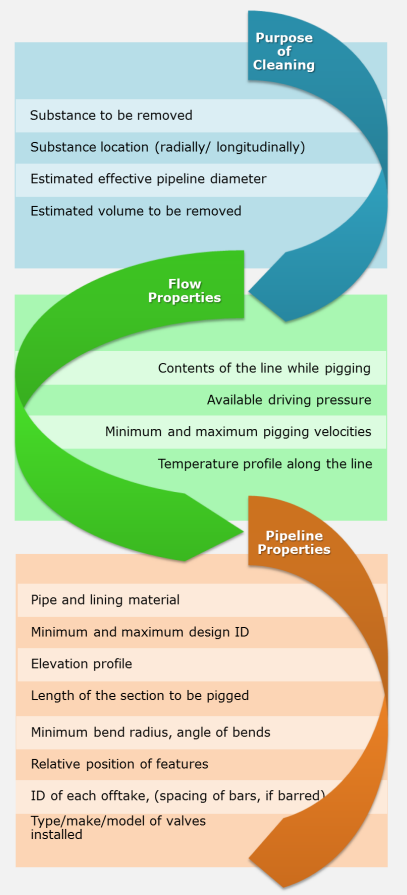**KEEPER**

is published for the benefit of our friends and clients. If you have any questions about this article please contact us at 281-398-5781
info@gateinc.com

Table 1: Factors to be Considered Prior to Pig Selection

Purpose of Cleaning
- Substance to be removed
- Substance location (radially/ longitudinally)
- Estimated effective pipeline diameter
- Estimated volume to be removed

Flow Properties
- Contents of the line while pigging
- Available driving pressure
- Minimum and maximum pigging velocities
- Temperature profile along the line

Pipeline Properties
- Pipe and lining material
- Minimum and maximum design ID
- Elevation profile
- Length of the section to be pigged
- Minimum bend radius, angle of bends
- Relative position of features
- ID of each offtake, (spacing of bars, if barred)
- Type/make/model of valves installed

Pipeline Pigging Part 1: Cleaning Pigs & Pigging Strategy

Build-up of deposits can create conditions for accelerated localized corrosion, which may be caused by under-deposit corrosion, localized acidic conditions and/or bacterial attack (microbiologically induced corrosion - MIC). This may result in sections of the pipeline needing repair or replacement before the end of their anticipated design life. Deposits will also impact throughput due to the reduction in the effective pipe diameter, which may require up to 140% increase in pressure in the line to maintain flow (Titratsoo [1]).

This paper is the first part of a two part series and presents an overview of pig selection criteria for cleaning and maintenance of the pipelines, and covers high level guidance on establishing a progressive pigging strategy.

Pig Selection

Pigs are tools traveling through the pipe, which are driven by the pressure differential across the pig. Several factors can affect the seal between the pig and pipewall; in addition, fluids accumulated in the flow will also be effective in pig selection. Some of these factors are presented in Table 1.

There are many different pig designs available which can be grouped under two main categories- utility and in-line inspection (ILI) pigs. Cleaning and sealing pigs fall under utility pigs. Cleaning pigs are mainly used to remove accumulated solids and debris, whereas the sealing pigs are utilized mostly to remove accumulated liquids, separate dissimilar fluids, dewatering, etc. Selection of the correct pig type for a given application is also dependent on features such as pig material, length, sealing discs, driving cups, guiding discs and additional tools attached such as blades and brushes. As a rule of thumb, guidance regarding the sizing of these features can be summarized as follows:

- **Length** – Overall pig length should generally be 1.5 – 2 times the pipe's nominal size. With a length of less than 1.5 times the nominal size, the pig may roll in the pipeline. Spacing between the extreme pig supports should therefore be no less than 1.1 times the pipe diameter. The maximum allowable pig length is a function of the minimum pipe bend radius encountered.

- **Sealing discs** – These are normally sized between 103% and 108 % of the pipe internal diameter. Where the pipe internal diameter varies, discs are 103% of the largest internal diameter as long as the disc is no more than 110% of the smaller internal diameter. If this criterion cannot be met, either thin, more flexible discs, or split cups will be required.

- **Driving cups** – Minimum size is approximately 102% of pipe internal diameter. Maximum interference is determined by the size of the cup shoulder.

- **Guiding discs** – Size is normally 99% of pipe internal diameter. When the internal diameter varies significantly, the guiding disc is segmented.

- **Gauge plates** – These are normally sized to 95% of pipe's internal diameter.

- **Brushes** – Circular and spring-mounted brushes are sized to 103% of pipe internal diameter.

Pigging Strategy

The methodology chosen for a specific line is a function of the time allocated for cleaning it, the degree of line cleaning that is required (i.e. how much deposit it is acceptable to leave in the line), operational restrictions, line condition, and how much risk will be present in the event that the pig blocks the line. It is usually recommended to carry out a progressive pigging program which can be defined as the process of running a series of pigs that are progressively harder and/or larger (increased aggressiveness) in order to remove deposits partially during each run. Although this approach may take longer period of time, it reduces the risk of a stuck pig.
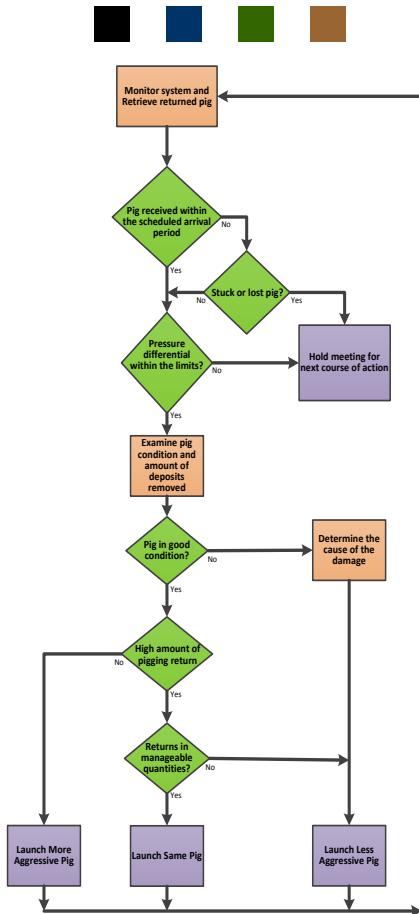
Depending on the line conditions, operational limits, line and pig geometries and the types of pigs considered, a decision tree providing guidance to the progressive pigging operations should be defined as illustrated in Figure 1. During a typical progressive program, the next pig to be run will be determined from the results of the previous run; therefore, planning should include the number of spare pigs in each pig category. If large quantities of deposits are collected or if a large pressure drop in the line is recorded, then a similar pig should be sent though the line again. If there are low amounts of recovered deposits and pressure drops are relatively unaffected by the pig run, then a more aggressive pig can be considered for the next run.

Figure 2: Change in Differential Pressure vs. Flowrate (Long-Term Data Monitoring)

Obviously, it is significantly important to identify the flow conditions prior to the commencement of the program to minimize the risks associated with any type of pigging activity. A flow test is recommended, which confirms that there is communication of fluids from one end of the pigged section to the other. It can also help identify if all the equipment is correctly configured and can indicate the amount of deposits or restrictions present. Where there is a possibility that significant deposits are present in the line, the first pig that is sent through should be a very soft (1-2 lb/ft^3) foam pig, which is designed to pass through restrictions and break up if the restriction becomes too great or the deposits too heavy.

Information Collected

The information collected during each run should include the following:

- Type of the pig, date and time of the pig launch and receipt.
- Deposits Removed: Type and quantity with photographs for future reference.
- Pig Condition: All types of damage from visual inspection with photographs for future reference.
- Pressure and Flowrate Profiles: Can indicate amount of deposits and the main build-up locations.

The data collected during the cleaning or maintenance pigging and the pig return analysis can be used to further improve the future operating and pigging strategies.

As we highlight the significance of monitoring and reporting, Figure 2 and 3 illustrate the change in the differential pressure in the line with respect to flowrate. This can be used to measure the effectiveness of the cleaning program, improve the maintenance pigging frequency based on the pressure buildup over time, improve the chemical injection strategy, or to establish baseline cleanliness for a given pipe.

Figure 3: Change in Differential Pressure vs. Flowrate (With & Without Chemical Injection)

There is no industry standard to define the cleanliness level of a pipe. This brings a particular challenge into play, especially if the purpose of the cleaning is to run an inspection tool (also termed as intelligent pig). There is, however, a required level of cleanliness associated with the limits of the tool utilized. Available technology, applications and limitations for various ILI tools will be covered in Part 2 of the Pipeline Pigging series.
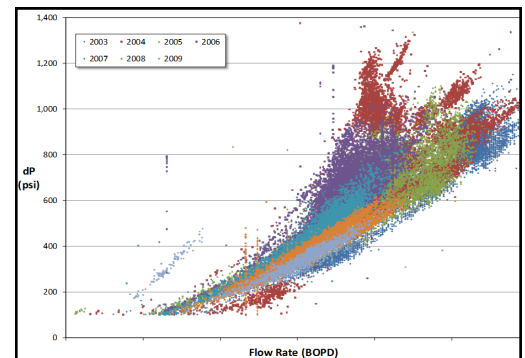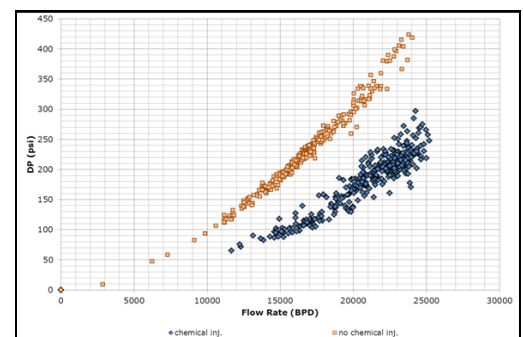

Figure 1: Progressive Pigging Decision Tree Example

Reference

1. Titratsoo, J., *Pipeline Pigging & Integrity Technology, 3rd Edition. Houston, TX. 2003.*

Upstream engineering for offshore oil and gas specializing in:
- Chemical Systems Engineering
- Materials & Corrosion
- Flow Assurance
- Waterflood
- Commissioning & Startup

Gibson Applied Technology and Engineering, Inc.   **www.gateinc.com**