINEERING AND FIELD SUPPORT

Our in-house engineering team can collaborate with you from project inception to field installation and ongoing performance monitoring. They provide engineering support and recommendations to your design teams and field crews. This typically includes

- pre-job application reviews,
- flow assurance,
- and pressure curve analysis to ensure
  - proper sizing,
  - application and installation,
  - hydrotesting recommendation and supervision, and
  - 24/7 technical support.

The Baker Hughes Field Service team can provide additional benefits including:

- **Transport & logistics**: Our field-service team can deliver pipe on reels to your location from the manufacturing facility. Because we also manufacture the pipe, we can handle all the hassles of logistics – you just focus on the project.

- **Staging & unspooling**: In addition to logistical support, our experienced field-service technicians will be by your side to assist in staging the installation equipment and unspooling the pipe from reels.

- **Installation & Connection**: To ensure the best possible outcome, we can inspect every installation – including any necessary connections. This includes training for your staff onsite.

- **Hydrostatic testing**: Setting up and performing a hydrostatic test correctly is crucial to properly deploy spoolable pipelines. Our field service team is here to provide support and facilitate successful testing post-installation and beyond.

BAKER HUGHES GLOBAL FOOTPRINT

We are global.....but we're local too. With operations in more than 120 countries and over 58,000 employees, we work in partnership with our customers, wherever they are, to deliver better outcomes. We are proud that our people and our businesses are part of the fabric of the communities in which they work.

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