

A high pressure test rig constructed for flow loop testing © Brinker Technology



# SEALING SOLUTIONS

A tiny cut on a finger inspired a leak-sealing innovation which has the potential to change the shape of integrity management across the pipeline industry worldwide. Claire Evans from Brinker Technology, a MacRobert Award 2006 finalist, talks about the company's journey from concept to field implementation.

In 1998, Ian McEwan, a Reader from the University of Aberdeen, was travelling on a train reading an article about leakage problems in the UK water industry, and cut his finger on the paper. This cut, and its subsequent healing, led Ian to question whether the method the human body uses to seal cuts and wounds could be adapted for use in pressurised pipelines. Here, the concept of Platelet Technology™ was born.

Platelets in the human body are irregularly-shaped, discrete particles which constantly patrol our veins. When bleeding from a wound occurs the platelets react, gathering at the leak site and attempting to stem the blood flow. Ian sought to take this concept and adapt it for use in industrial pipelines using his research field of particle and flow mechanics. He surmised that discrete specially-designed particles could be injected into a pipeline at a position upstream of a known or suspected defect. The particles would then utilise the fluid flow inside the pipeline to travel to the leak site.

### GOING WITH THE FLOW

Designing these particles with the necessary material properties would enable fluid forces to draw them into the leak and hold them against the pipe wall, thus facilitating sealing. By embedding a remote tagging device into these discrete particles prior to deployment they can also be used to locate leaks. Once the particle is entrained into the defect the embedded tag is uniquely positioned at the leak site and can be detected by running a suitable device either externally or internally along the length of the pipeline.

Platelet Technology enables leaks to be sealed and located in a single integrated process. This reduces the lifetime of the leak, which helps to limit any consequential environmental damage. Platelets® are

implemented remotely, removing the need for direct access to the leak site which helps to ensure the safety of those involved in the repair. In addition, Platelets require no disturbance to pipeline operation meaning that, in some cases, costly shutdowns can be avoided.

### A BESPOKE SYSTEM

The material that a batch of Platelets is made from is dictated by the environment in which it must operate. For example, fluid compatibility is a strong consideration when selecting the optimum material for a specific operation. A material must be selected which is not adversely affected by the carrier fluid for the required duration of the Platelet seal, which in some organic, high pressure/high temperature applications can prove very challenging.

The operating pressure of the line also has a strong bearing on the selection of Platelet material – if the material is too soft it may be entirely extruded through the leak, but if the material is too hard a complete seal may not be attainable. For this reason a wide variety of materials have been used on Platelet operations to date, for which the pressures have varied from 2 to over 500 bar.

### MADE TO MEASURE

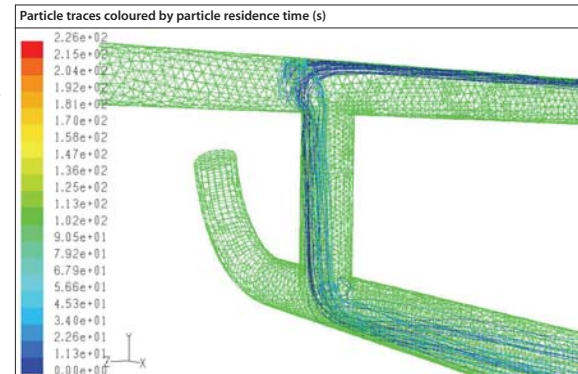
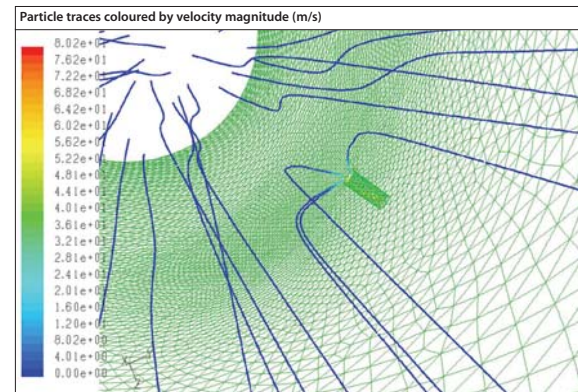
The exact size and shape of a Platelet cannot be defined because it varies from operation to operation. For each operation undertaken by Brinker Technology, unique batches of Platelets are manufactured with properties which are specifically tuned to give the optimum results under the operating conditions in question. To give some idea, in projects carried out to date, defect sizes ranging from 0.3mm to 50mm diameter have been successfully sealed.

Platelets utilise the turbulent flow in pipelines to become evenly distributed across the pipeline cross-section, enabling leaks at any location to be targeted. To do this they need to be neutrally buoyant in the carrier fluid (ie the same density) and therefore this too affects the choice of material for each application. As such, there is no hard and fast rule which governs what a Platelet is made from; however, polymeric and elastomeric materials have demonstrated a good combination of properties for most applications.

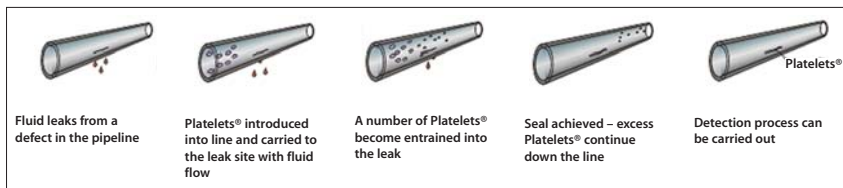
### BACKGROUND PREPARATIONS

Although the concept is elegant in its simplicity, underpinning the theory is extensive use of Computational Fluid Dynamics (CFD) in conjunction with Finite Element Analysis, plus over five years of rigorous physical testing. In non-urgent uses, when presented with a new application the first stage in the engineering process is to

*The use of both physical and numerical tools is crucial to the success of the entire approach because it gives much confidence in the quality and robustness of the solution.*



Figures 2 and 3. Computational Fluid Dynamics is used to assess Platelet entrainment rates © Brinker Technology



*Since this first operation in 2004 Platelet Technology has repeatedly been used on live operations, most notably in August 2005 in a rapid response application for Shell. Brinker Technology were able to deliver a solution within five days from initial client contact.*

create a model of the defective pipeline geometry using CFD which enables all conditions in the line, such as pressure, flow rate, and fluid density and viscosity to be accurately simulated. Discrete particles, which represent Platelets, are then introduced into the pipeline and their behaviour around the leak monitored.

This modelling process generates important information regarding Platelet dispersion and entrainment rates (see figures 2 and 3) which enables the required batch sizes and Platelet densities to be calculated. Finite Element Analysis is then used to assess the structural integrity of entrained Platelets in position over a leak. This enables the effect of stresses and strains which the Platelet will experience in the field to be monitored and is a key tool when selecting the optimal material for Platelet manufacture.

Using the information obtained from these numerical modelling processes, batches of Platelets are manufactured and subjected to rigorous physical testing. This involves flow loop testing to assess Platelet entrainment and pressure vessel testing to verify the Platelets' structural integrity at representative pressure. If the results of the physical tests support those obtained analytically and numerically then there can be a high level of confidence and the solution is considered ready for implementation. The use of both physical

and numerical tools is crucial to the success of the entire approach because it gives much confidence in the quality and robustness of the solution.

### INITIAL IMPLEMENTATION

The first field use of Platelet Technology came as a result of a Joint Industry Project (JIP) funded by a number of North Sea oil majors. In September 2004, Platelets were successfully used to seal a water injection line leak in BP's Foinaven field. The water injection method used in oil production is where water is injected back into the reservoir in order to increase the well pressure and thereby stimulate production. By supporting reservoir pressure in this way the product recovery from the well is increased as the oil is displaced by water and pushed to the top. In this instance, the pipeline geometry immediately upstream of the leak was relatively complex, with two 90° bends immediately prior to the defect. This meant that flow in the near vicinity of the leak was non-uniform and directed away from the leak.

CFD played a vital role in quantifying this effect and was used extensively in the development of a solution. A number of simulations were run with Platelets of a range of sizes and densities. It was found that by using Platelets of a lower density than the

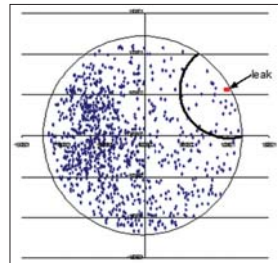


Figure 4. Simulated distribution of 'neutrally buoyant' Platelets<sup>®</sup> across the pipeline (Platelet<sup>™</sup> density = 1030 kg/m<sup>3</sup>, sea-water density 1030 kg/m<sup>3</sup>) © Brinker Technology

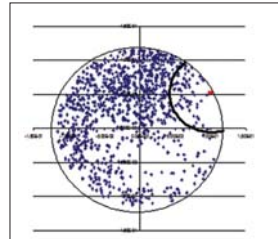


Figure 5. Simulated distribution of 'light' Platelets<sup>®</sup> across the pipeline (Platelet<sup>™</sup> density = 1005 kg/m<sup>3</sup>, sea-water density 1026 kg/m<sup>3</sup>) © Brinker Technology

carrier fluid (seawater, 1,030kg/m<sup>3</sup>) it was possible to increase entrainment rates, enabling the required batch size to be reduced. Figures 4 and 5 demonstrate the significant effects that a slight change in Platelet density has on their cross-sectional distribution in the pipe at the leak site.

Here, the Platelet deployment was a complete success, with the leak sealed within 24 hours of the start of the offshore operation. The Platelet seal enabled the line pressure to increase by 20 bar which resulted in a significant increase in production.

Since this first operation in 2004 Platelet Technology has repeatedly been used on live operations, most notably in August 2005 in a rapid response application for Shell. Brinker Technology were able to deliver a solution within five days from initial client contact. Further low pressure 'proof of concept' trials were very promising and representative trials at 60 bar are scheduled to take place before the end of the year.

### LOW PRESSURE TRIALS

In addition to this ongoing work in the oil and gas sector, Brinker Technology has been seeking to develop the technology for use in the water industry – a prime candidate for a novel leak sealing solution. In England and Wales alone 3,600 mega litres of water are lost every day due to leakage. This loss of valuable resources, combined with two unseasonably dry winters and rapid population growth has resulted in the south-east of England facing one of the most serious droughts of the last 100 years. Platelet Technology was recently trialled on a 4" disused clean water main, at a pressure of 4.5 bar. Although this pressure is significantly less than any encountered in the oil and gas industry, by selecting a material with the required characteristics (ie deformability under low force), successful seals were obtained on a variety of leak geometries.

A number of barriers must be overcome before the technology can be used in this field. These include ensuring that the material used for Platelet manufacture has regulatory approval from the UK Drinking Water Inspectorate, and ensuring that procedures are in place to guarantee that Platelets cannot reach customer homes. Due to the fact that they do not have the same regulatory restrictions enforced upon them, raw untreated water or sewerage systems could be the first place that Platelets are deployed.

### A NON-INVASIVE TECHNOLOGY

Despite the challenges that lie ahead Platelets have the potential to transform the way the water industry deals with leaks. Platelets are implemented remotely and travel to the leak site with the flow in the line, so they are a ideal example of a 'no-dig' technology. This means that disruptions to traffic currently caused by technologies which require direct access to buried pipelines could be avoided.

It has been estimated by industry experts that reducing the leakage across England and Wales by 10% (360 Ml/d) through traditional dig and repair methods will cost around £2.5 billion in capital expense. Platelet Technology has the potential to significantly reduce this figure to the benefit of the 52 million customers nationwide.

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Further reference  
[www.brinker-technology.com](http://www.brinker-technology.com)

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Klaire read Mechanical Engineering at Exeter University and graduated with a First Class Honours Degree in 2002. She began her career with ExxonMobil on their Graduate Development Programme, run in conjunction with the London Business School. Klaire joined Brinker Technology in March 2005 as a Projects Engineer and a year later moved to the position of Sales and Marketing Engineer.