Introduction of biogenic carbon into sustainable aviation fuels: applying aldol condensation and selective hydrodeoxygenation technologies to oxygenated bio-intermediates

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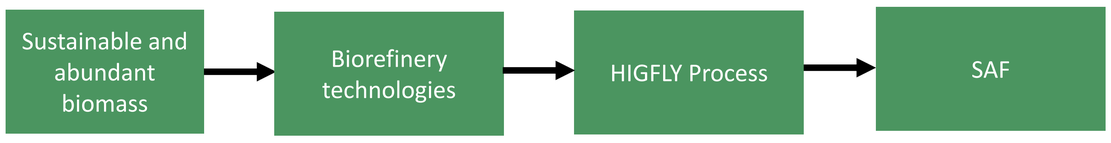
HIGFLY – developing sustainable aviation fuels

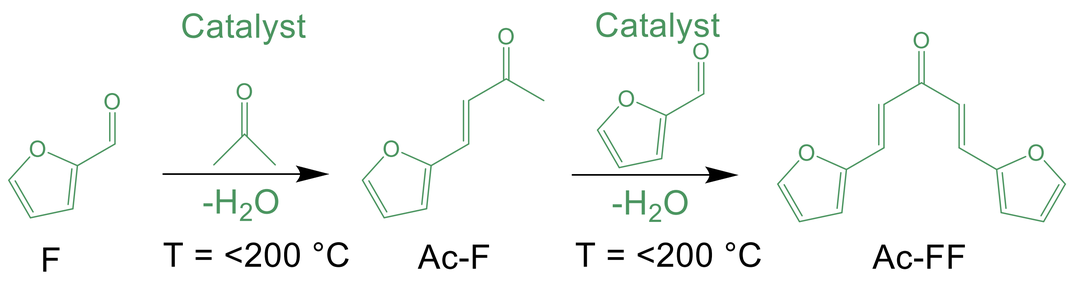
Within the fuel sector, aviation is the fastest growing greenhouse-gas emission source and most difficult to decarbonise.[1] Alternative technologies and feedstocks are essential to meet global demand whilst achieving 2050 fly net zero targets,[2] with chemo-catalytic routes considered attractive given their potentially high carbon yield.

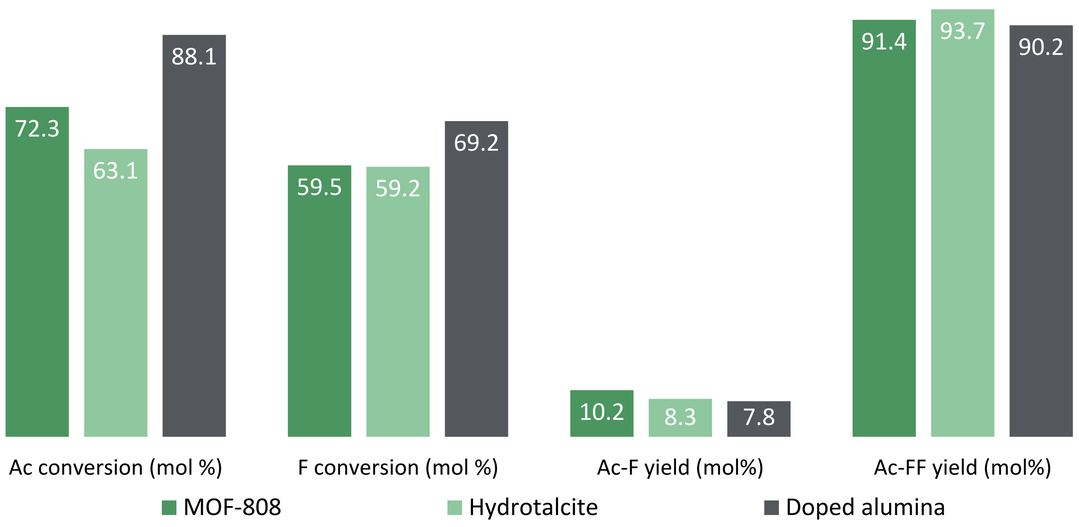
The aim of the H2020 HIGFLY[3] project is to develop sustainable aviation fuel (SAF), from second generation feedstock, which mitigates the environmental impact of aviation.



Aldol condensation of bio-derived feedstock

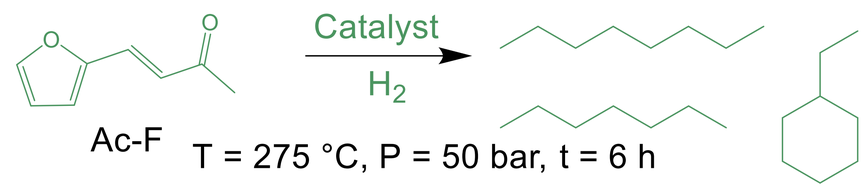
Furfural, derived from C5 sugars, has undergone catalytic conversion through aldol condensation reactions with bio-derived ketones to produce oxygenated condensate compounds of increased carbon number. A series of catalysts were investigated based on the conversion of furfural and acetone and furfural and cyclopentanone to the desired double-condensate. Metal-doped alumina, MOF-808 and hydrotalcite catalysts were found to be the most active and selective.

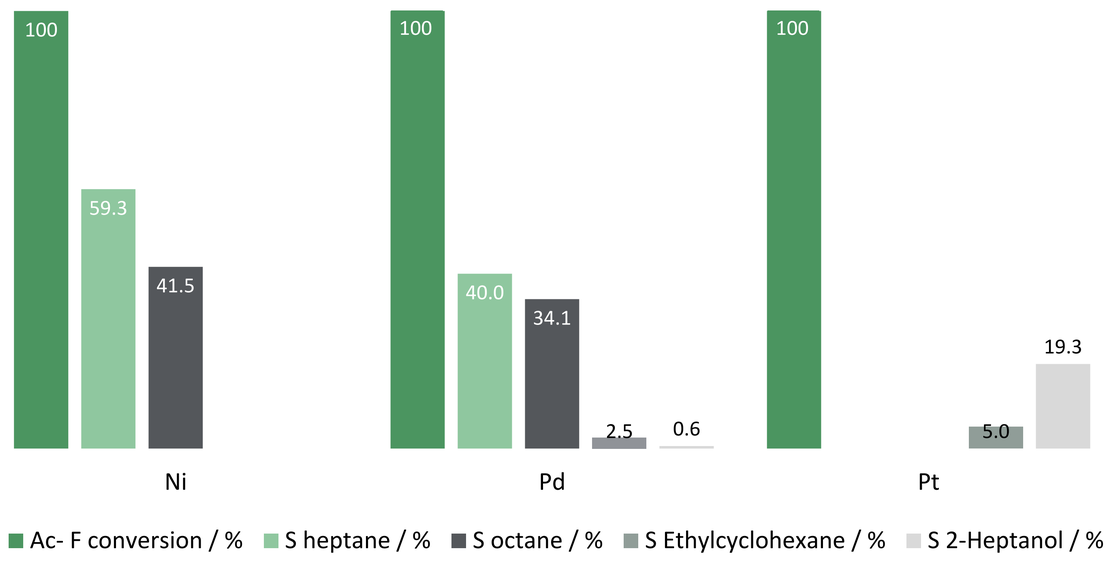




Hydrodeoxygenation of model condensate compounds

Model condensate products undergo a hydrodeoxygenation (HDO) treatment, which can utilise renewable hydrogen, to yield compounds that can be used as drop-in SAF. Using furfural-acetone single-condensate as a model compound, HDO catalysts investigated have included both nickel-based and PGM-based materials, with the most-active material achieving >98% deoxygenation and >90% Carbon yield, producing SAF molecules of both linear and cyclic nature.





SAF product composed of Linear and cyclic molecules

Overall a SAF product has been demonstrated through catalytic aldol condensation of bio-derived feedstock followed by hydrodeoxygenation to yield linear and cyclic molecules in high yields. Cyclic molecules could add value to SAF blends since they may have the potential to swell the seals found in the fuel systems of aviation aircraft.

References

[1] European Parliament Emissions from planes and ships: facts and figures (infographic) webpage. https://www.europarl.europa.eu/news/en/headlines/society/20191129STO67756/emissions-fromplanes-and-ships-facts-and-figures-infographic (accessed 6/10/23).

[2] IATA Fly Net Zero webpage. https://www.iata.org/en/programs/environment/flynetzero/ (accessed13/10/23).

[3] HIGFLY, higfly.eu (accessed 29/04/24)

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