

Activation and Regeneration of Sponge Nickel Catalysts

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Abstract

A general method for the regeneration of commercially available sponge nickel catalysts is presented. The developed procedure preserves or increases the activity of used sponge nickel catalyst by *in-situ* catalyst treatment under mild conditions [1]. The catalyst is treated with the activator ABX, which is inexpensive, non toxic and the consumption of which depends on the type of reaction. The scope of the regeneration procedure was tested in several model hydrogenation reactions with sponge nickel as the standard hydrogenation catalyst. The results show that the regeneration procedure can be applied advantageously in the hydrogenation of various functional groups. The regeneration procedure must, however, be appropriately tuned for each hydrogenation reaction.

The Principle of the Regeneration Procedure

- in-situ treatment of the catalyst with activator ABX
- treatment conditions: room temperature, stirring in solvent
- activator concentration: 0.1-10 wt% of wet catalyst weight

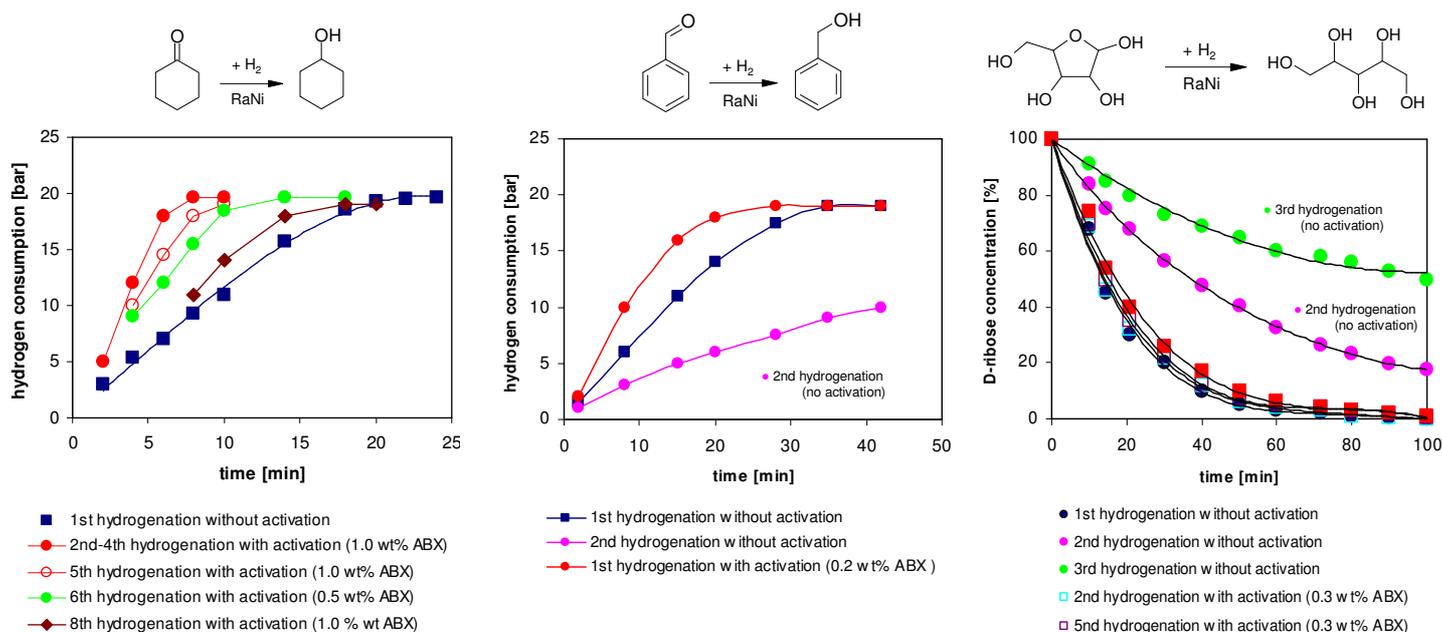
Reduction of Various Functional Groups

- ketones to alcohols (cyclohexanone)
- aldehydes to alcohols (benzaldehyde)
- saccharides to polyols (D-ribose)
- nitriles to amines (acetonitrile)
- reduction of C=C bond (diethylfumarate)
- nitro compounds to amines (p-chloro-nitrobenzene)
- reductive amination (benzaldehyde with methyl amine)

Examples of Catalyst Regeneration

Reaction conditions: batch process; <55°C; <20 bar; catalyst: sponge nickel (Degussa); S/C_{wet} ≥ 2; 0.2 mol substrate; 70-120 mL solvent (ethanol, water)

Re-activation conditions: amount of the activator ABX: 0.1-1 wt% of wet catalyst, stirring in ethanol for 30 minutes



Results

Activity: The catalyst treatment with the activator ABX preserves or increases catalyst activity in various hydrogenation reactions.

Activator concentration: Only small amounts of the activator ABX are required; there is an optimal value, at which the maximum catalytic activity is obtained and, with increasing activator concentration (above optimum), catalyst activity decreases.

Mode of action: The activator removes the organic residues deposited on the catalyst after the reaction and, at the same time, it increases hydrogen availability.

Catalyst recycling: It is possible to re-use the catalyst up to 20 times.

Large scale application: Hydrogenation; 2000-litre autoclave; catalyst recycled 20 times [2].

Conclusions

A new method of re-activation and regeneration of sponge nickel catalysts was developed. The main advantages of this method are the following:

- **Significant catalyst savings:** catalyst can be re-used up to 20 times
- **Improved or preserved catalytic activity:** shorter reaction times; no or minimal decrease in conversion
- **Improved selectivity:** fewer by-products; higher yields
- **Further technological advantages:** easy applicability and increased safety of the hydrogenation process

References:

[1] <http://www.ranido.cz>; [2] Dr. Ivan Hlaváček, Interpharma Praha a.s., Komofánská 955, 143 10 Praha 12, Czech republic