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# Restored $CO_2$ from Flue Gas and Utilization by Converting to Methanol by 3 Step Processes: Steam Reforming, Reverse Water Gas Shift and Hydrogenation

**Authors :** Rujira Jitrwung, Kuntima Krekkeitsakul, Weerawat Patthaveekongka, Chiraphat Kumpidet, Jarukit Tepkeaw, Krissana Jaikengdee, Anantachai Wannajampa

**Abstract :** Flue gas discharging from coal fired or gas combustion power plant contains around 12% Carbon dioxide ($CO_2$), 6% Oxygen ($O_2$), and 82% Nitrogen ($N_2$).$CO_2$ is a greenhouse gas which has been concerned to the global warming. Carbon Capture, Utilization, and Storage (CCUS) is a topic which is a tool to deal with this $CO_2$ realization. Flue gas is drawn down from the chimney and filtered, then it is compressed to build up the pressure until 8 bar. This compressed flue gas is sent to three stages Pressure Swing Adsorption (PSA), which is filled with activated carbon. Experiments were showed the optimum adsorption pressure at 7bar, which $CO_2$ can be adsorbed step by step in 1st, 2nd, and 3rd stage, obtaining $CO_2$ concentration 29.8, 66.4, and 96.7 %, respectively. The mixed gas concentration from the last step is composed of 96.7% $CO_2$,2.7% $N_2$, and 0.6%$O_2$. This mixed $CO_2$product gas obtained from 3 stages PSA contained high concentration $CO_2$, which is ready to use for methanol synthesis. The mixed $CO_2$ was experimented in 5 Liter/Day of methanol synthesis reactor skid by 3 step processes as followed steam reforming, reverse water gas shift, and then hydrogenation. The result showed that proportional of mixed $CO_2$ and $CH_4$ 70/30, 50/50, 30/70 % (v/v), and 10/90 yielded methanol 2.4, 4.3, 5.6, and 6.0 Liter/day and save $CO_2$ 40, 30, 20, and 5 % respectively. The optimum condition resulted both methanol yield and $CO_2$ consumption using $CO_2/CH_4$ ratio 43/57 % (v/v), which yielded 4.8 Liter/day methanol and save $CO_2$ 27% comparing with traditional methanol production from methane steam reforming (5 Liter/day)and absent $CO_2$ consumption.

**Keywords :** carbon capture utilization and storage, pressure swing adsorption, reforming, reverse water gas shift, methanol
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