THE USE OF SEALANTS AS ONE OF THE METHODS OF REPAIRING LEAKS AND DAMAGED PIPE CLOSURES DURING OPERATION

ANTON PANDA, LUKAS ANDROVIC, IVETA PANDOVA

Technical University of Kosice, Department of Automotive and Manufacturing Technologies, Faculty of Manufacturing Technologies with a seat in Presov, Slovak Republic

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e-mail: anton.panda@tuke.sk

Piping systems are exposed to many negative effects during their operation, which often cause the occurrence and development of various erroneous states that significantly affect the safety and the economy of other operations. Therefore, it is important to test the implementation effectivity of technologies that could be suitable to be used to repair these pipes or their components without system operation shutdown as presented in this article.

KEYWORDS

Sealant, pipeline, repair, damage, composite, procedure, material loss, operation,

1 INTRODUCTION

Repairs during operation reduce production costs as a well as costs of lost production, which means lost profits due to technology shutdown [SEPS 2022].

2 OBJECTIVES OF THE PIPELINE OPERATOR

The pipeline, although it looks very simple at the first glance, is basically a relatively complex structure consisting of several components. These components mean not only piping itself, but also welds, flanges, reducers, closures, valves, supports, etc. During operation, these components are exposed to a wide range of negative influences, which are reflected in the overall condition of the pipeline and directly affect the safety and the economy of operation. Not to mention, that the pipeline serves mainly for the transport of products between individual technological plants, which form one complex unit. Therefore, any problem that occurs on the pipeline affects not only the pipeline itself, but especially the actual operation of the technology. [SEPS 2022, Panda 2021, Domanski 2016, Panda 2016, Duplakova 2018, Dyadyura 2017, Dyadyura 2016, Flegner 2019, Flegner 2020, Jurko 2016, Krenicky 2015, Flegner 2020, Macala 2009, Monkova 2013, Panda 2013, Panda 2014, Panda 2017, Panda 2018a, Panda 2018b, Panda 2019, Pandova 2018, Pandova 2012].

The main goal of the pipeline operator is to operate the pipeline safely and especially profitably for a long time. However, during operation, the pipeline and its components are exposed to several negative influences, which result in the occurrence of various types of errors – see Fig. 1 [SEPS 2022].

If during operation any component of the piping system fails, the supply of the transported medium will usually be interrupted. However, failure like this can have far-reaching consequences in the form of a system crash or the need to shut down the technological process, which always results in a company's financial losses [SEPS 2022, Pandova 2018, Panda 2017, Pandová 2012, Murcinkova 2017, Baron 2016, Mrkvica 2012, Zaborowski 2007, Chaus 2018, Vagaska 2017, Vagaska 2021, Straka 2018a, Straka 2018b, Modrak 2019, Michalik 2014, Olejarova 2017, Prislupcak 2014, Valíček 2016, Rimar 2016].

a) cost of operation shutdown including the cost of lost production (leaked profit due to technology shutdown),

b) cost for self-repair and subsequent operation of the entire technology,

c) cost of liquidation of any subsequent damages.

Figure 1. Different types of damage to the pipeline and its components [SEPS 2022]

3 PIPELINE REPAIRS DURING OPERATION

The choice of a suitable method of a pipeline repair or its accessories depends in particular on [SEPS 2022].

a) leaks locations: flange joint, welded joint, straight pipe section, elbow, T-piece, closure body, measuring point connection or other technologies, etc [SEPS 2022].

b) type of damage such as: corrosion, cracking, deformation of the pipeline, leakage on the pipeline, leaking through the closure [SEPS 2022]

c) operating conditions and especially significance of the pipeline in the technological process with regard to the possibility of a possible temporary interruption of the pipeline operation: the repair must be carried out during operation, without stopping the product flow in the pipeline, or it is possible to temporarily shut down the pipeline and temporarily interrupt the flow or delivery of the product flowing in the pipeline [SEPS 2022]

d) basic physical conditions: maximum operating pressure and temperature of the medium in the pipeline during operation, etc [SEPS 2022].

Leaks repairs during operation

When choosing a suitable method or technology for leak repair during operation, it is necessary to assess especially the physical conditions of the product (pressure and temperature) and its chemical composition including the extent of its effect on flammability, explosiveness, toxicity and other factors affecting working safety [SEPS 2022].

Pipe or weld leak repair

Mechanically mounted sleeves and clamps

One of the possible ways to solve the leak repair is to use a divided steel sleeve PLIDCO Split + sleeve (Fig. 2), which closes the leak in a safe way and ensures that the leak does not spread further into the surrounding area [SEPS 2022].

Another type of repair is the use of a sealing clamp PLIDCO Smith+Clamp (Fig. 3), which is used to repair separate spot leaks from the pipeline (Fig. 2), most often in places with pitting corrosion. If the Smith+Clamp sealing clamp for permanent repair is used, the entire area including sealing cone will be covered with a PLIDCO Weld+Cap protective cap after the leak is closed [SEPS 2022].

Figure 2. Pipe leak and split sleeve PLIDCO Split+Sleeve [SEPS 2022]

Figure 3. Pitting corrosion and sealing clamp PLIDCO Smith+Clamp [SEPS 2022]

Fully welded sleeves with an outlet

In case of large diameter pipelines (Fig. 4 and 5), on which the use of split steel sleeves PLIDCO Split+Sleeve would be difficult, we use fully welded split steel sleeves with an outlet. After finishing the work, we insert under pressure into the outlet, which drains the leak, a special threaded plug with the drilling device T. D. Williamson [SEPS 2022].

Figure 2. Water leak through a hole in a pipe [SEPS 2022]

Figure 3. An unsuccessful attempt to stop the water leak by patch [SEPS 2022]

Figure 4. Insertion of the plug after the installation of a sleeve with a leak diversion [SEPS 2022]

Composite bandage

When repairing a leak where there is not an immediate risk to the health of the personnel performing the repair, we use Clock Spring NRI compositional bandage systems to repair the leak [SEPS 2022].

Figure 5. Stopping of the leak using a steel strap with a rubber seal [SEPS 2022]

Pipe repair composite bandages (Fig. 8) use aluminum or glass fibers to reinforce the mechanical properties of the pipe (Fig. 6 and 7). The fibers transmit and absorb the strains (tensions) caused by a pipe fault. Thanks to their flexibility, they are suitable for repairs of broken pipe objects such as branches, elbows, etc. [SEPS 2022].

Figure 6. Composite bandage installation [SEPS 2022]

4 REPAIR OF LEAKS ON FLANGE JOINTS

One of the most important elements of the pipeline are its joints (Fig. 9). Joints could be welded or flanged.

Figure 7. Leaks at flange joints [SEPS 2022]

We use the PLIDCO Flange+Repair Ring (Figs. 10 and 12) to seal the leaks at the flange joints. Repair of leaks on the flange joint is very fast, without the need to drill into the flanges, thanks to which none of the original material is destroyed. At the earliest pipe shut down, just remove the ring, replace the seal on the flange and restart the pipeline [SEPS 2022].

Figure 8. PLIDCO Flange Repair+Ring flange sealing ring [SEPS 2022]

We use PLIDCO Flange Repair Split+Sleeve (Fig. 11), in case of leaks found on circumferential welds of the pipe flange, or in case of damage to the entire flange [SEPS 2022].

Figure 9. PLIDCO Flange Repair Split+Sleeve flange reinforcement sleeve [SEPS 2022]

After installing the ring on the flange joint, using a filling pump, a sealing compound is pressed through the filling valves (Fig. 13) into the intermediate space of the ring and the flange joint, which seals the leakage and prevents the medium from escaping [SEPS 2022].

Figure 10. Flange joint leak stop [SEPS 2022]

Figure 11. Sealer filling pump [SEPS 2022]

Sealants for sealing leaks

We use CHECK SEAL sealants from the American company South Coast Products (SOCO), LP from Houston to seal leaks [SEPS 2022].

Figure 12. CHECK SEAL sealants to seal the leaks [SEPS 2022]

Thanks to their properties, these sealants (Fig. 14) are able to seal leaks of known chemical substances up to a temperature of +815' C and can fully replace the sealants of other manufacturers, such as FURMANITE. SOCO Company is not only a manufacturer of "sealant", but also a provider of compete know-how for correct, high quality and safe sealing of operation leaks [SEPS 2022].

<u>Repair or replacement of damaged closures during operation</u>

Kinds of possible types of leaks and damages to the pipeline closure:

Figure 13. Leak outside the closure [SEPS 2022]

Figure 14. Leak through the closure [SEPS 2022]

Figure 15. Torn off plate of the closure [SEPS 2022]

Figure 16. Torn off closure [SEPS 2022]

Leak outside a closure

In most cases, leaks outside the closure (Fig. 15) can only be solved by replacements. If it is not possible to shut down the pipeline, we use one of the "non-stop" technologies T. D. Williamson (Figs. 19 and 20), or PLIDCO Shear+Plug (Figs. 21 and 22) [SEPS 2022].

Figure 17. Two-position closing operation with STOPPLE Train [SEPS 2022]

Figure 18. Use of bypass in case of a need of continuous supply of product in a pipeline [SEPS 2022]

The T. D. Williamson method makes it possible to carry out pipe line repairs, reconstructions, change of pipeline route, connection of other technology to the main pipe line, but especially replacement of the non-compliant pipe line parts, non-compliant closures, replacement of technological pipeline components, tanks and pressure vessels, as well as other specific activities during the pipeline system operation [SEPS 2022].

If it is necessary to close the pipeline at high temperatures up to 537' C or at high pressure up to 170 bar (17,0 MPa), the PLIDCO Shear+Plug closing device can be used (Figs. 21 and 22). This device is used to close pipes with a diameter from DN20 up to DN450 [SEPS 2022].

Figure 19. Boiler water pipe closure (Boiled Feed Water) DN80 [SEPS 2022]

Figure 20. Steam line closure DN350 [SEPS 2022]

Leak through a closure

Leakage of the product through (Fig. 16) the sealing element of the closure (cone, ball, plate, flap, etc.) can be repaired in principle in two possible ways:

1) by replacing the closure during operation using the same closing device like in the previous chapter (3.1.),
2) by closing the free end and pressing the sealant into it.

In this case (Figs. 23 and 24) we used an assembled pipe coupling (adapter) PLIDCO Weld+End. We closed the adapter at the bottom with a neck with a connection for pressing a sealant into it and slid it on the other side to the end of the pipe with the product leak. After securing the mounting screws and sealing the leak into the environment with the help of pressure screws which expanded the seal and thus sealed the leak, we pressed in the sealer and sealed off the leaking product [SEPS 2022].

Figure 21. Closure leak DN50 [SEPS 2022]

Figure 22. Stopping leakage using PLIDCO Weld+End blanking sleeve [SEPS 2022]

Torn off spindle of the plate closure

If the integrity of the spindle of the closure is compromised due to the physical and chemical factors of the product inside the closure, the spindle often tears off and thus the closure cannot be operated [SEPS 2022].

Figure 23. Torn off spindle of the closure plate in a closed position [SEPS 2022]

Figure 24. Welding the throat on and drilling through it during operation [SEPS 2022]

Figure 25. Pushing the closure plate out of the closed position [SEPS 2022]

In this case (Fig. 25), the spindle tore off, the plate remained in the closed position and it was not possible to open it, causing the flow in the pipeline to be interrupted. On a similar old closure, which was provided to us by the operator for testing, we proposed a method of welding the drill neck to the pipeline during operation. After welding and performing all the necessary flaw detection tests, we proceeded to welding and subsequent drilling modeling of the closure during operation (Fig. 26). After successfully performing all tests in the workshop, we welded a drill neck in the lower part of the closure and drilled an access opening into the body all during operation. After drilling, we then moved away the plate using a rod installed on the shaft of the drill (Fig. 27) and during operation we opened the closure, which cleared the pipeline route, so the operator did not have to shut down a given part of technology [SEPS 2022].

Torn off closure

One of the most problematic repairs is the tearing off the closure in the weld (Fig. 28). Such a problem usually ends with the shutdown of the pipeline and thus the relevant technology. However, this damage (Fig. 17 and 18) can be solved by repairing the pipeline during operation by closing the piping like in the previous chapter (3.1.), or by installing a special sleeve with the neck and exhaust (Figs. 29 and 30). In this case, the repair ended with insertion of a special threaded plug T. D. Williamson during operation (during leaking) and by fitting a threaded protective cap (Fig. 30) [SEPS 2022].

Figure 26. Torn off closure of the steam line in the weld under the flange [SEPS 2022]

Figure 27. Installation of the sleeve with throat and exhaust [SEPS 2022]

Figure 28. Sleeve with a throat after the works finish during operation [SEPS 2022]

5 CONCLUSIONS

Pipes and piping systems are a very important part of every production and operation. They are a very important means of transportation for the transport of liquids and gasses needed to ensure the operation of production and operation. Therefore, any unexpected situation that occurs on the pipeline system with a leak of medium from the pipeline, or a leak in any of the joints, can also cause the entire production process to stop and thus cause financial losses due to unexpected shutdowns.

Therefore, every operator needs to have available technologies that will allow him to react quickly to unexpected operating situations that may occur during the pipeline operation. The very diversity of pipe sizes (pipe diameter, pipe material, wall thickness), their segmentation and the physical and chemical parameters of the medium flowing in the pipe mean that it is not always possible to immediately and unambiguously select a suitable repair technology.

Every repair that requires welding on the pipeline in operation, so under pressure, is always high risk and every such repair must be thoroughly prepared and carried out. This requires a very high level of experience and a highly professional approach in order to ensure that the risk is reduced to a minimum during repair. The technical requirements must be drawn up and applied in such a way as to take into account the current state of science and technology and proven practice (experience) at the time of the repair, as well as the technical and economic considerations during implementation, which must comply with the maximum degree of protection of safety and health.

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CONTACT:
Prof. Eng. Anton Panda, PhD.
Faculty of Manufacturing Technologies with a seat in Presov,
Technical University of Kosice,
Sturova 31, 080 001 Presov, Slovak Republic
e-mail: anton.panda@tuke.sk