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09 Intern Assignment Refractory Materials

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Patrick Kessler, Intern Assignment

Post-class

Suppose you were an engineer at a plant that performs the process you have been discussing. If you were instructed to design and plan out the construction of this heater, refractory, kiln or furnace layout, what are key points that you would make to the plant manager to approve the funding of refractory for the system? (some cost analysis information: refractory costs ~$150-500 (depends on type of refractory used) / metric ton, cost of steel ~$800-850 / metric ton; life span of refractory varies from 1 to 10 years depending on the type of refractory, with average lifespan of 5 years, life span of a well-kept kiln or furnace ~30 years). These numbers are just some crude reference numbers, but use sound scientific reasoning to help explain why the purchase of refractory would be important for your process.

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Reflective Writing Assignment #2

If I was an engineer at a plant, and I was put in charge of designing the construction of a heater, kiln, or furnace layout, I would make sure I was able to convince my plant manager to approve the construction of a refractory for each system. There are certain points I would make in order to get him to approve implementing refractory. First, the plant manager has to understand that heaters, kilns, and furnaces will all last longer with a refractory system. All of those things are metal, and we know that metal is a really good conductor of heat. Because metal has good conductivity, it is going to melt at temperatures that are not conducive to performing the tasks that you would use a heater, kiln, or furnace for. Let us say, for example, that this plant is producing glass. The temperature at which you need a furnace to be to melt glass is much higher than the melting point of metal. The metal in the furnace will become pliable and melt, and the plant manager will have to fund another new furnace. This is where the refractory comes in. Refractories are made out of a material that is a low conductor of heat, or they insulate heat really well. By lining the inside of a heater/furnace/kiln with a refractory, the heat will remain insulated and it won't raise the temperature of the metal to a high enough temperature to melt it.

Clearly, by funding a refractory we would have the ability to produce equipment that has a longer life-span than equipment built without refractories. From the perspective of a business trying to make the biggest profit it can, buying and implementing the use of refractories when building equipment can be a real cost saver. The cost of steal per metric ton is close to $300 more than the most expensive refractory. If you were to build a piece of steel equipment with no refractory, not only is it going to have a much shorter life-span, when you inevitably have to replace it, it is going to be so much more expensive because of how much steel costs. If you purchase refractory for the plant when you build the machines, the initial cost is going to be higher, but each machine is going to have a longer life span, and it is much cheaper to replace refractory than it is to replace the whole machine altogether. In conclusion, it is obvious that approving the purchase of refractory when designing the plant is the smartest way to go. Refractory will improve the life-span and quality of each machine, and it will drastically reduce costs in the long run.

C37
April 4, 2015
CHEM444 Fire and Ice
Reflective Writing Assignment

Refractory in Industrial Applications

5. Refractories are used for the linings of extremely high temperature processing units such as furnaces and kilns. There are a variety of refractory methods for all types of industrial applications and each method has fluctuating costs. Some refractory costs can be high, so an engineer in charge of planning the construction of a refractory would have to explain the extreme importance of refractory for that plant in order to get funding for the system. Depending upon the process it will be used for, the refractory materials must posses certain properties and performance characteristics. In general, the materials used to make any refractory are usually nonmetal because metals are good conductors of heat, and therefore not very resistant to thermal stress caused by heat. Refractories must be made of materials that are more heat resistant than metals as they will be exposed to temperatures above 1000 degrees Fahrenheit. Refractory materials must also be able to withstand corrosion from the chemicals used in the industrial process as well as physical wear from the environment and harsh processing conditions.

A refractory system must be purchased for use in iron ore processing plant as refractory plays an important role in this process. A rotary kiln is used in iron ore processing to heat harden the iron ore pellets. The temperature inside of the kiln needs to be about 2400 degrees Fahrenheit in order for necessary chemical reactions to take place and cause the hardening of the pellets. Since the kiln itself is made of steel, which begins to creep at temperatures over 842 degrees Fahrenheit, there has to be a refractory lining inside the kiln to provide protection from the high temperatures. Without the refractory lining, the steel would exhibit the creep phenomena and become deformed. In addition to becoming deformed, the steel kiln could also potentially melt. The purchase of a refractory is clearly very important in iron ore processing to keep the kiln well kept and in good condition. The refractory lining would also keep the high amount of heat inside, allowing more heat energy to go into the pellets and not be lost to the environment. An engineer could argue that without a refractory lining, it would be extremely difficult and most likely more costly to process iron ore as the process would be less efficient, less safe, and the kiln would constantly need repairs or replacement.

In order for the reduction of aluminum to occur, refractory would be essential to avoid the steel kiln from melting, and to avoid any meltdown or spill. Aluminum is reduced at around 950 degrees Celsius, which is much higher than the melting point of aluminum itself, which is 660 degrees Celsius. The kiln must reach a temperature much higher than the melting point in order for the breakdown of alumina to be efficient, and effective. A refractory is necessary to contain such a high temperature and to withstand the physical wear, because without a refractory, the steel would melt, and it would have to be replaced each time aluminum is reduced. Steel costs around $800 per metric ton, and to replace that each year for 30 years (the average lifespan of a well kept kiln) if no refractory were used, that would cost around $24,000. If anywhere from $150-$500 was spent one time on refractory, averaging a 5 year lifespan, it would only cost around $900-$3,000 for that same 30 year period. While this refractory adds to the initial cost, it is an investment, and ultimately allows for the saving of money in the long run. With the addition of refractory, there is at least a $21,000 saving. Since the refractory is meant to withstand such high heats, it is the best, safest, and most cost efficient method for the reduction of aluminum.

G33

CHEM 444

April 05, 2015

Reflection on Refractories

A material that is considered to be refractory has a special characteristic. This is that it is able to maintain its strength and shape at high temperatures. Not all materials have this special property. For example, the steel used in our furnaces is not a good refractory. This is because it is a type of metal and is a good conductor. On a molecular level, refractories are heat resistant. This is because their bonds are stronger. For example, a ceramic refractory is composed of ionic bonds, which are very strong. Bonds that are harder to break make it harder for a substance to be vulnerable to high temperatures of heat. This contrasts with the properties of metal, which has free electrons and weaker bonds. The weaker bonds in metal are what makes it so resistant to heat.

Keeping all of this in mind, now think of the use of refractory in our work environment. For example, glass is heated up inside of our furnace. The temperature is extremely high (up to 1500 °C). These high temperatures will melt the steel that composes our furnace without refractory to protect it. The melting point of steel is 1370 °C. This means that without refractory inside of our furnaces, the steel of the furnace will be getting too warm. Complications of this include deformed the shape or melting the steel, as well as a fire safety hazard. Refractory brick is relatively inexpensive ($150-500), with a lifespan of 1-10 years. Looking at this situation, it is clear that refractory must continue to be used at our glass making plant. Refractory is saving our furnace, it is safer for our workplace, all the while being at a cost-efficient price.

H22

CHEM 444A

Professor Bauer

07 April 2015

Question 5 – Reflective Writing Assignment

The purchase of refractory is a key component of the construction and maintenance of any high heat furnace, kiln, etc. Refractory provides many benefits, including but not limited to heat retention, improved efficiency and protection. In order for furnaces or kilns to function for extended periods of time under extreme temperatures, some type of refractory is needed. The refractory prevents the external steel structure from melting or "creeping". Without the use of refractory, furnaces and kilns won't last nearly as long as they would if they have refractory protection. Therefore furnaces would last for very short periods of time. Also, they would be very inefficient since immense amounts of heat would escape causing the process to take longer. On top of the financial cost issues, without the use of refractory workers can be in serious danger of spills or breaks in the furnace walls exposing them to molten materials. Refractory helps prevent structural destruction of the furnace, helping to decrease the risk of factory damaging leaks which can be life-threatening to any nearby workers.

The process of forming aluminum requires the alumina to be placed in a furnace that reaches temperatures up to 950^0C. Steel cannot maintain its structural shape and strength at extreme temperatures like these. As a result the steal would change shape increasing the risk of breaks in the furnace walls exposing workers to serious dangers. Therefore refractory is absolutely necessary and should be used to line the inside of the steel structure. Refractory will

definitely increase short run costs, but it will extend the life of the furnace while increasing efficiency (heat retention), lowering costs significantly in the long run. This is true because the cost of refractory is much less than the cost of steel so it is much cheaper to replace the refractory than to replace the steel. Therefore if the furnace is maintained properly it can last for about 30 years. The refractory used for this furnace will last about 5 years. Therefore the company will only have to purchase steel once every 30 years and purchase refractory 6 times over the course of the furnace's lifespan. The other approach would be to cut short run costs by not using refractory. This would end up being much more expensive since the more expensive steel would have to be replaced frequently (more than the refractory) at a cost of $800-$850 per metric ton each time. With the use of refractory within these terms the furnace would present costs of $1700-$3500 per metric ton every 30 years (rough estimates). Assuming a steel furnace without refractory would last 3 years, the costs would be $8,000-$8,500 per metric ton every 30 years (rough estimates). Overall, using refractory in the construction is the better choice for both finances and safety. The use of refractory is cheaper in the long run and it also helps prevent high amounts of heat from reaching and damaging the steel structure, which also cuts cost through increases in efficiency. Refractory should undoubtedly be used to line the steel structure of the furnace. Refractory helps improve the efficiency of the process since it allows high temperatures (950^{o}C) to be reached easier by preventing heat loss. In a more scientific sense, refractory helps prevent heat from transferring to the steal through conduction. By retaining heat, the company would have to spend less on utilities to heat the furnace since there is a significantly lower amount of heat loss (waste). Also since this process requires high temperatures to be attained, the refractory helps to retain heat allowing these extreme temperatures to be achieved relatively quickly and efficiently. For example if refractory isn't used the heat will escape the furnace

quickly requiring energy to be constantly added to the system at a fast rate. The refractory helps hold heat in the furnace which undoubtedly reduces costs. In addition to increasing efficiency, retaining heat, and preventing the structure from deforming, refractory also helps prevent “physical wear” to the structure of the furnace. There are several chemicals within the furnace, some that would possibly react with steel. The refractory prevents the chemicals from damaging the furnace or kiln’s structure, immensely increasing its life span. Refractory seems like a big expense, but when the numbers are presented it is actually cheaper in the long run to incorporate refractory into the construction of any high heat furnace or kiln.

Works Cited

"About Refractories." The Refractories Institute. N.p., n.d. Web. 02 Apr. 2015.

"Structural Material Behavior in Fire: Steel." Structural Material Behavior in Fire: Steel. N.p., n.d. Web. 02 Apr. 2015.

Kilns and Refractory

Refractory is a necessary investment for the well-keeping of a kiln. With refractory, a kiln can last up to 30 years. Without refractory a kiln could deform in one use. Creep occurs at temperatures over 450◦ C and steel melts at around 1500◦ C. Kilns used in the iron ore processing fire up to 2400◦ F ≈ 1316◦ C. With such a high firing temperature a kiln would possibly melt the steel kiln itself, and certainly deform it. The average refractory lasts five years. With a cost of ≈ $150-500 / metric ton, it would cost $900-3000 to buy a metric ton of refractory every five years. If instead a metric ton of steel was necessary every five years it would cost $4800-5100. However, if refractory was not in use it is very likely that the kiln would need to be replaced even more often than every five years, causing the noted price difference to increase drastically.

Refractory is used to contain heat. As previously explained this would benefit the steel of the kiln, however, this is not the only benefit. The refractory would ensure that nearly all the heat is being transferred to the iron pellets and not to the steel kiln and further out to the surrounding environment. Thus, refractory saves fuel costs, because a kiln without refractory would certain require more energy to keep the temperature up. The containment of heat is additionally important for safety issues. The heat transferred to the environment by a kiln reaching such high temperatures without refractory would be a safety danger to those in the work environment.

K29
CHEM 444
April 7, 2015
Reflective Assignment

Dear Plant Manager,

The furnace used here at the Glass Manufacturing Plant needs to be replaced. As one of the team's engineers I am seeking your approval to use refractory for the furnace instead of steel. The furnace runs 24 hours a day and seven days a week at approximately 1500˚C. Steel will not be able to withstand the high temperatures needed to melt batches delivered to the furnace. Steel begins to slowly lose strength at temperatures around 300˚C and steadily decreases in strength once 800˚C is reached. Not only does steel prove to be too weak to withstand the intense heat, but steel also begins to creep at 450˚C. The creep phenomenon is when the steel becomes deformed and mangled from its original shape, due to extremely high temperatures. The melting point of steel is also around 1500˚C, which is the temperature required to melt the batches. Steel has a lower melting point than refractory due the amount of carbon in steel. Carbon has four electrons available for covalent bonding. Covalent bonding affects the melting point of a substance because covalent bonds form when atoms share electrons. Covalent bonds are weaker due to their shared electrons and therefore, do not withstand heat very well. Steel is also made from iron, which is a type of metal. Metals are good conductors of heat because they have loose electrons, which have the ability to move freely across the metal. Due to the ability of carbon to form covalent bonds and the loose electrons found in metals, like iron, steel has a lower melting point than refractory. Refractory is a heat-resistant material, which is specifically designed to withstand temperatures above 1000˚C and damage from chemicals. Refractories are usually made with nonmetallic substances, which can be natural or synthetic. Refractories have a low thermal conductivity due to the substances in its composition. Non-metallic substances are better insulators, while metals are good conductors. A low thermal conductivity is ideal for a furnace because refractories will not easily transfer heat. This means that the heat from the fire will not be easily taken up by the refractory and therefore, will not melt like steel. The furnace would not lose heat through the walls or roof of the furnace if it was lined with refractory. This is optimal because heat loss can result in a decrease in temperature in the furnace, which would disrupt the melting process. Refractory would work like an insulator because of its low thermal conductivity. If refractory was used to build the furnace there would be no concern of the furnace creeping or melting during the glass making process. The use of refractory would also be more cost-effective for the plant. Refractory costs about $100-$500 per metric ton, while steel costs about $800-$850 per metric ton. Refractory has an average lifespan of about five years, but with proper maintenance the furnace has the potential to last for around 30 years. A furnace made of steel would start to creep and melt during its first batch delivery. Refractory is the cheaper and more long-term option, which will save the company money and the trouble of replacing the furnace so frequently.

Sincerely,
K29

L18

Prof Bauer/Patches

Chem 444 Honors

7 April 2015

Refractory in Industrial Applications

5. The purchase of refractory for this kiln is very important because of the benefits it would offer. Refractory is made to prevent the conduction of heat from one material to another. This would keep the material on the inside of the kiln from losing its heat to the steel kiln itself. If the heat were to be conducted to the kiln, the energy that you put into the heating of this material would be lost, and your plant would be inefficient in its energy consumption. Furthermore, the refractory prevents warping and damage to the steel, which melts at a temperature likely lower than the temperature required inside the kiln. This means that the refractory is absolutely necessary not only to prevent a meltdown but also to help the lifespan of the steel. Steel costs much more than refractory does, so using refractory, which lasts about 5 years on average would be cost effective, because it would extend the lifespan of your kiln. You could replace the refractory between 2 and 5 times (depending on the type of refractory) before reaching the cost of the kiln alone. This would give you between 10 and 25 years of protection to the kiln, just for the same cost as the kiln itself. If you chose not to use refractory, you might end up having to replace the kiln itself before you get such use out of it. This makes it clear that refractory is a lucrative and logical option.

M27
April 4, 2015
CHEM 444A.H01

Refractory in Industrial Applications

Glass Manufacturing Process

The process of glass manufacturing requires the use of extreme temperatures in order to turn the raw materials of sand, soda ash, limestone, carbon, and iron, into the glass used in bottles and other containers. Once the raw material is collected, and separated into batches, the batches are fed into a furnace, which is at approximately 1500°C. In the furnace, the addition of heat transforms the raw materials into molten glass in a process taking 24 hours to complete. After the time in the furnace, the liquid glass flows into a refiner, where the temperature is cooled to 1200°C. From here, the glass is molded and cooled until it is ready for use in packaging beverages or other substances.

Furnaces are used for high-temperature heating, an appropriate device when dealing with glass production; however, furnaces are most commonly made out of cast-iron or steel, which cannot withstand the temperature necessary to create glass. Steel begins to lose strength at temperatures above 300°C, and its melting point is approximately 1370°C. This means that before the furnace reaches its required temperature for the process of glass manufacturing, the furnace would melt into a liquid, thus making it impossible to create glass. For steel furnaces to be used in the production of steel, refractory would be necessary because it is a heat-resistant material that would line the inside of the furnace, preventing the steel from melting, while reaching extreme temperatures, thus allowing glass to form. Although refractory is an added expense to the production company, it is a valuable material because of its ability to withstand extreme temperatures, which allows the process to be managed by human capital. In addition, the material can withstand physical wear and corrosion by chemical agents. Without the use of refractory, a metal furnace would not be useful in producing glass. The addition of refractory to a steel furnace would increase its lifespan to between eight and ten years, and without it, the furnace would have no extended life. The incurred refractory expense would be worth the investment because it is being used to produce glass, which is an extremely useful product that is recognized as a trusted, versatile, and 100% recyclable material for packaging. Due to the popularity of glass, the revenue associated with the demand of glass, and products contained in glass, would significantly outweigh the expense of refractory incurred each decade.

Refractory in Industrial Applications

The funding for refractory is completely necessary. Where there are costs of anywhere between $150 and $500 per metric ton, the refractory would increase the longevity of the kiln by a wide margin, because the refractory would prevent the melting of the kiln's steal frame. Steal is very expensive, costing around $850 per metric ton, and lining of the steal in refractory would prevent having to buy new steal often. Steal begins to "creep" or deform at around 450 degrees Celsius, and temperatures in the kiln will likely be much higher than that, so a layer of refractory is imperative. Refractory keeps the heat within the kiln, improving productivity of the task at hand, and maintains the functionality and form of the kiln.

Refractory Discussion Questions
P14
April 7, 2015

> Suppose you were an engineer at a plant that performs the process you have been discussing. If you were instructed to design and plan out the construction of this heater, refractory, kiln or furnace layout, what are key points that you would make to the plant manager to approve the funding of refractory for the system? (some cost analysis information: refractory costs ~$150-500 (depends on type of refractory used) / metric ton, cost of steel ~$800-850 / metric ton; life span of refractory varies from 1 to 10 years depending on the type of refractory, with average lifespan of 5 years, life span of a well-kept kiln or furnace ~30 years). These numbers are just some crude reference numbers, but use sound scientific reasoning to help explain why the purchase of refractory would be important for your process.

Despite the cost associated with lining one's furnace with refractory, in the long run it is Important that you have it. Without the refractory, it will be more difficult for the internal system to reach the temperature necessary to accomplish the chemical process being utilized. If this occurs, there will be much lower productivity and much lower output from the system, causing the company to lose money over time. On top of this is the risk of the high temperatures damaging the integrity of the furnace itself. Damage to the furnace as well as possible injury that could result is another large cost associated with not investing in refractory. So despite the initial cost needed to purchase the refractory, it is a necessary purchase.

Q25

CHEM 444AH

Professor Bauer

Due: April 7, 2015

Refractory in Industrial Applications

5. The purchase of refractory material is an investment in your equipment. Although it costs extra money, it will be worth it in the long run. By lining the inside of a kiln or furnace with refractory material, you are allowing all of the heat energy be absorbed by the product the company needs to heat up (limestone, clay, alumina, etc). The heat energy provided by a heat source, like a flame, bounces off of refractory material. Refractory material will improve the industrial process by speeding it up and making for a more efficient work day. In turn, this will make the company more money. After all, you have to spend money to make money. Not only will work efficiency increase, but the lifespan of your equipment will also increase. You can save money by making the kiln or furnace out of steel and use the extra money to splurge a bit on refractory lining. Steel will melt if it is exposed to high temperatures. The refractory lining will protect the steel from deforming and creeping, allowing it to be used for a long time.

To Professor Bauer,

Here is my challenge question for Tuesday.

If I was constructing a cement rotary kiln I would argue that it is incredibly important that a chunk of funding was set aside for refractory. The cement rotary kiln, which is made of steel, reaches 2,700 degrees Fahrenheit. Steal starts to creep at 842 degrees Fahrenheit and it melts at just over 2,700 degrees Fahrenheit. Therefore if we didn't use refractory we would have to replace the steal after every use. Steal costs around $800 per metric ton and kilns usually last for about 30 years. Even if we were only replacing the steel once a year that's $24,000 per metric ton. Plus at the temperature the kiln is reaching it is going to have to be replaced more than once a year. On the other hand refractory is a heat-resistant material that would prevent steel from creeping and eventually melting. Refractory only costs about $150 per metric ton and it has an average life span of 5 years. If we were to use refractory on the kiln it would only cost roughly $900 per metric ton for the 30 years. That's over a $23,000 difference and a lot less time spent replacing steal. Therefore in respect to saving time and money is makes much more sense to spend money on refractory.

Regards,

R23

S21
April 5, 2015
CHEM 444

Why Buy Refractory for Iron Ore Processing?

Refractory is necessary for the lining of the kiln that is used to harden the pellets of iron. This process requires a temperature of 2400 degrees Fahrenheit, which is well above the melting point of steel, which is what the kiln is made of. Without refractory to protect the steel of the kiln, the kiln will be destroyed during the processing of the iron ore and will have to be replaced. It is more logical and cost-effective to line the steel kiln with refractory, which will prevent the conduction of heat to the steel layer of the kiln. This protects the kiln and prevents it from melting or distorting, which will reduce the funding required for replacing damaged steel.

T19

CHEM 444A

4/3/2015

Reflection Assignment: Refractory

When making a business purchase it is important to determine if the product is worth the cost of both obtaining and installing. In looking at purchasing a form of refractory for the plant's kilns/furnaces there are many factors to consider. The first is the safety risks inherent in the process of purifying aluminum. When the alumina is being heated in order to separate aluminum and oxygen, temperatures reach 950°C. This is a temperature that can be dangerous to workers if not contained. Refractory helps to insulate the kiln/furnace and keep the heat within the system. While this decreases safety risks, it also increases the efficiency of the process. If more heat leaves the system it will take longer and require more energy to complete the process. In addition, at temperatures such as this steel begins to lose its integrity. Over time this requires the company to purchase new furnaces/kilns. This is a great expense. Due to its poor conductivity and insulating properties, refractory helps protect steel from the extreme heat. This lengthens the life of the furnaces/kilns, and saves the company from the expense of replacing them more frequently. Overall, purchasing refractory is an investment that will save the company money in the future. It will reduce energy costs, promote safety, and prolong the life of the furnaces/kilns. The initial cost will be offset by these future gains.

A refractory is crucial for iron ore processing. The iron ore must be able to be transported as a base product to other companies without being damaged. The heat contained in the refractory helps to harden and pelletize the product so that it can be distributed to blast furnaces and steel mills and made into finished steel. Heat is contained within the kiln because of the insulation of the refractory material. This concentration of heat at a temperature of 2,400 degrees Fahrenheit hardens the pellets by encouraging a chemical reaction to occur among the binding agents (bentonite and limestone).

Without a substantial refractory, the process could take longer and could potentially do serious damage to the other equipment involved. A kiln with a good refractory creates a space in which the contained heat is concentrated on the pellets and is able to efficiently and effectively harden them. The pelletizing process that occurs within the kiln is a necessary step in the production, loadout, and shipping of iron ore. It is a solid investment and well worth the cost of $150-$500, especially given the average lifespan of 5 years.

W12
4/6/2015
CHEM 444AH

Refractory Question #5

The making of glass is a fairly simplistic process that requires massive amounts of energy and heat. Sand, soda ash, limestone, and other materials, start off in silos. They are then measured out into the perfect amounts, and placed into a giant mixture. From there, they are brought to a steel furnace that is heated up to 1500C. This furnace melts the ingredients into a molten mixture of glass. From this furnace, the glass then travels to a refiner. The refiner is another type of furnace that begins to cool down the molten mixture. The glass is kept at a constant 1200C. Finally, during the forming stage, the semi-cooled mixture can be cut into globs of glass. The glass then travels down conveyor belts where it is continuously cooled more and more, while it is being shaped and blown simultaneously. By the end of the process, the glass is about 600C, and then will continue to rest until it reaches room temperature.

The furnaces that hold the molten glass need to be able to withstand the temperatures of the mixture itself, otherwise the heat would not be contained and dangerous situations could ensue. That is why these furnaces need refractories. When considering what refractories need to be used, cost, lifespan, and the type of refractory all need to be considered. Not all refractories are the same. Some are made of different materials. This means that they could react differently depending on the type of mixture they are holding in. Before a refractory was purchased, it would be pivotal to make sure that the type of refractory would react well with the glass mixture. This also plays a role into the pricing and lifespan. Some refractories are more advanced than others, and therefore will cost more and likely last longer. By knowing the type of refractory needed, it can save money and also preserve the lifespan of the refractory. You would also want to know how compatible the refractory would be with the furnace. This could involve the ease of its implementation, finding the right fit, and possibly how it will behave with the furnace itself.

X15
Professor Bauer
Chem 444
7 April 2015

Reflective Writing Assignment

Refractory is much more than just an extraneous and expendable expense. In fact, the use of refractory is necessary to guarantee the efficiency and longevity of a strong and well-built furnace. Without a refractory lining, the steel furnace is likely to creep beginning at 450°C, leading to deformations in the steel over time, and by 1500°C, the steel can melt—so by building a steel furnace not lined with refractory, we would run the risk of it being ruined in a very short amount of time, and would have to restore or rebuild it often. Since refractory is specifically made to withstand temperatures above 538°C, using it as a lining will significantly decrease the chance that the furnace will begin to creep or melt soon. Refractory can be a great help in preserving the quality of the furnace over a long period of time, so I think that it is well worth the cost. Depending on the quality, it can range from $150-500 per ton, which is a relatively affordable extra cost, considering that steel is $800-850 per ton. Refractory lasts an average of five years before it has to be replaced, but if we are careful to take proper care of the furnace and use refractory to protect the steel, the furnace itself can last about thirty years. On the other hand, if we did not line the furnace with refractory, we would save that cost, but we would have to replace the steel much more frequently, and it would be much more costly than simply replacing the refractory every few years, so the benefits of using refractory certainly outweigh any financial drawbacks.

Question 5 on Refractory

Refractory is a lot smaller of a price to pay for a firm than replacing a steel structure that can melt or be damaged under high temperatures. It is worth the investment to pay the extra price in the beginning than to have to completely replace your equipment. Refractory is good to use for these kinds of conditions (protecting materials from high temperatures) because the material it is made of makes it a good insulator, so it does not transfer heat easily. Refractories are used as a material to build structures subjected to high temperatures. Examples are alumina, fireclays, magnesite, silicon, and zirconia. Bricks are a common example that can be used to explain refractory and used in most homes in fireplaces. Using this type of material allows the structure to withstand higher temperatures without fear of it breaking, melting, or anything that can damage the material itself or things around it. It also states that refractories must resist other things than temperature such as unexpected chemical attacks, molten metal, thermal shock, physical impact, etc. If refractory can withstand all this then it is great asset to add to a steel structure that will be exposed to high temperatures and the unexpected.

Z11
Refractory in Industrial Applications
7 April 2015

Refractory is very important in iron ore processing because of the high heat involved in the kiln to harden the iron pellets. Refractory is used within the steel kilns because steel begins to loose its strength at 300°C and the kiln hits 2,400°F. Without the refractory, the steel would loose its shape or a more resistant metal would need to be used to contain the heat. This kind of insulating metal would be much more expensive than steel and refractory to insulate the heat inside the kiln.