BGLR 2286: Balmoral Solguard ™ UFP (extruded) Datasheet generation and full qualification to API17L ISO DIS 13628 16/17

1. Background/Objective

Aker Solutions make Flexibles (flexible riser modules) for the oil industry. These pipes perform well, however, the materials they are made of are not UV stable and the units may spend some time top side in storage prior to installation. Balmoral Comtec have proposed coating the flexibles with Solguard in order to protect them from the effects of UV radiation. Previous trials examine performance of Solguard UV protection by spray elastomer. Here, materials which could be applied to pipelines by extrusion are investigated.

Two thicknesses of MPD 494A CD141RM440 extruded Solguard were delivered for testing- 0.5 mm and 0.8 mm in a long, narrow roll. ISO 37 and ISO 34 test pieces were punched out and tested on the tensometer using the standard methods. These original samples were produced via a white pre-compounded material.

Further samples of Solguard material were sent in by the suppliers a few weeks after this original shipment. This contained a different version of MPD 494A CD141RM440 - MPD 494 A AG9550 which had been made using a white master-batch to obtain the colour and a new grade MPD00492 (EG100 wht) which was produced from a white pre-coloured compound. The supplier suggested it may be worthwhile testing all 3 samples in order to see a comparison of performance between the different grades as well as between film that has been produced using a master-batch versus film which has been pre-compounded.

As far as possible, all three samples were qualified. The MPD 494A CD141RM440 samples were limiting due to their size. The width of the roll was not sufficient to perform abrasion and there was not enough to perform all tests. The Technical Manager rated the importance of each test to ensure the most important were performed.

For the purpose of this report, the original MPD 494A CD141RM440 roll samples were punched and both thicknesses combined to be used in its qualification. Both thicknesses varied so much along the width of the sample, there was little point in separating them.

2. Conclusion/ Discussion

In conclusion, although all three types of Solguard show similar properties, MPD00492 EG100 shows more favourable results. In general, it is the strongest of the three, it does not distort or discolour when exposed to long term ageing or elevated temperatures and has the higher specific heat capacity. It shows the lowest water ingress at all temperatures as well as the lowest unaged and low temperature abrasion loss. One issue with this material was the negative water ingress 40 °C experienced at 97 days. This should be re-tested for assure the material is not leaching into the water.

An accurate modulus was attempted using ISO 527 samples. The samples however were too thin and the extensometer caused the samples to be stretched to one side. This resulted in distorted

Trial Number:	2286	Trial Start Date:	03/03/2014	Trial End Date:	14/10/2014
Trial/Testing Carried Out By:	Eleanore Stephen				
Signed: (Author)			**Approved:**		

and un-reliable end results which could not be reported. The graphs are available for inspection from the Technical Department.

Table 1 shows each Solguard type tested un-aged at 23 °C. As is shown, there is little difference between the three types. MPD00492 EG100 has a slightly higher tensile stress at break (MPa) while MDP494A CD141RM440 has a higher elongation at break (%).

Figure 1 shows both MPD00492 EG100 and MPD494A AG9550 have very similar results over a varied temperature range. When looking at tables 2 and 3 which show tensile stress at break and elongation, at 90 °C MPD00492 EG100 shows an advantage over MPD494A AG9550. The tear results continue to show that advantage at 4, 23, 70 and 90 °C.

When looking at the results gathered from UV ageing in figures 4 and 5, it can be seen that there is very little difference between MPD00492 EG100 and MPD494A AG9550. MPD00492 EG100 shows higher tensile stress at break (MPa) at all intervals of UV exposure when compared to both MPD494A AG9550 and MPD494A CD141RM440. MPD00492 EG100 and MPD494A AG9550 show higher tensile stress results when compared to MPD494A CD141RM440. When comparing all three materials for elongation at break over UV exposure time, they are again very similar.

Results obtained through hot-wet ageing at 55 °C showed that all 3 types gave consistent results up to 14 days ageing. After this time the tensile stress at break is greatest for MPD494A CD141RM440. It however shows lower elongation at break than the other two types which continue to show similar results. This can be seen in figures 6 and 7.

It should be noted that when raised to 90 °C, MPD00492 EG100 held a constant shape. MPD494A AG9550 and MPD494A CD141RM440 distorted at high temperatures. When they were aged at high temperature, they became discoloured and warped. This can be seen in figure 8. One of the MPD494A AG9550 water ingress samples also became distorted at 70 °C.

Table 13 and figure 9 shows the water ingress results for MPD00492 EG100. Water ingress at 4, 20, 55 and 70 °C sits between 0.76 and 1.08 % after 97 days. At 90 °C after 97 days, the sample is sitting with a 1.83 % increase in mass. At 40 °C the sample appears to have a reduction in mass by 0.17 % which could possibly be as a result of leaching however as this is not the case at higher temperatures, it is more likely an issue with the results gathered.

Table 14 and figure 10 shows the water ingress results for MPD494A A9550. Water ingress at 4, 20, 40 and 55 °C after 97 days is between 0.87 and 1.46 %. At 70 °C water ingress increases to 1.46% after 97 days. At 90 °C it's 7.73 %.

Table 15 and figure 11 shows the water ingress results for MPD0494A CD141RM440. Water ingress at 4, 20, 40 and 55 °C after 97 days is between 0.95 and 1.35 %. At 70 °C water ingress is 2.19 % and at 90 °C it's 6.40 %.

It can be concluded from the water ingress results, - pages 12-14- MPD00492 EG100 would be the most appropriate material to use especially if the material was experiencing temperatures up to 90 °C. It may be prudent to repeat the water ingress testing to see if a weight loss can be shown again at 40 °C.

Abrasion was initially carried out using CS-10 wheels and 1000 g weights. This is typically adequate for softer materials. In this case however, the abrasive cycles resulted in no reduction in mass. H-22 wheels were substituted in order to apply a more abrasive force on the Solguard material. In figure 16, the abrasion results show MPD00492 EG100 to be beneficial over MPD494A A9550 when unaged and at lower temperatures. When the samples have been aged in 55 °C water until full saturation MPD494A A9550 shows lower percentage abrasion loss (%).

Table 17 and figure 12 shows the specific heat capacity of the three Solguard types. MPD00492 EG100 shows the highest result trend followed closely by MPD494A A9550 then MPD494A CD141RM440.

3. References

-CTMI-1-051 - Tensile Strength & Modulus of Elasticity Testing of Polyethylene, TSS, Solid Pure Syntactic & Epoxy Based Materials.

-CTMI.1.062 Tensile Testing of Elastomeric Material.

-CTMI-1-059 Hardness Testing of Elastomeric and Rotationally Moulded Materials.

-CTMI.1.088 Tear Strength Testing of Elastomeric Materials.

-CTMI-1-054 - Density Testing of Solids.

-CTMI.1.89 Work Instruction for the Determination of Specific Heat Capacity.

-BGLR 2295: Report on Castable and Sprayable Solguard. KJT January 2014 Trial.

4. Equipment

-TECH 214 - Instron Tensometer for tensile testing

-TECH 028 – Vernier Callipers

-TECH 031 – Durometer

-TECH 142 - 10 tonne Strong Press Arm

-TECH 051 - Gas Pycnometer

-TECH 537 – Accelerated weathering chamber

5. Procedure

Two thicknesses of extruded Solguard ™ were delivered for testing as tensiles. 0.5 mm and 0.8 mm thick ISO 37 and ISO 34 test pieces were punched out from the extruded Solguard ™ material. Both were tested on the Tensometer using the standard methods. The jaws of the tensometer had to be rotated in order to accommodate the thin material allowing ~~it~~ the extensometer to be attached to the gauge.

As far as possible, all three samples were tested for Hardness, tensile capabilities at various temperatures, ageing in a water bath at 55 °C, UV resistance, Water Ingress and Abrasion.

Samples aged in the water bath – including abrasion samples- were cooled for 24 hours in room temperature water before being dried off and immediately tested.

Samples removed from the UV chamber were allowed to cool for 24 hours before being tested.