**Tar Removal by Catalytic Cracking in Biomass and Waste Gasification**

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**Highlights**

* Thermal and catalytic cracking of tar from biomass and waste gasification was studied
* Different types of clay based and char based cheap catalysts were characterized and tested
* Both calcined and Ni impregnated clay catalysts reduced the tar content
* Char based catalysts showed large catalytic effect in the reduction of tar

**1. Introduction**

Gasification of biomass or solid waste produces combustible gases consisting mainly of H2, CO and CO2. Air, oxygen, steam or their mixtures can be used as a gasifying agent [1]. Although much attention has been devoted to gasification in recent years, there are still a number of challenges to full commercialization of biomass and solid waste gasification [2].

One of the critical issues in biomass and waste gasification is the quality of produced gas. To be used in internal combustion engines or turbines, the gas should fulfil relatively strict requirements for gas composition, heating value and tar content. Production of fuel quality gas requires the removal of tar from the producer gas. This work deals with secondary catalytic tar cracking in the gasification of biomass and waste, using low cost catalysts. Different types of catalysts based on two different types of materials (red clay (RC), tire pyrolytic char) have been prepared by calcination (carbonization) at different conditions and/or impregnation with Ni. The catalysts were tested by using toluene and p-Xylene as model tar components and also by experiments with gasification of RDF (Refused-Derived Fuel) samples.

**2. Methods**

The catalysts were characterized by pore structure and specific surface measurement (before and after use), thermogravimetric analysis, elemental analysis and X-ray diffraction analysis. In the first step, the catalyst activity was tested by cracking of a model organic compound at different conditions. In the next step, the catalysts were used for cracking of tars in a two stage laboratory scale gasification unit, where the composition of producer gas and gas tar content were observed for different process conditions and catalyst types. As the raw material in these experiments, RDF, a fraction of municipal solid waste, MSW was used. The gas composition was measured by gas chromatography GC. Tar content of the gas was measured using a standard method based on tar capture in isopropanol and subsequent distillation at specific conditions and gravimetric measurement.

**3. Results and discussion**

Char based catalysts were thermally stabilized (carbonized) at temperatures from 800 to 1000 °C. Ni impregnated char catalysts were prepared by impregnation of carbonized char catalysts. Specific surface area of char catalysts increased from 28 m2/g to 105 m2/g due to carbonization. Char based catalysts showed large catalytic effect also in the reduction of tar in the gas from the RDF gasification. Char catalysts prepared by carbonization at 900 oC reduced the tar content of producer gas by 92.3 % compared to the non-catalytic (thermal) decomposition process.

The red clay containing mainly SiO2 and some amounts of Al2O3, Fe2O3, CaCO3, MgCO3 and others [3] had the initial specific surface area of around 100 m2/g; however, its surface area decreased by calcination up to 35 m2/g. Both calcined and Ni impregnated clays reduced the tar content of the gas up to 80 and 91.8%, respectively. An example of tar yield versus clay catalyst to RDF ratio is shown in Figure 1. Ni impregnation of both clay on char catalysts resulted in higher H2 content of the produced gas [4].



**Figure 1.** Tar yield versus catalyst/RDF
 ratio (Temperature: 800°C)

**4. Conclusions**

Calcined red clay and carbonized pyrolytic char can serve as low cost catalyst in the removal of tar from gas produced by the gasification of solid waste and biomass. Impregnation of these catalysts with Ni leads to better char removal and higher content of H2 in the gas, however it can also represent additional costs related to catalyst preparation and after use treatment.

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