

## The Art of Pigging



### Introduction

The purpose of this paper is to further the knowledge of pigging and review the various pig designs available to do it. 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, dimensioning, or inspecting." This definition covers in excess of 500 different designs and types of pigs. In this paper we will discuss many of the various designs.

### Why Pig a Pipeline?

There are various reasons to pig a pipe-line. After the pipeline is built, it will be necessary to run pigs to remove any debris left in the line from new construction; items such as 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 start up 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.

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 dummy 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. Lines are sometimes abandoned and require cleaning before moth balling the line.

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. The running of pigs in dual diameter lines always poses a challenge.

## 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 two categories: Cleaning and Sealing pigs.

**A. Cleaning pigs** are used to remove accumulated solids and debris from the walls of the pipeline. This is normally paraffin in crude oil pipelines. When inhibitors are used in a gas pipeline, the solvents in the inhibitors evaporate, forming a gunk on the pipe walls which can be removed by cleaning pigs. 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. Cleaning pigs are normally equipped with brushes or blades to do the cleaning.

**B. Sealing pigs** are used during hydrostatic testing of pipelines to fill the line with water and then de-water the line. Removing condensate and water in wet gas systems, water from product pipelines or separating dissimilar products in a products pipeline, are other applications. Sealing pigs can be spheres, solid cast polyurethane pigs, or mandrel type pigs with sealing cups or discs.

These categories can be further broken down into four different types of pigs. 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/ft<sup>3</sup>), medium density (5-8 lbs/ft<sup>3</sup>), to heavy density (9-10 lbs/ft<sup>3</sup>). Although normally found in a bullet shape, they can have concave ends,

flat ends, or bullet noses on both 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 twice the diameter. 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. Polly-pigs are also inexpensive.

The disadvantages of Polly-Pigs are that they are a one time 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 seals (scraper cups or discs) to 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 or polyurethane blades. These pigs are designed for long runs. Bypass holes in the nose of the pig control 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.

## Cleaning Pigs

Cleaning pigs are designed to remove solids or accumulated debris in the pipeline. This increases the efficiency and lowers the operating cost. They have wire brushes to scrape the walls of the pipe to remove the solids. Pigs 14" and smaller normally use rotary wire wheel brushes. These brushes are easy to replace and inexpensive. Special rotary brushes are used on some larger pigs. Larger pigs have wear compensating brushes.

These brushes can be individually replaced as needed and are mounted on either leaf springs, cantilever springs, or coil springs. The springs 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. The standard brushes are made of fine or coarse carbon steel wire. For pipe lines with internal coatings, Prostran is the material of choice. Some

service requires a stainless steel brush. Special brush designs such as the pit cleaning brush are also available.

When soft deposits of paraffin, mud, etc., need to be removed, the urethane blade is an excellent choice. The blade design is interchangeable with the brushes.

Bypass ports are installed in the nose of the pig or on the body. These ports are used to control fluid bypass. If the ports are on the body of the pig, the flow will also flow through the brushes and keep them clean. As the fluid passes through the ports on the nose of the pig, it helps keep the debris in front of the pig stirred up and moving. Plugs are used to regulate the bypass.

The sealing elements are either elastomer cups or discs. They are used as a combination cleaning and sealing element to remove soft deposits. Cups are of standard or conical design. Specialty cups are available for some applications. The cup and disc material is normally manufactured from a polyurethane material which gives outstanding abrasion and tear resistance but is limited in temperature range. Neoprene, nitrile, EPDM, and Viton are available for higher temperature applications.

### **Batching Pigs**

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.

### **Displacement Pigs**

Displacement pigs displace one fluid with another. They can be bidirectional or unidirectional in design. They are used in the testing and commissioning phase of the pipeline, i.e., hydrostatic testing, line fills and de-watering, etc. Line evacuation and abandonment is another application for the displacement pig.

### **Gauging Pigs**

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 front or rear of the pig and is made of a mild steel or aluminum. The plate may be slotted or solid. The outside diameter of the plate is 90-95% of the pipe's inside diameter.

### **Profile Pig**

A profile pig is a gauging pig with multiple gauging plates, usually three plates. One plate is mounted on the front, one in the middle, and one on the rear of the pig. It is normally used before running an ILI (In Line Inspection) tool to assure the tool's passage around bends and through the pipeline.

### **Dual Diameter Pigs**

There are many miles of dual diameter pipelines crossing the country side. The lines are normally two pipe sizes different, i.e., 4" x 6", 8" x 10", etc. The mandrel pig is usually fitted with solid discs for the smaller line and slotted discs for the larger line. If it's a cleaning pig, the brushes will support it in the line and keep the pig centered. The Polly-Pig is also widely used in this application.

### Transmitter Pigs

Occasionally pigs will get stuck in a line. The location of the stuck pig can be found by using a [detector pig](#) with a transmitter in its body. 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

Many applications require special pigs. Manufacturers in the pigging industry have made special pigs for many applications. A pinwheel pig which uses steel pins with hardened tips was developed to remove wax and scale from a pipeline. A magnetic cleaning pig was developed to pick up ferrous debris left in the pipeline.

### Solid Cast Pigs

Solid cast 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. Most of the pigs are of one piece construction but several manufacturers have all urethane pigs with replaceable sealing elements.

Because of the cost to redress a mandrel pig, (material and labor), and to transport them, many companies use the solid cast pig up through 14" or 16". Some solid cast designs are available in sizes up to 36".

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.