The Effect of Biodiesel on Selected Materials is Evaluated.

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In the past years we have seen an increase of the demand of consumption of environmental friendly fuels like biodiesel. At the Technical Centre in Matrix we have now completed an extensive work on materials behaviour in contact with biodiesel. We have assessed XL400 (the cross-linkable PE grade) and developed 2 specific LLDPE grades like XP9107 and XP9108. We have analysed their behaviour when they were in contact with biodiesel at 10% and 100% - B10 and B100.

What is Biodiesel? And Why

Biodiesel is a diesel replacement fuel that is manufactured from vegetable oils, recycled cooking greases or oils, or animal fats. Those oils are renewable. The biodiesel manufacturing process converts oils and fats into chemicals called alkyl esters, or biodiesel. Blends of biodiesel and conventional hydrocarbon-based diesel are products most commonly distributed for use in the retail diesel fuel marketplace. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix: fuel containing 10% biodiesel is labeled **B10**, while pure biodiesel is referred to as **B100**. An often mentioned incentive for using biodiesel is its capacity to lower greenhouse gas emissions (CO2) compared to those of fossil fuels. That's why they are becoming so popular.

Test Method

The biodiesel used in this study is made from oilseed crops. Samples of Revolve XP9107 (0.939/3.5), XP9108 (0.939/4.0), and black XL400 (cross-linkable PE) were rotomoulded to achieve the optimum moulding conditions by using a Ferry RS190 carousel machine. A shot weight of 1.25kg was used yielding a part with a wall thickness of 3mm. Specimens were placed in tubes which were immersed in a water bath at controlled temperature to accelerate the time in which any effects would be observed.

The total mass of the specimens in each tube was measured before the test began. At intervals specimens were removed from the tubes, washed with cold water and left to stand for some hours. After this period the mass was measured again to assess the absorption. The test ran for over 1000 hours at 50 °C. Then variation of the sample mass along the conditioning period was calculated. Tensile properties and a cold impact test are also reported.

Mass Variation

The increase in mass of the specimens varied with the time that they were exposed to the B10 biodiesel mixture is plotted in figure 1 and to the B100 in figure 2.

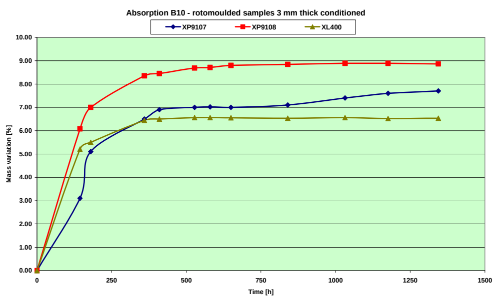

Figure 1 – Mass variation B10 at 50 °C

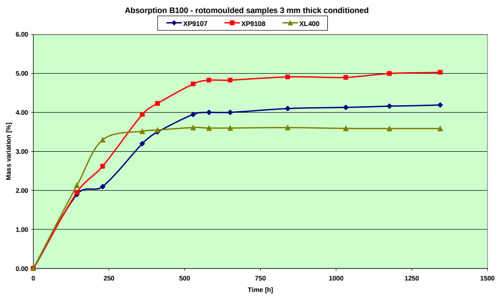

Figure 2 – Mass variation B100 at 50 °C

In both cases XL400 absorbs less biodiesel.

A comparative analysis on the effect of the conditioning temperature is plotted in figure 3. The analysis is carried out only on XL400.

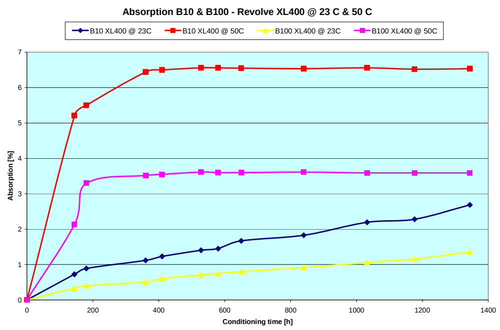

Figure 3 – Mass variation B10 & B100 @ 23 °C & 50 °C

As it can be seen in figure 3, the conditioning temperature does accelerate the absorption of the biodiesel of the material tested – XL400. At room temperature 1000 hours is a period not enough to achieve a plateau.

Tensile properties

The following 2 graphs show the results of the tensile test. Both sets of data show the same trend, the difference in results between the 2 solutions is achieved within the first 200 hours of the test. This difference is generally maintained for the remainder of the test. The 10% biodiesel solution has a greater detrimental effect on the tensile properties than the 100% solution.

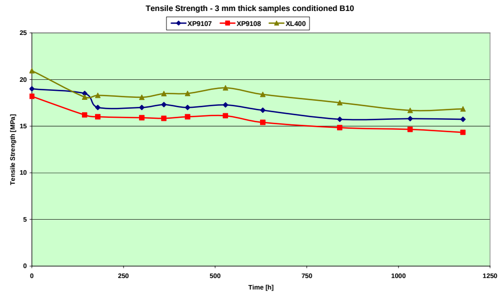

Figure 4 – Tensile Strength B10

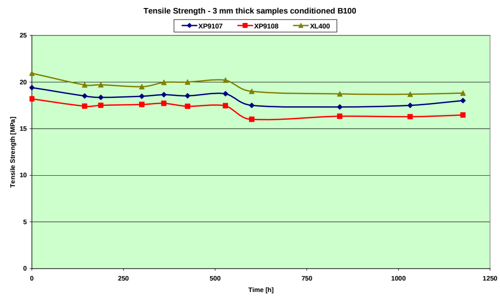

Figure 5 – Tensile Strength B100

Elongations at break test results are also reported at B10 and B100 biodiesel concentration.

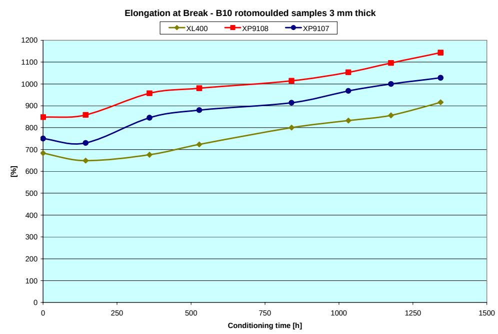

Figure 6 – Elongation at Break B10

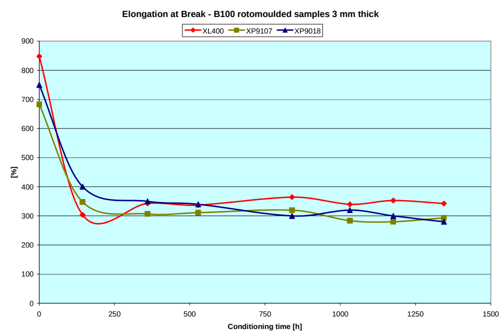

Figure 7 – Elongation at Break B100

As it can be seen in figure 6 and 7, the effect of the material performance depends on the concentration of biodiesel. At B10 (10% biodiesel and 90% diesel) it has been registered an increase of elongation at break due to the plasticizer effect of the diesel. At B100 (100% biodiesel) the graph shows a reduction of performances for all of the materials just after 200 hours. After 200 hours of conditioning the elongation at break remains constant for all of the grades without a significant difference between them.

Impact Performance

125mm square and 3 mm thick plaques were cut from rotomoulded hexagonal bins. Half of these were placed into a container filled with B10 and the other half into a container filled with B100. At intervals sets of 12 plaques were removed from each container. They were washed with cold water and dried to remove excess fuel. They were left at room temperature for 24 hours before being placed in a freezer for a further 24 hours before being impacted. Impact testing was performed in line with the ARM regulation (cold temperature falling dart impact method). Impact results are so reported.

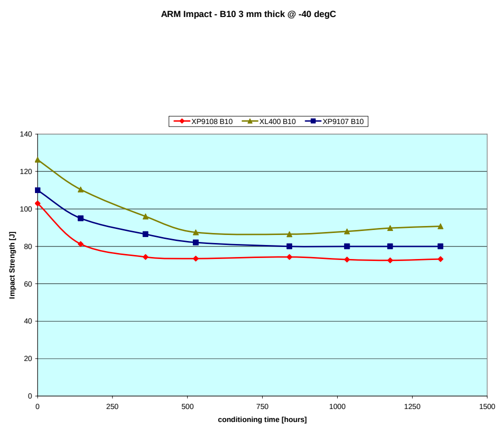

Figure 8 – ARM Impact B10

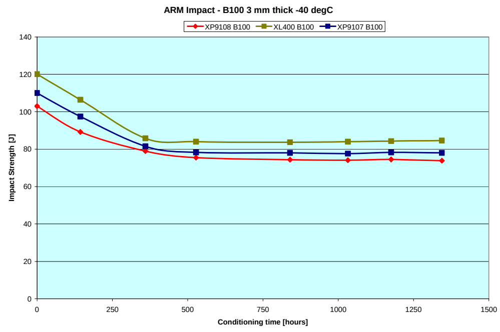

Figure 9 – ARM Impact B100

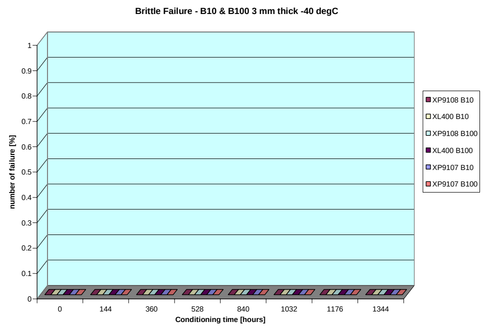

Figure 10 – Brittle failure B10 and B100

As it can be seen in the graphs, B10 and B100 have the same effect on the materials impact performances. The major reduction effect is seen before 200 hours of conditioning. After 200 hours the impact results are constant for all of the conditioning time. It is also interesting to note that all grades at all time they break in ductile mode.

Final Comments and Conclusions

This research shows that the effect of biodiesel on selected grades XP9107, XP9108 and XL400 is in line with what we expected. Although biodiesel at B10 and B100 have not any detrimental effects on physical performance of those grades, it is evident that the selected grades behave differently. The cross-link grade XL400 is less affected by the biodiesel affect. Based on our study it does appear that biodiesel at a concentration of 10% (and 90% diesel) has a greater plasticizer effect than B100. This can be explained observing the absorption results plotted in figure 1 and 2 and the elongation at break results plotted in figure 6.

Impact results are affected in a very similar way looking the variation of impact versus the conditioning time plotted in figure 8 and 9. And for all of the grades tested it is interesting to note that no one of the impacted plaques have exhibited a brittle failure.

This study shows an analysis carried out on material samples and the effect biodiesel can have on material behaviour. However we recommend our customers to assess and evaluate the suitability of the material mentioned in this article for their applications.

For more information about this study the co-author can be contacted at *aldo.quaratino@matrixpolymers.com*.