Cemented Fiber Glass Tubulars Used In Injection Wells

J. H. BOWERS
Shell Oil Company

INTRODUCTION

A total of 51 fiber glass (reinforced thermal resin pipe) liners have been set in the Shell Denver Unit, Wasson Field, Gaines and Yoakum Counties, Texas. These liners were run to control fill and provide injection profile control in open hole completed injection wells. Fiber glass pipe was chosen for this application as the most economical alternative to steel for corrosion resistance to the fresh oxygen-saturated injection water.

The liners were run and set on conventional steel liner hangers and cemented with the two-plug cementing method. They were then perforated with select-fire hollow carrier perforating guns and the perforated intervals selectively acidized with a straddle-packer arrangement. Injection equipment was run so as to present a completely protected system to the corrosive injection water. This equipment was made up of internally plastic-coated steel tubing with packers to isolate the crossover between the casing and the top of the fiber glass liner.

HISTORY

Most Wasson San Andres wells were completed open hole for primary production. When water injection began in 1964, injection wells were equipped with plastic-coated tubing and casing packers, and water was injected into the gross open-hole interval. After injecting for a time, fill became a problem in some injectors. This fill was caused by the fresh injection water leaching anhydrite from the open hole and letting the interbedded dolomite slough into the hole. With more experience it became apparent that cemented liners were needed to control this fill and to achieve the desired injection profile. Research was begun to find an alternative to bare steel pipe for liner material to provide corrosion resistance to the oxygen-saturated fresh injection water. Estimated life of a bare steel liner was two years. Other criteria were that the liner must have strength to withstand perforating, be resistant to hydrochloric acid and be a material that would not act as a sacrificial anode to the steel casing. Materials considered were plastic-coated steel, fiber glass, aluminum and securaloy. Fiber glass tubing was chosen as the most practical and economically attractive alternative, the cost of a 500-ft, 3-½-in. fiber glass liner installation being only $1000 more than the cost for a comparable steel liner.

INSTALLATION

Two considerations were held to be of prime importance in installing and injecting into the fiber glass liner. The first was to provide a completely inert corrosion resistant downhole injection system with no bare steel pipe exposed to the injection water. This condition requires that the top of the liner be isolated with packers while injecting. The second was that no packer with slips would be set in the fiber glass. These two conditions have been met for all fiber glass installed to date (See Fig. 1 for example).

These liners averaged 500 ft in length and were set at about 5200 ft total depth. Bottom-hole temperature was 105°F. They were run and cemented with conventional liner setting techniques. After cleaning out the hole, the liner was run with a side-ported guide shoe on bottom, a shoe joint, landing collar and liner hanger with holddown. The liner was circulated with fresh water and cemented through the running string. Cements used have been Class "H" saturated salt cement and Class "C" cement with ¼ lb per sack of Flocel. Since the epoxy on the exterior of the fiber glass presents a very smooth slick surface, the pipe was either sand-blasted or "Ruff-Coted" to assure adhesion of the cement to the pipe. Profile surveys show no apparent difference in the quality of the cement job with either type of cement or surface preparation. It is also worthy of note that the fiber glass tubing is supplied with API 8R threads and presents no problem when connecting to the steel components of the liner assembly.

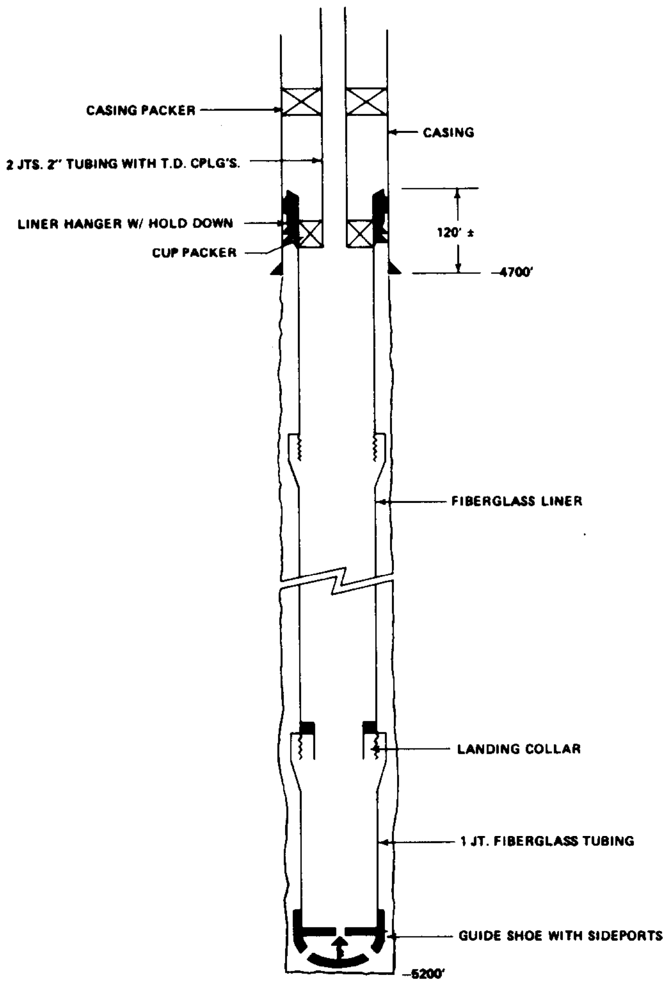

FIGURE 1

COMPLETING

All liners were loaded with fresh water and tested at 1500 psi surface pressure prior to perforating. The liners were then perforated with select-fire hollow carrier perforating guns. Research has shown that the hollow carrier gun will absorb the energy of the shot and not damage the fiber glass, while an expendible type gun will burst the fiber glass pipe. There have been no indications of damage from perforating with the hollow-carrier gun. The perforated intervals were then selectively acidized with a straddle-packer arrangement. This assembly consisted of two cup-type packers run on integral-joint tubing with a seating nipple below the lower packer and a sliding sleeve between the packers.

PROBLEMS

A major problem encountered in running these liners was failure of cement to circulate around the top of the liner. Cement would either be lost into a fractured or high permeability thief zone, or be dehydrated and lose pumpability preventing complete displacement from the liner. Cement volumes were calculated from caliper surveys and 100 percent excess cement volume was used. However, the deteriorated condition of the hole made an accurate estimation of required cement volume difficult. In any event the liner was cemented successfully by "squeezing" around the top of the liner.

In the case of losing cement to a thief zone, the cement was displaced from the liner and no drilling out was required. However, when the cement dehydrated and pumpability was lost it was necessary to drill as much as 500 ft of cement out of the liner in some cases. This drilling out was done with both "scalloped" collars used as bits and with rock bits.

Experience has been that the rock bit is better for drilling cement out of the liner and that there is no damage to the fiber glass in drilling out, but the drilling out should be done immediately after the cement is pumped. Damage to one liner was experienced when drilling out with a "scalloped" collar.

It is pointed out, however, that these cementing difficulties are not attributed to the fiber glass but rather to bad hole conditions.

Two liners developed leaks subsequent to completion and starting injection. One liner was found leaking below the injection interval and was repaired by plugging back with cement. The other is leaking above the injection interval. Since the leak is of small consequence, no attempt has been made to repair it.

DEVELOPMENTS

Both 7-in, and 5-½-in. fiber glass casing are now available. To date, six Denver Unit infill injection wells have been equipped as dual injectors in 7-in. fiber glass casing. The fiber glass was run as the bottom 400 ft of the casing string and cemented over the injection interval. Completions were made with the same techniques as described above for fiber glass liners.

Tests are now being conducted by the fiber glass tubing and packer manufacturers to determine the feasibility of setting slip-type packers in the fiber glass. The results of these tests are pending.

SUMMARY

There were no problems encountered that were unique to using fiber glass tubulars in this application. Other than perforating with a hollow-carrier gun and not setting slip-type packers in the fiber glass, no special consideration was given the fiber glass tubulars. Results to date have been satisfactory and it is planned to equip more injection wells with fiber glass in the future. Although the reason for running the fiber glass liner was for fill and injection profile control, this paper only discussed problems with the installation of and the completion in the fiber glass tubulars.

CONCLUSIONS

1. Fiber glass tubulars can be run and cemented as liners and casing with conventional running techniques.
2. The fiber glass pipe will not be damaged by:
   a. Drilling out cement with rock bits
   b. Perforating with a hollow carrier perforating gun
   c. Acidizing with hydrochloric acid.

In conclusion, fiber glass pipe provides an inert corrosion-resistant system for protection of the injection interval in waterflood injection wells. In view of the success with fiber glass liners and casing in the Denver Unit, the application is being extended to other water floods.

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