Sheffield Hallam University
City Campus
Howard Street
Sheffield, S1 1WB

T +44(0)114 225 3712

www.shu.ac.uk/cim
v.starinieri@shu.ac.uk

The Hey Group
Unit 3 Ripley Close
Normanton, Wakefield
WF6 1TB
Geoff Hunt
geoffhunt@theheygroup.net

13th May 2019
Reference Number CIM 438 Condensation test r0

Condensation test

Introduction

The Centre for Infrastructure Management (CIM) at Sheffield Hallam University was requested by The Hey Group (from now on referred to as the client) to investigate the formation of moisture condensation on the surface of three pipes covered with their RZ-Ecoseal sealing product and two different pipe insulation systems (from now on referred to as System 1 and System 2), respectively (Figure 1).

Experiment

The test was performed on pipe sections measuring 400 mm long and 60 mm diameter. Each pipe was supplied with a handle lever for opening and closing the pipe at one end. A thin thermocouple was introduced in each pipe at mid-length and a second thermocouple was applied on the surface of the pipe also at mid-length. In the case of the pipes covered with Systems 1 and 2 the second thermocouple was positioned under the insulation, which is where condensation normally takes place. In the case of the pipe sealed with RZ-Ecoseal, the same thermocouple was applied on top of the sealing surface, as shown in Figure 2. Each pipe was then filled with water at 6 ± 0.5 °C and immediately moved into a climatic chamber maintained at 40 °C and 60% RH. The temperatures of the water in the pipe and of the surface of the pipe were recorded at one minute intervals for a period of two hours from the introduction of the pipe in the chamber by means of a DataTaker DT85G digital data logger. Following the two hours exposure period, each pipe was removed from the chamber and inspected for the presence of moisture condensation on its surface (on top of RZ-Ecoseal and under the two insulation systems). The test was

Sheffield Hallam University
City Campus
Howard Street
Sheffield, S1 1WB

T +44(0)114 225 3712

www.shu.ac.uk/cim
v.starinieri@shu.ac.uk

The Hey Group
Unit 3 Ripley Close
Normanton, Wakefield
WF6 1TB
Geoff Hunt
geoffhunt@theheygroup.net

1st May 2019
Reference Number CIM 438 Thermal Conductivity r0

Determination of the Thermal Conductivity of RZ-Ecoseal

Introduction

The Centre for Infrastructure Management (CIM) at Sheffield Hallam University was requested by The Hey Group (from now on referred to as the client) to determine the Thermal Conductivity of RZ-Ecoseal.

Experiment

The test specimen, manufactured by the client, consisted of a RZ-Ecoseal sheet measuring approximately 305 x 305 x 3.5 mm (Figure 1). An HFM300/1 heat flow meter from Linseis (Figure 2) was used to carry out the test according to BS EN 1266:2001. The temperatures of the bottom and top plate of the meter were set at 10°C and 20°C, respectively (mean test temperature ≈ 10°C). The thermal conductivity was automatically calculated using the HFM300/1 software (displayed as shown in Figure 2).

Figure 1 Test specimen

Figure 2 HFM1 heat flow meter

Sheffield Hallam University
City Campus
Howard Street
Sheffield, S1 1WB

T +44(0)114 225 3712

www.shu.ac.uk/cim
v.starinieri@shu.ac.uk

The Hey Group
Unit 3 Ripley Close
Normanton, Wakefield
WF6 1TB
Geoff Hunt
geoffhunt@theheygroup.net

7th May 2019
Reference Number CIM 438 Water Vapour Permeability r0

Determination of the water vapour transmission properties of RZ-Ecoseal

Introduction

The Centre for Infrastructure Management (CIM) at Sheffield Hallam University was requested by The Hey Group (from now on referred to as the client) to determine the water vapour transmission properties of RZ-Ecoseal and two other pipe insulation systems (from now on referred to as System 1 and System 2).

Experiment

The tests followed a methodology based on BS EN 12086:2013 (test conditions C). The test specimens, consisting of 185 mm diameter discs with thicknesses of 1.5mm (RZ-Ecoseal), 18mm (System 1) and 20mm (System 2) were provided by the client. Upon delivery to the laboratory, the discs were sealed onto the open mouth of circular test cups (Figure 1) in which the relative humidity was maintained constant at 93.7% by means of a saturated solution of potassium nitrate (KNO_3). The samples were then placed in a fan-assisted environmental chamber maintained at 23°C and 50% RH (Figure 2) and weighed every 24 hours until steady state vapour transmission was achieved. Water vapour transmission properties (Water Vapour Resistance Factor μ and Water Vapour Permeability δ) were calculated using the formulas recommended by BS EN 12086:2013. Two samples per insulation system were tested.

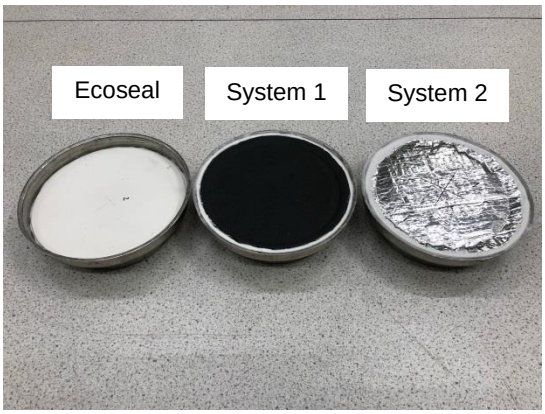

Figure 1 Test cups with specimens

Figure 2 Test cups with specimens in the environmental chamber

Results

The results of the tests are summarised in Table 1 and Figures 3 - 4.

Table 1 Water vapour transmission properties

Sample	Water Vapour Resistance Factor μ	Water vapour permeability δ kg/(m·s·Pa)
Ecoseal	677.75	$2.86 \cdot 10^{-13}$
System 1	52.12	$3.71 \cdot 10^{-12}$
System 2	66.50	$2.91 \cdot 10^{-12}$

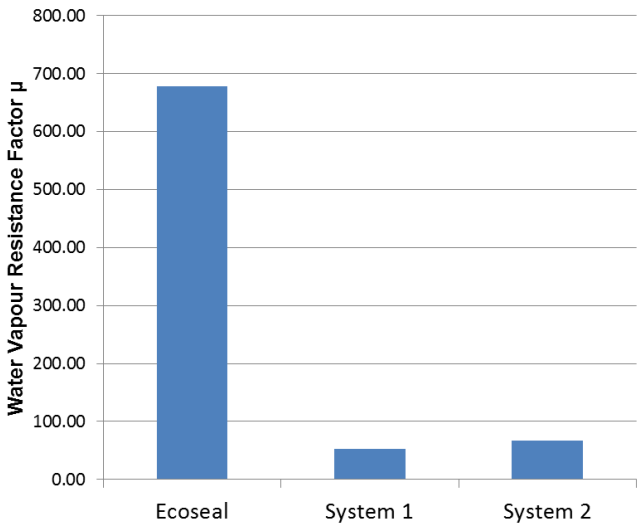

Figure 3 Water Vapour Resistance Factor μ

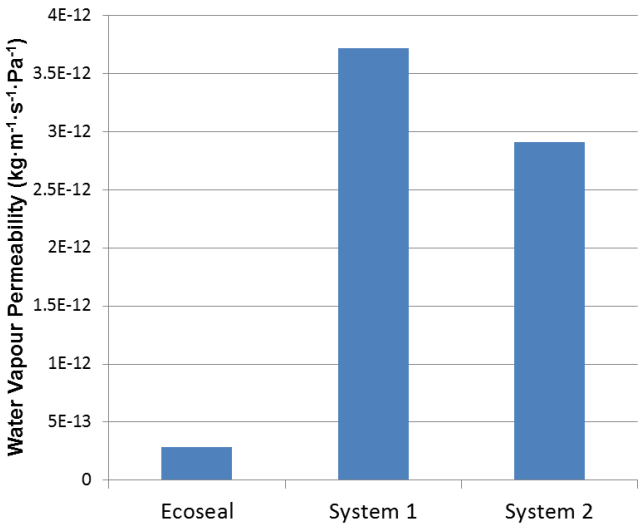

Figure 4 Water Vapour Permeability δ

carried out separately for each pipe. All pipes were stored in laboratory conditions (≈ 22 °C and ≈ 60% RH) for 24 hours prior to testing.

Figure 1 Pipe sections

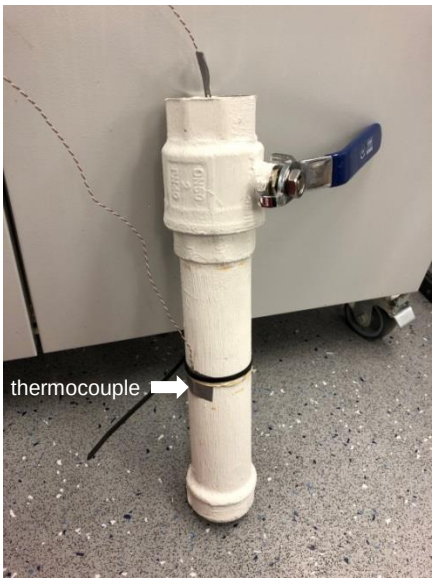

Figure 2 Pipe section sealed with RZ-Ecoseal

Results

Figure 3 shows the temperatures of the water inside the pipes and of the surface of the pipes during the two hours monitoring period. It can be seen that both pipe surface temperature and water temperature increase at a slower rate for the pipes covered with insulation (System 1 and System 2) than for the pipe sealed with RZ-Ecoseal. The Dew Point at the temperature and relative humidity maintained inside the chamber (40 °C and 60% RH) is estimated to be 30 °C and is shown by a red line in Figure 3. The dew point is the temperature below which water vapour condenses to form liquid water. This means that when the air in the chamber cools to below 30 °C through contact with the pipe surface at a temperature below 30 °C, water will condense on the surface of the pipe.

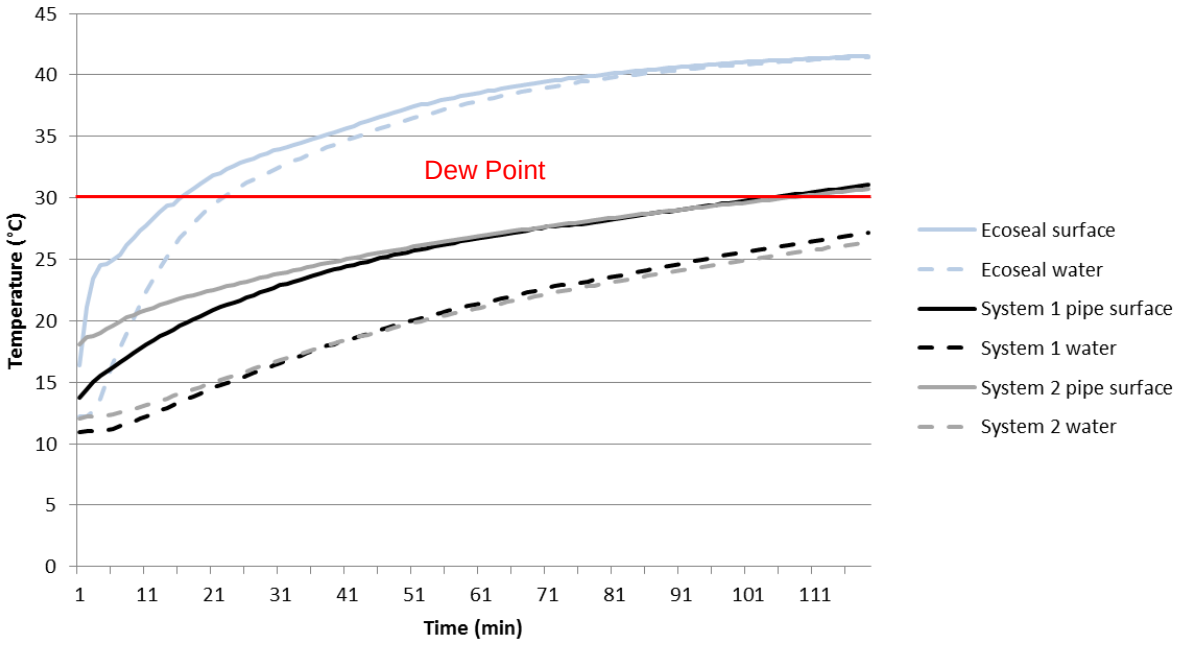

Figure 3 Water and pipe surface temperature during the two hours monitoring period

The inspection of the pipe surfaces following the two hours exposure in the chamber revealed the presence of condensation under the insulation systems 1 and 2 (Figures 4 and 5). No condensation was observed on the surface of RZ-Ecoseal at two hours, however, some condensation was observed at 5 min from the introduction of the pipe in the chamber (Figure 6) which disappeared at around 20 min.

Figure 4 Condensation on the pipe covered with System 1 at the end of the two hours exposure

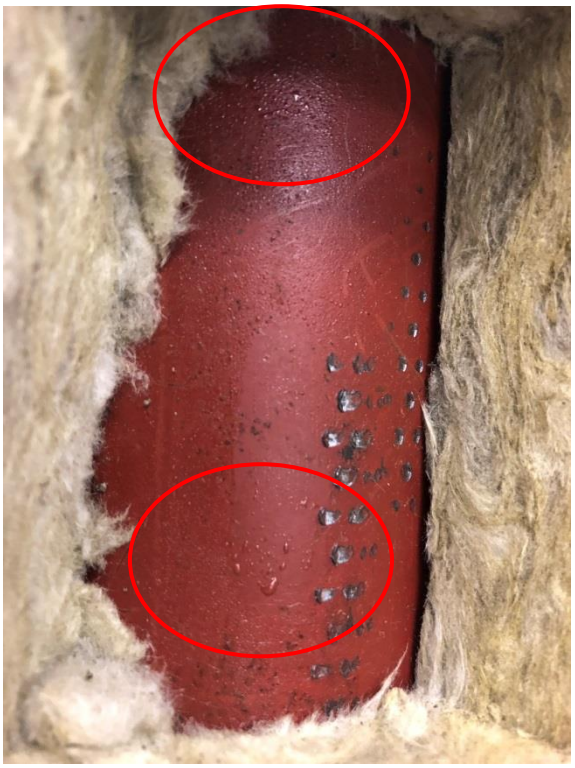

Figure 5 Condensation on the pipe covered with System 2 at the end of the two hours exposure

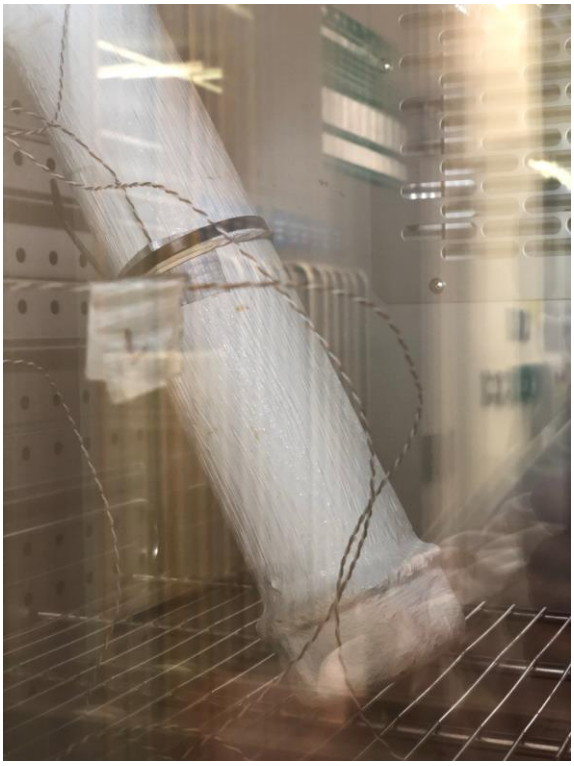

Figure 6 Condensation on the pipe sealed with RZ-Ecoseal between 5 and 20 min from the start of the exposure

Project Manager:  Date: 07 May 2019

& Report Author Dr V. Starinieri

Checked by:  Date: 07 May 2019

Prof F. O'Flaherty

Results

The results of the tests are as below.

Sample	Thermal conductivity (W/mK)
1	0.15207

Project Manager:  Date: 01 May 2019

& Report Author Dr V. Starinieri

Checked by:  Date: 01 May 2019

Prof F. O'Flaherty

These results are in line with the temperature data plotted in Figure 3, which shows that the surface of the pipe sealed with RZ-Ecoseal reaches a temperature above the dew point at around 17 min from the introduction of the pipe in the chamber. The observed condensation disappeared at about 20 min due to the rapid increase of the temperature of the pipe surface. Figure 3 also shows that the temperature of the surface of the pipes covered with Systems 1 and 2 stays below the dew point until about 106 min from the start of the exposure and condensation was still observed at 120 min due to the slower increase of their surface temperatures.

Conclusions

The test carried out demonstrated that at the temperature and relative humidity conditions maintained in the chamber (20 °C and 60% RH):

- condensation occurs on the surface of the pipe sealed with RZ-Ecoseal between 5 and 17 min from the start of the test and disappears at around 20 min;
- condensation occurs on the surface of the pipes covered with Systems 1 and 2 from the beginning of the exposure until the temperature of the pipe surfaces reaches the dew point at 106 min and is still present at 120 min.

Project Manager: _____ Date: 13 May 2019

& Report Author Dr V. Starinieri

Checked by: _____ Date: 13 May 2019

Prof F. O'Flaherty