PIPENET® Application Bulletin – Pipelines, Transient Module Case Study

MODELLING A PIG RECEIVER

BACKGROUND

This project was for the purposes of designing a pig receiver, a small network whose purpose it is to catch a pig. A pig is a solid object, often of rubber or plastic sent through a pipeline for the purposes of cleaning it. This is clearly a non-trivial problem to model in PIPENET, as it consists of a solid-liquid interface, often followed by a solid-gas interface, as gas pressure is often used to push the pig through the network. The receiver itself is designed to trap the pig, allowing normal operation of the network to resume.

MODELLING THE PIG

The reason for the use of the PIPENET Transient Module to model this pig, as opposed to a solid dynamics modelling program is that the pressure surge caused by the presence of the pig, pushing liquid through the network (liquid that it has cleaned from the pipeline), can be considerable, so use of PIPENET to model such a surge is of value.

The way that has been chosen to model this, is by considering the pig as it passes a point as a prevention of flow. This can be modelled by the rapid closure of a valve for the length of time the pig passes. A spherical pig has been chosen, so that the flowrate is 0 for 0s, but is decreasing from maximum for the length of time it takes the pig to pass that given point.

THE NETWORK

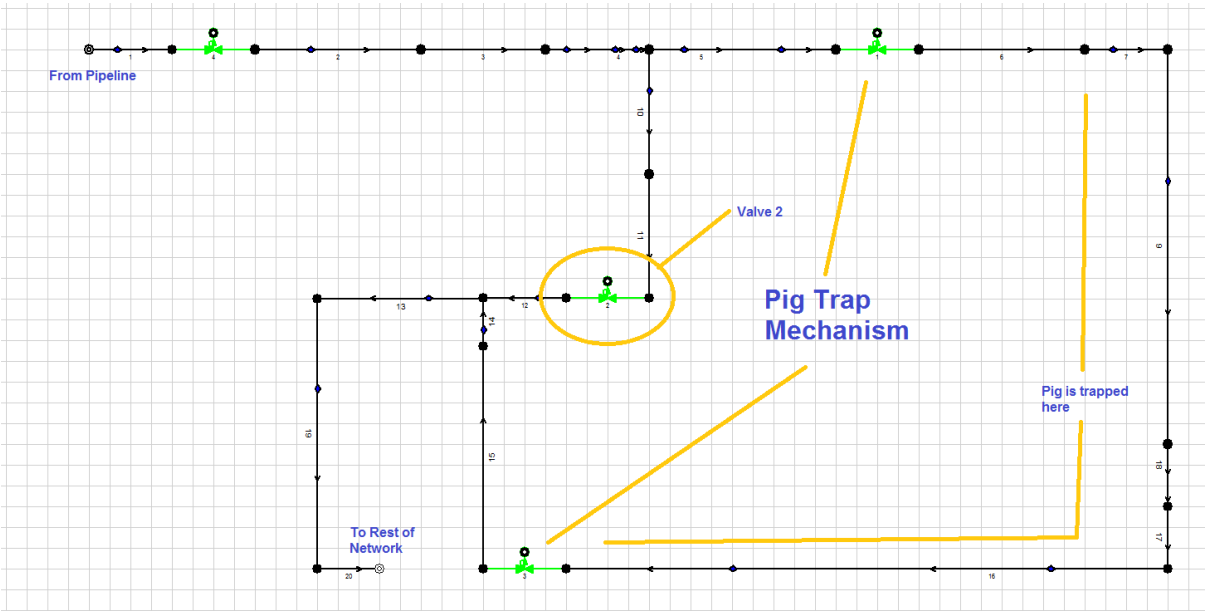

Figure 1 – Pig Trap Mechanism

The pig trap mechanism is shown in figure 1. Essentially, while the pig is operating in the pipeline, valve 2 is shut and the flow ahead of the pig is pushed into the pig trap mechanism. As the pig passes the first pig trap mechanism valves, valve 2 is opened and both pig trap mechanisms are shut, thus “trapping the pig”.

MODELLING IN PIPENET

Looking at the pipeline inlet valve, we will set the valve closure profile as explained in the modelling section above:

Pig Velocity: 25 ft/s

Pig Diameter: 10 in (0.833 ft)

Time required: 0.03332 s

We then enter this into the information node above the valve as a linear profile as shown below.

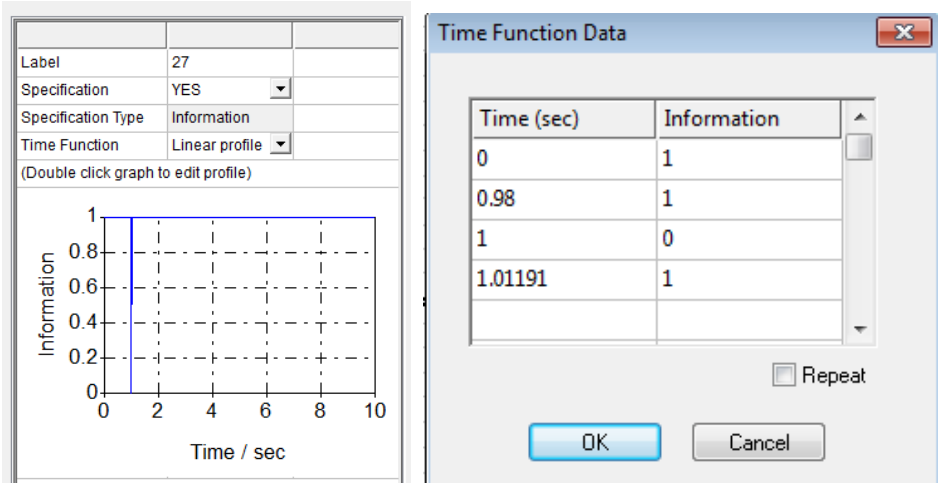

Figure 2 – Linear Time Function

In this case we are interested in the case where the pig does not go into the receiver and what forces are generated as a result of this, so we have simply set the receiver valves to shut and kept the main operating valve open. This would constitute an operation error. This type of calculation is important as these operational errors can happen and could be devastating to a system if the forces are too great.

RESULTS

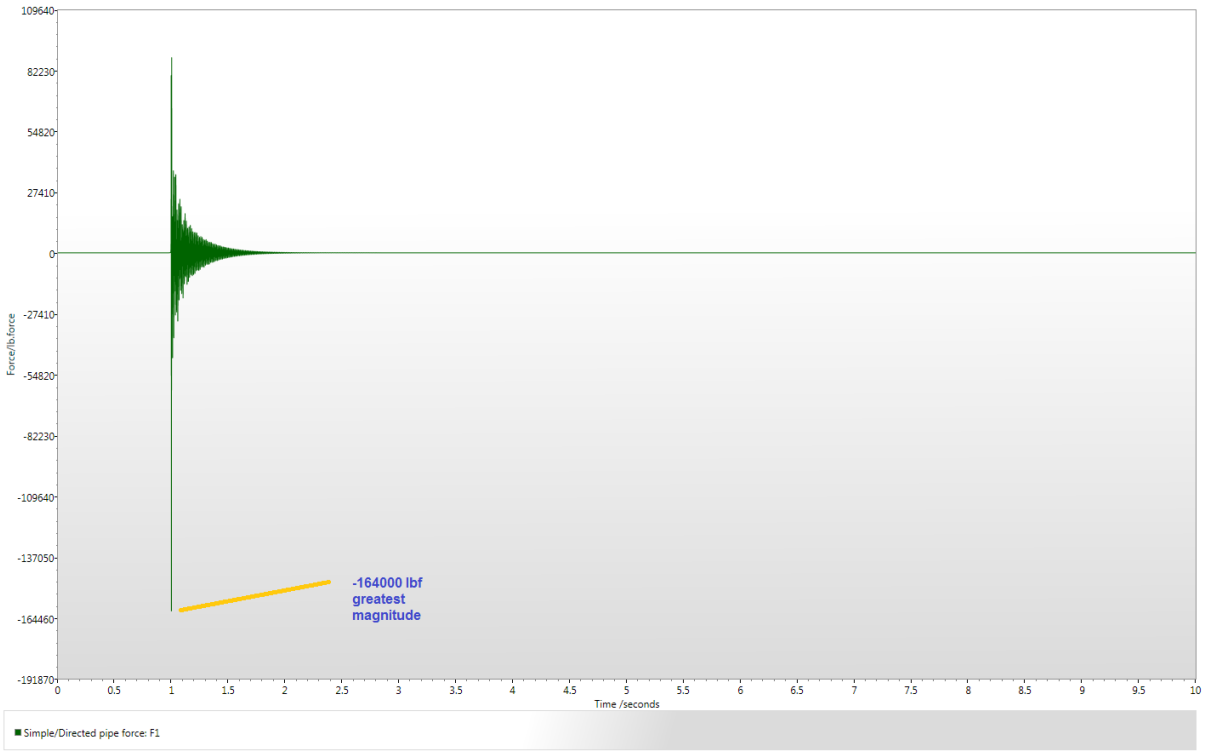

Figure 3 – Graphical results of force

This has a greatest force magnitude of -164000 lbf as the pig is forced into the wrong section of pipe. This could be cause significant damage to the pipe network and so it would be recommended to have safety features in place to prevent this type of erroneous pig operation.

CONCLUSIONS

It must be noted that PIPENET's calculation does not take into account the mass of the pig itself, nor any contact force and cannot be used to model a situation where the fluid behind the pig is a gas (as this would be a two phase simulation). For the mass of the pig, it would be recommended that a solid dynamics simulation were attempted and the differences between the two be resolved using the expertise of the engineer.

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