GOPOLYMER BASED BRAKE PADS

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The challenges related to the environmental impact caused by oil-based resources have led industries to select green materials with a reduced carbon footprint. These challenges are also of great interest to the automotive industry, for example in the development of brake pads (BPs). Within BPs, phenolic resin (PR), a petroleum-derived product that is highly CO_2-impacting and hazardous to human health and environment, is commonly used as a binder. Geopolymers (GPs) are environmentally friendly materials and their application as binder in brake pads formulation has been already tested[1] in combination with PR.

RAICAM industry[2] is investigating the total replacement of PR with GP as a binder in the BPs. GP was obtained by reacting metakaolin with a potassium silicate solution. Both PR and GP were fully characterised (i.e. by SEM-EDS, DSC, TGA) and their comparison shows a higher thermal stability of GP. In fact, the degradation of PR starts around 350°C and leads to a total weight loss of 85-90%. GP has a total weight loss of 20-22%, which can be attributed to water loss.

To test the application of GP as a binder, prototypes P1 and P2 were prepared using the same formulation but adding GP to the first one and PR to the second. P1 is weaker in terms of hardness and shear strength but shows higher thermal resistance in TG analysis; instead, P2 shows higher degradation up to 600°C due to thermal instability of PR, but the prototype is harder and shear resistant.

The performance of the prototypes was carried out on a dynamometer bench by means of AK Master test[3] (involving brakes at different pressures, speeds and temperatures) and by a Block Wear test (temperature steps at 100°, 300° and 500°C). The tests were applied for both prototypes in order to have a comparative evaluation between the commercial phenolic resin and the innovative use of geopolymer in the industry.

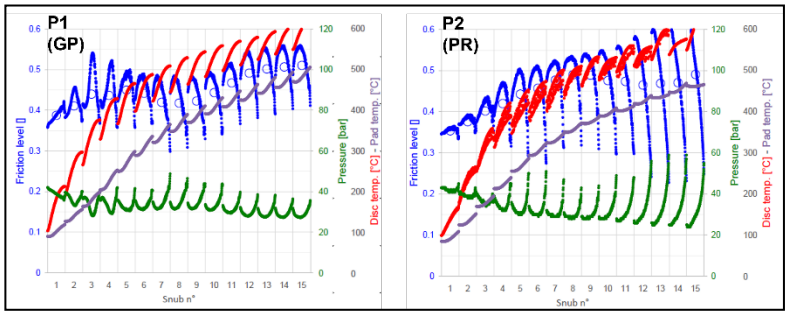

Figure 1 – Fade sections of AK Master test

As can be seen from Figure 1, P1 shows a more stable friction level than P2 in the fade sections of the AK Master (temperature above 500°C). The friction variation throughout the test is significantly greater for P2 than for P1, due to the thermal instability of PR.

In the Block Wear Test, P1 shows generally higher BPs wear up to 300°C, due to the weaker binder structure.
In contrast, wear does not change at 500°C due to the thermal stability of GP. In conclusion, the geopolymer-based formulation shows a more stable friction level than the phenolic-based one, especially at high temperature, but placed in the prototype shows a weaker structure than the phenolic resin.

Further studies are needed to improve the structural stability of GP for convenient application in the manufacture of brake pads aimed to reducing the carbon footprint and the non-exhaust emissions of brake systems caused by pad wear.

References

[1] Lee, P. W., Lee, L., & Filip, P. (2015). Friction performance of eco-friendly Cu-free brake materials with geopolymer matrixes. *Biocomposites in Automotive Applications*, *165*, 81
[2] www.raicam.com
[3] ISO26867:2009(E)