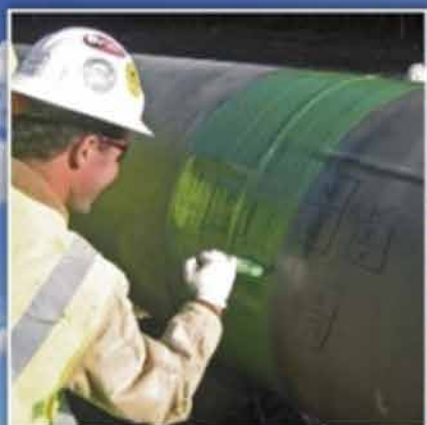


WORLD PIPELINES®

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PATCHWORK

POWER



Olivier Marin, 3X ENGINEERING, Monaco, provides an overview of an online leak sealing solution to deal with emergency pipe repairs.

Pipelines and piping are widely used for the transportation of hydrocarbon fluids from production sites to distribution depots. Leaks in pipelines and piping networks can result in serious ecological disasters, human casualties, and financial loss. Moreover, hydrocarbon releases have a serious impact on the greenhouse effect. With increasing public awareness and concern regarding the environment and more

rigorous regulations, reliable solutions to stop leakages must be available on the market.

Hydrocarbon releases have been closely monitored since the late 1990s, following major accidents. The goal was to determine leak frequencies and size breakdown for oil and gas pipework by gathering and analysing data. HSE hydrocarbon release constitutes a useful database and has been considered suitable for use in



Figure 1. STOPKIT® product installed on an elbow.

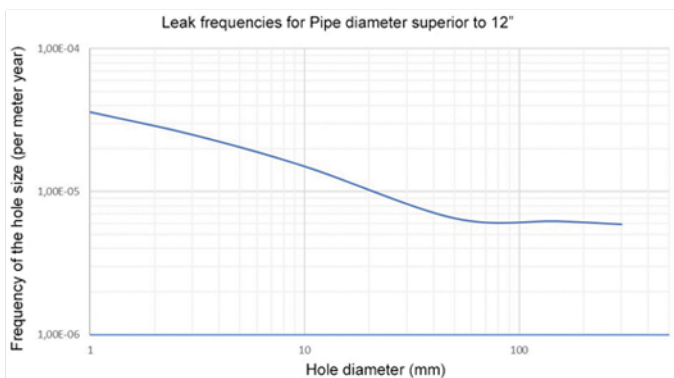


Figure 2. Leak frequency as a function of hole diameter (extrapolated from HSE hydrocarbon database 1992 - 2006).

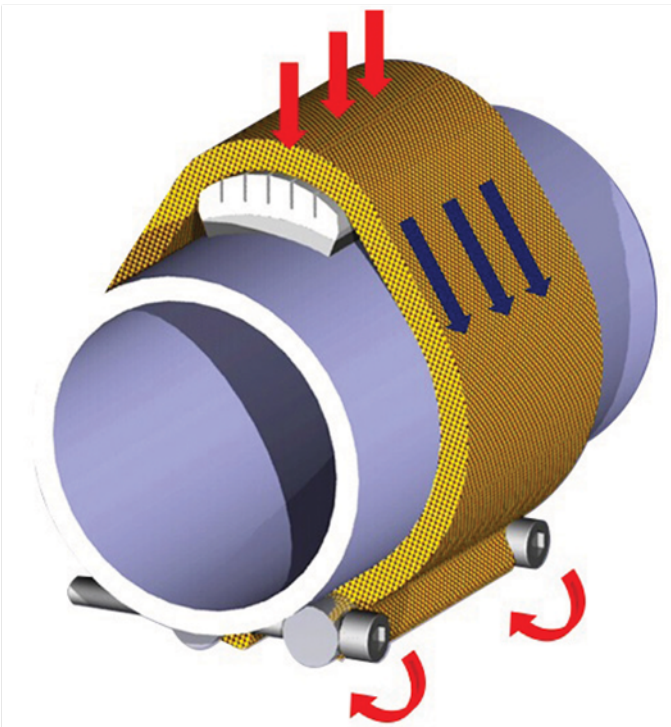


Figure 3. STOPKIT concept – by compressing the patch over the defect, the rubber can seal the leakage.

offshore as well as in onshore. It appears that the likelihood of discovering a small diameter hole is maximum.

To meet this demand, 3X ENGINEERING (3X) developed a product called STOPKIT®, which can be used as an emergency pipe repair system (EPRS). One of the main advantages of this system is its ability to stop leakage online without shutdown (within safety operations) – up to 80 bars (1160 psi) in a limited time of several minutes.

STOPKIT has a track record of more than 10 years, with a reputation established from years of experience.

Principle

STOPKIT is a patented concept, and it is made of a rubber patch and tightening system. By compressing the patch over the leaking defect, the rubber seals the leakage.

Installation

Implementation of the product requires a trained installer. After positioning the STOPKIT next to the leakage, the installer uses a magnetic positioner to target the defect (Figure 7). Next, the STOPKIT is slid over the leakage and kept firmly in position with a second magnetic positioner. The installer just needs to tighten both screws alternatively using a torque wrench until reaching the specified torque (40 Nm if the temperature is less than 40°C, otherwise 30 Nm). In only a few minutes, the active leakage is managed and stopped. The product can remain in position for several months until a long-term solution can be considered.

Many trial tests were required to determine the most suitable design and materials to achieve a high-performance product.

Material selection

The patch is made of rubber material, providing high chemical resistance to most hydrocarbon fluids and gas, as well as a large range of industrial chemicals. The rubber can offer strong shear resistance when compressed over a defect.

As it is not possible to check the belt tension on a daily basis, it is important to select the proper material to avoid belt creeping. By choosing a belt reinforced with aramid material, the strain under constraint is kept to a minimum.

The tightening system, bars and screws, are made of a combination of steels subject to surface treatment, avoiding

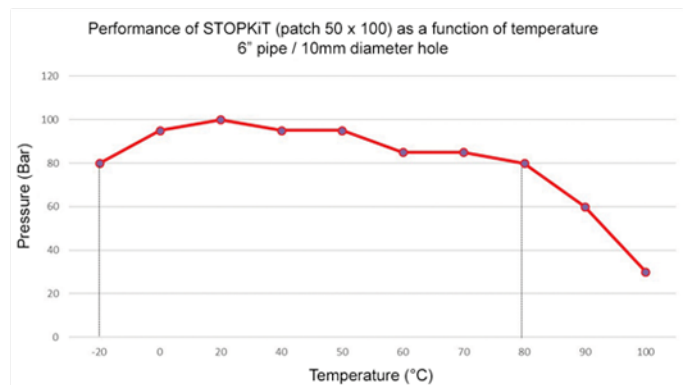


Figure 4. Performance of STOPKIT (patch 50 mm x 100 mm) as a function of temperature – 6 in. pipe/10 mm (0.4 in.) diameter hole.



Figure 5. STOPKIT recovered with 3X filler before wrapping with R4D-HT+.



Figure 6. Reinforcement completed and identity plate installed for traceability.

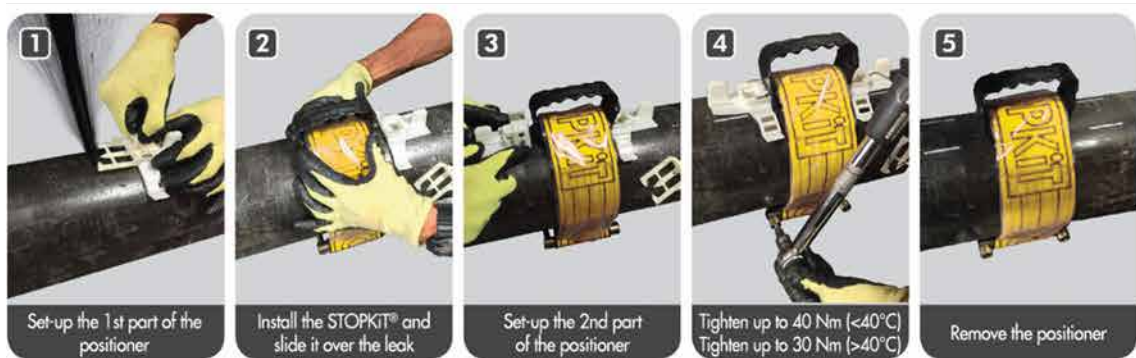


Figure 7. Implementation steps using the STOPKIT positioner device.

the issue of corrosion and strengthening the screws. A subsea version of STOPKIT has also been developed to be suitable for underwater environments.

With its design made mainly of polymeric materials, STOPKIT's weight is limited, generating no overloading when compared with alternative solutions such as metallic clamps.

Geometry

STOPKIT focuses the stress needed to stop the leak at the leaking point. In fact, tightening the screws will induce a tension force in the belt, and this will perform the radial force via the applicator. Then the distributor will increase the pressure locally with the ribs and the containment grooves, as a stress concentrator, on the sealing patch.

Even if the patch geometry seems to be basic, many trial runs were required to achieve the final product design. It was tested successfully on leaks close to welding wire up to 8 mm (0.3 in.) in height. Indeed, the patch should provide leak sealing in versatile conditions, and the flexibility of the system can also allow for applications on pitted surfaces or on bend geometries.

Size of leakage

The most common defect found on the field is a pinhole. However, in some cases, the leakage can be larger than several centimetres. 3X has developed two patches to cover a wide range of diameters.

- Patch 50 mm × 100 mm: This patch is dedicated to hole diameters up to 10 mm (0.4 in.). It can offer high performance with leak sealing up to 80 bars minimum.
- Patch 100 mm × 100 mm: This larger patch is dedicated to larger hole diameters, up to 50 mm (2 in.). However, the pressure that can be handled is 30 bars.

Temperature

Temperature is a key parameter for the behaviour of rubber. At low temperature, when approaching the glass transition of the material, the patch becomes too rigid and cannot closely fit the shape of the defected area. On the other side, at high temperature, the mechanical performance drops. As the patch is highly stressed, mostly shear mode, the rubber can fail. For this reason, the range of temperature

for STOPKIT is set from -20°C to 80°C (-4°F to 176°F).

Good positioning: key to success

When sliding the STOPKIT over the leakage, it is no longer possible to locate the exact position of the defect.

Consequently, the correct positioning is essential to leak sealing success.

To assist the operator, 3X developed a solution based on a magnetic marker, which can maintain the optimal position of the patch during STOPKiT implementation.

Long-term solution

In some cases, the final user wants to secure the STOPKiT as a long-term solution. An example of this can be seen in a recent STOPKiT application in Iraq.

A 12 in. line was subject to external corrosion, leading to leakage. Process shutdown was not an option so only online repairs were considered. Several attempts were performed by a local company to seal the leakage with use of technical polymer, but there was no success.

3X proposed that the leakage should be sealed with STOPKiT online. By choosing the proper STOPKiT to suit the diameter and patch size, the leak was sealed within a few minutes.

The second part of the job was to achieve a long-term repair. Without protection, STOPKiT could be subject to ageing or external damage. As a result, it was decided that a composite repair should be applied over the STOPKiT to secure it.

The composite repair, REINFORCEKIT® 4D (R4D) provided by 3X, was designed as per ASME PCC-2 with a design pressure of 42 bars (610 psi). This composite repair is made of an epoxy matrix reinforced by bidirectional aramid fibres.

After checking the absence of leakage, the surface was prepared with the Bristle Blaster® to reach ST3 cleanliness and a roughness superior to 60 µm (Rz). The surface was then thoroughly cleaned with acetone to degrease and remove residual contaminants. The surface preparation is one of the most critical steps of composite wrapping, allowing good bonding of the polymeric system to the pipe wall.

To allow easier wrapping and encompassing of STOPKiT, the screws are cut by a bolt cutter and the patch handle removed. Filler material was then applied all around the patch to secure the defected area. It was also applied either side of the belt to create a slope and to fill in any remaining cavities.

After filler hardening, the wrapping began using the R4D-HT+ composite system. Kevlar® tape is wet lay-up impregnated and wrapped helicoidally with 50% overlapping. A total of 36 layers with a total repair length of 600 mm were required to restore the pipe integrity.

Conclusion

Keeping oil and gas assets safe is a priority for people and the environment. As leak occurrence is unpredictable, it is essential to have reliable emergency pipe repair systems available to the market. 3X Engineering's patented solution – already applied worldwide for over 10 years – aims to be efficient and provide value. Despite competitors' attempts to copy it, it remains a fast leak sealing solution. 