Chemical-Looping Technology to Capture and Convert CO_2 to Methanol

Yaşar Demirel
Department of Chemical and Biomolecular Engineering, University of Nebraska Lincoln, Lincoln 68588;
ydemirel2@unl.edu; 402 472 2745

The captured CO_2 can be converted to formic acid using the oxidation of a zero-valent metal (Zn, Al, Fe, Mn, Ni) under hydrothermal conditions in periodically operated chemical-looping packed bed system. With the catalysts of Ni and Cu, and small amount of $NaHCO_3$, the formic acid yield is around 48%. The reaction conditions are 573 K, and 120 minutes. Oxidized metal can be regenerated by a chemical such as crude glycerin, which is converted to lactic acid. Oxidation uses $FeCl_2$ $4H_2O$ and glycerin in the presence of NaOH without water to avoid reoxidation of Fe^0. The conversion of iron oxide and glycerin is around 100%. The lactic acid yield is around 82%. The hydrogen yield is around 50%.

Many metals (Cu, Al, Cu+Al, etc.) can react with water to produce H_2 efficiently under hydrothermal conditions. The H_2 produced by the oxidation of metals could be active to reduce the formic acid into methanol. Especially Cu may have high potential for reducing formic acid into methanol under hydrothermal conditions. Because of *in situ* production of H_2, no storage or transportation of H_2 would be required. Besides, the oxidative product of metals can catalyze the reduction of formic acid. There is possibility of converting CO_2 to methanol directly starting with CO_2 in a packed bed chemical-looping system. By combining the chemical-looping combustion of a fuel as shown in Fig. 1 and the hydrothermal process of converting CO_2 to formic acid, we may have a system converting a fuel, such as coal, natural gas or biomass, to methanol.

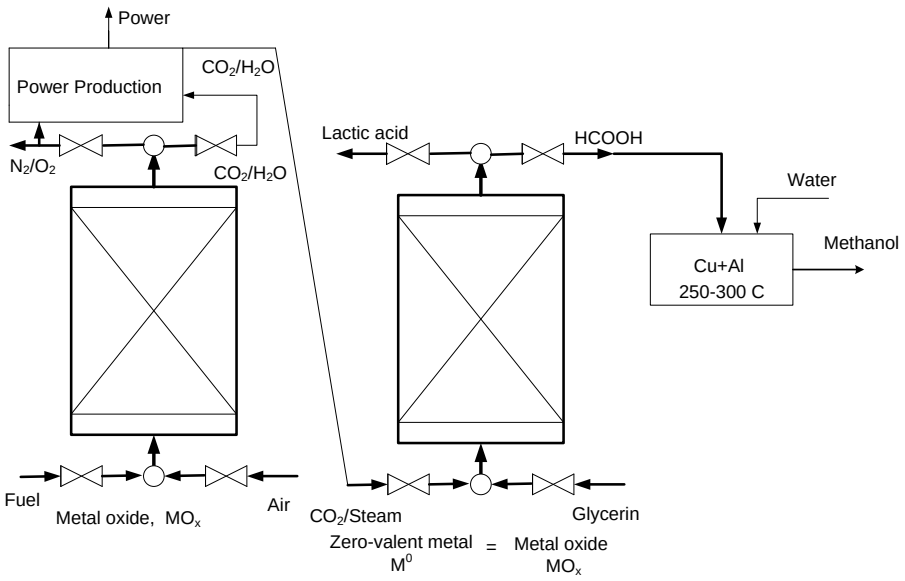

Fig. 1. Chemical-looping processes combining combustion of a fuel at the first stage and hydrothermal process of converting CO_2 to methanol at the second stage.