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TOPIC(s) : Renewable carbon

Continuous high-pressure CO2 and H2 evolution by the decomposition of formic acid

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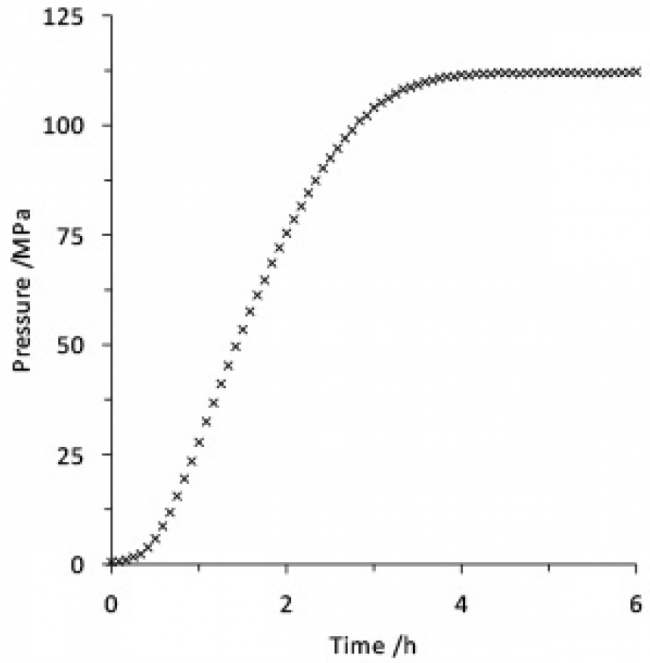
PURPOSE OF THE ABSTRACT

Formic acid is obtained from various biomass derivatives such as the synthesis of levulinic acid from 5-hydroxymethyfurfural, hydrothermal oxidation of oligosaccharides, etc. Biomass refinery is mainly focused on the synthesis of valuable organic compounds from cellulose, lignin, etc. for the replacement of many chemicals from petroleum, whereas C1 compounds such CO2, formaldehyde, formic acid, methane, methanol are not concerned as the valuable chemicals. Formic acid is well-known compound to decompose to CO2 and H2. With its properties, we concerned the formic acid as the good sources of high-pressure or supercritical CO2 and H2 without compressor or high-pressure pump and these high-pressure gases can utilize for not only the solvent as scCO2 but also the reagents such for carboxylation, hydrogenation, redustion. In our presentation, we would like to show the development of the continuous production of high-pressure CO2 and H2 over 100 MPa without any compressor (figure 1), and easy separation method from the generated mixed gases to CO2 and H2 (figure 2).

For the development of the high-pressure gas generation system from formic acid, we studied the decomposition of formic acid catalyzed by the Ir catalyst ([Cp*Ir(4DHBP)(H2O)][SO4], 4DHBP = 4,4?-dihydroxy-2,2?-bipyridine).[1] The system can generate the high-pressure gas (H2 : CO2 = 1:1) continuously with a high rate (TOF = 1900 - 2500 h-1 at 30 MPa) even at a mild temperature of 80oC for several hours. In the high-pressure conditions, Ir catalyst is deactivated gradually, we further developed durable catalyst under high-pressure conditions, and the catalyst can generates high-pressure CO2 and H2 for further longer time.[2] We also demonstrated the high-pressure H2 gas separation from the generated gas simply by just cooling the gas to change the supercritical phase to gas-liquid phase. This system has a potential to be used as a simple and easy to handle system for the generation of high-pressure CO2 and H2 and these high-pressure gases can used for the variety of system such as fuel cell vehicles.

FIGURES



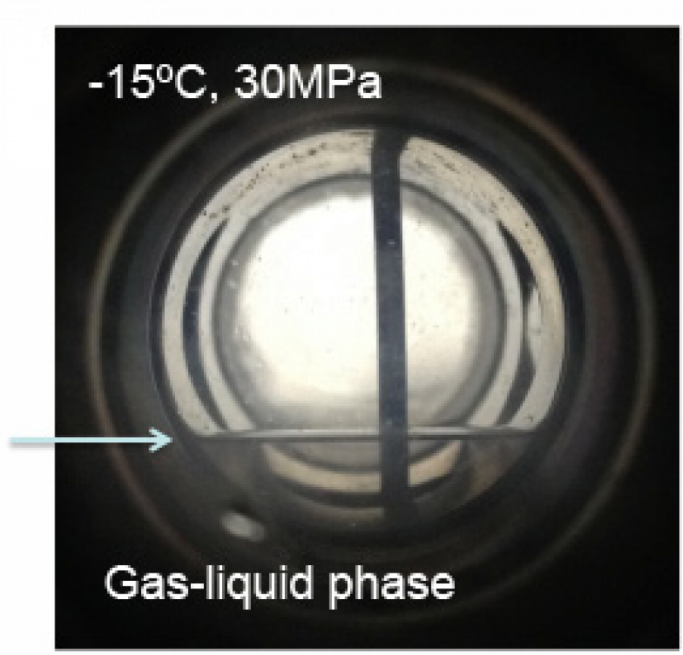


FIGURE 1

Time course of the generated pressure by the decomposition of FA

Gas pressure catalyzed by 4DHBP (black cross). Reaction conditions: 80 oC, aqueous solution of FA (16 mol/L, 13 mL), catalyst (2.0 mmol/L). Final pressure is 112 MPa with 88 mol% conversion.

FIGURE 2

Observation of the gas-liquid separation from the generated high-pressure gas

Conditions: 30MPa and -15oC. The black vertical tube in the view cell is the inlet tube of the generated gas.

KEYWORDS

formic acid | CO2 | H2 | high-pressure

BIBLIOGRAPHY

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