A new breed of black powder pigs

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presents new cleaning pig technology for the removal of black powder.

The occurrence of black powder is causing increasing concern in the natural gas industry worldwide. Although it is a relatively new phenomenon, a growing number of pipeline operators are now turning their attention to the problem, because of the substantial effects it has on their pipeline systems. In combination, these effects and the wide range of other difficulties are creating a major challenge for pipeline operators, notably for pigging activities (cleaning and inspection).

Black powder can be found in both dry and wet gas lines and in conjunction with any other contaminants found in gas pipelines, such as water, liquid hydrocarbons, and sand, etc. The powder mainly consists of iron and sulfur, as well as iron oxide in different chemical combinations. Under dry conditions, it can take the form of a very fine powder or solid sediment, whereas under wet conditions it usually appears as a tar-like substance. Black powder not only influences the flow performance of the pipeline, but it can also impair the function of installations such as valves and pipeline measurement systems. Since the performance and efficiency of pipeline inspections can be significantly reduced due to the particular characteristics of the powder, the development of specific cleaning methods for black powder posed an urgent challenge.[1] To meet this challenge ROSEN has developed a new black powder cleaning tool. Figure 1 shows the 48 in. black powder cleaning tool just before launching in a 170 km natural gas pipeline in which the common problem of heavy black powder contamination is present.

The problems of heavy wear

Conventional cleaning methods involving standard cleaning tools showed both low efficiency and heavy wear on the polyurethane of the cleaning equipment used. Even the ROSEN cleaning tools, otherwise well proven for their high wear resistance in long gas pipelines, showed heavy wear in relatively short pipelines containing dry black powder (Figure 2). Under these particular conditions, an increased volume of polyurethane on the cleaning tools cannot remarkably improve the wear resistance of the cleaning tools. The combination of heavy wear and low cleaning efficiency means that a large number of cleaning runs are required, thereby causing both heavy operating efforts and high spare part costs.

Experience has shown that although the use of magnetic inspection tools provides better cleaning efficiency, it is still marked by heavy wear on the tool components. This causes high maintenance and spare part replacement for a tool which was originally built for pipeline inspection rather than cleaning.

Due to the urgency of the problem, other methods have been developed. These include, for example, cleaning procedures such as batch washing or gel pigging. While these procedures are more effective than standard cleaning, they are very laborious and expensive: usually a pig train with up to eight single cleaning tools is required to separate the different fluids, solvents and chemicals. Moreover, the problem of high wear is not only virtually the same as in standard cleaning tools, but the inserted fluids can cause additional problems. For example, water may react with the powder either mechanically or chemically, whereby new components with different characteristics are formed. Finally, all inserted fluids and chemicals must be removed from the pipeline completely by means of a complex procedure.

Figure 1. ROSEN 48 in. black powder cleaning tool before launching.

Figure 2. Cleaning tool after a 50 km run through black powder.

Figure 3. Receiver filled with black powder.

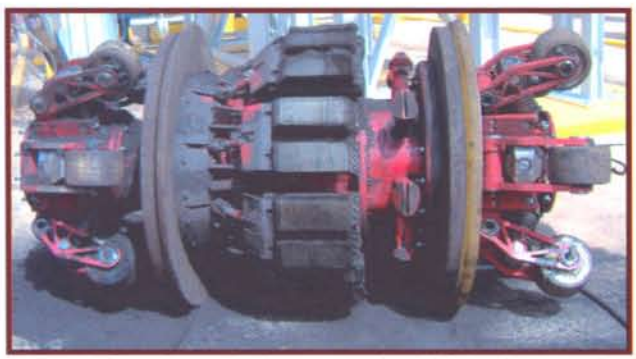

Figure 4. Cleaning tool after more than 170 km in a gas line containing dry black powder.

More cleaning capability

Faced with the new challenge of black powder, ROSEN has developed a new cleaning system which is especially effective in dry gas lines. Combining the advantages of regular cleaning tools with those of magnetic inspection tools, the new technological approach also incorporates a specifically developed bypass system. Carried by support wheels to prevent wear of wall-touching components, the tool is sealed with polyurethane guiding and sealing discs. To improve cleaning capability, the tool is equipped with spring-supported magnetic brushes. All these mechanical components can be adapted to any pipeline properties, thereby optimising cleaning efficiency under a wide range of different conditions.

The central feature of the new concept is a calculated bypass flow running through the middle of the tool. The negative pressure created as a result of the acceleration of the medium permits flow into the bypass, from where it is transported to the downstream area of the tool. It is performed by specially designed channels. The specific dynamic of the tool's flow means that an optimised value of powder particles can be removed from the pipeline wall. Moreover, the bypass flow through the middle of the tool transports additional powder particles.

The highly sophisticated concept, which is the result of more than 20 years of pipeline cleaning and inspection experience, is based on several different components. All these components make a specific contribution to the cleaning process as a whole. The overall characteristics and performance of such complex interlinked processes must be calculated with extended methods of 'Computational Fluid Dynamics'. Thus the brush/magnet system not only ensures surface cleaning, but also the required differential pressure. Furthermore, the actual pressure and flow in the line has to be taken into account to optimise cleaning performance on the one hand, but also to prevent run problems due to excessive bypass on the other. A particular challenge in this context is the passage of full bore tees. On account of the flow around the front disk package, the entire bypass value has to be calculated to allow for this situation. It is imperative, therefore, that all pipeline and run conditions are taken into account to ensure optimal preparation of these particular cleaning tools.

To monitor overall performance and function, each tool is equipped with the ROSEN 'Pipeline Data Logger' (PDL) data acquisition system. The Data Logger measures temperature; absolute and differential pressure; and acceleration in three orthogonal directions with one data triple per second (minimum; maximum; average). To get a maximum of information about the differential pressures, two PDLs are used for each cleaning tool.

On the basis of specifically developed technology, ROSEN has built a 48 in. and a 56 in. tool and recently performed the first runs with both tool sizes.

Conclusion

The runs produced excellent results. Figure 3 shows the dust-filled receiver. In the background, the front of the cleaning tools can be seen. The tool brought out 39 bbls of black powder in the receiver alone. The amount of dust blown through the offtake during the run can only be estimated.

Perhaps even more impressive than its cleaning capacity was the tool's condition after the run: it was so good that it could be launched again without the need to replace any parts. Even the disks only showed minor signs of wear, and all this after a run in more than 170 km of dry black powder (Figure 4).

With this new sophisticated concept (patent pending), ROSEN provides an effective solution for the problem of black powder in gas lines: despite comparably low efforts for pigging, maintenance and spare parts; the tool achieves high cleaning efficiency even in heavily contaminated pipelines.

References

1. BALDWIN, Richard, *The characteristics of black powder in gas pipelines, and how to combat the problem* (http://www.blackpowderforum.org/Baldwin%20paper.pdf).