EDSGN100 Design Project #2
Final Design Report
Recycling of Advanced High Strength Steel
Introduction to Engineering Design
EDGSN 100 Section: 002

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Executive Summary

<A summary, of approximately 100-150 words, to summarize the objectives, contents, results, and
conclusions as specifically as possible. The purpose of the executive summary is to allow the reader to
learn the major ideas and findings without having to read the whole report. Generally an executive
summary is written after the report is finished.>
<NOTE: All of the content shown here should fit on the cover page of your report.>

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1.0 Introduction

The production of new steel from scratch is a very expensive and resource consuming process so most steel is recycled in order to reduce the costs. Companies like AccelorMittal buy advanced high strength steel (AHSS) scrap and use it to make new steel. The purpose of this project is to design a more efficient and less expensive method to separate AHSS from scrap metal. Our group generated several concept designs for separating the scrap and compared their practicality, cost, and likelihood of success. We chose the concept that we felt had a reasonable expense, the highest success rate, would deliver the best quality steel, and the easiest to accomplish with today's technology.

2.0 Project Background

Steel and iron are the most used metals in the world. Our society is so reliant on these materials that they can be found in almost anything. Steel and iron can be found in objects ranging from soda cans and household appliances to bridges and skyscrapers. Steel is mostly made up of iron but also contains percentages of carbon, aluminum, calcium, chrome, columbium and manganese. The addition of these elements is what makes steel strong and more resistant to the environment.

Because of all the resources that go into making new steel, it is way more cost efficient to recycle old steel from scrap and use it in the production of new steel. Scrap is the largest source of raw materials for the production of new steel. Almost 100% of scrap steel is turned into new steel and for each ton of scrap recycled, about 1030kg of iron, 580kg of coal, and 50kg of limestone are saved. Energy is also conserved in the recycling of steel scrap. In one year enough steel is conserved to power about 18 million homes for a year.

Most scrap steel comes from automobiles. Large pieces of scrap are first cut into fist sized chunks by a large shredder and then separated into piles of like metals by magnets, fans, manual labor, and flotation devices. These organized metals are then pounded together into manageable bundles by baling presses and then shipped to scrap dealers. Every year for the past 50 years, more than 50% of the steel produced in the United States has been recycled and reused. One way that recycled steel is turned into new steel by use of the basic oxygen furnace (BOF). The BOF takes molten metal and injects oxygen into it at high speeds to oxidize carbon and other impurities. Lime from limestone is also added to react with the impurities.

3.0 Project Objectives

Our group will define our objectives by analyzing our customer's (AccelorMittal) needs. AccelorMittal needs a more effective way to retrieve AHSS from scrap metal and turn it into new steel. Therefore our main goal is to design a process to separate AHSS from other scrap metals to be used as a substitute for other alloying elements while maintaining steel quality. We want our method to cause there to be 0 off-chemistry heats when the AHSS is added to LCAK heat and be less expensive than current methods.

4.0 Conceptual Designs

<Generate conceptual designs, or *Design Concepts* and the supporting research and analysis to
determine the feasibility of each alternative. After appropriate consideration of at least 4 alternatives, apply a methodical process to choose the best concept for further development.>
Automotive Dismantler
Identifying Marker
Melting Point Separation
Magnetic Separation

4.1 Descriptions

<u>Automotive Dismantler</u>
-Scope: Scrap Supplier
-Summary: Use of a facility similar to those used by auto makers to build cars but set up in reverse as to take cars apart and separate each component for "perfect recycling."

<u>Identifying Marker</u>
-Scope: Auto Makers/ Scrap Suppliers
-Summary: Coating the AHSS in some form of identifier such as a paint or chemical laminate.

<u>Melting Point Separation</u>
-Scope: Either Scrap Supplier or ArcelorMittal
-Summary: Using a furnace to separate the varying types of ferrous scrap based on melting point.

<u>Magnetic Separation</u>
-Scope: Scrap Supplier
-Summary: Use of fine-tuned magnets to separate AHSS from other ferrous alloys.

4.2 Research & Analysis

< use external and internal research, benchmarking, etc.; analyze performance>
<u>Automotive Dismantler</u>
Pros:

- Allows for complete part separation and recovery from cars with little need for more processes.
- All scrap sold by this method could easily be guaranteed to be 100% of whatever material it claims to be.

Cons:

- Extremely Expensive
- Very complex machinery and computer programming required

Identifying Marker

Pros:

- Cheap
- Easy to apply.
- Easy to detect by the human eye.

Cons:

- Coating liable to be stripped off of the AHSS during the scrapping process.
- Additional human labor required to pick out the coated AHSS from other ferrous scrap.
- Pieces of AHSS that are not coated for any reason may not be collected.

Melting Point Separation

Pros:

- Allows for almost 100% separation of AHSS from other alloys.
- Well within known technologies.

Cons:

- Relatively expensive

Magnetic Separation

Pros:

- Relatively cheap.
- Would not require much space or changes to existing facilities.

Cons:

- Ability for magnetic separation is arbitrary at best.
- All ferrous alloys are comparably affected by magnets.

4.3 Concept Selection

<use and document a methodical process of choosing the best concept based on meeting your design objectives>

5.0 Detailed Design

Melting Point Separation

<The selected design concept is refined and the design is further developed, completed and discussed in appropriate detail. Final design must include; (i) a detailed description of all of the components and how they work; (ii) a systems diagram; and (iii) either a virtual model (Google SketchUp, Solidworks, professional hand sketches, etc.) or a prototype (physical) model of the

proposed final design (include documentation, drawings, photographs, etc. in report). The use of appropriate figures, tables, graphs, sketches, etc. are required as needed, and each must be discussed in the text.>

6.0 Conclusions

After further analyzation of the final design, we believe that our design meets most, but not all of our objectives. The melting point separation method would separate AHSS from the scrap without causing off-chemistry heats but it would be expensive to keep a furnace heated at the high temperatures needed to melt steel for an extended period of time. However, the purity of the end product and the ability of this method to produce different specific types of AHSS are both factors that our group believes outweighs the costs. So, in conclusion, our design accomplishes our main objective and goes beyond it (purity of AHSS harvested and ability to generate multiple types). Therefore the expenses incurred by this method are negligible compared to the positive outcomes of the process.

7.0 References

Euless Recycles, "Steel Facts", http://www.eulesstx.gov/recycling/steel_facts.htm, viewed on April 22, 2012

Fenton. D. Michaels, "IRON AND STEEL RECYCLING IN THE UNITED STATES IN 1998", http://pubs.usgs.gov/of/2001/of01-224/of01-224.pdf, viewed on April, 22 2012

Kopeliovich, Dr. Dmitri, "Basic Oxygen Furnace (BOF)", http://www.substech.com/dokuwiki/doku.php?id=basic_oxygen_furnace_bof, viewed on April 22, 2012

Steel Recycling Institute, "Steel Recycling Rates", http://www.recycle-steel.org/en/Recycling%20Resources/Steel%20Recycling%20Rates.aspx, viewed on April 22, 2012