Using Waste Plastics in the Production of Magnesium

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Goals

- Propose new process of magnesium production
- Identify benefits of new process
- Suggest future implementation strategies

Abstract

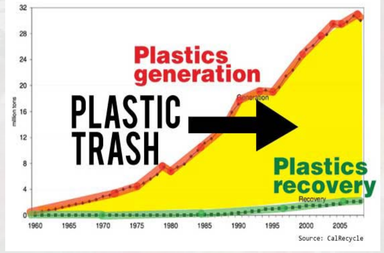
The objective of this project is to present the economic and environmental benefits of using waste plastics as a reducing agent in the thermal reduction process of magnesium production. The current process for magnesium production uses petroleum coke, an expensive reducing agent. Replacing petroleum coke with waste plastics not only reduces the cost of production, but also eliminates a large amount of waste plastics.

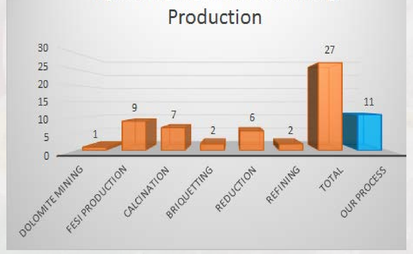
Proposed Process

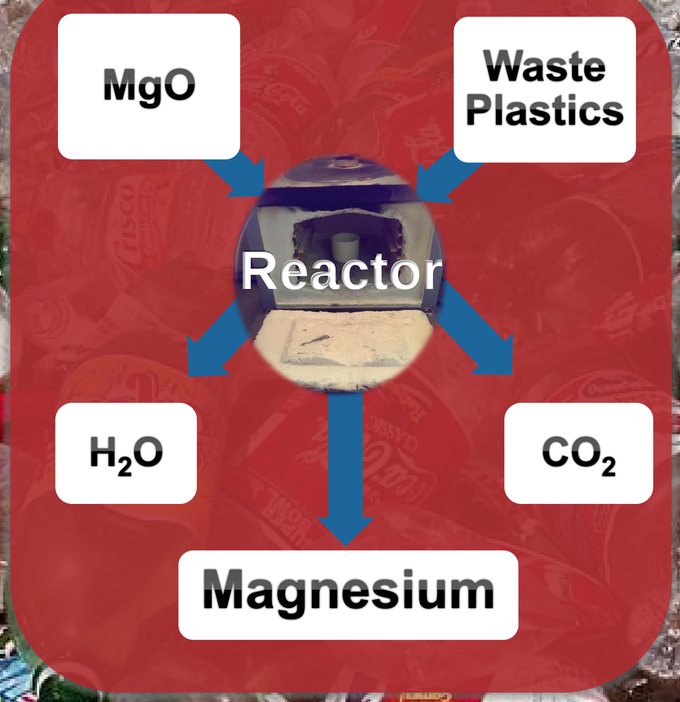
Currently, petroleum coke is used as a reducing agent in the thermal reduction of magnesium oxide to magnesium. It has been proposed that waste plastics can be used in place of petroleum coke in this reaction.

Environmental Benefits

- Cuts CO_2 emissions by eliminating the use of FeSi
- HFC-134a, a replacement for SF_6, reduces the global warming potential of the process
- Using oven gas in place of petroleum coke decreases overall CO_2 emissions
- Will reduce the amount of plastics left in our ecosystems

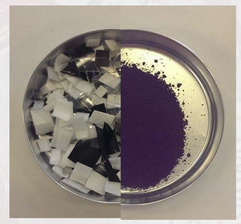




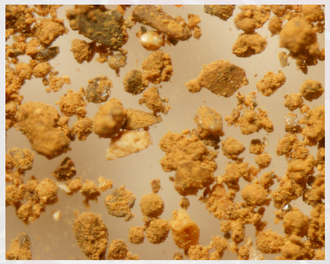


Experimental Results

In place of magnesium oxide, a mixture of other metal oxides was reacted with a mixture of plastics at 700°C for 15 minutes. The originally black metal oxide powder was observed to have turned brownish orange with a few bright and shiny particles, suggesting the presence of pure metals.

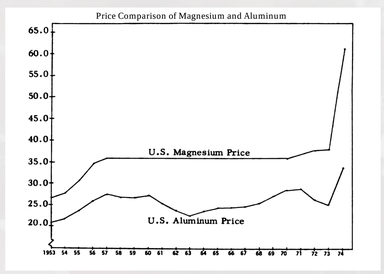


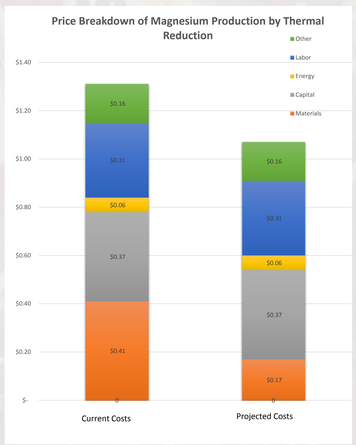
X-Ray Diffraction (XRD) and metallographic analysis were preformed to confirm the presence of pure metals.



Economics

Using waste plastics instead of petroleum coke lowers production materials cost. This could lower the price of magnesium, making it a more competitive alternative to other metals such as aluminum.





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References

- Ehrenberger, Simone, and Dr. H.E. Friedrich. "Greenhouse Gas Emissions and Intensities." Light Metal Age (2014): n. pag. The World Magnesium Association. Web. 24 Nov. 2015.
- Kotrba, Ron. "Power and Fuel From Plastic Wastes." Power and Fuel From Plastic Wastes. Biomass Magazine, 2015. Web. 30 Nov. 2015.
- "Harry Potter and the Magic of Perspective (or How to Make Plastic Pollution Disappear)." Brngit. N.p., n.d. Web. 04 Dec. 2015. <http://blog.brng.it/advocacy/harry-potter-and-the-magic-of-perspective-or-how-to-make-plastic-pollution-disappear/>.
- Das, Sujit. "Primary Magnesium Production Costs for Automotive Applications." *JOM* 60.11 (2008): 63-9. Web.
- Chen, Hukui, Jianrui Lui, and Weidong Huang. "Characterization of the Protective Surface Films Formed on Molten Magnesium in Air/HFC-134 Atmosphere." *Materials Characterization* 58.1 (2007): 51-58. *ScienceDirect*. Web. 30 Nov. 2015.

Implementation

- Use HFC-134a as a cover gas rather than SF_6
- Use a gravity separator and near-infrared spectroscopy to separate plastics from other solid waste
- Introduce new process to US Magnesium, the largest magnesium producer in North America
- Present process at 73rd Magnesium Conference being held in Rome in May 2016
- Recommend as a possible MQP or GPS project for further research