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Environmental Catalysts for Refining Technology Application: Reduction of CO Emission and Gasoline Sulphur in Fluid Catalytic Cracking Unit

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Abstract : Environmentally driven regulations throughout the world stipulate dramatic improvements in the quality of transportation fuels and refining operations. The exhaust gases like CO, NOx, and SOx from stationary sources (e.g., refinery) and motor vehicles contribute to a large extent for air pollution. The refining industry is under constant environmental pressure to achieve more rigorous standards on sulphur content in the fuel used in the transportation sector and other off-gas emissions. Fluid catalytic cracking unit (FCCU) is a major secondary process in refinery for gasoline and diesel production. CO-combustion promoter additive and gasoline sulphur reduction (GSR) additive are catalytic systems used in FCCU to assist the combustion of CO to CO_2 in the regenerator and regulate sulphur in gasoline faction respectively along with main FCC catalyst. Effectiveness of these catalysts is governed by the active metal used, its dispersion, the type of base material employed, and retention characteristics of additive in FCCU such as attrition resistance and density. The challenge is to have a high-density microsphere catalyst support for its retention and high activity of the active metals as these catalyst additives are used in low concentration compare to the main FCC catalyst. The present paper discusses in the first part development of high dense microsphere of nanocrystalline alumina by hydro-thermal method for CO combustion promoter application. Performance evaluation of additive was conducted under simulated regenerator conditions and shows CO combustion efficiency above 90%. The second part discusses the efficacy of a co-precipitation method for the generation of the active crystalline spinels of Zn, Mg, and Cu with aluminium oxides as an additive. The characterization and micro activity test using heavy combined hydrocarbon feedstock at FCC unit conditions for evaluating gasoline sulphur reduction activity are studied. These additives were characterized by X-Ray Diffraction, NH_3-TPD & N_2 sorption analysis, TPR analysis to establish structure-activity relationship. The reaction of sulphur removal mechanisms involving hydrogen transfer reaction, aromatization and alkylation functionalities are established to rank GSR additives for their activity, selectivity, and gasoline sulphur removal efficiency. The sulphur shifting in other liquid products such as heavy naphtha, light cycle oil, and clarified oil were also studied. PIONA analysis of liquid product reveals 20-40% reduction of sulphur in gasoline without compromising research octane number (RON) of gasoline and olefins content.

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