FRP versus HDPE

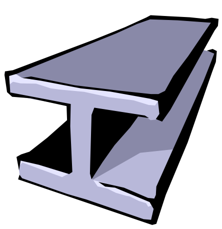
Unit Pricing

Inevitably the unit pricing for HDPE pipe is lower than FRP pipe. The actual installed price can be quite a different story. IPS competes with HDPE on regular basis. When proper engineering is present for both types of systems, the product and installation cost of FRP becomes highly competitive when comparing it to HDPE. Both products, if properly engineered, can do a good job. Proper engineering is the key. FRP pipe should also be considered for underground installations also due to its superior material properties and installation benefits. As for above ground pipe installations, FRP should almost always be the material of choice for above ground installations.

Thermal Expansion and Contraction

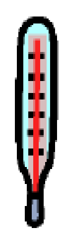
Expansion and contraction are major considerations for HDPE pipeline engineers and designers. FRP will change 1” in length per 100’ of pipe per 100ºF change in temperature. HDPE will change 10” in length with the same conditions. This expansion and contraction of HDPE is critical when designing above ground pipelines. Expensive expansion joints or heavily reinforced pipe anchors and their foundations must be implemented into above ground HDPE pipelines.

Pipe Beam Spans



Typical spans for 50 psi FRP pipe are from 12’ to 30’ for diameters from 4” – 60” up to 150ºF plus temperatures. HDPE, SDR11, spans for the same conditions for 36” Ø pipe to 60” Ø is probably less than 10’. With surface temperatures exceeding 135ºF – 150ºF, HDPE spans and pressure ratings will degrade approximately 50%.

Operating and Design Temperatures



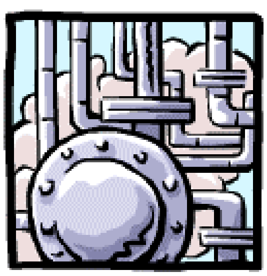
FRP pipe’s mechanical properties do not degrade until operating temperatures reach 180ºF – 220ºF depending on the resin system selected. HDPE pipe is rated at 70ºF. HDPE mechanical properties fall off immediately above 70ºF. See the comparison table on the next page.

FRP Strength versus HDPE Strength Ultimate Tensile Stresses vs. Temperature		
Operating Temperature, ºF	Ultimate FRP[1] Stress, psi	Ultimate HDPE[2] Stress, psi
75º	15900	3300
100º	17700	2750
125º	19500	2125
150º	21400	1440
175º	21400	NR
200º	21400	NR
250º	17600	NR

1. Contact molded, vinyl ester laminate (V, 2M, R, M, R, M) used.
2. 20 life expectancy HDPE factors used.
3. NR = not recommended.

It should be noted that surface temperatures in HDPE pipe exposed to direct sunlight exceed 150ºF. HDPE is colored black to offer maximum resistance to stress cracking which is a common failure mode for this product. The black color increases pipe temperature from radiant heat absorption.

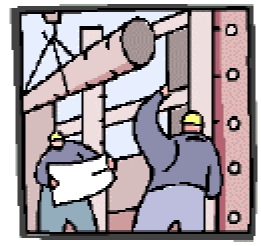
Pressure Surges



FRP is typically designed using a 6:1 to 10:1 safety factor depending on the complexity of the piping requirement i.e. pressure surges, operating temperatures, water hammer (valve closure times), etc. HDPE uses a lower safety factor. Existence of the extreme conditions just mentioned can create problems for HDPE unless proper engineering exists. Design for filament wound FRP pipe is done on an allowable strain basis with temperature, pressure and installation considerations in order that the FRP will not experience any permanent strain damage.

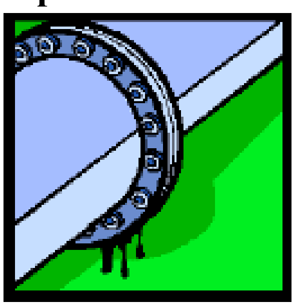
Fabrication and Installation

Both products are easily fabricated in the smaller diameters. Fabrication times are quicker for HDPE. The major difference is that FRP can be fabricated to precise, accurate dimensions. FRP can also be fabricated in place on a pipe bridge. HDPE must be fabricated on the ground and dimensions are impossible to hold due to high expansion/contraction coefficients. HDPE 40' pipe lengths can change 3"-6" during any day which has a large temperature swing.



HDPE welding requires heavy, bulky tools and high priced operators. Standard hand tools such as grinders, drills, saws, glass rollers, utility knives for glass cutting and one gallon buckets are all that is required for FRP fabricating. Using lightweight tools for FRP pipe field fabrications allows for highly versatile field modifications and repairs, which keeps pipeline lifetime maintenance costs low.

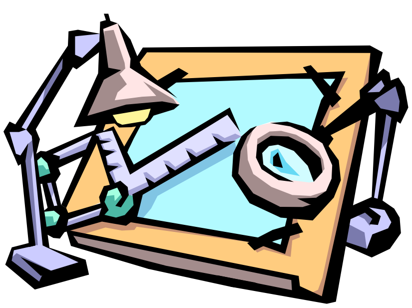
Pipe Failures and Fatigue Stress



Failures in FRP pipe generally result in a weeping leak that can easily be repaired. HDPE failures are typically catastrophic and repairs generally are difficult requiring special fusion equipment. Special fittings, modification to piping systems, etc. all of those difficulties usually experienced in construction of a plant are easily accommodated in FRP.

Concerns regarding 1000+ cycle failure of FRP are unwarranted. Standard testing for an engineered FRP piping system can exceed 50,000 –100,000 cycles. This is not a major concern for FRP pipe. In IPS's thirty-five years experience of selling and installing FRP pressure piping systems, we have never seen a failure due to fatigue or cyclical operation.

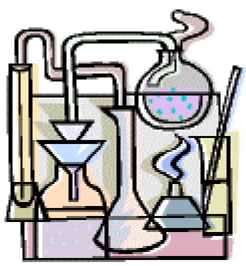
If a pipeline being designed operates at high cyclical rates (off and on) then the pipeline can be designed accordingly. This type of design usually requires a more conservative safety factor.



Material Design and Engineering

HDPE is an isotropic material. Its mechanical strengths are the same throughout its body. Its material properties are not easily engineered for strength improvement. FRP is orthotropic composite. Its strengths are directly correlated to the glass fibers' orientations when they are embedded in a thermoset resin to make a laminate. Because of this, FRP laminates can be designed for optimum strength in relationship to the loads the FRP laminate will be experiencing. In order to optimize the FRP laminate's strengths, the glass fibers must be oriented in the direction of the laminate's intended loads. Additionally, increasing glass content in a laminate will also increase its strength.

An example of this type of material engineering would be above ground pipe design. Above ground pipe has glass oriented in the axial direction as much as possible. This is to allow for long distances between pipe supports. This increases the allowable bending stress of the pipe and reduces beam deflection. For underground pipe, the case is the opposite. Glass fibers are oriented in the hoop direction to support the roundness of the pipe. This type of design aids in supporting the soil above the pipe to prevent pipe ovation.



Pipe Material Modulus of Elasticity

Pipe material modulus of elasticity is a mechanical property that inversely effects above ground pipe on supports beam deflection and the amount of diameter deflection for underground pipe. Filament wound FRP has a hoop modulus exceeding 4,000,000 and an axial modulus of up to 1,800,000 psi. HDPE has a modulus of 100,000. IPS has seen specifications requiring continuous supports for HDPE above ground installations at higher temperatures to avoid excessive beam deflection between supports..

This higher modulus of FRP allows for higher operating pressures at higher temperatures. The modulus of FRP is beneficial in underground burial of the pipe. The high modulus in burial installations allows for less diameter deflection after the pipe is buried.