



Pyrolysis oil can be easily produced from lignocellulosic biomass and waste, making it an attractive intermediate for biofuel production. However, it cannot be used directly as a liquid fuel due to its high instability.



In the context of the project, an upgrading step is necessary to improve its stability and acidity before co-processing in refineries. For this purpose, a low-temperature catalytic hydrogenation process is used to enhance the storage, transport, and usability of pyrolysis oils.

Low-temperature process benefit

The low-temperature process is less intensive and its benefits include improved storage and handling, higher energy density (by reducing water and oxygen content), reduced equipment corrosion, and being more cost-effective. The oil stabilized by this process can be effectively co-processed in a Fluid Catalytic Cracking (FCC) unit of a conventional refinery to produce fuels for the automotive, aviation, and marine sectors, which is the specific objective of the REFOLUTION project.

Pyrolysis oil stabilization tests

Pyrolysis oil stabilization tests were conducted in a fixed bed reactor, running continuously, at 70°C and 60 bar. Specific compounds, representative of groups of substances, were added to the crude pyrolysis oil, and their impact on catalyst performance was evaluated. Hydrogen conversion, oil composition, and characteristics of the used catalyst were analyzed. The potential poisons selected for this study included acetic acid, methyl-furfural, and thiophene.

Preliminary results

Tests conducted at 70°C and 80°C show a similar trend in hydrogen conversion over time, with a rapid initial decrease followed by relative stability, while at 60°C, deactivation seems different. The temperature of 70°C was chosen for subsequent experiments.



The main reaction observed in the liquids is the transformation of aldehydes into alcohols.



Sulfur-containing components present in pyrolysis oil (36 ppm) do not appear to be the main cause of deactivation. Adding methyl-thiophene to the oil did not accelerate catalyst deactivation.



The tested oxygenated compounds were also not found to be the cause of deactivation. Adding furfural showed no significant difference in catalyst stability compared to regular oil, ruling out furfural and aldehyde groups in general. Adding acetic acid (the most concentrated organic acid in the oil) resulted in lower hydrogen conversion, but, when corrected for dilution, the activity trend was similar, leading to the exclusion of carboxylic acids as well.



Analysis of the used catalyst confirmed a decrease in surface area, but the results were very similar for all tests, indicating that the added components did not have a significant effect on catalyst aging under the studied conditions.

Conclusions

Although catalyst deactivation in the low-temperature stabilization process represents a challenge for the REFOLUTION project, the specific compounds tested in this study – methyl-thiophene, furfural, and acetic acid – were not identified as catalyst poisons. Further experiments are planned to study the effect of other potentially responsible components, such as levoglucosan, di-carboxylic acids, minerals, and water.

