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Novel Reactivation Allows Effective Reuse of Nafion Super-acid Nano-catalyst

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Abstract

An alternative clean regeneration method to calcination on special grade resins, *i.e.* Nafion, is introduced. The reactivation strategy makes use of advanced oxidation processes (Fenton and *non*-Fenton) to remove the organic deposits generated from sequential catalytic cycles. Hot water treatment was considered as a control case to evaluate the extraction capacity of water itself at the oxidative conditions. Advanced oxidation processes were effective in reactivating the Nafion SAC-13 resin, which also rendered a cleaner and more sustainable reactivation process. Beta zeolite was studied as model fouled system prior to the Nafion SAC-13. Even though zeolites are considered to be thermally stable, this approach can be used when a full preservation of the acid sites is required. As far as resin Nafion SAC-13 is concerned, organic species deposition was found to be responsible of a selective poisoning of the sulfonic groups in Nafion, with a consequent drop in catalytic activity on the octanoic acid esterification with methanol. The Nafion resin was reactivated either with H_2O_2 or with Fenton chemistry; the resin remained stable under these oxidative conditions, which is the benefit of the presented *non*-thermal methodologies as compared to calcination. The optimal method showed full recovery of the initial activity and 90% of the final conversion. This methodology seems attractive for a whole-range of organic catalytic reactions, including those related with biomass valorization, that require the use of highly acidic catalysts, such as acidic resins, in liquid phase reactions.

Highlights

- Alternative mild regeneration method to calcination for superacid resin-catalysts.
- Fenton and *non*-Fenton oxidation remove organics after reaction.
- Superb reactivation efficiency on the esterification of octanoic acid with methanol.
- Cleaner process than hot-water extraction in terms of residual liquids' TOC.

Graphical abstract