

## ArcelorMittal Project Report

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### Identify Customer Needs

ArcelorMittal presented this year's engineering design classes with a problem that they we were tasked to solve. The provided a customer statement which was then turned into a customer need in order to determine the objectives that needed to be completed.

Customer Statement	Customer Need
Reduce ArcelorMittal's waste stream at one of its facilities by designing an opportunity to reuse and/or recycle one or more of the largest sources of refuse: pallets from incoming material delivery, empty drums or totes received from delivery of fluids, and waste refractory brick	A process that will reduce, reuse, or recycle either wooden pallets, plastic and steel drums, or waste refractory brick

ArcelorMittal produces a large amount of waste from their steel mills and it is not recycled or reused in an efficient way. ArcelorMittal produces several different types of waste with the top three being wood pallets, steel and plastic drums, and waste refractory bricks. Wooden pallets are essential to ArcelorMittal's production process, almost everything from motors or rollers are transported on pallets. These pallets are then discarded or given to people for firewood free. There is no current reuse for wood pallets due to the nails embedded into them. Then there is the problem with the steel and plastic drums, they once contained propylene and ethylene glycol (antifreeze) and they cannot be reused without going through a treatment to neutralize the toxic chemicals present. This presents a major issue for their recycling possibilities. This left us with the waste refractory bricks. Refractory brick is huge output that is not being recycled and going straight into landfills. In 2014, ArcelorMittal had a total of 2567 metric tons of refractory brick waste, majority comes from 1586 metric tons of

ladle brick disposed weekly. We decided to examine each of the different types of refractory bricks and choose the one that would be best for reuse or recycling possibilities.

#### Target Specifications:

We wanted to use a design process that would not just recycle the ladle bricks but also save money in the long run. ArcelorMittal will no longer have to pay for the transportation of the ladle bricks from the factory to the landfill. Sustainability is a very important aspect of the target specifications. Sustainability is to fulfill all our needs and making it last now and future generations. In order to achieve sustainability environmentally, as a society we can find substitutes for non-renewable resources, reduce pollution and wastes, and use of resources wisely.

#### Ladle Brick:

Ladle brick is used in the lining of the liquid steel ladles. The composition of ladle brick includes 47.6% magnesium oxide and 50.2% calcium oxide. The magnesia in the brick matrix is slag resistant. The ladle brick was the best type of brick to choose for our solution that will be talked about in the next section. We also chose this type of brick because it was the type of brick that got disposed of most.

#### Select Product Concepts

Introducing our solution to the ladle brick waste problem: a fluidizer that not only recycles the ladle bricks but also converts them into energy at the same time. Here's a quick run-down on how it works. A detailed description will be provided after.

This technology absorbs approximately 95% of pollutants.

How it works:

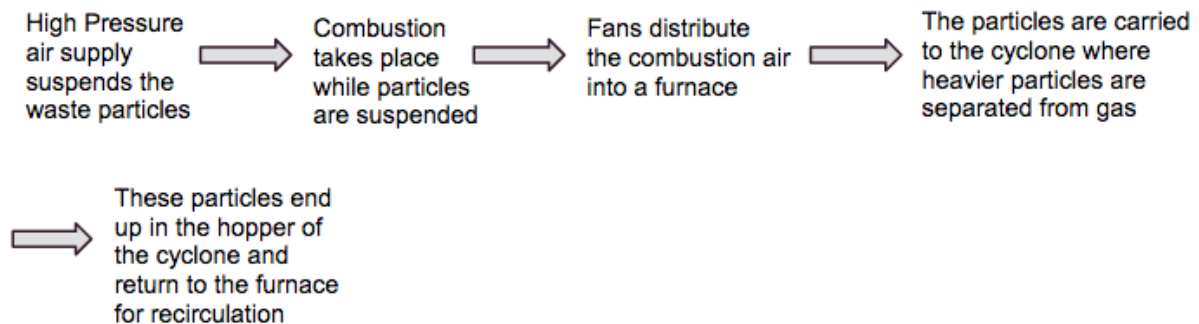


Fig. 1 Diagram of fluidizing process

Process of Fluidization

The ladle bricks are first pulverized into small particles, since the bricks are already brittle it is easy to crush. Gas is injected into the particles placed in a bed causing them to separate and enter into a fluid like state at a such a high temperature. Air pressure passes through the particles. The air pressure drops, suspending the particles. Fans distribute particles into a furnace and gas carries them to the cyclone. The particles are separated in the cyclone. Objects with lower density will float to the surface, and objects higher density will sink to the bottom of the bed. The heavier particles fall into the hopper of the cyclone and recirculate through the furnace. The melted slag particles can be recovered and then used back in the steel-making process. Hot gases produced from the cyclone pass through heat transfer surfaces and escape through the boiler. This produces steam that can be captured through a steam power generator, which is converted to energy. Only 5% of refractory brick particles are turned into ash, however the ash can be used in the process again if the particle is big enough.

1. Pulverization
2. Feeder: fluidized bed
3. Fluidization
4. Recovery of melted slag
5. Heat Recovery

TABLE IV-13  
COMPARISON OF TYPICAL ENERGY REQUIREMENTS  
FOR FLUIDIZED-BED PROCESS AND LONG KILN  
(Btu/ton Cement)

	<u>Feed Preparation</u> (quarry, crush, dry, mix feed)	<u>Clinkering</u> (burn, cool)	<u>Finishing</u> (grind, pack)	<u>Available Energy Recovery</u> (steam/power gen- eration, dryer fuel savings)	<u>Net Energy Required After Energy Recovery</u>
<u>S.D. Fluidized-Bed Kiln</u>					
Electrical	490,000	-	760,000	(1,400,000)	(150,000)
Fuel	<u>310,000</u>	<u>5,000,000</u>	<u>-</u>	<u>(180,000)</u>	<u>5,130,000</u>
Total	800,000	5,000,000	760,000	(1,580,000)	4,980,000
<u>Dry, Long Kiln</u>					
Electrical	534,000	315,000	760,000	-	1,609,000
Fuel	<u>336,000</u>	<u>4,600,000</u>	<u>-</u>	<u>(320,000)</u>	<u>4,616,000</u>
Total	870,000	4,915,000	760,000	(320,000)	6,225,000

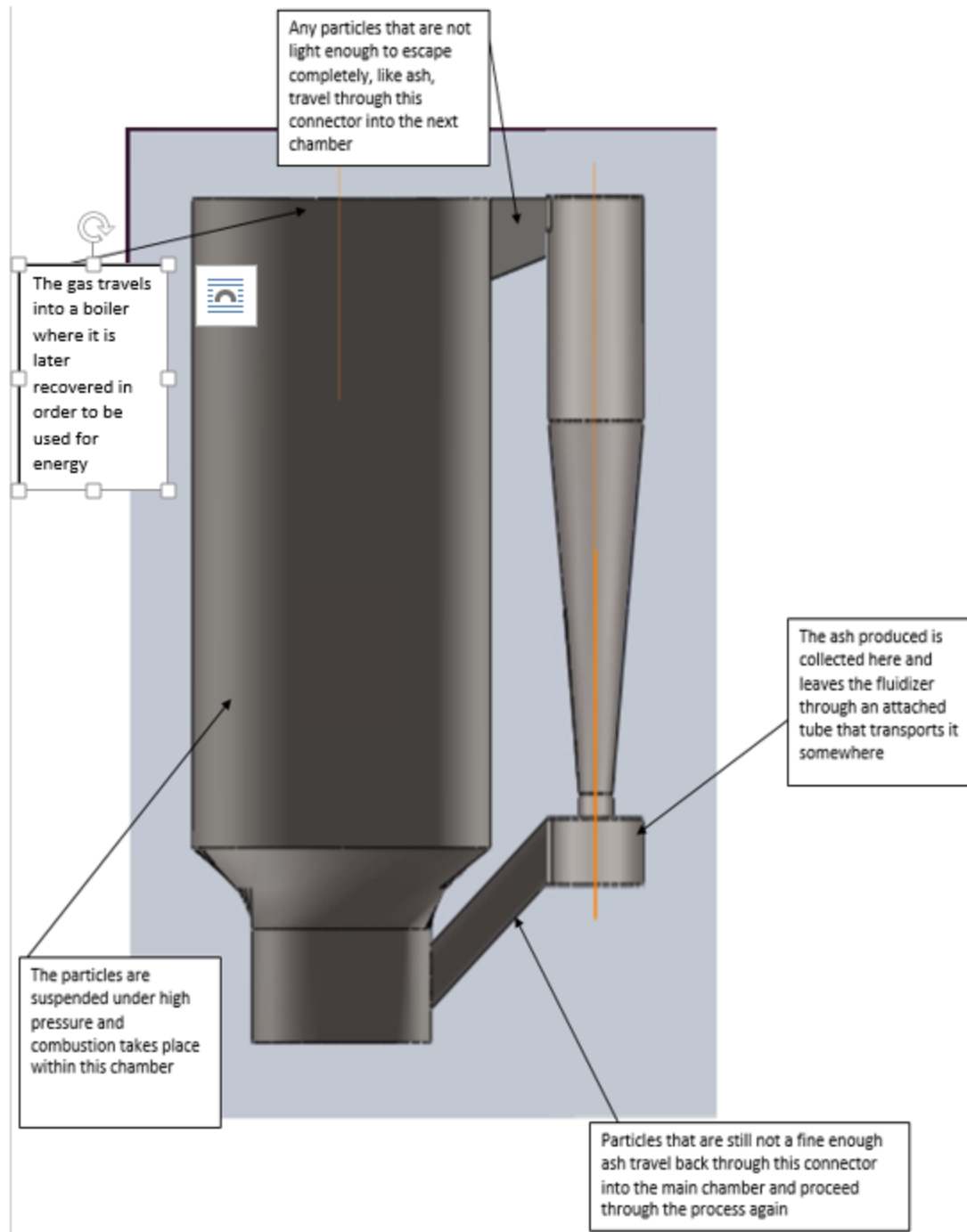


Fig.2 SolidWorks model of fluidizer

### Why this design should be used by ArcelorMittal

ArcelorMittal has given us the opportunity to design a system for them to use in their steelmaking company in the United States that is more efficient and better for reducing their carbon footprint than the system that they already have in place. There are many resources that is used to go into steel making and with those resources outputs also come with a cost. Right now so much refractory brick is going straight into a landfill. This is a method to get rid of their most used type of brick in a method that is cleaner with little waste, more green, and can even produce more electricity than it consumes. ArcelorMittal was looking to significantly reduce their carbon footprint and this is the perfect solution since it will be getting rid of one of their largest waste products. The fluidization process can use almost any fuel and is able to combust the waste without harmful emissions. The fluidizer also requires little maintenance once it is installed so ArcelorMittal will only need to factor in the fact that someone will have to remove the little ash that the fluidizer produces. We are confident that the downsides to this design are outweighed by the benefits.



Works Cited:

C. *Waste Stream Reuse and Recycling* (n.d.): n. pag. Web.

"Directory:Waste to Energy." - *PESWiki*. N.p., n.d. Web. 01 May 2015.

"Download PDFs." *Heat Recovery from Hot Solid Particles in a Shallow Fluidized Bed*. N.p., n.d. Web. 01 May 2015.

"Energy.gov." *Fluidized Bed Technology*. N.p., n.d. Web. 01 May 2015.

"How Circulating Fluidized Bed Boilers Work?" *Brighthub Engineering*. N.p., n.d. Web. 01 May 2015.