Hydrogenation of phenol and benzene on nanostructurated Ru- and Pt-catalysts

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Introduction

Today in many countries there is growing interest in the production of liquid fuels and petrochemicals from bio-oil, obtained by pyrolysis of plant biomass. However, bio-oil is characterized by a high amount of oxygen-containing compounds, which limits its application as a fuel due to its high corrosivity (TAN - 100 mg KOH kg^{-1}), low mass calorific value (16-19 MJ/kg) and tendency to polymerization. Catalytic hydrotreating can solve these problems, which makes this process especially relevant.

Aims

- Synthesis of Ru- and Pt-containing catalysts based on natural aluminosilicates nanotubes;
- Study of the structure and composition of synthesized catalysts;
- Catalytic testing in the deep hydrogenation of phenol and benzene in various conditions (temperature, pressure and solvent nature)

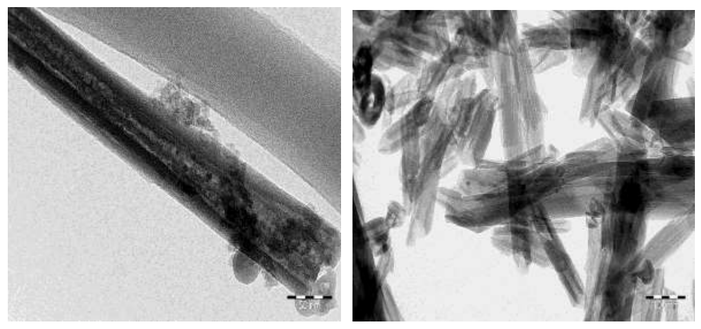
Catalytic experiments

The catalytic activity in hydrogenation of phenol and benzene on the catalysts Ru/HNT and Pt/HNT with an active component content of 2% by weight were studied. The activity of the synthesized catalysts in the deep hydrogenation of phenol was investigated at 140 °C and of benzene – at 80 °C in autoclaves at a H_2 pressure of 3.0 MPa.

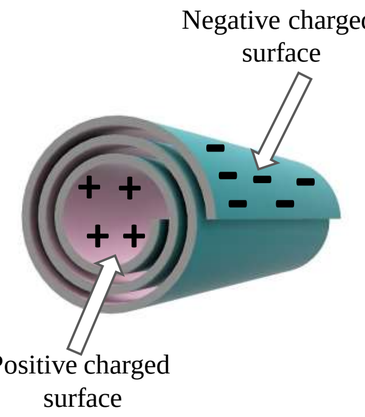
Materials and methods

Halloysite-natural aluminosilicate micro-mesoporous nanotubes formed by the rolling of the kaolin sheets.

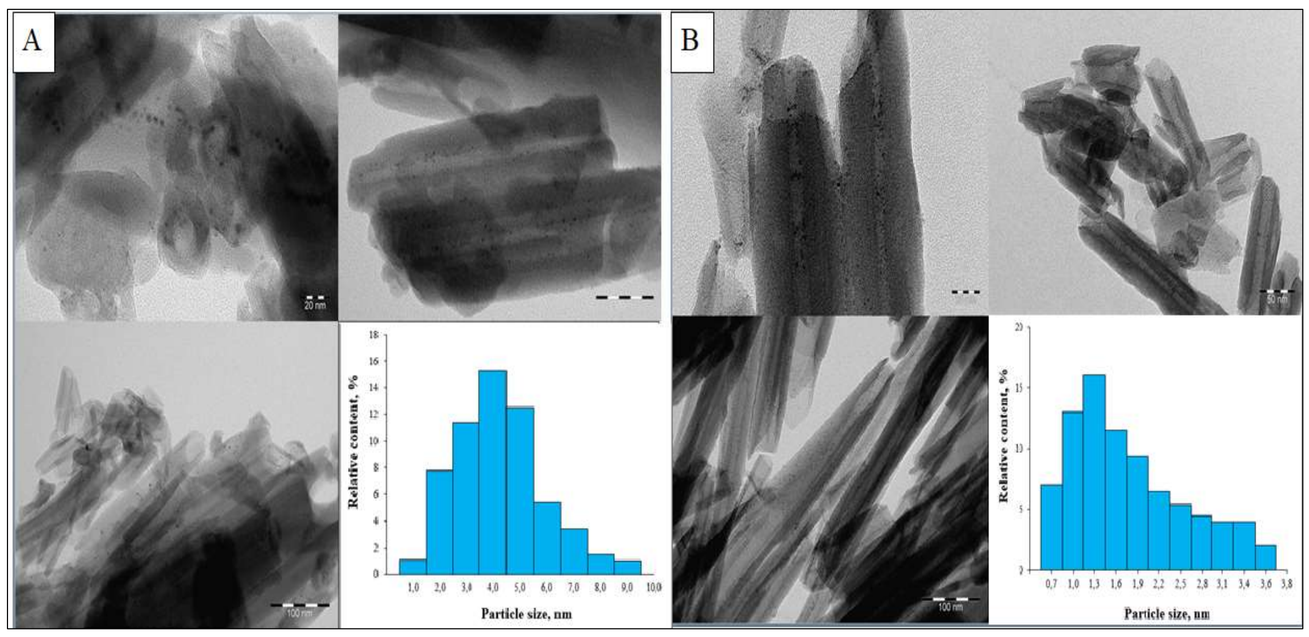
Chemical formula $Al_2O_3 \cdot 2\,SiO_2 \cdot 4\,H_2O$



TEM images of halloysite nannotubes



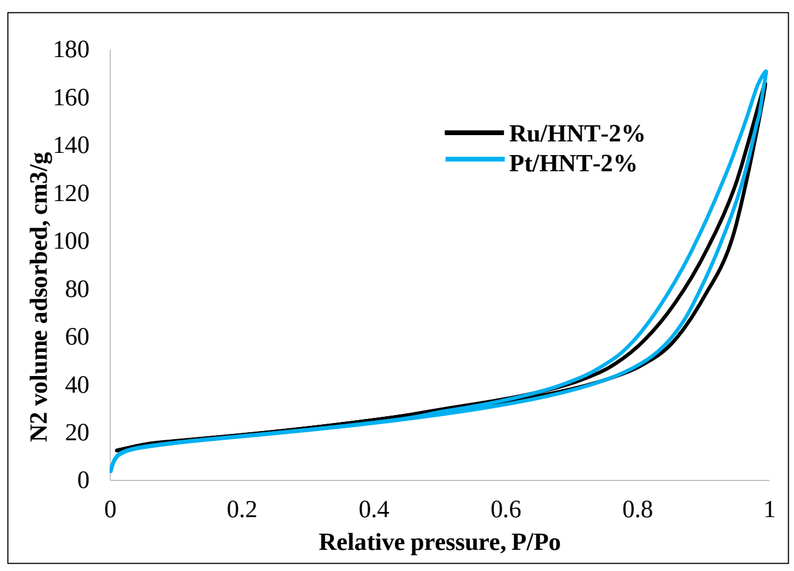
Main results:



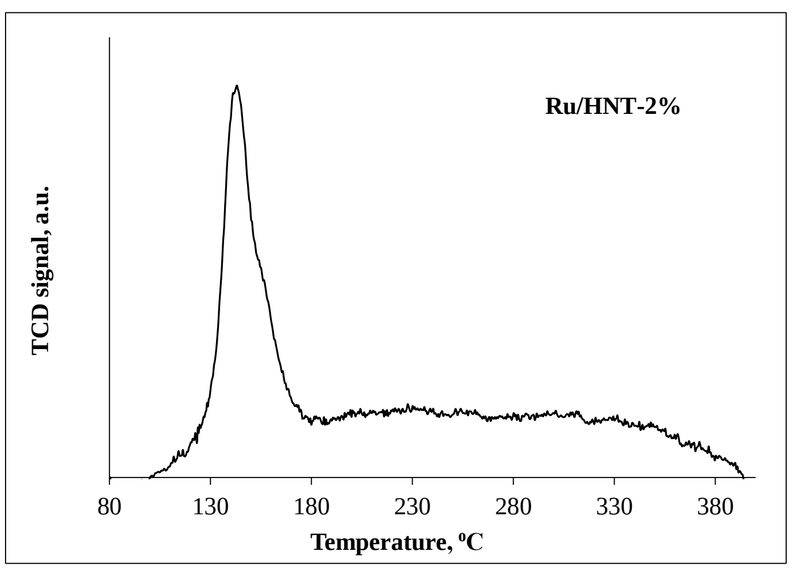
TEM micrographs and nanoparticle size distribution of Pt/HNT (A) and Ru/HNT (B) catalysts

Element content (XRF) and textural characteristics of support and catalysts

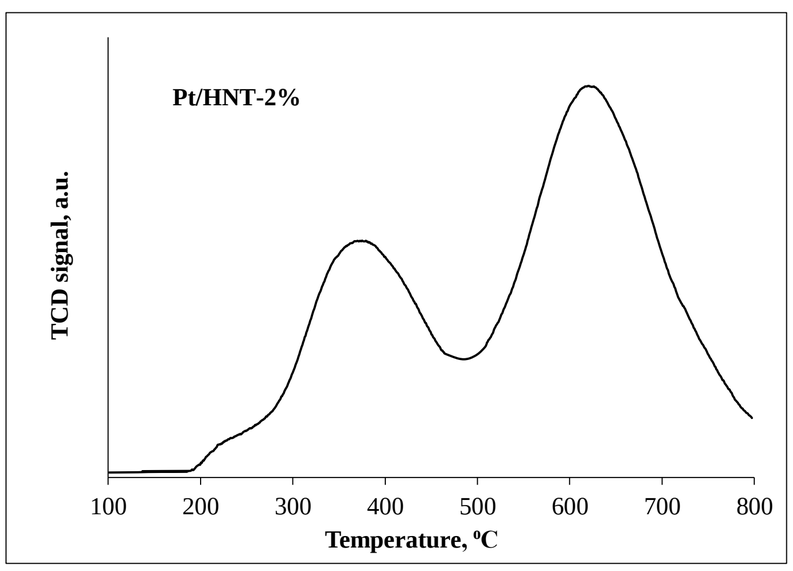
Sample	Textural characteristics			Element content, % wt.			
	S_{BET}, m^2/g	V_{pore}, cm^3/g	D_{pore}, Å	Ru	Si	Al	O
Halloysite	74	0,5	80	-	27,23	24,36	48,34
Ru/HNT-2%	59	0,32	78	1,85	26,09	24,05	48,01
Pt/HNT-2%	63	0,29	70	1,81	26,08	24,06	48,05



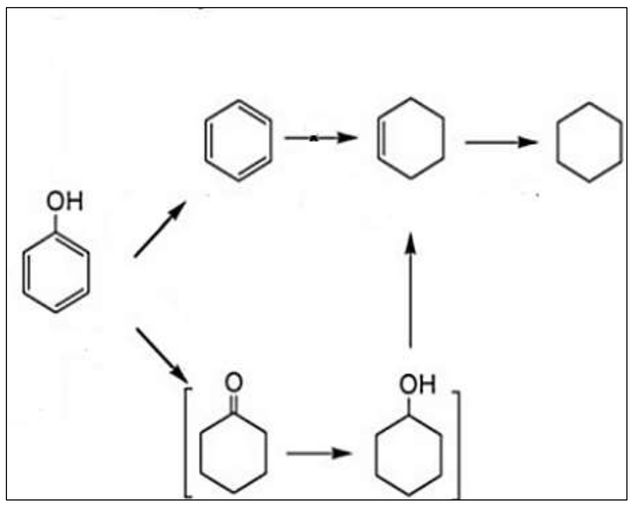
N2 adsorbtion/desorption isotherms for the Ru/HNT and Pt/HNT



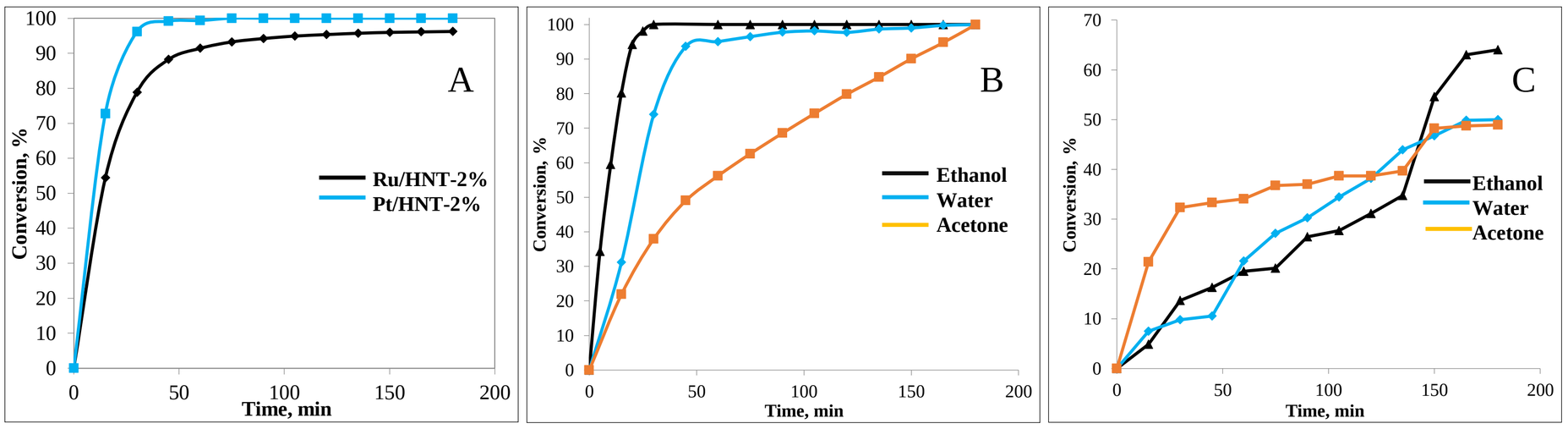
TPR-H2 profile for the Ru/HNT



TPR-H2 profile for the Pt/HNT



Possible routes for phenol and benzene hydrogenation



Catalytic hydrogenation of benzene (A) and phenol in different solvents on Ru/HNT (B) and Pt/HNT (C) catalysts

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