SUBJECT: COMPLETION

TECHNICAL SUBJECT: Wellhead ring groove corrosion / repair.

SUMMARY:

3 years after wellhead installation, Bongkot well BK9-MW was drilled and completed. When the Production tree was installed, a pressure leak was observed coming from the ring groove / gasket between the wellhead and the Production tree.

Upon closer inspection, it was found that 3 such wellheads were corroded (BK9-MW, BK-HW and BK9-GW) to such an extent that the ring grooves would not hold pressure. The worst corrosion (BK9-GW) was estimated to be between 5 and 6 millimeter metal loss.

All 3 wells were drilled and temporarily plugged with dry hole trees whilst onshore investigation was commenced to find an acceptable repair method.

All 3 wells were repaired, production trees installed and successfully pressure tested (with no loss of gas production) prior to the drilling tender moving to the next wellhead platform.

TYPE OF REPORT: OPERATIONAL REPORT

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REFERENCE DOCUMENTS: None

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1. INTRODUCTION

Due to severe corrosion of the ring groove seal surfaces on wells BK9-MW, BK9-HW and BK9-GW, a repair program had to be initiated in a short lead-time to allow for the installation of the Production trees onto the drilled and completed wells prior to the drilling tender rig move to the next wellhead platform. This would ensure that no loss of production occurred and also that the rig package could be removed from the wellhead platform under safe conditions (heavy lift criteria).

2. BACKGROUND

During the Bongkot Phase 3A Drilling campaign, Kvaerner Splitter wellheads (manufactured from a solid block of metal) were used to allow 2 wells to be drilled through 1 conductor slot. After wellhead installation, the first well was drilled to TD and completed, but in some cases it was deemed undesirable to immediately drill the 2^{nd} well through the newly installed Splitter wellhead. In some cases the 2^{nd} wells were drilled 1 month after the first well was drilled and in other cases some 2 years passed before it was necessary to drill this 2^{nd} well.

All sealing surfaces of the unused side of the Splitter wellhead were coated in grease but no maintenance program was initiated to ensure the integrity of these sealing surfaces.

The corrosion problem was first seen when the drilling riser / BOP package was installed on well BK9-MW. The ring groove was heavily contaminated with rust / corrosion and took several hours to clean with emery paper. The drilling package was pressure tested and a satisfactory test was obtained. After the well was completed, the Production tree was installed but failed to hold its pressure test of the ring groove (the studs / nuts were torqued with the use of a ring spanner and sledgehammer).

The failure of the pressure test was identified by the fact that when the drilling riser was installed, all torque applied to the RX-49 ring groove gasket went directly into the gasket. The failure of the Production tree pressure test was due to the fact that the DA Carrier between the tubing hanger neck and the Production tree bonnet was being energized at the same time as the gasket.

The problem wells were left with dry tee caps whilst onshore investigations were conducted to seek a solution to the problem.

2. ONSHORE INVESTIGATIONS

Initial investigations were carried out to find out why the leaks had occurred and to find a suitable repair method. The problems that were analyzed were as follows:

1. Not enough torque was being generated through the studs / nuts of the Production tree to allow for the ring gasket and the DA carrier to be fully energized. This was apparent as the connection leaked at a higher pressure the tighter the flange became. We eventually had the 2 mating surfaces (the bonnet of the Production tree and the upper section of the wellhead) touching one another. The solution to this was to acquire a hydraulic torque wrench from abroad that would give exact torque readings and would ensure the connection was tightened to API specifications (which is not possible when using a ring spanner and sledgehammer). See figure 3.

   We also had to ensure that both mating parts were completely free of paint, rust, etc as the tolerance of the gap between the bonnet and the wellhead is only fractions of a millimeter.

2. The corrosion / pitting had to be removed from the ring grove. The problem with this is that it is very hard to remove all corrosion as the adjacent Production tree on the splitter wellhead is only millimeters away from the ring groove location, so no large machines could be used. Also the tubing hanger neck protruded from the wellhead to some 40 - 50 centimeters which also added to the problem.

   Manual tools had to be used for the cleaning of the ring groove. For this we took some old ring gaskets and had them modified at a local machine shop so that tungsten cutters were imbedded into the gasket and a suitable frame was welded to the top of the gasket to allow for rotation past the top of the tubing hanger neck. These tools were tested in the Songkhla workshop and it was felt that they would be adequate for the job. See figures 4 and 5.

3. The pitting created by the corrosion had to be filled with some compound that would be both temperature and pressure resistant. On BK9-GW, when the drilling riser was installed, the pitting in the ring groove was so bad that a washout occurred when pressure testing this connection. A short-term fix for this problem was to use a thread-locking compound (Bakerlock). This short-term solution allowed for the well to be drilled safely but was deemed unacceptable for long term production.

After contacting specialist companies for so called liquid metal, it became apparent that only one product would suit all of our requirements (high temperature at the wellhead of 100 degrees Celsius and pressure of 3500 psi. This product is called Belzona 1111. The local Supply Company that market this product was called in for informal meetings and guidelines were established as to how this product could be used in our specialized application. This product (and other similar products) had been used within the Oil and Gas Industry on many occasions, but never in this application. This product is applied to large areas of corrosion / cracking on flanges, rotating shafts and the like. Our application of having to fill very small pitting crevices was very different. The basic method of cleaning the area prior to using this Belzona 1111 was to shot blast the effected area with copper slag to create 35 microns of metal penetration, so that the Belzona 1111 could properly adhere to the ring groove. It was felt that we could not carry out this operation as the shot blasting material could get into the snap-ring profile within the wellhead. (The tubing hanger is locked in place within the confines of the wellhead by the use of a snap ring on the tubing hanger body and a reciprocal groove within the wellhead). We therefore had to make specialized tools (see subsection 2 above).

The Supply Company recommended that we install the Belzona 1111 into the ring groove then allow for time to cure before installing the Production trees. This was felt to be too much of a risk as if the dried Belzona 1111 was not completely smooth and uniform, we would have great difficulty in obtaining a pressure test of the connection. If the pressure test had failed, we would have been in a worse position as we would then have to find a way of removing the Belzona 1111 from the ring groove prior to re-trying the above procedures. We decided to tighten the Production tree to the wellhead whilst the Belzona 1111 was in its liquid state. See figures 1 and 2.

4 During the above discussions, it was felt that we would have a greater chance of success with the repair job by using softer RX-49 gaskets (i.e. less torque required to compress the gasket). We therefore purchased some of these gaskets locally and planned on using them when installing the Production tree. As a back-up to this we also contacted a specialist company in the UK (Walkers) who manufacture special sized ring gaskets. We purchased several of these but ended up not using them as the regular "soft" ring gaskets worked.

4. OFFSHORE OPERATIONS

A suitable time slot was found within the Drilling and Well Servicing schedules to accommodate the wellhead repairs. The first job was to thoroughly clean and degrease the affected ring grooves. See figures 1 and 2.This took about 8 hours to accomplish. One problem that was encountered was that the ring grooves, once cleaned, had to remain completely dry and free from water ingress. This proved problematic as offshore there is continual wash down operations ongoing both on the rig floor and also through out the wellhead platform. We also had to plan the jobs with Production to allow for shutting in adjacent wells during the heavy lifting operations (lowering the Production trees to the wellheads). The actual placement of the Belzona within the ring groove was also a problem as there is only a few millimeters of gap between the adjacent wellhead and the ring groove. The best tool found for this job was the human finger and was used very successfully.

Once the repair job got underway, each wellhead took approximately 2 hours complete. That included re-cleaning the ring grooves, applying the Belzona 1111, lowering the Production trees into position and torquing the stud bolts / nuts to the specified torque. Once the job was complete, we left the wellheads for 8 hours to allow for the curing of the Belzona 1111 before attempting to pressure test the connections.

One problem that was encountered offshore was the fact that the wellheads were very hot which effected the setting time of the Belzona1111. During workshop trials it was noted that the "workable" time for the Belzona was 30 - 45 minutes. In reality the product remained "workable for only 10 minutes. That meant that a great amount of teamwork was required in co-ordinating the job (lowering Production trees through the deck hatch whilst being ready to tighten the stud bolts when the tree was landed and also ensuring that the area remained free of water).

Once the trees were installed, tightened and time allowed for the curing of the Belzona, we pressure tested the connections. All 3 wellheads were successfully pressure tested to 5000 psi.

5. CONCLUSIONS

The combined usage of the Belzona 1111, the soft RX-49 ring gaskets and the hydraulic torque wrench all helped in achieving the desired result of a successful repair to the corroded ring grooves of the wellheads.

More attention needs to be paid to protecting seal surfaces that remain exposed to rain and seawater. Although the surfaces were initially protected using grease, no plan was activated to ensure that the seal surfaces remained protected after the drilling package was removed from the wellhead platform. We have now initiated a program, of cleaning such seal surfaces, spraying liquid Teflon onto the surfaces and allowing it to dry. We then use protective grease, a gasket and a cover plate to ensure complete coverage of the surfaces. Additional checking will be instigated every month to ensure that the protection is still in place and is still effective.

Photographs of BK9-GW during repair.

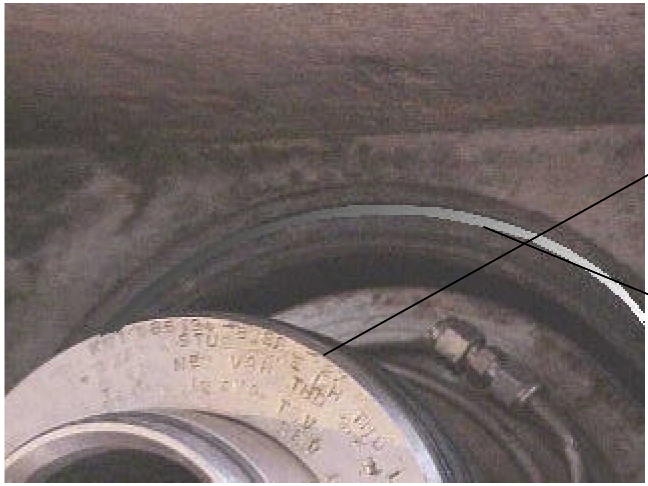
Figure 1

Adjacent Production tree

RX-49 ring grove treated with Belzona 1111.

Due to height restriction and close proximity of adjacent tree, no standard machinery available to clean ring groove.

Figure 2



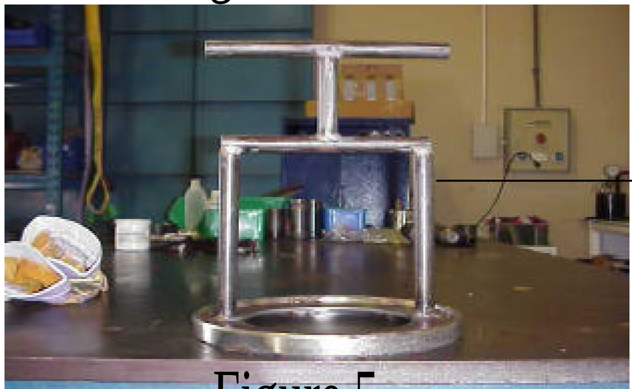
Tubing Hanger neck w/ DA carrier.

RX-49 corroded ring groove cleaned and ready to receive the Belzona 1111.

Figure 3

Hydraulic torque wrench allowed for the exact torque to be applied through the tree / RX-49 gasket and the DA carrier.

Figure 4



RX-49 ring grove cleaning tool. Handle extension added to allow for height of tubing hanger neck.

Figure 5

Tungsten cutter inserted into RX-49 gasket to aid in removal of corrosion in the ring grove.