

Steam reforming of biomass tar over hydrotalcite catalyst.

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Introduction.

Gasification of biomass into syngas is expected to be used in various fields such as power generation and the production of hydrogen and liquid fuels (e.g., methanol and Fischer–Tropsch oil) (Chen, 2015). However, this syngas also contains some impurities, such as organic tars, which need to be removed before its application.

Tars are the main contaminants in the syngas. their content varies with the type of gasifier from 5 to 100 g/N m³. Their maximum allowable content depends on the end use and usually is 5 mg/N m³ in gas turbines and 100 mg/Nm³ in internal combustion engines. (Artetxe et al. 2017, Anis & Zainal, 2011)

Tars are a complex mixture of aromatic and oxygenated hydrocarbons that may cause several operational problems, Among the different strategies to remove tars from the gas, catalytic steam reforming is a useful technic.

By the other hand, hydrotalcite-like compounds (HTLCs), are anionic clays, that represent a class of layered materials with chemical composition expressed by the general formula $[M^{II}_{1-x}M^{III}_x(OH)_2]^{x+}[A^{n-}_{x/n}\cdot yH_2O]^{x-}$ where M^{II} and M^{III} are divalent and trivalent metal cations, A^{n-} is an n-valent anion and x has usually values between 0.20 and 0.33. The M^{II}/M^{III} isomorphous substitution in octahedral sites of the hydroxide sheets results in a net positive charge, which is neutralized by the interlayers composed of anions and water molecules.

In this context, the objective of this work is to study steam reforming of biomass tar over hydrotalcite catalysts.

Material and methods.

Catalyst preparation

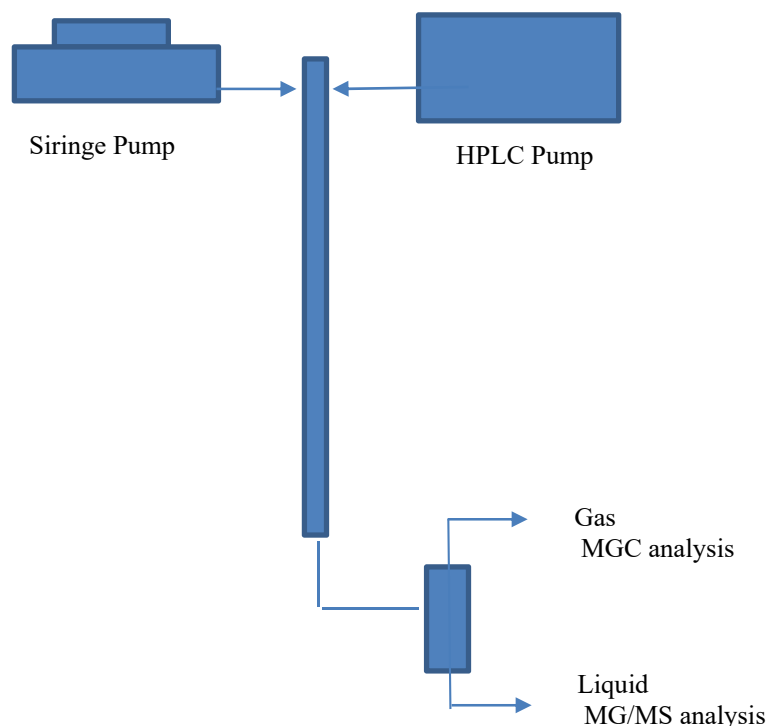
The HTLCs were prepared by constant pH-controlled co-precipitation of the nitrates of metal components. An aqueous solution of $Mg(NO_3)_2\cdot 6H_2O$, $Al(NO_3)_3\cdot 9H_2O$ and another nitrates of metal components (Ni, Cu, Co, Fe La and mixtures) was added slowly by HPLC pump into a multiple stage dispersing reactor. At the same time, an aqueous solution $Na_2CO_3/NaOH$ was added slowly by another HPLC pump into the same reactor. Both pumps used the same dosing rate (0.3 or 0.6 ml/min). The temperature was keeping constant at 60 °C. The pH of the solution was adjusted continuously to be 9-10.

The precipitate was filtered, thoroughly washed with de-ionized water until the conductivity of the filtrate was $<0.5\text{ mS cm}^{-1}$ and dried at 105 °C, over night (Mette, et al., 2016). The precipitate was ground to fine powders and then calcined in air with a heating rate of 5 °C/min until 850°C and keeping in this temperature for 2 h. The obtained material was pressed to a disk, then crushed and sieved.

Steam reforming of biomass tar

Steam reforming of biomass tar derived from biomass was carried out using a fixed-bed reactor. The reactor was made of a stainless steel tube (10 mm i.d.). The activity tests were carried out at 800 °C. The catalyst weight was 500 mg in all the experiments. Before the experiment, the catalysts were reduced in flowing H_2 and N_2 ($H_2/N_2=100/100\text{ ml min}^{-1}$) at 800 °C for 0.5 h. After the reactor was purged with N_2 , reactants were supplied through the vaporizing zone. The Steam to Carbon ratio used in all experiments was $S/C=1, 2$ and 3.

Figure 1. Reactor using in steam reforming of biomass tar



The structure of the catalysts before and after the catalytic use was studied by means of BET, X-ray diffraction (XRD), and transmission electron microscopy (TEM).

Main conclusions.

Between all the catalysts analysed, the Ni-Cu-La/Mg/Al and Ni-Co-La/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 than Ni/Mg/Al hydrotalcite catalysts.

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