The acceleration of the neutralization for concrete aggregate by using the sparging process of supercritical CO_2

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1. Introduction – Recycled aggregate is derived from waste concrete which occupies about 60 % of construction waste in Korea and is mainly used for road construction [1]. However, due to the cement mortar present on the surface of the concrete, the alkalinity of recycled aggregate is very high, which can cause environmental problems. Therefore, many studies are currently underway to neutralize the alkalinity of concrete aggregates before its recycling. From previous researches, the neutralization treatment of recycled aggregate using Supercritical Carbon Dioxide (SCD) was performed by the SCD-water-aggregate reaction in a fixed high-pressure reaction cell [2]. By the SCD reaction, the pH of the concrete aggregate could be lowered to less than 9.8 (the Korean tolerance limit), but a treatment time takes more than 10 days (mostly 30 days), which is very limited to apply to the field. Therefore, the goal of this study is to decrease the neutralization time for concrete aggregate to less than 3 hours by the SCD sparing process to accelerate the neutralization rate.

2. Experimental - The SCD was stored in a large stainless steel tank, which was maintained at 110 - 120 bar and 50 °C. In the high-pressurized stainless steel cell of 150 mL volume, concrete aggregate samples was immersed in distilled water at 80 bar and 50 °C. Then SCD was sparged from the large tank into the high-pressurized cell at a pressure of 90 bar (Δ p: 10 bar), so that the micro bubbles of SCD and water directly contacted aggregate particles in the cell. The sparged $scCO_2$-water-aggregate reaction was maintained for 1 hour to neutralize pH of the aggregate and the sparged $scCO_2$ was flushed out from the top of the cell through a regulator attached in the cell. After one hour reaction, the cell was left to a standstill for 2 hour and the pH and ion concentration of water in the cell were analysed. Various chemical reactions such as dissociation, secondary mineralization and precipitation occurred on aggregates to lower the pH was verified in the laboratory scale extraction experiments. The $scCO_2$ sparged concrete aggregate and the original concrete aggregate were dried and 20g of each aggregate was poured into a glass flask, which was filled with 100 mL of distilled water. The mixed solution in the flask was stirred with a magnetic stir for 10 min. at 150 rpm. The pH change of solution in each flask was measured at different extraction time for 10 days and their results were compared to evaluate the effect of the SCD treatment on the pH neutralization of concrete aggregates.

3. Results and Discussion - The pHs of waste concrete aggregate without the SCD sparging ranged at 11 – 12. In the case of waste concrete sparged with SCD and water bubbles for 1 hour, the average pH of aggregate decreased to 8.5. As the extraction time increased, the pH slightly increased but remained in the range of 9.3-9.8 (average 9.5).

4. Conclusion - From results of this experiment, it was suggested that the one hour SCD sparging has a great possibility to accelerate the carbonation process, lowering pH of aggregate (< 9.8) and to recycle them as an alternative aggregate resource for the construction material in the field.

5. References

[1] MOE (Ministry of Environment). 2013 survey on the generation and the treatment of wastes in Korea. 2014.
[2] Kim, T., Lee J., Chung, C., Kim, J., Lee, M. and Kim, S. The Neutralization Treatment of Waste Mortar and Recycled Aggregate by Using the scCO2-Water-Aggregate Reaction, Econ. Environ. Geol. 51(4), (2018) p.359-370.