Where the Rubber Meets the Road

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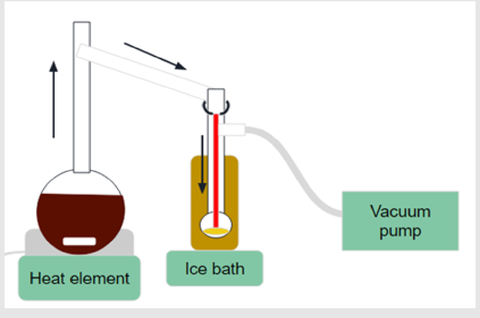
Abstract

Tire pyrolysis oil (TPO) produced by heating used tires under the exclusion of oxygen has been identified as a material with the potential to rejuvenate aged asphalt. In addition, TPOs offers a promising solution to the increasing amount of used car tires by repurposing them for a useful application. TPO samples, aged asphalt, and the mixtures of the two were analyzed with nuclear magnetic resonance (NMR) spectroscopy to determine their properties and interactions. The NMR studies reveal that TPOs and asphalt contains similar chemical compounds, which makes them easily compatible and mixable with each other.

We collected TPO samples from two different pyrolysis processes (P4 and P8) and characterized them using ^{1}H NMR spectroscopy. We compared the aliphatic and aromatic regions of TPO spectra with those of RTFO and PAV aged asphalt binder to assess their compatibility.

Vacuum distillation



A labeled diagram of the distillation setup.

Picture of the reservoir used in study

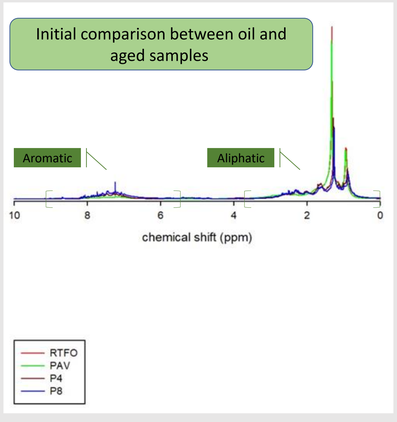
Fractional vacuum distillation was used to separate TPOs into its components. The more volatile compounds of TPOs were extracted at temperatures between 100 °C and 150 °C, while the non-volatile fractions were collected to treat the aged asphalt.

Examples of pavement failure

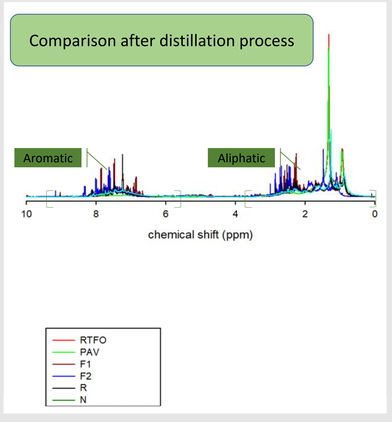
Source: https://www.maininfrastructure.com/blog/wp-content/uploads/2019/01/Slippage-Cracking.jpg

Source: https://www.maininfrastructure.com/blog/wp-content/uploads/2019/01/potholes.jpg

Graphs



"RTFO" and "PAV" are standard civil engineering aged asphalt samples, that have been aged through artificial means. While the "P4" and "P8" are the two pyrolysis oils.



"F1" and "F2" are fractions of the pyrolysis oil, "R" is the remaining sample in the collection compartment, and "N" is the neat, or unaltered pyrolysis oil.

Results

Our NMR data showed that TPO and asphalt binder have similar chemical components with more aliphatic than aromatic compounds. The distillation experiments produced distinct fractions and remaining oil with sharper NMR peaks, indicating a reduction in complexity.

Conclusion

Our study demonstrates the potential of NMR and distillation techniques for characterizing TPO and identifying compatible applications in asphalt binder. The NMR data revealed that TPO has similar chemical components to asphalt binder, making it a suitable additive for asphalt binder. The distillation experiments successfully separated lightweight components and reduced TPO complexity.

Future studies should explore the impact of other process variables on TPO properties and applications. Overall, our findings contribute to the understanding of TPO's chemical composition and provide insights into its potential applications in the energy and chemical industries.

The NMR device used to conduct the experiment.

Acknowledgments

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