Valorisation of stainless steel slag by selective Cr recovery and carbonation of the matrix material

E. Kim1,2, J. Spooren1, K. Broos1, L. Horckmans1, B. Mignon2, H. Bréque13, J. Möller4, M. Denecke4

Introduction

The Flemish Institute for Technological Research (VITO), Centre Terre et Pierre (CTP) and the University of Duisburg Essen (UDE) researched and developed processes to selectively recover chromium (Cr) from historic stainless steel slags. The technical and environmental qualities of the material improve enabling re-use of both the metal and the mineral matrix (closing material circles). In Europe 1-2 Mton/y of stainless steel slags (containing <2% Cr) are produced. Currently, 50% of these slags are still disposed of in landfills (because they contain hazardous metals) and 50% are used in low-grade applications: e.g. road aggregate.

Conducted research and proposed treatment process

VITO developed an alkaline oxidative pressure leaching (APL) process to remove Cr from the slag material. In this process the slag is treated in a closed stainless steel reactor at an increased temperature (240 °C) and pressure in the presence of an alkaline NaOH solution and oxygen (O2) gas. The advantage of this process is that Cr can be leached selectively, without dissolving matrix materials. Alternatively, UDE investigated if Cr could be removed and recovered from the slag material by using an aerobic biological process (biological leaching). In this process specific bacteria are used to produce H2SO4 acid by oxidising sulphur and oxidising iron ions in an acidic environment. However, the tested biological leaching system did not lead to the release of heavy metals from the slag material. Possibly, the alkaline slag material inhibits functioning of the bacteria, which prefer an acidic environment. While biological leaching offers an economical alternative to regain metals, the application was limited by the surrounding parameters.

Conclusion

An effective hydrometallurgical recovery of Cr from historic stainless steel slags was developed and demonstrated. Selective Cr leaching by alkaline pressurised oxidation combined with a mechanical activation pre-treatment step was investigated.

- The leaching efficiency of Cr under alkaline oxidising conditions increased with temperature and MA time. An optimal reaction condition was 240°C, 6hr, MA 30min, 1M NaOH, 8.4 bar pO2.
- After Cr leaching by APL assisted with MA and a subsequent washing step the left over matrix material can be used for building materials through a carbonation step. This results in a complete recycling of the slag material ("zero waste principle").

Contact Details

1. Flemish Institute for Technological Research VITO NV, Boeretang 200, B-2400 Mol, Belgium;
2. Department of Bioengineering, University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerp, Belgium;
3. Centre Terre et Pierre, Chaussée d’Antoing 55, B-3500 Tourna, Belgium
4. Department Urban Water- and Waste Management, University of Duisburg-Essen, Universitaetsstrasse 15, 45141 Essen, Germany