Aalto University
School of Engineering

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Advancements in the recovery of calcium from steelmaking slags

Title of the dissertation	Enhanced calcium extraction from steel converter slag using wet extractive grinding and comparison with traditional mechanical mixing - Selective extraction of Ca, V, Si and Mg.
Contents of the dissertation	The goal of this research was to develop an effective recovery method for calcium from industrial waste streams to produce precipitated calcium carbonate, PCC. This would reduce our dependency on virgin raw material resources, reduce CO_2 emissions and offer a pathway to circular economy by closing material loops in industrial processes. We focused on the utilization of steel converter slag as a source of calcium for the pH-swing process named as X2PCC (X refers to Ca-bearing materials). As the first process step, we extract calcium from steelmaking slag using aqueous ammonium chloride solvent and separate solids by filtering. In the second step, the Ca-rich solution is treated with CO_2 gas to produce precipitated calcium carbonate (PCC). The main scientific contribution of this thesis is in identifying the limiting factors in the Ca extraction stage and presenting and analyzing the new wet extractive grinding method. We were able to show that with the EG method, Ca yield increased from 35 to 73%, processing time decreased from earlier used 30 to 5 min. To obtain Ca yield higher than 70% via mechanical mixing, energy intensive fine grinding is required. With EG method, based on preliminary calculations, energy saving can be up to 56 % compared to fine grinding and mechanical mixing path. We also found that EG method does not significantly affect the particle size distribution, which means that there are fewer filtering issues expected, compared with the fine-grinded slag. We are presenting unique data on the effects of solvent molarity, slag to solvent ratio, particle size distribution, process time. These will be later used in the actual process design and feasibility analysis. Finally, we studied also initially a concept for the integration of CO_2-capture Ca-looping integrated with our X2PCC process. Initial results show that CO_2 capture potential of the process could be significantly increased by this. This will be further studied in our future work and we will evaluate what would be the optimal use for the PCC produced in terms of circular economy and environment.
Field of the dissertation	Process and energy engineering
Doctoral candidate	Muhammad Owais, M.Sc. (Tech.), born in 1988 on 7th May, Pakistan
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Supervisor	Professor Mika Järvinen, Aalto University School of Engineering, Department of Mechanical Engineering, Finland
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Doctoral candidate's contact information	Muhammad Owais, Aalto University, muhammad.owais@aalto.fi, phone +1 (365) 885-9468

The dissertation is publicly displayed online 10 days before the defense at
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