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CO_2 Valorization into Synthetic Natural Gas (SNG) using a Co-Ni bimetallic Y_2O_3 Based Catalysts

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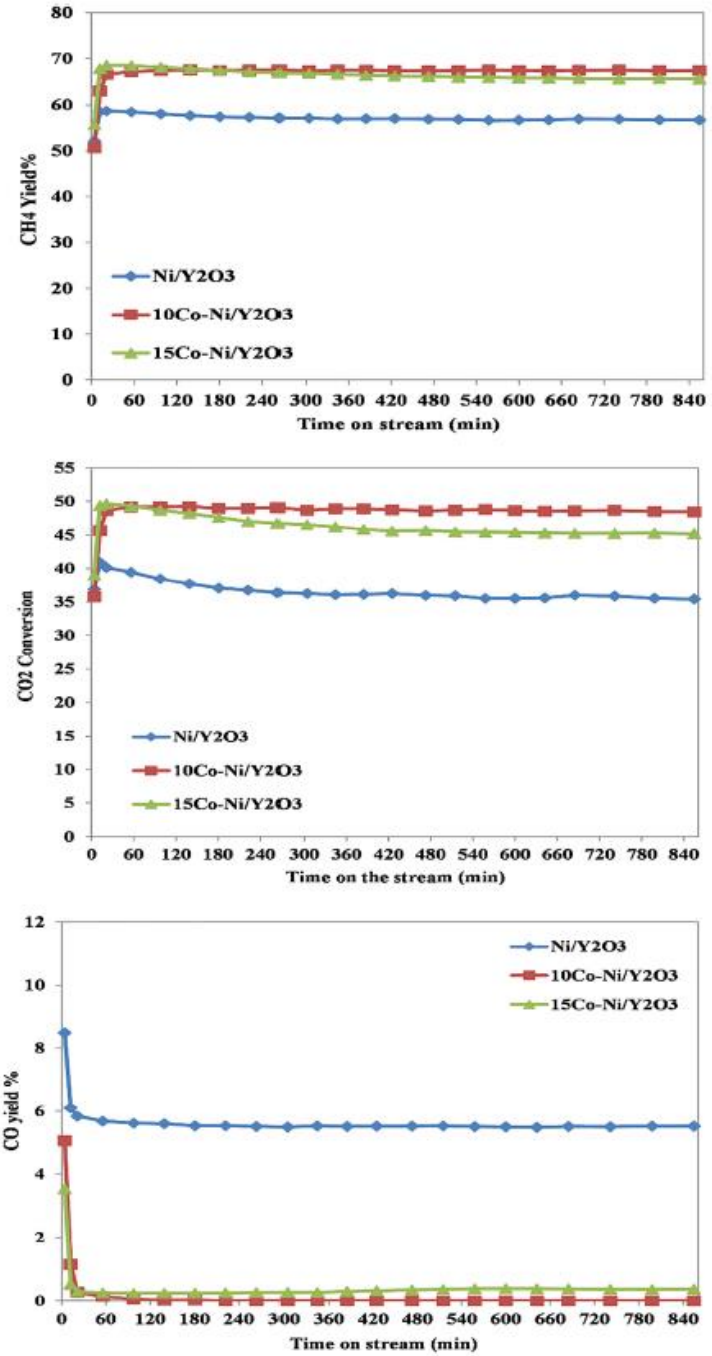
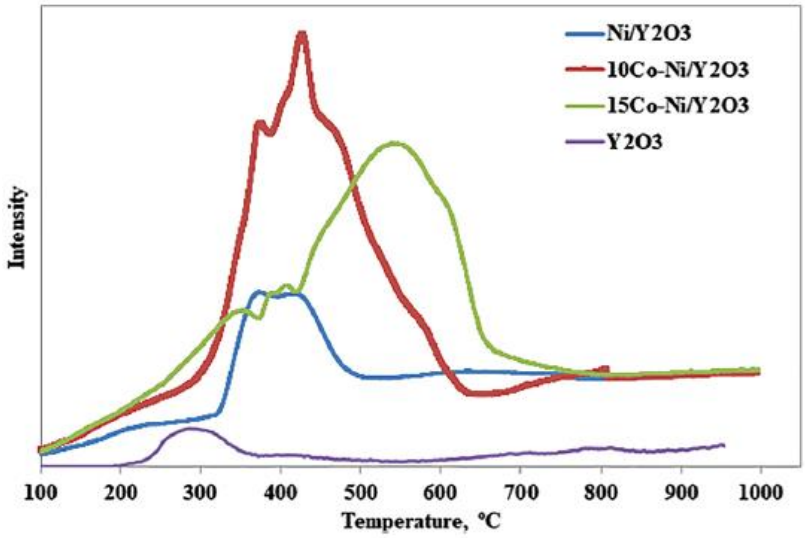
Recently, because of the increasing demand for natural gas and the reduction of greenhouse gases, interests have focused on the production of synthetic natural gas (SNG), which is suggested as an important future energy carrier. Hydrogenation of CO_2, the so-called methanation reaction, is a suitable technique for the fixation of CO_2. Nickel supported on yttrium oxide and promoted with cobalt were prepared by the wet-impregnation method respectively and characterized using SBET, XRD, FTIR, XPS, TPR, and HRTEM/EDX. CO_2 hydrogenation over the Ni/Y_2O_3 catalyst was examined and compared with $Co\text{-}Ni/Y_2O_3$ catalysts, Co% = 10 and 15 wt/wt. Carbon dioxide hydrogenation was carried out in a homemade fixed bed tubular reactor operating at atmospheric pressure. The quartz silica reactor was heated in an electric furnace equipped with a programmable temperature controller. 2 gm of the fresh catalyst were diluted with silicon carbide (SiC) to obtain 5cm bed height packed in the middle of the reactor. The temperature was monitored by a K-type thermocouple placed in the center of the catalyst bed. Before the catalytic test, all the samples were activated in situ with a 30 mL/min flow of pure hydrogen at atmospheric pressure for 2 h at 600 °C. After the reduction, the catalysts were cooled down and the flow of premixed gas at a molar ratio $CO_2/H_2/Ar$ = 1/4/5 with GHSV of 6000 $ccg^{-1}h^{-1}$ was gradually introduced through the catalysts. Then, the temperature was increased to 350 °C and the reaction time was 3h. Gaseous reaction products were analyzed on-line by a



CO_2 conversion, CH_4 yield%, and CO yield% during the methanation reaction over yttrium-based catalysts.

quantitative gas analysis system (**HIDEN ANALYTICAL QGA, England**). The selectivity of H_2, CO_2, CH_4 and, CO was detected by the gas analyzer using a matrix equation to correct the overlapped detection values from the m/z of 28 (CO), 44 (CO_2), 2 (H_2), and 16 (CH_4).
The CH_4 yield reached 67% and CO_2 conversion extended to 48.5% with CO traces over 10Co-Ni/Y_2O_3 catalyst. This encourages the direct methanation reaction mechanism. However; the reaction mechanism over Ni/Y_2O_3 catalyst show different behaviors rather than that over bi-metal catalysts whereas the steam reforming of methane reaction was arisen associated with consumption of methane besides increase in H_2 and CO formation; at the same reaction temperature.



H_2-TPR of the prepared catalysts

Project summary by:
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