A NEW JOINING SYSTEM FOR FRP OILFIELD PIPING

LOUIS C. diSIOUDI
Ciba - Geigy Corporation

INTRODUCTION AND HISTORICAL BACKGROUND

Fiberglass reinforced pipe (FRP) was originally developed and marketed in the oil field as a highly corrosion-resistant alternative to steel in relatively small-diameter, low-pressure gathering and flow lines. As the acceptance of FRP grew, so did the demand for larger diameters, and higher operating pressures.

This acceptance of FRP in the oil field as an almost commodity item inevitably led to widespread stocks of fiberglass at both the distributor and the end-user level, until now probably 70% of the pipe sold is installed without the specific knowledge of the manufacturer.

Aside from the educational aspects which are necessary with all new materials, the major reason for this kind of attention was the need to insure that the crews were trained in the proper installation of the adhesive bonded joint. It can be proven that a properly made adhesive joint, under the right conditions, is as strong as the pipe itself and, in fact, these requirements are written just that way in some standards and specifications.

Unfortunately, this is more easily specified than it is attained. Most thermosetting adhesives are sensitive to both humidity and temperature conditions. Adhesives, by definition, rely on intimate surface contact in order to perform efficiently, hence the need for nearly perfectly clean and dry bonding surfaces. As anyone who has tried to lay adhesive joint pipe in a West Texas dust storm or a Louisiana "Sun Shower" can tell you, these conditions are not always easily attainable. In addition to all this, because adhesives undergo a chemical reaction, temperature plays a critical role in the working time in the container and in the curing time of the joint.

Recognizing these limitations, FRP manufacturers have spent a great deal of time and money working to minimize these difficulties and increase the overall realiability of the joint. For example, nearly all FRP is supplied with end protectors to keep the bonding surfaces clean and dry. Many suppliers offer heat assist methods for curing the joints in cold weather. Installation instructions are supplied with each adhesive kit. At least two of the major manufacturers are offering adhesive joints with a built-in mechanical assist to hold the joint straight and immobile while the adhesive cures — all of this in an effort to improve the reliability and acceptance of FRP throughout the industry.

MECHANICAL JOINING SYSTEMS

A predictable reaction to this need for reliability of the joint would be to adopt known and proven techniques for use with FRP. So the use of threads has been employed by a number of FRP manufacturers. But, probably because of manufacturing costs and the need for a higher selling price, they have found their broadest applications in downhole tubing and high-pressure line pipe services.

In addition, as diameters increase, the practicality of steel threaded pipe for line pipe applications diminishes rapidly; for example, there is very little threaded line pipe over 4-in. diameter ever used.

A review of the mechanical joining systems in the 6-in. sizes and larger shows that the most widely accepted technique is some variation of the bell and spigot push-on joint with an elastomeric seal. This joining concept is reliable and widely accepted, and now available in FRP on almost any size desired. The application and refinement of this joining concept is bringing FRP out of the specialty product class. FRP can now be considered a viable alternative for the vast majority of piping applications. As a matter of fact, fiberglass piping systems can now compete successfully not only with protected, thin-wall steel but also with such hitherto "untouchables" as asbestos-cement and thermoplastic piping in certain applications.

The following case histories, all of which are based on the PRONTO-LOCK II joining concept from Ciba-Geigy, have been assembled in an effort to demonstrate the real economics possible with FRP.

CASE HISTORY NO. 1— GAS GATHERING SYSTEM

A major oil company was able to save more than $90,000 in total installed costs using 8-in. diameter fiberglass-reinforced epoxy pipe with a mechanical joining system for a new 30,000-ft, low-pressure gas gathering line in West Texas.

Previously, the oil company had used steel pipe for such applications. However, because of the steel pipe shortage, they began investigating alternative means for piping gas from two wells to a processing plant during the summer of 1974. Favorable economics, combined with ease-of-handling, encouraged them to select FRP pipe.

The oil company determined that, for this job, both the cost of the pipe as well as installation costs would be lower with FRP.

At the time of purchase, the outlay for 0.188-in wall plain-end steel pipe would have run $47,000 more than for FRP. In addition, doping and wrapping the steel to provide the necessary resistance would have added an additional $13,000 to the pipe costs.

The contractor estimated that installation costs for steel pipe carried a $1.10/ft premium over FRP. Thus, the oil company realized a $30,000 installation cost savings by installing the FRP pipe with mechanical joint. Because of its light weight and the mechanical joining system, FRP required a smaller work crew and less equipment. The contractor found that his crews could make up the FRP mechanical coupling in one minute or less versus approximately nine minutes needed to weld a steel joint.

To make up the mechanical joint, the tapered pin end of the pipe is stabbed into the box (female end), compressing a Buna-N "O" ring to provide a leak-free connection. A threaded sleeve is then spun into place and tightened with a spanner wrench to lick the joint into position.

Because of the ease in making up the joint, the pipe was installed at rates of more than 1600 ft/hr. The contractor estimated that a good crew working a ten-hour day could install approximately 16,000 ft/day of FRP pipe with mechanical joints.

CASE HISTORY NO. 2 — SALT WATER HANDLING SYSTEM

To help boost domestic crude oil production, many petroleum companies are automating and repressurizing reservoirs and existing field gathering systems.

In-place asbestos-cement water transfer line was replaced with FRP pipe in the salt water disposal system for a major oil company in one of its East Texas fields. Installed cost of the pipe was estimated to be 50% lower than that of steel pipe, and 33% below that of adhesive-joint FRP pipe.

The field has produced approximately 150 million barrels of oil since 1940 and much recent production results from secondary recovery operations. Several conditions in East Texas fields — the produced sour crude, the presence of salt water, increasing age of the field and "hot" soil — create corrosion problems for producers.

The new water transfer line (11,500 ft of 8-in. diameter fiberglass pipe) is replacing 20-year-old asbestos-cement pipe that had deteriorated from corrosives in the soil and salt water and which had begun leaking after the fluid volumes and pressures were increased.

Again, the unique mechanical joint of the FRP system was the deciding factor.

Another key feature of this particular system is its 2° angular deflection capability. Because of the joint design, the system also has a ±1/4-in. axial movement capacity after make-up.

During the installation, the contractor explained that he was able to conform the FRP to the ditch contour without using specialty fittings and was able to make minor positioning adjustments to accommodate the large number of valves and fittings that were required.

CASE HISTORY NO. 3— FRP PIPE USED FOR MARSHLAND GAS GATHERING SYSTEM

Unusual environmental and installation conditions in the marshy Port Neches field in Orange County, Texas, recently prompted another major oil company to install a lightweight, fiber-glass-reinforced epoxy low-pressure gas gathering pipeline as part of a modernization program.

Because of the extremely corrosive salt water environment in the marsh, most steel lines require frequent replacement, and because the pipelines cross the marsh, installation of steel pipe with welded joints is cumbersome and time-consuming.

By contrast, 10-in. FRP pipe used for the installation, offered three advantages:

1. Corrosion resistance that should provide a long, maintenance-free life;
2. A unique mechanical joint that could be made up quickly in any weather conditions, and
3. Light weight that eliminated the need for sidebooms and other heavy equipment and permitted pipe flotation across the marsh.

The approximately one-mile-long pipeline carries 6 MMCFD natural gas from 45 wells in the Port Neches field to the shore at an operating pressure of 30 psi.

Although the gas poses no internal corrosion problems for the pipeline, the salt air in the marsh area, combined with intermittent submersion of pipe during high tides, creates a potential corrosion hazard to the exterior of the pipe that is eliminated with FRP. A five-man crew installed 3600 ft of pipe in less than three hours. As each joint was made-up, the pipeline was floated across the marsh in 40-ft sections with the help of a swamp cat.

Because the FRP pipe is one-tenth the weight of equal lengths of steel, no heavy equipment (such as a sideboom) was needed. In addition, the pipe floated between the wooden support pilings until the completed line was raised into place.

The ease of making up the mechanical joint resulted in substantial savings in installation time and costs.

Because of the ease in making up the joint, there was no need for special training of crews. Even during the rainy weather conditions that existed throughout the installation, the pipe was easy to work with.

The 2° angular deflection capability of the joint offered a further advantage because marsh conditions did not permit placement of supports in completely parallel lines.

Through the use of fiberglass-reinforced epoxy pipe with a mechanical joining system, substantial time and cost savings were realized during installation, and maintenance-free long life can be expected to facilitate future operations in the Port Neches field.

CASE HISTORY NO. 4— FRP HEADER SYSTEM IMPROVES CORROSION RESISTANCE

During a modernization of its facilities at the Darst Creek field, Luling, Texas, another major oil company installed an all fiberglass-reinforced, 10-in. diameter, epoxy header system.

Custom-fabricated, to handle 40,000 BPD of oil, gas and salt water produced by the field's 50 wells, the 14-in. FRP header, with improved corrosion resistance, replaced a steel system. Because half of the Darst Creek wells produce 99% salt water with 1% oil, some earlier steel header sections had corroded in less than one month.

Water legs for three 1000-bbl capacity gun barrels that produce 400 BOPD were made of FRP pipe as well. The pipe system selected for these applications featured a mechanical joining system that substantially reduced installation time.

Working with an oil company engineer, the FRP manufacturer fabricated two 60-ft long, 10-in. diameter header sections with two and three-inch flanged outlets, approximately 12 in. apart.

A steel header would have required numerous threaded fittings and welded joints, resulting in substantially increased installation time and costs.

The two separate header sections are used to facilitate testing of wells located in two different oil sands in the Darst Creek field. Those wells which produce higher volumes of fluid feed into the 3-in. inlets of the header, while the lower-volume wells are accommodated by the 2-in. inlets.

Water legs in the lease's separation system were made up of 8-in. FRP pipe with mechanical joints, which greatly reduced installation time. Installation was quick and easy with the mechanical joints, and the pipe could be installed in any type of weather.

The highly corrosive nature of the sour crude produced by these wells, in combination with the environment in the field, necessitated selection of a corrosion-resistant pipe that was easy to work with and install. This oil company found the answer with a custom-fabricated header and FRP with a mechanical joining system.

SUMMARY

In summary then, it can be seen that FRP is a truly competitive piping material offering greater advantages and cost savings to end-users than ever before. The ability to join the pipe reliably with efficient, low-cost mechanical coupling systems has enabled the end-user to effect substantial savings over traditional materials while at the same time enjoying the long range benefits inherent in an FRP system.

As labor becomes an even greater proportion of the job, users will increase their concern with the total installed cost of a system rather than just look at the initial materials' cost. As a means of helping to facilitate this kind of analysis, an installed cost estimate can be prepared which will allow the engineer to total up the entire job cost and directly compare with costs of alternate materials.

Items which must be included besides the initial material costs are:

1. Various corrosion protection costs
2. Freight costs
3. Adhesive costs
4. Forced-curing costs
5. Installation costs

All of these items can be quantified, but must be up-dated regularly to insure validity of each comparison made. Usually, all of these data will be available to the engineer for each job.

Based on experience, it is believed that this technique will support the economies attainable through the use of FRP as described above. Most important, it promotes a direct side-by-side comparison of all competitive materials on an installed cost basis.

When this is done, FRP, with a fast, simple, reliable joining system, will usually be the most economical material for the job.