## III. Sustainable Hydrogen Production via Alkaline Hydrothermal Conversion of Bio-derived Liquids

Proposed by Yong L. Joo

To develop a cost-effective biorefining system for a local and small farm setting, we propose to investigate an environmentally sustainable, mass-producible compact energy conversion system that produces $H_2$ from various bio-derived liquids (e.g., bio-oil, sugars and alcohols). Compared to conventional gasification and pyrolysis, the proposed alkaline hydrothermal treatment is a less-studied method of biomass conversion but one with great potential since it can utilize a wide range of feedstock including minimally-processed raw bio-derived liquids with high water contents. The central concept we are pursuing in this project is the use of a strong base in removing carbon from the C, H, O equilibrium in mixtures of bio-derived liquids. Since the presence of water is either required or enhances the overall conversion of bio-derived liquids to $H_2$, the proposed technology can not only be energy efficient but also water-smart. By integrating alkaline industrial wastes into the hydroxide regeneration scheme, the system may even be C-negative via in-situ carbon sequestration. For the selected bio-derived liquids, a novel continuous Taylor-Couette Reactor (TCR) with controlled vortex flow will be utilized to provide enhanced heat and mass transfer, to give a mass-producible compact reactor design. The compact design and moderate reaction conditions of the proposed technology will allow traditional energy consumers to become energy producers. The proposed process using bio-derived liquids has a great potential to achieve > 70% conversion and the cost below \$6/gge $H_2$.

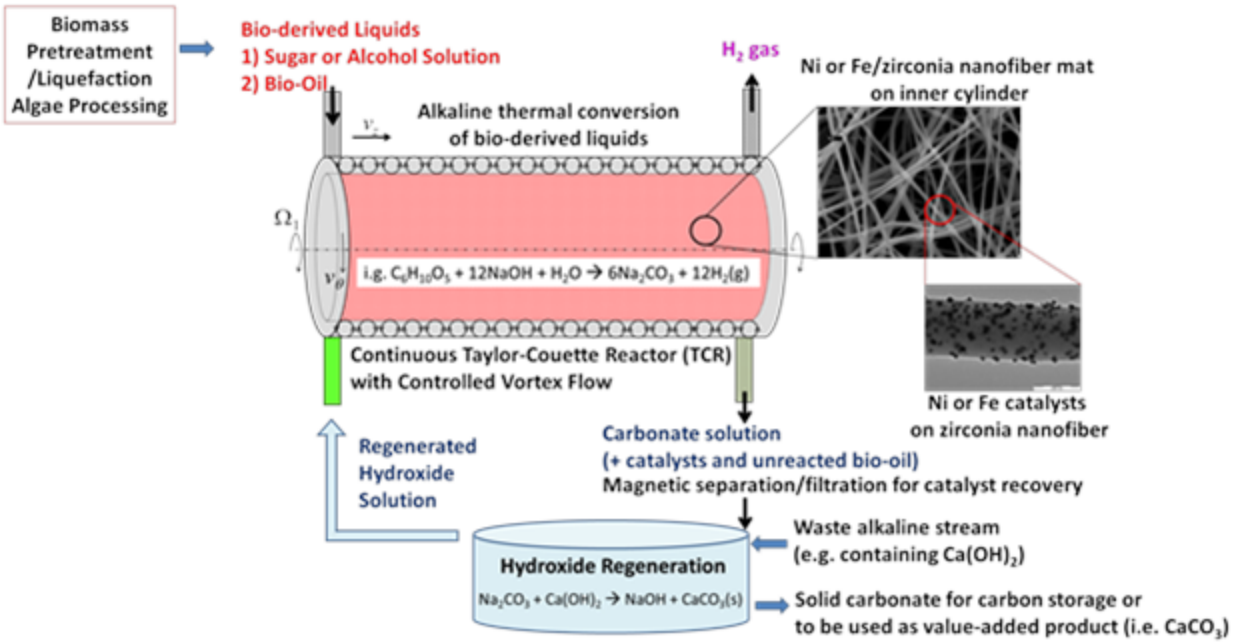


***Fig. 3*** *Schematics of the continuous TCR with miscible (or immiscible) liquids of alkaline solution and sugar/alcohol (or bio-oil) solution. Ni or Fe catalysts on $ZrO_2$ support or steam can be incorporated into one of liquid feeds. Catalyst nanofiber mat coated on the inner cylinder can also be utilized. Regeneration of hydroxide solution by treating carbonate solution with waste alkaline stream is also included.*