

The Art of Pigging



Introduction

The purpose of this paper is to further the knowledge of pigging and review the various pig designs available. We will discuss the reasons for pigging and the various types of pigs available to accomplish our pigging objectives. For many years on stream pigging was considered a necessary evil. After construction cleaning and testing, most companies would not pig on a regular basis. As the years passed and the capacities of the lines increased, the efficiency of the lines decreased. The decrease in efficiency relates to increased power costs, so the lines were pigged to increase the efficiency.

As pipelines get older we see increased corrosion. This is caused by lack of operational pigging, whether it is because of water accumulation in the line causing MIC, paraffin accumulation on the walls, or other reasons. So, we begin pigging the line to clean it or batch inhibitors, etc.

What is a pig?

A pig is defined as "A device that moves through the inside of a pipeline for the purpose of cleaning, separating, dimensioning, or inspecting." This definition covers more than 500 different designs and types of pigs. In this paper we will discuss many of the various designs. A pig is primarily composed of polyurethane due to its good wear characteristics, temperature tolerance and chemical compatibility. Other rubber compound including neoprene, nitrile, EPDM and viton are used for applications involving higher temperatures or chemical compatibility issues.

Why Pig a Pipeline?

There are various reasons to pig a pipeline. After the pipeline is built, it will be necessary to run pigs to remove any debris left in the line from new construction; examples of items that have been removed include lunch boxes, tools, welding rods, dead animals trapped in the line, etc. Pigging will also remove mill scale or welding icicles in the line. The owner may also require a pig to verify the ovality of the pipeline. This will require a gauging pig and sometimes a geometry pig.

After the pipeline has been cleaned, the next phase is acceptance testing where pigs are used for filling the line with water for hydrostatic testing, de-watering (removing the water after testing), and drying. If it is a liquid line, a pig is used to fill the line with a product during the commissioning and startup of the line.

When the pipeline is in service, it will be necessary to pig the line to maintain line efficiency and aid in the control of corrosion. It is necessary to remove the liquids in wet gas systems, remove accumulated water in product pipelines, and paraffin removal and control in crude oil pipelines. Pigs are also used to batch inhibitors. Typically when the pipeline is decommissioned there is also a required cleaning so that it will be in a useable state if ever it is required to return to service.

As time passes special cleaning applications may arise. Pre-Inspection pigging before running an ILI (In Line Inspection) tool will not only require the pipe be clean but a proving pig be run to assure the ILI tool will go through the line. Under certain conditions pipelines may require chemical cleaning or a train of gel pigs may be used for certain cleaning conditions.

Other applications include running a Geometry Pig to determine if there are any dents or buckles in the line. To determine the amount of corrosion or metal loss in the pipeline, an ILI (In Line Inspection) tool is used. Pipelines that handle multiple products such as various grades of gasoline, heating oils, and jet fuels, often use a pig or sphere to separate these products. Pigs are often run to remove any water that has accumulated in the low spots of the pipeline and reduce corrosion.

Types of Pigs

Pigs can be divided into three general categories: the conventional or utility pig for "on stream" or

routine pigging, the geometry pigs for inspection, and the ILI (In Line Inspection) tools for metal loss and corrosion. This presentation is intended to discuss conventional or utility pigs.

Conventional or utility pigs can be divided into six categories:

Cleaning Pigs are used to remove accumulated solids and debris from the walls of the pipeline. This increases the efficiency and lowers the operating cost. Cleaning pigs are also used in conjunction with chemical treating of the lines to disturb the corrosion sites and remove water, microbes, corrosion products, and food for microbes. Brushes can be added to cleaning pigs for more aggressive cleaning against harder build-up on the pipe wall

Sealing/Displacement Pigs are used to remove or displace liquids in a pipeline. Applications include the testing and commissioning phase of the pipeline, i.e., hydrostatic testing, line fills and de-watering, removing condensate and water in wet gas systems, and during line evacuation and abandonment.

Batching Pigs are used to separate dissimilar fluids such as various grades of gasoline, heating oils, etc., in multiple product pipelines. These pigs are unidirectional if they have scraper cups and bidirectional if equipped with discs.

Gauging Pigs are used after constructing the pipeline to determine if there are any obstructions in the pipeline. It assures that the ovality of the line is within accepted tolerance. The gauging plate may be mounted on the pig and is made of aluminum which may be slotted or solid. The outside diameter of the plate is most commonly in the range of 90-95% of the pipe's inside diameter.

Tracking Pigs are designed to hold a transmitter which will be used to locate a pig in the event it becomes stuck or lost in the pipeline. The transmitter will emit a signal so it can be located with a receiver. After the pig is located, the line can be dug up and the pig removed. Transmitters will normally mount into a mandrel, solid cast, or Polly-Pig.

Specialty Pigs are pigs that designed to handle situations that are beyond the capabilities of standard pigs. These pigs might be called upon to run through a specific pipeline design, negotiate multiple pipeline diameters in a single pipeline, handle extreme temperatures, perform is aggressive chemicals, or perform some other non-standard pigging application. Manufacturers in the pigging industry have made special pigs for many applications.

The Full Product Range

There are four different styles of pigs that make up the full product range. They are Polly-Pigs (foam), Mandrel, Solid Cast, and Spheres.

Polly-Pigs (Foam)

Foam pigs, better known as [Polly-Pigs](#), are manufactured from open cell polyurethane foam. The foam is of various densities ranging from light density (2 lbs./ft³), medium density (5-8 lbs./ft³), to

heavy density (9-10 lbs./ft³). Although normally found in a bullet shape, they can have concave ends or flat ends. The Polly-Pig can be bare foam or coated with a 90-durometer polyurethane material. The coated pigs may have a spiral coating of polyurethane, various brush materials or silicon carbide coating. If the pig is of bare foam, it will have the base coated. The standard Polly-Pig length is typically twice the diameter but may vary depending on the specific pig. Some advantages of Polly-Pigs are that they are compressible, expandable, light weight, and flexible. Polly-pigs will travel through multiple diameter pipelines, go around mitered bends, and short radius 90-degree bends. They will make abrupt turns in tees so laterals can be cleaned. They will also go through valves with as little as 65% opening.

The disadvantages of Polly-Pigs are that they are a single use product, shorter length of runs, and high concentrations of some acids will shorten life.

Polly-pigs are used for line proving (proving a pig will pass through the line), drying and wiping, removal of thick soft deposits, condensate removal in wet gas pipelines and pigging multiple diameter lines. Polly-pigs coated with a wire brush or silicon carbide are used for scraping and mild abrasion of the pipeline.

Mandrel (Steel Shaft) Pigs

[Mandrel Pigs](#) have a metal body (steel or aluminum) and are equipped with polyurethane wear components such as cups or discs that provide the differential pressure to propel the pig in the pipeline. For cleaning the line, the pig is equipped with wire brushes or polyurethane blades.

One advantage of the mandrel pig is that it can be either a cleaning pig, sealing pig or a combination of both. The seals and brushes can be replaced to make the pig reusable. Cleaning pigs are designed for heavy scraping and can be equipped with wire brushes. The unique characteristic of Mandrel Pigs is that the brushes are mounted on springs which push the brushes against the pipe wall. As the wire brushes wear, the force of the spring keeps it in contact with the pipe wall compensating for the brush wear. There are many different brush materials available. Bypass holes are designed into the nose of the pig to control fluid by-pass which can reduce the speed or act as jet ports to keep debris suspended in front of the pig.

There are also disadvantages to the mandrel pig; the cost of redressing the pig is high, and larger pigs require special handling equipment to load and unload the pig. Occasionally the wire brush bristles will break off and get into instrumentation and other unwanted places. Smaller size mandrel pigs will not negotiate 1.5D bends.

Solid Cast Pigs

Solid cast pigs, referred to as our [Turbo Pigs](#), are of various designs and are usually made of polyurethane; however, neoprene, nitrile, Viton, and other rubber elastomers are available in smaller size pigs. They are considered sealing pigs although some solid cast pigs are available with wrap around brushes and can be used for cleaning purposes. The solid cast pig is available in the cup, disc, or a combination cup / disc design in sizes up to 36". Most of the pigs are of one-piece construction but several manufacturers have all urethane pigs with replaceable sealing elements.

One of the reasons companies use solid cast pigs is to avoid the costs associated with mandrel pigs which include the material, labor and transportation costs to redress a mandrel pig. Solid cast pigs are extremely effective in removing liquids from product pipelines, removing condensate and water from wet gas systems, and controlling paraffin build-up in crude oil systems.

Spheres

[Spheres](#) have been used for many years as a sealing pig. There are four basic types of spheres: inflatable, solid, foam, & soluble. The soluble sphere is usually used in crude oil pipelines and contains a micro crystalline wax and amorphous polyethylene which act as a paraffin inhibitor. Although the sphere will normally dissolve in a few hours, the dissolving rate is a function of fluid temperature, fluid movement, friction, and absorbability of the crude. If the line has never been pigged, it is a good idea to run the soluble pig. If it hangs up in the line, it will not obstruct the flow.

The inflatable sphere is manufactured of various elastomers (polyurethane, neoprene, nitrile, and viton) depending on the application. It has a hollow center with filling valves which are used to inflate the sphere with liquid. Spheres are filled with water, or water and glycol and inflated to the desired size. Spheres should never be inflated with air. Depending on the application and material, the sphere is inflated 1%-2% over the pipe inside diameter. As the sphere wears from service, it is resized, extending its life. In small sizes the sphere can be manufactured solid, eliminating the need to inflate it. The solid sphere does not have the life of an inflatable sphere because it cannot be resized.



Spheres can also be manufactured from open cell polyurethane foam. They can be coated with a polyurethane material to give better wear. For cleaning purposes, they can have wire brushes on the surface. The advantages of the foam sphere are that they are light weight, economical, and do not need to be inflated.

Spheres in general are easy to handle, will negotiate short radius 90's, irregular turns and bends. They will go from smaller lateral lines to larger main lines and are easier to automate than other styles of pigs.

Spheres are commonly used to remove liquids from wet gas systems, water from product pipelines, batching dissimilar products, meter prover service, paraffin control in crude oil pipelines, and hydrostatic testing and de-watering after pipeline rehabilitation or new construction.

Special design considerations for the pipeline should be considered when using spheres. They should never be run in lines that do not have special flow tees installed.

Conclusion

The need for pigging will be required so long as pipelines are used to transfer products. While many still believe pigs to be a necessary evil, the understanding of their importance as it relates to productivity and safety is becoming more common place. This is a welcome change as we depend upon pigs to extend the life of our aging infrastructure as well as overcome new obstacles in today's pipeline design.