INNOVATIVE APPLICATIONS OF BIOMASS GASIFICATION CHAR IN ADSORPTION AND CATALYSIS

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Small-scale gasification plants are becoming increasingly popular worldwide, with over 1700 in operation today [1]. While they are designed to produce mainly syngas, by-products such as char can pose both environmental and economic challenges. In the present work, locally sourced biomass gasification char from pilot and industrial scale gasifiers in South Tyrol, Italy, was used in adsorption and catalysis applications. Char A, Char B, and Char C were produced from industrial dual-stage, industrial downdraft, and pilot-scale downdraft gasifiers, respectively. Industrial chars were in powder form while pilot-scale char was in pellets form. In the first part of this study, the as-received three materials were tested for their ability to remove ibuprofen (IBP) and paracetamol from aqueous solutions. Moreover, the extrusion-dripping method was used to produce char-chitosan composites (Figure 1) for fixed bed adsorption tests. The tested chars had a remarkably high surface area (up to 1454 m^2/g) and high carbon content making them a suitable alternative to commercial activated carbons. Adsorption tests showed that the powder chars had a maximum adsorption capacity (q_m) ranging from 111 to 318 mg/g and 117 to 323 mg/g for IBP and paracetamol, respectively. This performance is very comparable to that of commercial activated carbons. Furthermore, char-chitosan beads showed a q_m value of 79 and 66 mg/g for IBP and paracetamol, respectively. Although characterized by slower kinetics and lower adsorption capacity, the char-chitosan beads offer a solution to handling fine powder char and enables continuous adsorption in fixed bed columns. In the second part of this study, Char C was used in dry and steam reforming of the tar generated from the same gasifier. It was the only available material for testing due to its pellets form. Investigation to implement powder chars in reforming tests is currently undergoing. Reforming tests showed a reduction in tar concentration from 2407 mg/Nm^3 to 20 mg/Nm^3 (Figure 2) and an increase in H_2 production from 15 to 26 vol% when performed with 0.18 kg/h steam for 2 h at 750 °C and a 600 g char bed.

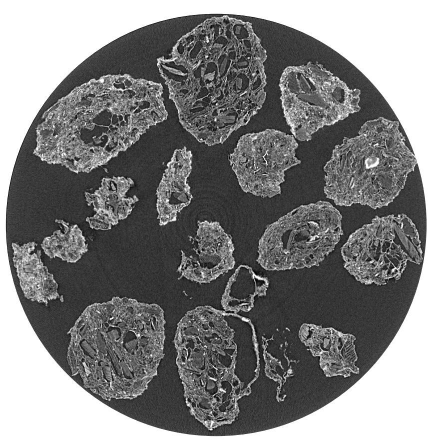

Figure 1 – Cross-section of char-chitosan beads using micro computed tomography X-ray

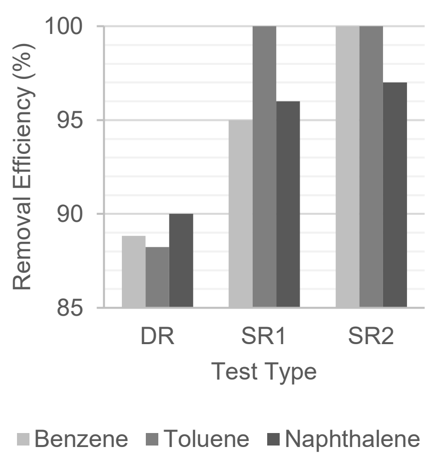

Figure 2 – Tar removal efficiency at different steam levels (DR – dry reforming, SR1 – steam reforming 1, SR2 – steam reforming 2)

[1] Hrbek J. Status report on thermal gasification of biomass and waste.2021