Steam reforming of model tar compounds over nickel catalysts prepared from hydrotalcite precursors

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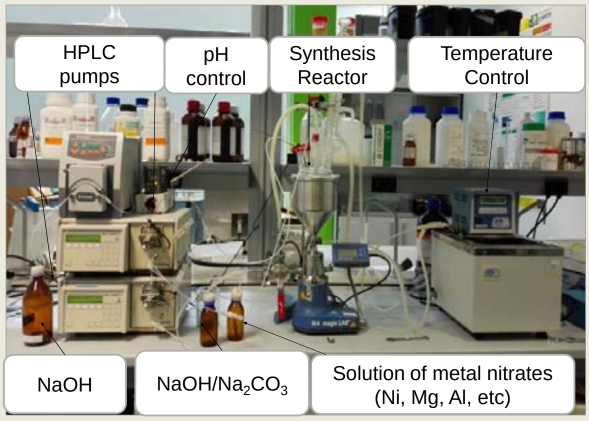
Introduction

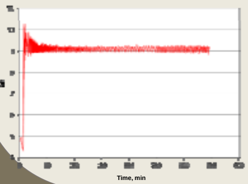
Biomass gasification is regarded as a promising technology in the development of a worldwide sustainable energy system. The major product in this process is a combustible gas, also called syngas. However, this syngas also contains some impurities, such as organic tars, which need to be removed before its application. Among the different strategies to remove tars from the gas, catalytic steam reforming by Ni-based catalysts, seems to be a promising alternative from an economic and technical point of view. By the other hand, hydrotalcite-like compounds (HTs) are layered double hydroxides, that can be thermal treatment to give a stable, high surface area, homogeneous mixture of oxides with very small crystal size, which by reduction results in high metallic dispersion that could contribute to reduce carbon deposition. In this context, the objective of this work is to study steam reforming of model tar compounds over nickel catalysts prepared from hydrotalcite precursors and doped with different metals, during the conversion of three different aromatics: benzene, toluene and phenol.

Results & Discussion

1. Synthesis of hydrotalcites

Synthesis by constant pH-controlled co-precipitation





- Stirring: 10.000 or 20.000 rpm
- Aging temperature : 60 or 100 ºC
- Aging time: 17 h
- Reaction time: 2 or 4h
- Dosing speed: 0,3 or 0,6 ml/min
- pH: 9

Aging at 60 or 100 ºC

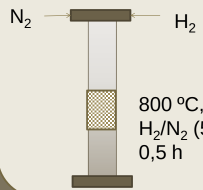
Filtration and washing
Conductivity<0,5mS/cm

Drying at 100º C and grinding

Calcination at 800 ºC

Heating rate: 5 ºC/min, up to 800 ºC

Hidrogenation



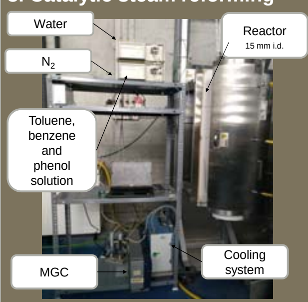
800 ºC,
H_2/N_2 (50%/50%)
0,5 h

2. Hydrotalcites obtained

$(Ni^{2+},Mg^{2+},Co^{2+},Cu^{2+})_{1-x}\ (Al^{3+}, Fe^{3+},La^{3+})_x\ (OH)_2\ (CO_3)_{x/2}\ .nH_2O$ (x = 0,32)

Ref	Metals	Molar rate
HTNix (x=17,22,27,32, 37,42,47,52)	Ni/Mg/Al	52-17/16-51/32
HTNi47Co5	Ni/Co/Mg/Al	47/5/16/32
HTNi42Co10	Ni/Co/Mg/Al	42/10/16/32
HTNi47Cu5	Ni/Cu/Mg/Al	47/5/16/32
HTNi42Cu10	Ni/Cu/Mg/Al	42/10/16/32
HTNi52Fe5	Ni/Fe/Mg/Al	52/5/16/27
HTNi52Fe10	Ni/Fe/Mg/Al	52/10/16/22
HTNi52La5	Ni/La/Mg/Al	52/5/16/27

3. Catalytic steam reforming



Conclusions

The Ni/La/Mg/Al and Ni/Fe/Mg/Al catalyst showed high catalytic performance in the steam reforming of tar in terms of catalytic activity, suppression of coke deposition, and catalyst stability.

Ni/Co/Mg/Al bimetallic hydrotalcite derived nanocatalyst increase activity and stability due to highly dispersed nano Ni particles.

The Ni/Cu/Mg/Al bimetallic catalyst exhibited much higher catalytic activity, coke resistance and higher oxygen affinity, than the corresponding monometallic Ni/Mg/Al.

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