Advanced Magnet Lab

www.magnetlab.com

1720 Main Street
Palm Bay, FL 32905
321.728.7543
FAX 321.728.7536

AML Oil Spill Flow Reduction Solution Using Magnetic Particles
Test Results

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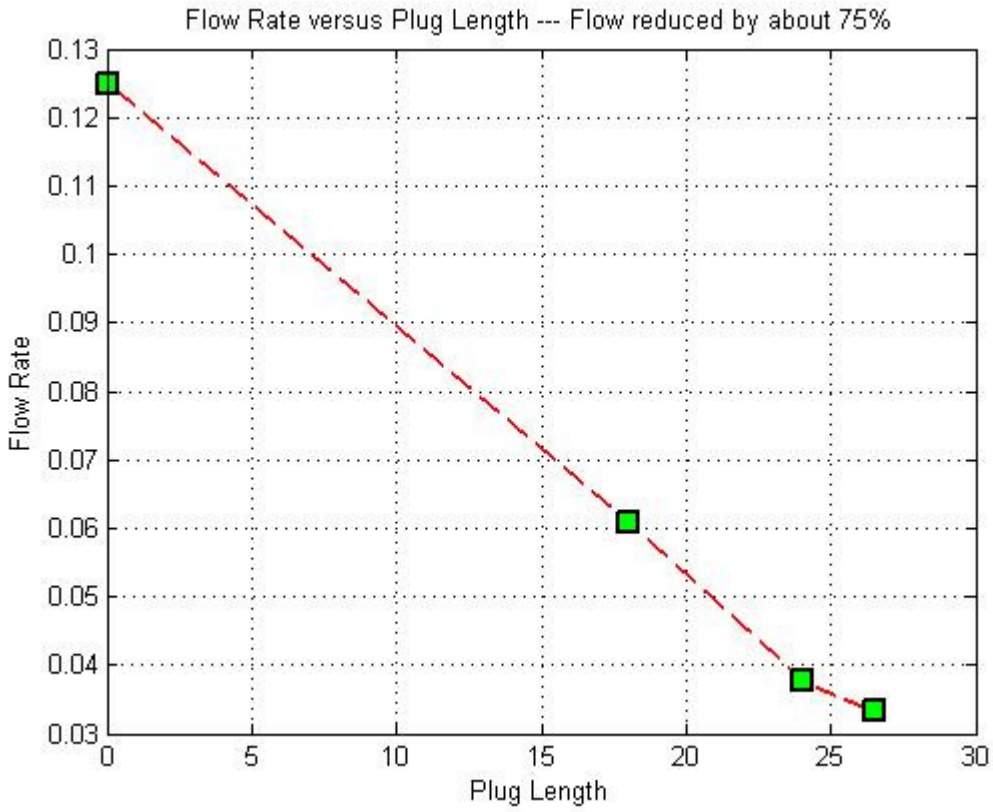
info@magnetlab.com

To simulate the flow conditions of a spilling oil well, a water pump has been connected to a 3" pipe. In the simulation water is used instead of oil and its flow velocity has been adjusted to be equivalent to 44,000 barrels/day for a 20" diameter pipe, representative of the Deepwater Horizon conditions.

The 3" pipe has been filled with a mixture of steel balls and permanent magnets, which form a plug of adjustable thickness. The thickness of the plug has been increased from zero (no plug at all) to a thickness of 26.5" (the maximum possible for the given test setup). The resulting flow rate of water has been measured as a function of the plug thickness. The data are shown in the figure below.

As can be seen from the figure, the flow rate decreases linearly with plug thickness. For the maximum plug thickness of 26.6", the test flow has been reduced by about 75%.



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The aspect ratio of plug length to pipe diameter for the maximum plug length (26.5") is about 8.8. Assuming that the aspect ratio is the relevant parameter for scaling to a larger pipe diameter, a plug length of about 15 feet will give the same flow reduction of 75% for a 20" diameter pipe. Since flow resistance of a liquid through a system of orifices depends on viscosity a higher reduction can be expected for crude oil (depending on temperature crude oil viscosity is significantly larger than the viscosity of water).

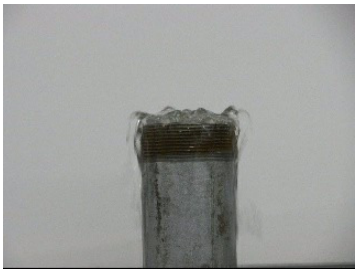
The strong magnetic forces acting in the magnetic material of the plug are essential for the success of the proposed procedure. Due to the magnets the whole plug forms an almost monolithic structure, which conforms to the any shape of the surrounding pipe and bonds to it

We have calculated that due to the high density of the permanent magnet material and the iron balls the drag force acting on them in the oil spill is insufficient by a large margin to flush the material out. Instead gravity in the oil still wins against its flow. We have furthermore determined that an aluminum pipe of about 1-cm wall thickness is strong enough to withstand the water pressure at a depth of 1500 m and can be used to insert the magnetic material into the spilling pipe. The feeding of the magnetic material into the well pipe could be accommodated with the help of conventional drill mud, in which the permanent magnets and the iron balls are inserted.

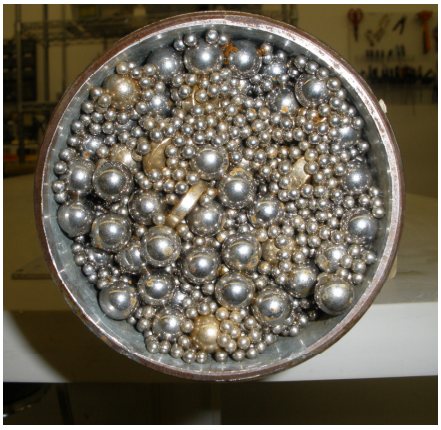
Based on the performed tests we are rather confident that our proposed procedure would be successful in significantly reducing the oil spill.

AML Test Set-Up

Flow Reduced by 30%



Flow Reduced by 75%



Bottom and Top of Plugged Pipe