BRINGING A NEW DIMENSION TO PIPELINE PIGGING

By: David Aitken, Aubin Group, UK

The importance of keeping pipework clear of restrictions and debris to allow maximum flow conditions cannot be emphasised enough.

Restrictions or blockages to pipework can not only restrict flow, but can also cause dangerous build-up of pressure. Debris collection can also accelerate corrosion, leading to pipeline integrity issues. Blockages to pipelines currently cost the oil and gas industry hundreds of millions of dollars every year. Aubin's EVO-Pig and Pipeline Gel technology can help to remove unwanted contaminants and debris from lines, ensuring flow conditions are optimised, maintaining production and pipeline integrity.

Pigging has been in existence for over 100 years, with first operations being the removal of deposits and to prove lines were clear of restriction. Today, the variety of different types of pigging operations has increased, yet many of the original pipeline challenges remain and there continues to be a reportedly high incidence of pipelines being in a vulnerable condition due to improper maintenance.

Many existing and new lines are difficult to pig using conventional pigging tools due to significant diameter changes, short radius bends, and a lack of pig launching & receiving facilities. With the current pricing challenge there is a growing need to investigate and utilise effective & innovative methods & materials to provide essential cost savings through both improved production and reduced service costs.

Our range of Pipeline Gels and EVO-Pigs offer pipeline engineers a new tool for maintaining pipelines, bringing a new dimension to pipeline pigging.

Pipeline Gels

Aubin has developed a range of gels that can be utilised in cleaning, de-oiling, de-watering and corrosion protection and separation applications. The gels are either linear and supplied as a "ready-to-pump" viscous liquid, or cross-linked, where the final high viscosity is only produced at the time of pumping. Cross-linked gels are supplied as a base fluid and cross-linker, which is metered into the pipeline while pumping base fluid. The base cross-links in seconds forming a viscous gel within the pipeline. This process makes the highly viscous cross-linked gels much easier to deploy, especially when pumping through small port sizes. Aubin Pipeline Gels are based on a variety of base fluids and have complex non-Newtonian properties, specifically designed for pipeline applications.

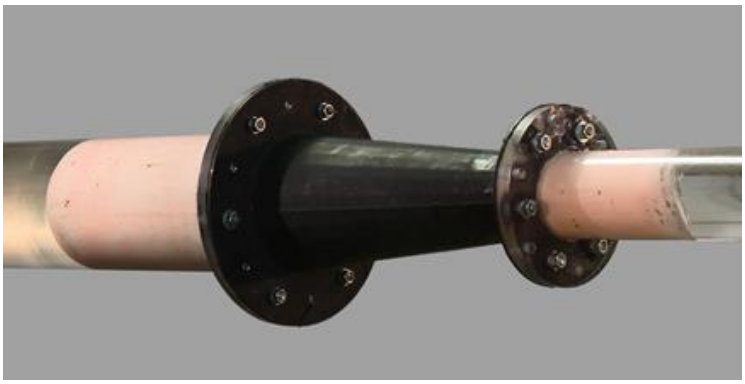
EVO-Pig

Aubin's EVO-Pigs have unique properties which evolved for applications outwith the capabilities of mechanical pigs. They do not require conventional pig launching & receiving facilities, however these can be utilised if they exist. Although very flexible to accommodate short radius bends and 50% diameter reductions, the material is essentially incompressible. With diameter reduction, foam pigs compress, harden, changing their mechanical properties. Instead, EVO-Pigs increase in length to maintain the same volume. By having "shape memory", they return to their original diameter after exiting the restriction. Variants have been developed, the most commonly used are EVO-Pig LG (formerly L-Gel) for standard temperatures, and EVO-Pig XT for extreme temperatures. Their features, depending on variant* are:

- Elastic, incompressible, negotiate diameter restriction & short radius bends
- Used in flexible lines, non-damaging to internal linings
- Provides good fluid separation, e.g. for product batching in multi-fluid lines
- Variable density, e.g. for easy recovery

- No need for pig launcher/receiver, supplied in launch canister
- May be extruded through suitable port
- In certain circumstances, may be formed in-situ, inside pipe
- Chemically compatible with most pipeline fluids*
- Non-hazardous materials
- Wide temperature range, -20 to +90°C*
- Slight surface swelling in contact with oil or water*, improves seal

Figure : EVO-Pig



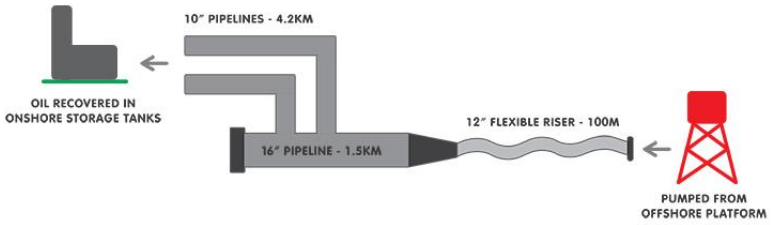
Case Histories

To demonstrate the features, benefits and track record of performance for our products we have a range of case histories covering a variety of applications.

De-oiling

A Middle East offshore subsea pipeline system consisting of two 10" pipelines and 16" header was being repurposed to provide water for emergency firefighting and maximised oil recovery and low oil in water content were the prime requirements. See Figure 1:

Figure 2: Diagram of doiling project



Because it was impossible to pig using conventional pigging techniques due to diameter changes and line geometry, Aubin's water-based separator gel, Gel 33, was used due to the high viscosity of the oil (up to 140cSt @ 50°C). The gel was supplied in its concentrate form to greatly reduce liquid volumes transported. 6,000 litres of Gel 33 was produced, cross-linked and injected through the 12" flexible riser and into the 16" header. Treated seawater pushed the slug into the two 10" lines and finally to onshore storage tanks. The line was successfully de-oiled and 344m^3 of residual crude oil recovered. The use of Aubin pipeline gel has other advantages: reduction in time required to meet oil in water specification, reduced water and treating chemical consumption, lower liquid processing and disposal costs with an associated environmental benefit.

The Gel 33 was mixed in the tanks shown in Figure 3 for approximately 60 minutes before being pumped into the lines, which were connected via a tee to a double diaphragm pump.

QC samples of the gel were taken during the mixing phase to ensure that the product was of the correct specification prior to pumping into the lines.

Figure 3:

North Sea Manifold – Pipeline De-watering

In a subsea 10inch production pipeline dewatering operation in the North Sea, the operator could not use conventional pigs as there were no pig launch or recovery facilities– a novel solution was required. Aubin proposed a single EVO-Pig LG to push dyed glycol/water **3**km, exiting via a 1" subsea check valve. The EVO-Pig LG was formed inside the vertical riser section supported by a higher density fluid. Once cured, the EVO-Pig LG dewatering train was then successfully pushed through the riser and pipeline using nitrogen as the driving medium.

Figure 4

Due to a lack of recovery facilities, the gel and the pigs were to be ejected into the sea once the flush was complete. All lines were successfully flushed and the pig train was ejected straight to the surrounding environment. Our Gel 33, as was used in this case, is certified as 100% PLONOR (Pose Little or No Risk to the environment) and is considered environmentally suitable for applications where receiving facilities may be limited. See in Figure 4, the gels and pig exit from the line via a subsea check valve.

Jumper Protection

A client enquired for a solution to protect two jumpers, 8" and 3", against seawater ingress during installation. Due to the nature of the application, it was decided that high viscosity slugs of MEG Gel 4000 would be deployed at each end, with standard MEG Gel 1000 placed between them. Our high viscosity MEG Gel 4000 is particularly suited to spool installation applications, and is frequently used in this type of work. When the flange covers are removed, the MEG Gel holds with little or no slumping and protects the spool from seawater ingress. In this particular application, a pre-commissioning trial

was conducted to check the gel interface and the back pressure that was likely to be experienced during pumping.

During deployment, the interface between the gels remained constant throughout the spool installation. The pumping pressure required to remove the MEG Gels post installation remained low throughout, never exceeding 1Bar at any point.

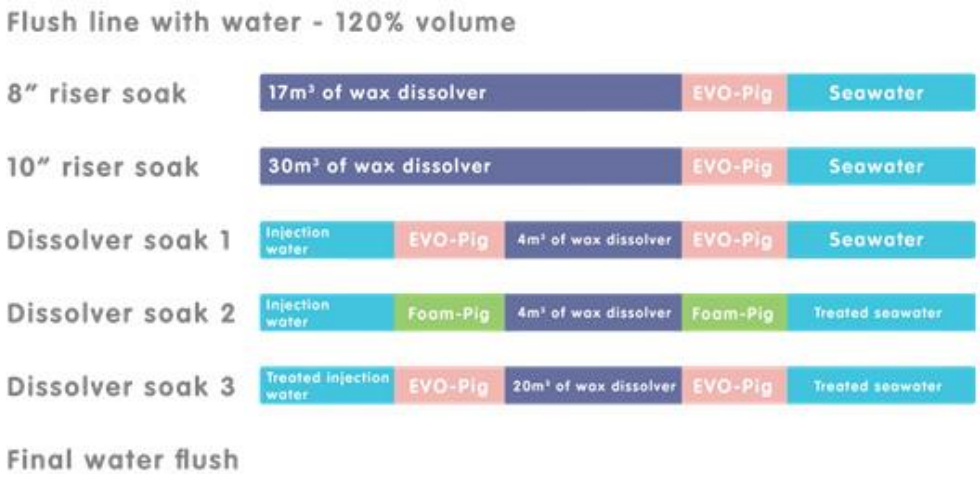
Wax Dissolver

A client requested that wax deposits which had built up in the pipeline be removed to improve flow assurance and pipeline operability. The client required a wax dissolver to be transported down the pipeline. The line was 30km in length, with an OD of 10". It was connected to two risers, one was 8" diameter, and the second was 10" diameter. EVO-Pigs are considered to be particularly suited to this type of application because of their ability to reduce in diameter by up to 50%, helping ensure they do not get stuck in the line.

In this operation, pigs were to be utilised as separators to allow slugs of wax dissolver to be delivered to the affected areas, with the pig train being stopped every 500m to allow sufficient time for the dissolver to soak into the wax deposits and dissolve them.

Figure 5

A diagram of the various stages of the operation and the pig trains used:



The EVO-Pig LG pigs successfully formed a pig train to carry the wax dissolver through the pipelines varying diameters and bends. The client was delighted to find an effective solution that allowed a pig train to be started and stopped to enable the dissolver to remove the unwanted wax deposits, improving flow assurance through the pipeline.

It should be noted that during Dissolver Soak 2 the foam pigs became stuck in the waxy line and required to be reversed out. In comparison, all of the EVO-Pigs were pumped through successfully.

Detection of Obstruction

A major operator contacted Aubin for assistance with an unusual obstruction detection and removal issue. The company was operating an FPSO offshore West Africa and suspected that a temporary metal flange plate, used to prevent debris entering a 20" flowline, had fallen inside. It was more likely that the plate had been lost overboard, however the risk of lost production due to the plate reducing flow was sufficient to justify an operation to verify that the line was clear.

The operator did not have any pigging facilities, but even if they had they could not risk putting a conventional pig, or even a foam pig, through the system as there would be a possibility of it getting stuck if it encountered the metal plate.

The EVO-Pig will not get stuck at restrictions that would stick conventional pigs. If the metal plate was firmly jammed in the line, e.g. at a bend, or similar, the EVO-Pig would shear around the obstruction and be received in pieces. If the pig was recovered undamaged without pushing out the plate then this would show the plate was not in the line. If the pig was recovered in pieces this would be a strong indication that the plate was indeed in the line.

After detailed discussion with the operator and their sub-contractor a decision was taken to run the pig from the portside offloading line and recover on the starboard side. This would be a distance of approximately 3.5km through 20" OD pipe.

The following methodology was implemented;

1. The operator identified a 2m spool piece on the port side of the FPSO which would be utilised as both the mould for the pig and its launch vessel.
2. Aubin supplied the EVO-Pig CD in the form of two liquid components which were mixed on the FPSO. To aid quality assurance during mixing the material changes colour to pink when the EVO-Pig CD is properly mixed.
3. The spool was greased, capped and set in a vertical orientation.
4. The EVO-Pig CD liquid was poured into the spool then the mix was left to set for 24 hours. The picture below shows the pig formed in the spool;
5. The spool containing the pig was bolted onto the portside offloading line. The pig was launched and propelled with water
6. A second, longer spool was installed on the starboard side of the vessel to act as a pig receiver. A grate was fitted to the end of the spool to catch the pig, whilst allowing water to exit.
7. The EVO-Pig CD was propelled through the offloading lines from the port side to the starboard side of the vessel, passing the barred tee, and was recovered in the temporary launcher.
8. The pig was removed from the launcher and examined.

The pig was recovered intact and the missing plate was not pushed out with it which meant that it had not fallen into the line. The operator considered the project a complete success.