J Chem Eng Process Technol 2017, 8:5 (Suppl)
DOI: 10.4172/2157-7048-C1-009

Highly selective production of formic acid from complex, water-insoluble biomass using a homogeneous polyoxometalate catalyst

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Growing concerns about global warming (related to increasing CO_2 emissions) are pushing the developed countries to consider the production of chemicals and energy in a more efficient and sustainable way. In this context, the substitution of fossil raw materials by biorenewables is of particular interest. A promising approach to replace a certain part of fossil fuel combustion is the energetic use of biomass. Furthermore, catalytic oxidation chemistry of biomass is a growing field of research. The main effort is to overcome the recalcitrant nature of the feedstock by acid-catalyzed depolymerization followed by oxidative cleavage of the carbon bonds in the biomolecule. Since 2011, our group is active in exploring an alternative way to convert biomass into energy molecules. In detail, we are reporting the highly selective oxidation of a broad range of complex biomasses to formic acid (FA) using oxygen as oxidant and polyoxometalate (POM) complexes as homogeneous catalyst. The concept of oxidative conversion of complex biomass to formic acid (OxFA-process) using homogeneous catalysis can be described as a "cold and wet combustion" which is restricted to a reaction temperature of 90°C as higher temperatures would lead to a thermal decomposition of FA to CO and water. The generated FA can be separated from the aqueous reaction mixture by simple liquid/liquid extraction. Besides the mild reaction conditions and the very broad range of useable biogenic substrates, the here described method has the advantage that all thermally induced side-reactions forming gluey or solid by-products are completely surpressed under the applied oxidative conditions. Moreover, the formed FA is not oxidized further to CO_2 while all carbon from the biomass ends up as either FA or carbon dioxide.

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