



SERYE SERVICIOS

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PETROBRAS INTERNATIONAL

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**SEÑORES:
PETROBRAS INTERNATIONAL
CAMPO YAGUARA
ING. OTTO MORALES
Yaguara - Huila**

REF: REPORT ON THE HYDROTEST OF THE SYNTHO-GLASS® REPAIR AND REINFORCING SYSTEM

Please allow me to send this report for your consideration regarding the hydrostatic test run on July 10 and 11 to test and observe the efficiency of the Syntho-Glass System®.

This test was coordinated and attended by Ing. Jorge Lugo, Carmenza Ortiz and Ing. Otto Serrano of PETROBRAS International. The repair was made by Ing. Jose M. Bernal of Serye Servicios using Syntho Glass®.

OBJETIVES

- The primary objective of the test was to demonstrate the versatility of the Syntho Glass® System by simulating typical defects found in the field.
- To show in real time, the advantages of repairing and reinforcing pipe with this System by demonstrating its ease and quickness.
- To show the efficiency of the material as well as its pressure resistance and ease of application.

FABRICATION OF THE PROBE

The test probe was made with a 3" schedule 40 pipe. An 80 cm length was used and both ends were welded closed using blind flanges. On the upper part of the probe, two outlets were installed; one for the installation of the pressure gauge and one as the inlet for the Baker pump to elevate the pressure.



In the areas where the defects were to be made, the metals was ground to white metals (See Figures 1 and 2)



Figure No.1 -Cleaning to White Metal the Repair Area for Defect "A"



Figure No.2 - Cleaning of the Area for Defect "B"

Two defects were made to the probe: one a hole approximately 1.5 cm in diameter (Defect "A") and the other, an internal wall loss of 70% (Defect "B").



Figure No.3 - Hole



Figure No.4 - Dimensions of the Hole

Once the defects were made, the probe was ready for the repairs using calculations based on Barlow's Formula.

**CALCULATION FOR THE REPAIR (NUMBER OF LAYERS NEEDED)**

For Defect "A" (Hole), a minimum of 8 layers should be applied. This minimum amount of layers (8) will guarantee a pressure retention up to 600 psi. Because this Defect has a remaining operating pressure of 0 psi, we based our calculations on burst pressure of 5000 psi . Table No. 1 shows the information for Defect "A".

Property	Unit	Value
Outside Diameter of Pipe	inches	3.5
Maximum Operating Pressure	psi	5,000
Remaining Wall Thickness	inches	0
Wall Loss	%	100
Remaining Pressure	psi	0
Diameter of the Defect	pulgadas	0.63
Number of Layers	--	16

Table No.1 – Data for Defect "A"

Defect "B" (Internal Wall Loss), was approximately 1" long and oval in shape. The remaining wall thickness was measured using a Ultrasonic Tester (Figure 5). Table no. 2 shows the details of this defect. The repair was calculated to reach 5000 psi.

Property	Unit	Value
Outside Diameter of Pipe	inches	3.5
Maximum Operating Press.	psi	5,000
Remaining Wall Thickness	inches	0.068
Wall Loss	%	70
Remaining Pressure	psi	1,044
Diameter of the Defect	inches	1
Number of Layers	--	13

Table No.2 – Data for Defect "B"

Reviewing this data, the pipe with this defect should burst at 1,044 psi.



Figure No.5 – Measuring the Remaining Wall Thickness in Defect “B”

INSTALLATION OF THE REPAIR

- **Identification and Measuring of the Defect:** In this step it is required that a complete identification of the repair is made: the cause, the diameter, the location, the line pressure and product, the temperature and the pipe specification.
- **Calculating the Required Amount of Material:** This calculation is based on the above parameters in addition to the specification and wall thickness of the pipe, the remaining operating pressure, and the size of the Syntho-Glass® rolls to be used.
- **Repair:** Once it has been determined how many wraps will be required for this repair to re-establish the serviceability of the line, the repair can begin taking into account the personnel required (related to the diameter of the pipe) and the logistics of the repair (excavation, water supply, etc.).

The following is a step by step description of the Repair Procedures



Defect "A"

As the surface area of the repair had been prepared, the hole was sealed using Syntho-Steel, a 2 part epoxy putty which provides an effective seal.

The cure time for this putty is 5 minutes, during which any excess is cleaned away using an abrasive medium.

The application of Syntho Glass® is begun over the area of Defect "A". The Syntho-Glass® is applied around the pipe and water is applied to activate the resin. Care must be taken to remove any wrinkles or gaps between layers.



Figure No. 6 – Application of Syntho Steel



Figure No. 7 – Application of Syntho Glass®

Once the Syntho Glass® has been applied, it is wrapped in a vinyl paper to contain the resin during its cure. Holes are punched into this covering to allow the release of CO₂ produced by the reaction of the resin with the water. By releasing the CO₂, this allows the water to migrate up to the surface of the last layer of Syntho-Glass® so it does not remain between the pipe wall and the first layer of Syntho Glass®.

The vinyl is removed after 15 to 20 minutes when Syntho Glass® has begun to harden. Figure no. 8 shows the completed repair to "A".



Figure No. 8 – Repair to "A" Completed

Defecto "B"



Figure No. 9 – Applying Syntho Glass® to Repair "B"



Figure No. 10 – Applying Syntho Glass® to Repair "B"

Once the repair to Defect "a" had been completed, the repair to "B" was begun

The procedure was the same. Syntho-Glass® was applied over the pipe, applying water and manually molding and squeezing the tape to assure the proper adhesion between layers and a monolithic finish.



After the application of the required layers, the vinyl paper was applied to maintain the tension. This wrap remain until the Syntho-Glass® had hardened. Figure No. 11 shows the finished repair "B" and Figure no. 12, the completed and repaired probe.

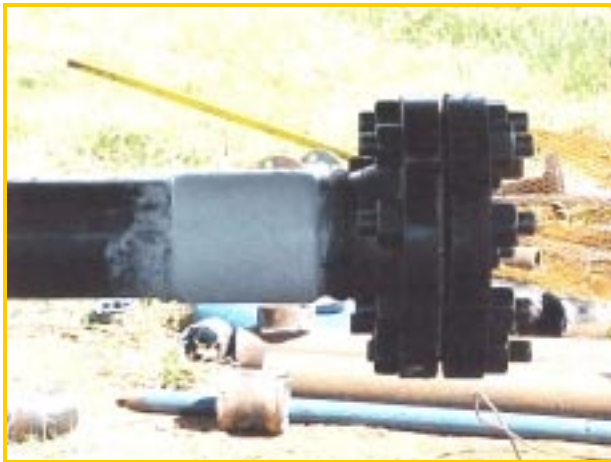


Figure No. 11 – Repair "B" Completed



Figure No. 12 – Repaired and Completed Probe

These two repairs were completed in 45 minutes. In agreement with Ing. Otto Morales, the hydro test was scheduled for 8 o'clock on July 11, 2000.

BURST TEST

The Burst Test was made 17 hours after the repairs had been completed. The Pressure Gauge (5,000 psi) was installed and the Baker Pump was connected to the probe. (Figures 13 and 14).



Figure No. 13 – Installing Pressure Gauge and Pump



Figure No. 14 – Testing Baker Pump



Once the connections were made and the probe filled with water, Pressure was applied. The first increase in pressure reached 1,250 psi and the second, 2000 psi. This pressure was reached in 30 seconds. (Figures 15 and 16)



Figura No. 15 - 1,250 psi



Figura No. 16 - 2,000 psi Presión de Falla

Defect "A" failed at 2,000 psi (Figure No. 17). The Syntho-Glass® Sleeve was removed (Figure No. 18).



Figure No. 17 - Failed @ 2,000 psi



Figure No. 17 - Defect "A" after Removing the Syntho Glass Sleeve

Looking at the failure, the Syntho-Glass® sleeve suffered no damage; the failure occurred in the Syntho-Steel Putty but no cracks or fractures were seen. To continue with the test, the Syntho-Steel was removed and the hole was welded off.



Once the hole was sealed off, the probe was refilled with water and pressure applied using the Baker Pump. The intervals between the increase in pressure were varied due to the difficulty in increasing the pressure by hand but we were able to reach 5,000 psi within 10 minutes. In the Figures 19 - 27 you can follow the increases in pressure.



Figura No. 19 - Reanudar la Prueba 0 psi



Figura No. 20 - 650 psi



Figura No. 21 - 1,500 psi



Figura No. 22 - 1,950 psi



Figura No. 23 - 2,450 psi



Figura No. 24 - 2,600 psi



Figura No. 25 - 4,000 psi



Figura No. 26 - 4,400 psi



Figura No. 27 - 4,600 psi



Figura No. 27 - 4,950 psi



The 5,000 psi limit of the pressure gauge was reached and at this pressure, leaks were observed coming from the threaded flange bolts on the blind flanges and it was decided to stop the test as it was impossible to further increase the pressure to burst pressure.

Once the test was stopped, pressure was bled out of the probe and Defect B was opened from the side to observe the status of the interior of the pipe. From this observation, Syntho-Glass prevented a rupture of the pipe.

CONCLUSIONS

- Syntho Glass® show its capacity to retain pressure, repair and reinforce pipe with defects. Through this test and procedure, Syntho-Glass meets the requirements of ASME and the DOT (U.S. Dept. of Transportation).
- The repair of the hole failed at 2000 psi, 800 psi over the MOP of the Campo Yaguara lines
- The Wall Loss Repair met and Exceeded the established parameters of the test
- This type of repair can be made by one trained and certified person with no need for special tools or equipment
- There is no need for the transport of specialized equipment to the job site.
- To repair a line with a hole, it is not necessary required that the line pressure be stopped for the entire time of the repair....Only the time it takes to plug the hole, clean the area and apply the tape.
- This repair method will decrease repair down time
- Because Syntho Glass® is not affected by water, this type of repair can be made in the rain or on submerged line
- Syntho Glass® can be applied on Elbows, Tees, Reducers, etc.
- Because each repair is designed specifically for the repair specifications, costs are minimized.



- A typical Syntho Glass® repair can be estimated to be 60% more economical than a traditional repair as far as materials are concerned without taking into consideration the savings in lost production and manpower.
- The repair and reinforcement of pipe using Syntho Glass®, is a safe procedure because it does not use any elements that could cause sparks or consequential fires, etc. thus substantially reducing the risk of accidents.

RECOMMENDATIONS

- If a higher degree of pressure retention is needed for holes or fissure repairs, Syntho Steel Epoxy Mastic can be used. This epoxy resin is reinforced with steel fibers and will have a higher mechanical properties than the Syntho Steel Epoxy Putty.
- If the repair will be exposed to sunlight, the Syntho Glass® must be coated with a U/V protectant coating.
- Syntho Glass® is not toxic nor flammable but you should use gloves while installing (each roll comes with a pair of latex gloves). The resin will stick to skin and will cause no harm but it will take about 3 days to wear off.
- Each repair is different and it is a requirement that all calculations be reviewed by Serye and that repairs be made only by trained and certified personnel to comply with the ASME and DOT regulations.
- Dry and Cure times are different. Normally at temperature above 30 °C, one hour is sufficient to return the line to operation.
- The repair area must be completely free of hydrocarbons and grease otherwise the adhesion of the resin to the substrate will be affected.

ING. JOSE M BERNAL
GERENTE DE PROYECTOS - SERYE LTDA