Why Bismuth-based Alloys?

Eutectic Metal

Expands like ice

Viscosity similar to water

Corrosion resistant

Dense – SG 10
Works Like a Candle
Alloy Viscosity & Expansion

The Thermite Reaction

Iron Oxide + Aluminium > Aluminium Oxide + Iron + Heat

AN EXOTHERMIC REACTION
2Al + Fe₂O₃ → Al₂O₃ + 2Fe + HEAT

ENERGY

— 2Al + Fe₂O₃

→ HEAT GIVEN OFF

— Al₂O₃ + 2Fe
Independent ISO 14310 VO Testing
April 2017 Offshore Norway

**Problem**
- P&A plug inside 5” liner
- V0 rated mechanical plug and cement previously set
- Gas pressure at surface leaking past existing plug up ~1,200 psi

**Solution**
- Set 3.45” OD Wel-lok M2M TS
- Pressure tested to 4,200 psi
- Initial inflow test charted
- One year monitor of well for pressure buildup

Inflow Test

Blue: Prior to Wel-Lok
Orange: Two days since setting Wel-Lok
5.5” Tubing Seal

• **Problem:**
  - 5.5” Tubing, 90C fluid, 40deg deviation
  - Seal tubing and remove heater
  - 5,000 PSI differential required

• **Tool:**
  - Alloy: High Temp
  - Pressure actuated anchoring skirt
  - Heater: 2-7/8”, Tool OD: 4.25”
Pressure in the "A" annulus

STC provides a gas tight seal in multiple annuli

**Wel-lok M2M STC**

Provide a Permanent Seal in Multiple Annuli

BEFORE

STC provides a gas tight seal in multiple annuli

AFTER

Pressure in the "A" annulus
Open Annulus

- Uses only the annulus fluid to solidify the alloy
- Pressure tested to 5,000psi
- Developed during 2017
- Ran on Valhall North Sea: April 2017
13 3/8” x 20” STC - Results

• Method
  • Drill large holes in inner casing
  • Break cement loose
  • Flow to remove cement
  • Set BiSN plug, remove heater

• Qualification method
  • Hydro test (Cycle)
  • Gas test

• Field test Q3 2018
9 5/8” x 13 3/8” x 20” STC - Results

• **Method**
  • Drill large holes in inner casings
  • Set BiSN plug

• **Qualification method**
  • Hydro test to 3,000 psi differential

• **Field test Q4 2018**
Casing vent flow through channeled cement

**Before**

**After**

CRT provides a gas tight seal in a cemented annulus
Gas tested to 2,500 psi with nitrogen for 24 hours with no bubbles
• Run through tubing or restriction
• Seals inside a large diameter casing or open hole
• Alloy in pellet form, deployed downhole in a bailer
• One-trip deployment
provide a seal in through tubing applications, wells with restrictions & large diameter casings

Alloy beads deployed in a bailer

MXD provides a gas tight seal in through tubing applications in a single deployment

M2M Sealing Solutions
Tools of All Sizes

9 5/8” x 13 3/8” x 20”
Casing Seal

2” Coil Tubing Seal