

Long-distance Pipeline Pigging Technology

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Abstract

Pigging operation is an important task for long distance pipeline before or during normal operation. It can ensure the normal operation of the pipeline and transportation efficiency. To achieve a better pigging effect, it must select reasonable kinds of pigging and pigging technology for different types of pipelines. It analyses the type of pigging and pig cleaning technology for pipeline that should be adopted first in the preparatory work before the pig is moved into the long distance pipeline and analyses the possible trouble during the pigging cleaning process systemically through the long distance pipelines of oil,gas or two-phase flow. The examples that the pig cleaning technology has been applied successfully will provide methods and strategies and references for operation and pigging online of different types of long distance pipelines.

Keywords

long distance pipeline;pig;sphere.

1. Introduction

With the rapid increase of world's demand for energy and the environment problem is becoming more and more seriously. The natural gas obtains more and more widespread application as a clean high-quality energy, its development is also attached importance. every year there are some large diameter pipeline have been put into operation. Underground pipeline transportation has become the fourth artery in today's society. The world's new pipelines is developing at an annual rate of hundreds of thousands of kilometers. The vigorous development of pipeline industry has led to the rapid development of other technologies, such as pigging technology.

In the process of long distance oil and gas transportation, pigging is a very important and also risky job. Regarding for new pipelines, there are a lot of legacy in the process of construction and a lot of water after the hydrostatic testing ,the main purpose of the pigging is clear and the construction of the water in the pipe remains, including welding rod, welding slag, sticks, rocks, soil, sand, lunch boxes, plastic and burr. If these stuff are not clear, will stop up the downstream the filter and valve, damages the compressor. Natural gas usually contains acid gases such as H₂S and CO₂, the presence of water will accelerate the pipeline corrosion. Once the hydrate formate, it will lead to block pipes and equipments, even gas well's off production, pipeline shutdown, and other serious accidents.

2. Pigging

Pipeline pigs and spheres are used for a variety of purpose in both liquids and natural gas pipelines. Mechanical pigs have long been used to clean pipelines and separate different fluids in a pipeline. Today, in addition, sophisticated instrumented pigs are used to monitor pipeline conditions and detect problems that might lead to failure.

Pigs and spheres are forced through the pipeline by the pressure of the flowing fluid. A mechanical pig usually consists of a steel body with rubber or plastic cups attached to seal against the inside of the pipeline and to allow pressure to move the pig along the pipeline. Different type of brushes and scrapers can be attached to the body of the pig for cleaning or to perform other function. Spheres are normally used to separate one fluid from another in pipeline, either during hydrostatic testing of the line or during operation.

Pipeline pigging is done for the following reasons:(1)To periodically remove wax, dirt, and water from the pipeline.(2)To separate products to reduce the amount of interface between different types of crude oil or refined products.(3)To control liquids in a pipeline, including two-phase pipelines, when filling lines for hydrostatic testing, dewatering following hydrostatic testing, and drying and purging operations.(4)To inspect pipelines for defects such as dents, buckles, or corrosion using gauging pigs and electronic or caliper pigs.(5)To apply internal coating to the walls of the pipeline for corrosion protection.

Differential pressure required to move a pig or sphere through the pipeline overcomes the friction of the pig with the inside wall of pipe. The force required depends on elevation changes in the pipeline, friction between the pig and the wall, and the amount of lubrication available in the line. A dry gas pipeline provides less lubrication than a crude oil pipeline, for example.

Cups are designed to seal against the wall by making them 1/16 to 1/18 in larger than the inside diameter of the pipe. As the cups become worn, the amount of blow-by increase because the seal is not as effective. In the case of spheres, the amount of inflation will depend on the purpose of the sphere. Pressure inside the sphere expands it against the inside of the pipe to provide a seal. In two-phase pipelines, sphere are sometimes underinflated to allow some blow-by to lower the density of the ahead of the sphere.

Pigs and sphere travel at about the same velocity as the fluid in the pipeline. In liquid pipelines, the travel speed is relatively constant; in gas pipeline, however, the pig may travel awhile, then stop. Since the force required to start the pig is greater than the force required to sustain travel, a pig will continue traveling at a lower differential pressure than that needed to start it moving. Typically, a pig will stop at a circumferential weld in the pipeline.

3. Pigging Method and Choice

3.1 Waxy Crude Oil Pipeline

After waxy crude pipeline running a certain period, the oil-wax will deposit on pipe wall. When the wax layer reaches a certain thickness, the pig is needed to reduce the operation cost of the pipeline, increase the throughput of pipeline. When the paraffin is carried out on the pipeline pigging, we should choose soft pig and mechanical pig.

When Pigging, first put the soft pig in order to know the status of the tube, after confirm there is no abnormal problem in the pipeline, and then use the mechanical pig. Mechanical pig not only can clean the pipe and can use its closed circular 360 brush to remove pipe wall wax and corrosion rust.

3.2 Gas Pipeline

Natural gas usually contains H₂S and CO₂ gases, it's easy to form hydrate, creates the jamming of pipelines and equipment. On the production operation of gas pipeline pigging via traditional pig, such as the cup pig; for the transport of moisture, the main task is to remove the water in the pipeline, choose better seal for straight pig; for pipe out of the field or basement, pipe contains light hydrocarbon liquids, choose straight pig to move them.

3.3 Oil-Gas Pipeline

The prominent problems in the operation of the two phase flow pipeline is effusion and internal corrosion in the pipeline, liquid accumulation in the low point of the pipeline, the pressure-drop will rising, pipe flow area decrease, so the efficiency will decline. Two phase flow in the pipeline pigging is mainly affected by the following factors: the ratio of gas and liquid; Gas-liquid mixture allowed pressure-drop and flow velocity in pipe; the profile shape of pipeline; In the pipeline system at sea, a the height between the liquid slug catcher at the bottom, the size of the liquid slug catcher.

Widely used in two phase flow pipeline pigging is to use normal sphere and pig.

4. Classification of Pig

The design of the Pig handling trolley is mainly about two kinds of common-used Pigs in the field, the pigging ball and spindle Pig. Because they are the 2 Pigs that cause the biggest manpower waste in service. Pigging ball has been used for many years for sealing. There are four basic types of pigging balls: hollow Pigging balls, solid Pigging balls, foam Pigging balls and soluble Pigging balls. Soluble pigging balls generally contain microcrystalline wax and amorphous polyurethane as its wax-proofing agent and are mainly used in crude oil pipelines. Soluble Pig usually melts within a few hours, but its dissolution rate is relevant to the temperature, motion, friction and the absorption ability of the crude oil. If the pipelines have never been cleaned before, it's better to use the soluble pig to clean them. Because even the ball was stuck, the soluble Pig would not stop the flow of crude oil. Pigging balls are usually used to clear water in the gas pipelines, remove the water in the product oil pipelines, separate different types of product oil, remove the wax in crude oil pipelines, test hydrostatic and sweep water after pipelines construction or reconstruction. Pigging balls were often used in China in 1960s and 1970s. Now it's not used except to clear the accumulated water in the gas pipelines, because their clear scale effect is not ideal. Spindle pigs' common feature is that there is a spindle in the middle. On the spindle, a variety of assistant parts can be installed to accomplish various needs. Usually two rubber bowls are installed at both ends of the spindle Pig, and in the middle a scraper or a steel brush is installed to remove wax or dirt on the wall of pipelines. According to the structural characteristics of pipelines to be cleaned, a spindle pig could be a single part or linked by several Pigs with a hinge structure. Usually the spindle pig has only one part, but if a lot of equipments need to be carried, it would be very long, thus you can link several parts to pass through the elbow of pipelines

5. Launching and receiving

Equipment is required to introduce the pig into the pipeline and retrieve the pig at the end of the segment being pigged. A launcher is required at the upstream of the section and a receiver at the downstream end. The distance between these pig "traps" depends on the service, location of pump or compressor stations, operating procedures, and the material used in the pig.

The amount of lubrication is a key factor in determining the distance between launching and receiving facilities. In gas transmission service, the maximum distance between traps has been recommended as 100 mi for sphere, in crude oil pipeline systems, the recommended distance between traps is 300 mi for pigs and 500 mi for spheres. These distance represent extremes; the proper distance depends on the amount of sand, wax, and other material that will be carried along with the pig.

The design of pig launchers, pig traps, and related equipment is done in accordance with standards developed by several organizations, Traps for brush pigs, squeegees, and foam pigs include a barrel, short pup joint, a trap valve, a side valve, and a bypass line (Fig1). The barrel holds the pig for loading and unloading and is equipped with a quick-opening closure or blind flange. A barrel diameter 2 in large than the diameter of the pipeline served has been recommended. In large-diameter gas pipelines, the barrel diameter can be 1 in large than the pipeline. Barrel length depends on operating procedures, service, and available space.

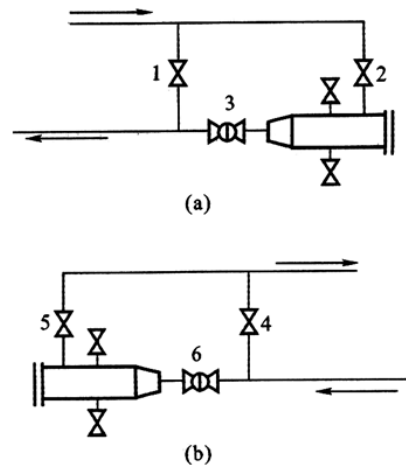


Fig.2 Pig launcher and receiver process

Sphere launchers often must be designed for launching multiple sphere, so the barrels for sphere launchers are typically longer than those for other types of pigs. The operator can load these “magazines” with several spheres that can be launched automatically. This approach is often used in two-phase pipelines. The sphere launcher consists of barrel, a launching mechanism, an isolation valve, an equalizer valve, and a reducing tee. A drain can serve as an equalizing line. Diameter of the launching and receiving barrels for sphere is typically 2 in larger than the pipeline, and they can hold up to 10 or more sphere.

Combination pig and sphere launchers can also be designed if both cleaning pigs and spheres for liquid control are needed.

6. The development trend of technology of pig

The pig run in the pipe may be due to different reasons failure or blocked, such as: pig card in the elbow, removal of heavy sediments accumulated in front of the pig, push the fluid flow around the pig, pig bend deformation, sealing falling drop caused by the wear and tear, and so on. Pig block the pipe flow decline, and even lead to the entire pipeline blockage, have serious consequences. Therefore, completely solve the blocking problem of the pipe cleaner is very important.

Pigging operation speed determines the pigging operation time and the effect of pipe cleaning, pressure drop and depends on both ends of the pipe cleaner. Therefore, in pigging operation, reduce the pigging resistance and achieved good cleaning and sealing effect, is to improve the efficiency of the important content of pipe cleaning.

To reduce the pipe cleaner material running in wear for the purpose, the selection of appropriate pigging material or research and development of new materials, is an important topic in the field of pigging technology. Pig foam and gel pipe cleaner is relatively not easy to block, but the poor wear resistance of foam materials, gel for running adhered to the pipe wall and the gradual loss of.

Good operation security of pipeline is the final purpose of pigging, detection and repair of the integrated operation of pigging operations has practical value for engineering, study of the realization of real-time monitoring and repair pipe cleaning device is necessary.

With the pigging technology development, for different pipe and pipe cleaning purpose pigging species continued to increase, but no matter what kind of pigging, lack the tools to predict and judge the reliable operation pipe cleaning in the pipeline, in most cases is based on field experience judgment. Therefore, the theoretical system of scientific model to describe the pigging operation, and provide the scientific basis for the selection of pipe cleaners, is also a pipe cleaner is one of the important directions of development.

7. Summary

This paper mainly introduces the pipe technology of long-distance pipeline, respectively from the effect of pig, pig's classification, and the choice of different types of pipeline pig is presented, finally elaborated the research trend of pig, and describes how to strengthen the effect of pig.

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