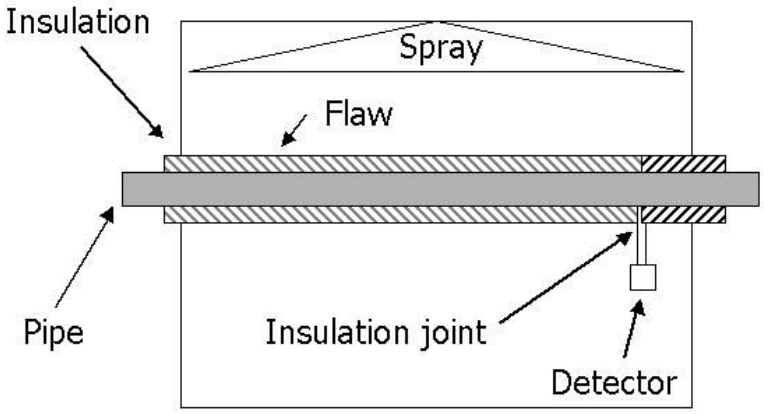
SUMMARY OF TEST SERIES 4: PIPE WITH CYCLIC HEATING

OUTLINE TEST METHOD

Tests were performed in parallel on 3" nominal bore carbon steel pipes with three insulation systems:

- System 2000
- Ultrashield
- Rockwool + metal cladding

The H2Obvious detector device was fitted at a joint in the insulation. Deliberate flaws were made through the top of the cladding at 0.8 m distance to the detector. Slits were cut in the System 2000 and Ultrashield. In the case of the metal cladding, one 25mm diameter hole was made in the sheath. The pipe was angled slightly with the detector at the low end.



Schematic diagram of test set-up

Artificial seawater (ASTM D1141) was used for spraying. Two air-mist nozzles produced a continuous fine spray, similar to a dense fog or fine drizzle. All surfaces, including those not in the direct line of spray, were wetted. The nominal spray rate was approximately 1.5 cm depth per 24 hours, and was measured daily by a collection funnel.

The pipes were heated internally. Internal pipe bore temperatures (equivalent to process fluid temperature) were measured by thermocouples and controlled by proportional temperature controllers. The external temperature in the chamber was 23-27°C.

Production model detectors were used in this test, whereas prototype devices were used in previous tests.

The extent of water penetration is largely a function of the deliberate flaws created in the coverings, and not indicative of the relative merits of the different insulation systems.

TEMPERATURE CYCLING

The internal pipe temperature was held at 180°C for 12 hours at the start of testing. Thereafter, the temperature was controlled according to the following cycle:

Step 1 Heat off for 12hrs
Step 2 120°C for 12hrs

After eighteen days, the cycle was changed to:

Step 1 Heat off for 48hrs
Step 2 120°C for 12hrs

The purpose of this change was to allow more time for water penetration to the pipe surface between the heating periods.

SUMMARY OF RESULTS

General

The condition of the detectors after testing was essentially identical to that before exposure, with no visible damage, for example from heat.

System 2000

The detector light activated after 16 days exposure. Water was visible inside the collection chamber, but not sufficient to lift the float.

Water had penetrated the outer sheath at the flaw, and possibly more generally. The inner sheath surface and outer side of the insulation was wet, and disbonded in parts. The sheath itself was beginning to wrinkle and open at some of the joins. Water had penetrated down to the steel pipe at the flaw and at a join in the insulation material, adjacent to the detector location, and hence reached the detector. There was no water penetration to the pipe surface at other points. There was no significant spread of water along the steel pipe surface, either from the flaw or from the joint location, presumably due to the heat.

Ultrashield clad pipe

The detector activated on the 45th day of the test. Moisture was visible inside the detector collection chamber, but not sufficient to lift the float.

The outside of the insulation and inside of the sheath was wetted, and there was some penetration through the rockwool towards the pipe, particularly at the joins. The pipe itself was entirely dry with no evidence of moisture having been present (for example, fresh corrosion).

The collector funnel, being set slightly off the pipe surface, collected water that had penetrated part-way through the insulation towards the pipe surface.

Stainless steel clad pipe

The detector did not activate up to 45 days testing, at which point the test was stopped, and the insulation removed to allow examination of the pipe.

The outside of the insulation, and inside of the sheath was wetted, and there was some penetration through the rockwool towards the pipe, particularly at the joins. The degree of penetration was less than in the case of the Ultrashield clad pipe. The pipe itself was entirely dry with no evidence of water having been present (for example, fresh corrosion).

CONCLUSIONS

The production model H2Obvious detectors survived exposure to pipe temperatures up to 180°C without apparent damage, and operated effectively after this exposure.

The H2Obvious detectors were able to detect the presence of water in a situation of fluctuating temperatures and cyclic vaporising and condensing within the insulation. Depending on the position of the collection funnel, the detector is able to detect water in the insulation which has not (yet) reached the pipe surface.