Blast Clean

ArcelorMittal

EDSGN 100
Section 022
Dr. Ritter
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Executive summary:

In order to reduce ArcelorMittal’s waste stream from the plastic drums and totes used to transport the chemicals used in the steelmaking process, we researched different ways to clean and then reuse or recycle the drums. We found that by using soda blasting (a power washer which uses sodium bicarbonate instead of water) in conjunction with traditional pressure washers combined with tests to determine the amounts of chemical residue in the drums, we could successfully recycle them in an environmentally friendly and profitable process.

Introduction and process statement:

ArcelorMittal would like to reduce its impact on the Earth by reusing and/or recycling their chemical drums and totes.

Currently, ArcelorMittal disposes of all its chemical drums and totes used at their steel plants because they contain harsh chemical residue. This residual waste leads to decreased profit and increased damage to the environment. If this problem is not resolved in the near future, it will continue to have negative side effects that pose a threat to future generations.

This project will develop a way to reuse and recycle the company’s chemical drums and totes by creating a more efficient method of processing the drums, while still providing a process that is environmentally and economically sustainable. We intend to accomplish this task by studying the current disposal procedure as well as the properties of the chemicals contained in the drums and totes.

Definition of sustainability:

We believe that sustainability is the use and maintenance of the Earth’s resources in ways that are able to support and strengthen the longevity and quality of the Earth and the lives of her inhabitants.
Background

- Chemical Properties Research, EPA standards, etc.
- Soda Blasting Research (+ other cleaning methods)
- Recycling vs. Reusing Research
- Recycling Facility Research
- Cost Research

Customer Needs

The customer needs our group deemed most important were cost efficiency, waste reduction and environmental friendliness. The design goal of our project was to create a system that reduced waste and did not harm the environment— for this reason, these needs were at the top of our priority list. ArcelorMittal would not want to adopt our system if it was going to be costly, therefore, a cost efficient system was also one our most important customer needs.

The need of a safe system for both employees and Mother Earth was also high on our list of customer needs, as ArcelorMittal would not want to adopt a dangerous system.

We wanted to create a system that only used a small amount of ArcelorMittal’s resources. With minimal capital usage, ArcelorMittal would not have to alter its current production processes to make room for our system. Ranked as importantly as minimal capital usage is sustainability. Obviously environmental sustainability is our of our goals, but sustainability for the company is also integral so that our system could continue to function for years to come.

Ranked lowest among our customer needs were a quick process and a positive company image. These needs are important, but they are outweighed by the more crucial needs.
### AHP

<table>
<thead>
<tr>
<th>Needs</th>
<th>Reduce Waste</th>
<th>Cost Efficient</th>
<th>Positive Image</th>
<th>Environmentally Friendly</th>
<th>Safe</th>
<th>Sustainable</th>
<th>Quick Process</th>
<th>Minimal Capital</th>
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**Concept Generation:**

Initially we had multiple ideas of what to do with the drums and totes-- but from the beginning, it was clear that the process of recycling would be split into 2 phases; phase 1 would be the cleaning step and phase 2 would be the reusing step.

For phase 1, we initially thought of neutralizing the chemicals inside the barrels. However, this would not work due to the cost of the chemicals-- plus, there was no easy and efficient way to test whether the solution inside the barrels would be neutral. The second idea was to sandblast the barrels. The issues with sandblasting, however, is that it is abrasive, messy and would be difficult to separate from the barrel once blasted into the barrel. We also
considered water washing the barrels, but realized we would not be able to be absolutely certain of whether the chemicals were completely cleared or not. Other ideas included vaporizing the liquid and breaking down the barrels and then cleaning them-- unfortunately, however, both of these would be too cost intensive. Ultimately, we decided to go with soda blasting, as it would not be very cost intensive nor highly corrosive, but would ensure cleanliness in the barrel. Furthermore, the sodium bicarbonate is water soluble, so when the barrels are cleaned with water, it will be removed along with any other contaminants.

Assuming the barrels are clean from phase 1, we would then proceed to phase 2-- the reusing step of the project. Our first idea was to shred the clean barrels, then put them back into the steel making process. However, this would involve a high start up cost of purchasing expensive metal shredders; this would also be highly inefficient energy-wise. Our second idea was to reuse the barrels, but this would require a high level of safety checks which would involve more bureaucracy and would be highly time consuming. The last idea that we went with would be to send the now clean barrels to a recycling plant. This would result in a slight source of revenue as they pay to purchase these steel barrels.

**Concept Scoring Matrix:**

Table 2: *This table depicts our Concept Selection Matrix which helped our team decide which of our proposed solutions would work best to resolve ArcelorMittal’s problem based on how each assessed the predetermined criteria from our AHP Matrix (Table 1).*

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<tr>
<td><strong>Reactions</strong> - after researching the chemical properties of the chemicals used in ArcelorMittal’s steelmaking process, it became clear that this solution would not because it would be very difficult to achieve the conditions required for the possible reactions to occur to any substantial extent, and there also were not any simple means of converting the chemicals into significantly more stable products.</td>
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<td><strong>Water Wash</strong> - We were able to find many patents on different techniques for cleaning chemical barrels. Our challenge will be to use these ideas as a springboard to develop a simple, safe, and cost efficient method for ArcelorMittal to clean the drums.</td>
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<tr>
<td><strong>Sand Blasting</strong> - An alternative to power washing the drums is sand blasting, which would offer superior cleaning ability, but with the costs of being more abrasive against the plastic drums, and creating a larger mess which would require additional cleanup.</td>
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<table>
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<th>3</th>
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</table>
**Soda Blasting** - Soda blasting is a technique used for stripping paint and cleaning large surface areas. It works much the same way as power washing or sandblasting, except it sprays particles of sodium bicarbonate. The advantages of soda blasting are that it is very effective at removing residue, does not damage the surface underneath, is biodegradable, and is water soluble.

**Post Cleaning Opportunities**

**Recycling Drums** - This is a possible solution, but for it to work we would need to first come up with a reliable wash technique, proper documentation, and an economically viable way to get the drums to a recycling plant.

**Reusing Drums** - Another possibility, but faces the problems mentioned for recycling the drums with the added concerns that it is often difficult for manufacturers to reuse drums/totes because of the increased liability from reusing old drums.

**Design Review:**

Throughout the overall review process, Team 2 generally liked our solution; they thought that the soda blasting process was a great way to clean the barrels and that our two different purity tests should be very manageable. Their biggest concerns and suggestions for improvement were to expand on our cost analysis and show that the cleaning and recycling process would be economically viable for ArcelorMittal to implement in their facilities. In order to expand on this, we would need to get a more accurate assessment of the transportation of the empty drums to the recycling facility. We would also need to come up with a more accurate cost assessment of the soda blaster, taking into account the equipment and the need for maintenance and operation. The final step to seeing the economic viability of this process would be to research how much the recycling companies would pay per ton of recycled material from the plastic totes/barrels and metal drums. The last step in moving from our current state to our final report and presentation is to update the SolidWorks model of our pressure washer head.

Based on the feedback provided by Team 2, we fortunately don’t have to change our core idea much. We will keep all of the main ideas in place, but also take into account the waste
stream of the water coming out of the barrels and whether we need to treat the wastewater from the cleaned drums, or if we can just send it down the drain and incorporate it into ArcelorMittal’s already existing waste stream. We would also need to confirm that the recycling plants will be willing to accept the drums and totes by showing how our cleaning process works, and that the two tests (pH test for GE Depositrol, and an infrared test for the propylene glycol and ethylene glycol) would show that the contaminants are well below the EPA limits. Moving forward we would also like to suggest that ArcelorMittal work with the chemical companies to be able to reuse the drums since it is better for the environment than recycling them, as it would require far less energy. This would also be a plausible option since the soda blasting doesn’t damage the substrate (material being cleaned) and the tests would be able to provide proof that the barrels are no longer contaminated, thus solving the two reasons that chemical companies currently can’t reuse the drums, totes, and barrels. That being said, we believe our solution can be improved and adjusted to resolve ArcelorMittal’s current problem and help them become a more economically and environmentally sustainable company.

3D Model/Prototype

Below is a model of our shower head system used in the pressure washing stage of our process. The circular shape allows the barrels to be cleaned at many different angles quickly and efficiently.
Cost and feasibility Analysis:

**Table 3:** The following table summarizes the total initial costs of the investments ArcelorMittal will need to make in order to implement our solution.

<table>
<thead>
<tr>
<th>Initial Investment</th>
<th>Industrial Pressure Washer</th>
<th>Heavy Duty Soda Blaster</th>
<th>IR Spectrometer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$4738</td>
<td>$2000</td>
<td>$3000</td>
<td>$9738</td>
</tr>
</tbody>
</table>

**Table 4:** The following table summarizes the recurring costs ArcelorMittal will need to pay in order to maintain our solution over time.
Return Costs  | Ton of Recycled Steel | Ton of Recycled Plastic | Total
---|---|---|---
Price | $360 | $800 | $1160

**Table 5:** The following table summarizes the total profit ArcelorMittal will make per 1 ton of recycled steel and 1 ton of recycled plastic after paying back the initial investment costs.

<p>|</p>
<table>
<thead>
<tr>
<th>Recurring Cost /1 ton recycled</th>
<th>Sodium Bicarbonate</th>
<th>Transportation</th>
<th>Energy</th>
<th>Water</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount</td>
<td>13.2 bags</td>
<td>12 miles diesel</td>
<td>-</td>
<td>264</td>
<td>-</td>
</tr>
<tr>
<td>Price</td>
<td>$528</td>
<td>$6.60</td>
<td>minimal</td>
<td>$1.06</td>
<td>$535</td>
</tr>
</tbody>
</table>

**Net gain /ton** $625

By recycling .5 tons/day it would take ArcelorMittal it would take about 32 days to pay back the initial costs then they would begin to make profit. ArcelorMittal could alternatively choose to reuse the barrels directly instead of recycling them.

ArcelorMittal would not have to change anything significantly to integrate our system. There are already government regulations placed on the chemical properties of the water that can be washed down the drain but after the soda blasting and pressure washing, the chemicals will be diluted enough to enter into general waste water streams.
Life Cycle Analysis:

Our proposed solution will resolve ArcelorMittal’s current issues with excess waste by recycling the valuable materials that make up the chemical drums, barrels, and totes. Instead of these containers being disposed of due to the chemical residue left inside after use, our system will clean them thoroughly and transport them to a nearby recycling facility. This solution eliminates the disposal step from ArcelorMittal’s involvement in the containers’ life cycles. Furthermore, when the containers reach the end of their use for ArcelorMittal, they will be recycled so that their life cycle starts anew once more—thus, exhibiting the cradle-to-cradle life cycle model (following the cyclical flow of green arrows in the diagram) as opposed to the cradle-to-grave cycle that they currently undergo (linear flow of blue/grey arrows).

Conclusion:

The best aspects our system has to offer is that it is economically feasible for ArcelorMittal to implement and that it is sustainable. The processes used, both soda blasting and pressure washing, create byproducts that can be washed down the drain and sent to a water treatment facility like any run-of-the-mill waste water. ArcelorMittal also has the option to recycle the barrels at a recycling center or send them back to the chemical plant to reuse.
them directly. By reusing or recycling the barrels ArcelorMittal. However the company would need to pay the initial costs and the costs of operation back before they get can make a profit.

To further develop the system for the future, some change we can make would be to find a way to more efficient use of some of the resources we use, such as sodium bicarbonate, water and energy. We can also integrate a shredder into the system to compact the area of the barrels and make trips to the recycling centers less frequent, lowering emissions.

Our group learned there are various solutions to a single problem and to approach the problem the group must have an open mind. We also learned more about the steelfmaking process.

References:


Appendices: For detailed information that does not fit within the body of your document as well as additional sketches, models, etc., you may include appendices. Label each appendix separately.