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DIRECT NON-OXIDATIVE CONVERSION OF SHALE GAS TO CHEMICALS: SELECTIVE ACTIVATION, CATALYST REGENERATION AND PROCESS INTENSIFICATION

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In the United States and rest of the world, there are abundant shale gas resources which are either physically or economically stranded. Commercially, natural gas conversion to chemicals is based on an indirect conversion route via syngas, followed by subsequent conversion processes (methanol plus metholine to gasoline (MTG) process, or Fischer-Tropsch and product refining). The indirect conversion processes are very capital intensive and less energy efficient. This presentation emphasizes the direct conversion of natural gas constituents (C_1-C_3) into aromatics and olefins using transition metal promoted Zeolite Socony Mobil–5 (ZSM-5) catalysts. Catalyst activity, selectivity, deactivation and regeneration of metal-promoted ZSM-5 zeolite catalysts will be discussed. We will introduce a new approach that employs non-thermal plasma to intensify catalytic reaction for natural gas conversion. Under low reaction severity, this approach synergistically integrates plasma reaction chemistry with novel heterogeneous catalysis that decouples methane activation from catalytic surface reaction, shifting rate-determining step from methane activation (cracking C-H bond) to surface C-C formation. One of the focus areas of the research is to elucidate deactivation mechanism of Ga-Pt prompted HZSM-5 and investigate feasibility of regenerating deactivated catalysts for commercial viability. The variation in daily production volume and the change in shale gas composition over time are hurdles to the engineering design of large chemical plants using shale gas as feedstock. The process intensified modular production at natural gas production site overcomes the hurdles with low capital requirements and flexible deployment and operation. Most importantly, the process intensification reduces energy consumption, waste production, and ultimately resulting in cheaper and sustainable technologies. This presentation includes direct natural gas conversion to aromatics using low-temperature plasma catalytic rector, natural gas pyrolysis for the production of CO_2-free H_2 and carbon nanotubes. The challenge in advance the fundamental science aspects presented in direct natural gas conversion will be discussed.

Biography

Jianli (John) Hu, an experienced Scientist and Engineer, is a Chair Professor and the Director of Center for Innovation in Gas Research and Utilization at West Virginia University. As a Director, he leads the creation of an interdisciplinary research center related to natural gas utilization, which is a strategic area of investment for WVU. He worked as a Director of Technology Innovation at Koch Industries, where he was responsible for developing future technological growth areas related to petrochemicals and catalytic and biological processing. He worked as a Research Manager at Pacific Northwest National Laboratory, undertaking DOE, DOD, and NASA projects. In the late 1990s, he served as a Lead Refinery Engineer for BP Oil. He has been granted 25 U S patents and published more than 90 peer reviewed journal and conference papers.

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