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"LEAK-SEALANT IN HYDRAULIC SYSTEMS MINIMIZES MAINTENANCE COSTS IN OFFSHORE WELLS"

Miguel A. Mendoza, and Javier Hernandez/PEMEX, and David W. Rusch/Seal-Tite International.

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Abstract

A solution is presented to problems related with leaks in hydraulic systems at the subsurface as well as surface accessories, in the offshore wells of the Marine Region in Mexico.

Offshore oil wells, by regulation, should have a subsurface safety valve. This valve is worked hydraulically from the surface. The production requirements demand that the well remains open and the failure of the hydraulic system of the valve causes the well to close, becoming necessary to use equipment and personnel to recover the production tubing and repair the valve.

It has been attempted by several methods to plug these leaks but without success. A new sealant liquid made with polymers is able to plug leaks hydraulically, which is activated by a differential pressure. It can be pumped into most of fluids used in the industry and it resists pressures and temperatures up of 5,000 psi (350 kg/cm^2) and 300 °F (148.8 ºC), respectively.

In the Marine Region, the sealant system was proved, both in the shop as well as in a production well with a leak in the hydraulic system of its safety valve. The results were excellent presenting a very good alternative to solve this type of problem and to maintain the wells operating within the security regulations, at low costs.

Introduction

One of the main problems detected by Petroleos Mexicanos in the offshore wells of the Marine Region are related to flaws in the hydraulic systems, both surface or subsurface, of the subsurface safety valves, which are one of the most important control devices that are required in this region by regulation.

The Subsurface Safety Valve (SSV) operates hydraulically from the surface through a hydraulic system wich includes: internal lines in the production assembly, hanger, tube of stainless steel and the hydraulic body of the valve (figure 1), wich is a closed system with flaps that resist the necessary internal pressure to keep the valve open. When these flaps present excessive leaks, the pressure decrese, causing the automatic closure of the valve. If the leak is small, the surface hydraulic pump delivers hydraulic oil to the system trying to maintain the aperture pressure. In some cases, the valve problem is remediated by adding high viscosity oil, resulting in diminishing the leak but increasing the slowness of response in valve operation. When exist a mayor leak and the valve is closed, a workower job is required for the well, to recover and change the valve and return to the operational regulations required for the well, with an approximate cost of 240,000 USD (table1).

Because the operational program for the workover equipment and personnel (POA and POT) is made with anticipation, the wells that recently show these problems have not been included and therefore they have to wait until they are re-programmed, and remain closed or isolated using the hydropneumatic supply of hydraulic oil.

Development

In order to plug leaks in SSV's, plastic, silicon and other materials and solids have been used without any success. It has been developed a sealant fluid designed exclusively to seal severe leaks in hydraulic systems with the help of polymers, compatible with oil and glycols, with the main characteristic that of the sealing mechanism is activated by the loss of pressure generated through the leak site, being capable to plug the leaks in SSV's, casings, tubing, packers, flexible pipes, systems for handling subsurface hydrocarbons and other applications in the oil industry.
It actuates in leaks within metal-metal and elastomers-metal seals, small fissures and connections.

The sealant can be injected as a liquid or atomized in gas; it remains fluid until it passes through the leak, then when the differential pressure actuates, it reacts in similar way to the platelets in the human blood, generating a deposit in the walls within the site of the leak, similar to the clotting of the blood in a wound (figures 2, 3, 4 and 5). Initially the seal is fragile but in the course of two weeks it becomes much more resistant, but flexible at the same time.

The seal resists pressures of 15,000 psi (1,050 kg/cm^2) and 320 °F (160 °C) without causing any damage or alteration to the elastomers neither the mechanisms or filters, that is because the loss of pressure during the movement of the valve occurred only in a few seconds and the sealant requires a loss of pressure sustained during several minutes before the polymer is activated.

The sealant is formulated and applied according to each case. When the area of leak is greater is more difficult to seal because the hydraulic pressure can break the flexible matrix created by the first sealer matrix that passed through the leak. The resistance time reached in a sealed leak is more than 2 years after its application.

Shop test and field

At the Geophysics Area facilities of the Well Services Department of the Marine Region, a test of the sealer was performed with the objective of observe its effectiveness in subsurface safety valve with leaks.

The test was carried out in a subsurface safety control valve OTIS 3 ½, with hinge that had leaks in its hydraulic system. ±250 ml of the sealant was pumped until it flew out through the leak. After that the pumping was continued until the pressure increased up to 4,000 psi (280 kg/cm^2), without signs of leaking fluid or sealant. The pressure was held for 10 minutes without showing any decrease in the pressure, then the pressure was released and the valve was open and closed in three cycles, without observing leaks, concluding that one sealant application was quick, resistant and satisfactory.

With the results observed in the shop successful, a field job was programmed and the well Cantarell-2277, C-10 of the platform Akal-S was selected. As production antecedents, the type of control valve was a Baker 4 ½ installed at 139.32 m in a production tubing of 4 ½ - 3 ½ diameter, presented a leak, requiring isolation of the control panel. To maintain the valve open, oil of high viscosity was injected into the oil Turbine 11 usually used. The sealant was injected through the line of ¼", and after pumping aprox 900 ml. the pressure remained at 5,000 psi (350 kg/cm^2), manteining this pressure during 1 hour without observing any decrease The independent console was eliminated and the valve was incorporated back on line to the general control panel at 3,200 psi (224 kg/cm^2) with no loss of pressure.

Since March 26th 1999 up to date, the valve is operating satisfactorily without presenting any leaks in its hydraulic system.

Cost

The chart 1 shows a typical repair cost of change a SSV.

QUANTITY	EQUIPMENT, MATERIALS AND SERVICES	COST (USD)
01	Jackup rig *(4.33 days)	129,900.00
01	Tugboat	8,500.00
150 m^3	Control fluid (FAPX)	57,855.00
01	Service of torque tools	960.00
01	Instalation service and test of SSV	1,800.00
01	SSV **	30,000.00
01	Instalation service and test of the Christmas tree and Hanger	1,600.00
01	Induction service with Coiled Tubing and N_2.	13,000.00
	TOTAL	**243,615.00**

* Includes the time of positioning and installation of the Jackup rig in the place.

* *Considers the cost of a SSV on the average of 30,000.00 USD.

Chart 1. - Teams, materials and costs required for a change of valve conventional subsurface using platform autolevel.

The chart 2 gives the cost of a service of sealing a hydraulic system for a subsurface valve.

EQUIPMENT, MATERIAL AND PERSONAL	COST
Manual tool	
Manual pump for 15,000 psi (1050 kg/cm^2).	
Sealer formulated according to the characteristics of the leak.	
Technician	
TOTAL	**20,000 USD**

Chart 2. – Cost of team, material and personnel required in a service of sealed.

Conclusions and Recommendations

This unique sealant service is quick and resistant; it is made in a closed circuit, with no risk of environmental contamination and only requires a minimum of tools and personnel for its application.

Although the sealant is not permanent, the typical two years of useful life gives an opportunity to program the logistics for a workover rig without the need of close or isolate the well because it is outside of regulations.

The cost is of approximately 6% of the cost of a valve change and the duration of the service is typically one day.

Using this service, loss of production caused by well closing is avoided.

It is necessary to make a detailed analysis of the conditions and characteristics of the leak in the well, in order to obtain information to program and formulate the type and quantity of sealer to use.

Figures

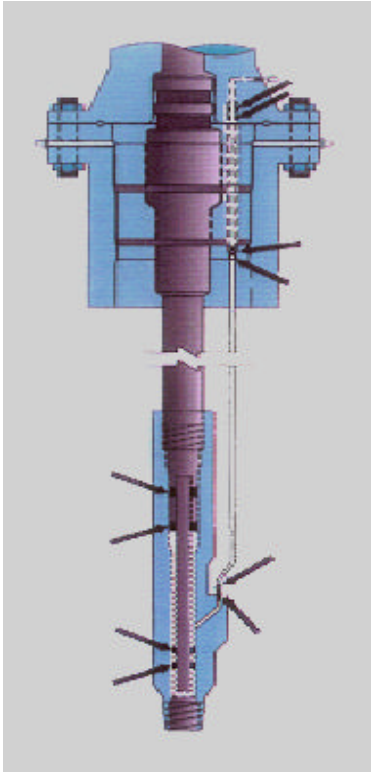

FIGURE 1.- Points of risk of leaks in a hydraulic saftey valve.

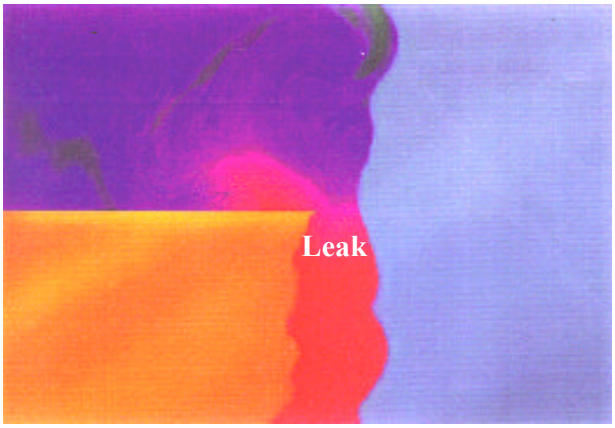

FIGURE 2.- Initial flow of sealant through the leak.

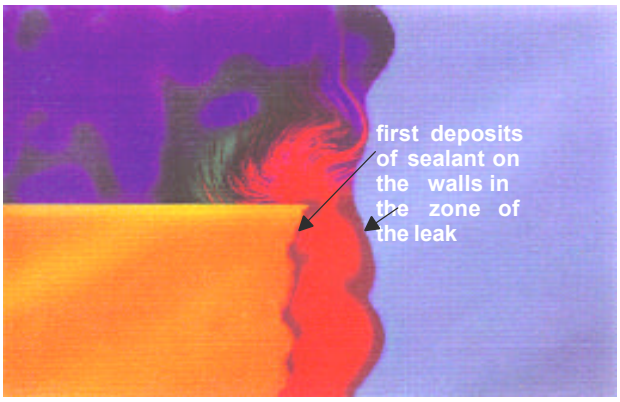

FIGURE 3.- Creation of the first deposits of sealant on the walls in the zone of the leak.

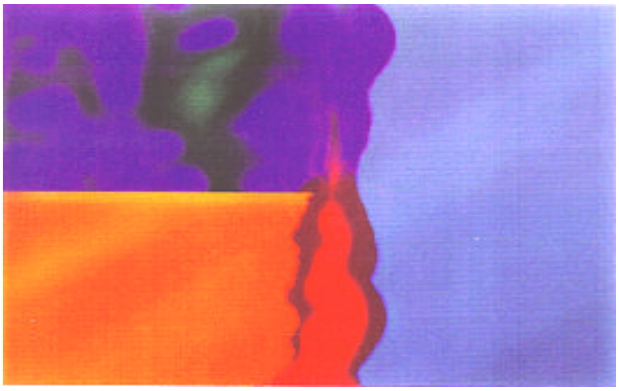

FIGURE 4.- Formation of the bridges across the leak, reducing the flow of fluid.

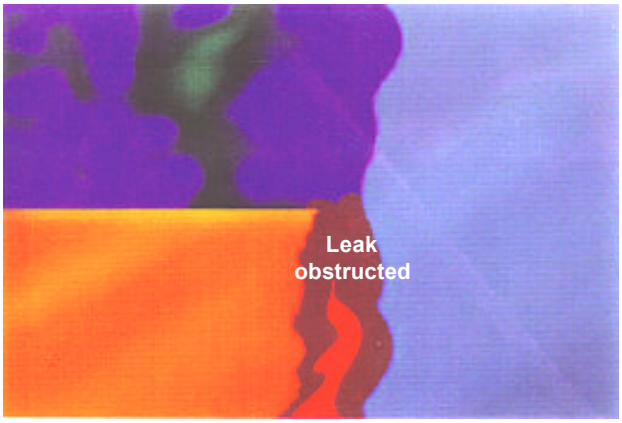

FIGURE 5.- Leak obstructed and tolal reduction of flow through leak.

References

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