ABSTRACT

The global warming associated with an increase of the greenhouse gas emissions particularly carbon dioxide (CO_2) represents a worldwide problem. The CO_2 emissions reduction is necessary. Thus researches on CO_2 capture technology which is effective and low cost are required. Interest in using industrial residue materials and by-products as sources of calcium for mineral carbonation has arisen because they are readily available and cheap. The slag from steelmaking process is known as a material has the ability to capture and convert CO_2 to calcium carbonate ($CaCO_3$). These researches focuses on method of CO_2 fixation as environmentally benign carbonate minerals and determine the optimum condition for Ca^{2+} leaching process.

The Ca^{2+} leaching procedure with two solutions acetic acid and deionized water. The optimum solution to remove CO_2 was calcium ion solution leachated with deionized water. The removal efficiency was up to 75.74 % where as the removal efficiency of 39.69% was obtained when acetic solution was applied. The lower efficiency was derived from acetic acid solution due to pH and alkalinity that do not suitable for capture CO_2. Therefore, this research selected calcium ion solution leachated with deionized water at liquid per solid ratio (L/S) 10:1 (g/g), room temperature. This optimum condition was further examined with CO_2 absorption process.

The CO_2 removal was investigated by synthesis gas of CO_2 and studied the optimum condition for CO_2 removal in packed column. The parameters studied including liquid flow rate (0.3 – 0.9 L/min), gas flow rate (0.25 – 0.85 L/min) and concentration of calcium ion (200 – 1000 mg/L). Design of experimental and mathematic model by response surface metrology (RSM) and central composite design (CCD) with Design Expert Software Program was used for evaluate and show relation between independent variables. The optimum condition for CO_2 removal process derived from Equation at liquid flow rate 0.77 L/min, gas flow rate 0.25 L/min and concentration of calcium ion 725 mg/L. The predicted-efficiency in treatment CO_2 was up to 100 % and the results of experiment that was 97.81 % with less than 5% errors.

$$y = 72.52 + 54.11x_1 - 164.79x_2 + 0.079x_3 + 0.13x_2x_3 - 8.28\times10^{-5}{x_3}^2$$

where y is removal efficiency of CO_2 (%)

x_1 is liquid flow rate (L/min)

x_2 is gas flow rate (L/min)

x_3 is concentration of calcium ion solution (mg/L)

In conclusion, this research has confirmed that the steel slag can effectively use to capture CO_2. In addition, this approach can be applied as a guideline for CO_2 emission reduction in industrial sector.