CO₂ REMOVAL EFFICIENCY FROM NATURAL GAS AT ELEVATED PRESSURE OF PACKED ABSORPTION COLUMN USING POTASSIUM CARBONATE PROMOTED WITH GLYCINE

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RESEARCH HIGHLIGHTS

The effect of liquid flow rate was assessed in term of its CO₂ removal efficiency and concentration profile along the packing. The study shows the increasing trend of CO₂ removal as liquid flow rate increases. This study demonstrated the efficient CO₂ absorption up to 77 % using non-precipitating potassium carbonate promoted with glycine.

RESEARCH OBJECTIVES

The research mainly focusses to study the absorption removal efficiency for carbon dioxide (CO₂) capture from natural gas using an environmental friendly solvent, potassium carbonate promoted with glycine. Recently, CO₂ capture using this solvent (with precipitating) was studied by previous researchers. However, the precipitates of the solvent increase the potential of blockage in the packing and piping thus result failure in absorption processes[1]. Therefore, this study focused to assess the CO₂ removal efficiency of non-precipitating potassium carbonate promoted with glycine (20 wt% potassium carbonate and 8 wt% glycine) using bench-scale packed absorption column.

MATERIALS AND METHOD

The aqueous blend of potassium carbonate promoted with glycine was prepared and stirred for at least 3 hours. It was heated up to 90°C in solvent feed tank. Then, the experiment was performed using bench-scale packed absorption column. Firstly, the inlet gas composition of CO₂ and natural gas was set using mass flow controllers. The mixed gas was then compressed and stored into the pressurized gas vessel. The inlet gas flow rate was regulated at its desired value and introduced into the bottom of the column. The operating pressure was maintained at 4.0 Mpa using backpressure regulator. The heated solvent was pump using high pressure liquid pump. The solvent was then regulated using needle valve to the desired flow rate. The pump pumped the solvent into the top of column consequently creates counter-current flow between mixed gas and the solvent within the column. The experiments were operated until steady-state conditions were achieved and the readings were recorded.

RESULTS

The result of CO₂ concentration profile along the packed absorption column with different liquid flow rate shows for the case of slow liquid flow rate (1.81-5.42 m³/m².h), CO₂ concentration at the top of the column was gradually decreased. The CO₂ absorption maintained until the amount of active chemicals in the solvent depleted along the column. This is due to the reduction of active absorbent at the lower section of the column [2]. Slow absorption rate was observed at the middle to bottom section of the column. Higher liquid flow rate resulted to the higher CO₂ absorption along the column. Different trending of CO₂ concentration along the column at 7.22 m³/m².h flow rate is observed. It is clearly indicated that the solvent have better absorption rate at liquid flow rate 7.22 m³/m².h.

The results of CO₂ removal efficiency over a range of liquid flow rate (1.81-7.22 m³/m².h) at elevated pressure 4.0 Mpa shows the increasing trending of CO₂ removal efficiency as the liquid flow rate varied from 1.81 to 7.22 m³/m².h. The trending was similar as reported by Hairul et.al [3, 4]. CO₂ removal increased from 15.9 % to 77.2 % as liquid flow rate increased from 1.81 to 7.22 m³/m².h.

FINDINGS

The effect of liquid flow rate ($1.81\text{--}7.22\text{ m}^3/\text{m}^2\cdot\text{h}$) on CO_2 absorption was investigated using bench scale packed absorption column at 4.0 Mpa with $33\text{ kmol}/\text{m}^2\cdot\text{h}$ gas flow rate and 60°C solvent temperature. CO_2 removal efficiency was studied at steady-state where the system in equilibrium condition. As shown in the result, as liquid flow rate increased from 1.81 to $7.22\text{ m}^3/\text{m}^2\cdot\text{h}$, the CO_2 removal efficiency increased from 15.9 % to 77.2 %. The study shows the increasing trend of CO_2 removal as liquid flow rate increases. Higher liquid/molar flow rate gas (L/G) offers a better absorption performance compared to lower L/G ratio. This finding was supported by Godini et.al (2008) where they discovered the absolute efficiency of CO_2 absorption can be increased by increasing the ratio of liquid/molar flow rate gas (L/G) in absorption system [5]. This study demonstrated the efficient absorption up to 77 % using non-precipitating potassium carbonate promoted with glycine.

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