INSULATION: FRIEND OR FOE?

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I thought this would be a timely subject as energy costs keep on rising and there is no reason to believe that this will stop any time soon. As a result I have seen a rush to add insulation to all manner of installations if it warrants it or not. In addition, because most companies have either a younger work force or nobody with a refractory background some applications have been rather ill advised.

Insulation can be considered a friend each time it allows a unit to reach temperature faster than without it, protects the unit's surrounding environment from excessive heat and saves energy costs, but it becomes a foe when its use degrades the other refractories in the unit quicker than expected, slows the temperature loss sufficiently to add considerable time before entrance to the unit is possible for repairs to take place or leads to outright catastrophic refractory failures.

One of the most important design criteria is how the unit will be used: cycling on and off in a short time span or, on for long periods of time. Insulation can be applied when a unit is first designed and build or later on as a retrofit. In this discussion I will consider a major reline like an initial installation, as it is a planned replacement of refractories, which allows for the rethinking of the lining design. As to insulation materials they can be fiber blanket/ modules, boards or insulating castable/gunning mix/brick. It should be pointed out that all insulating materials are quite sensitive to deterioration when their temperature use limit is exceeded. Depending on the material they may shrink excessively (fiber blanket), loose strength (insulating board), or soften (insulating brick).

Several aspects need to be considered when designing the lining for an industrial unit. Depending on the expected length of time at high temperature it may be totally lined with insulation or the insulating material may be installed against the shell and buried behind other refractories. A unit lined exclusively with insulating material will be extremely energy efficient, and have good thermal shock resistance or even be totally impervious to this problem if only fiber insulation was used. The down side is that insulating materials have little abrasion resistance. As a result the high wear area(s), usually the hearth, is made out of a hard refractory. Although units lined with insulation can be heated extremely fast, the hard refractory becomes the limiting factor as its heat up or cools down needs to proceed at a slow and controlled rate for optimum life. This lengthens the time allotted to reach the desired use temperature, but this needed time is often hard to obtain due to pressure to get the unit on line as fast as possible. Because damage to the hard refractory is not immediately obvious, and, furthermore will not be evident for a long time it is difficult to use it as an argument for a longer heat up schedule.

A unit that will be at temperature for a significant length of time and shut down on a limited basis is a candidate for insulation against the shell protected by hard refractory. Care should be taken to not only calculate the interface temperature, i.e. the temperature that the insulating material will be exposed to, of a new lining, but also of a highly worn one. I have seen many linings, which have failed because the temperature limit of the insulating layer was exceeded as a result of lining wear so that it lost its physical integrity. Another problem area is burying the metal part of a hard refractory anchor system in insulation. The metal overheats and recrystallizes thereby changing its properties to the extent that the anchor becomes unable to hold the refractory. Because this process takes time, the damage does not become apparent until later and it is not always easy to determine so that other factors are often blamed for the failure.

A new area of concern applies to brick linings whose effectiveness are based on efficiently conducting heat from inside the unit to the metal shell. When adding an insulating layer between the shell and the brick, the intrinsic design concept is altered leading to higher lining wear. This is not to say that such a design should be avoided, but to point out a consequence of the action.

Adding insulation as a retrofit needs to be carefully thought out as it greatly modifies the initial installation. Shell integrity and state need to be carefully evaluated and care should be taken not to trap excessive heat in the hard refractories as it could lead to catastrophic failure.

It should be noted that I have avoided specifically addressing units, which operate with a special atmosphere, but should point out that all problems are magnified and accelerated in such an environment.

I hope this simplified primer on the use or abuse of insulation has provided some points to think about before undertaking your next refractory installation.

If you have comments about this column or suggestions for future topics please visit me at refractoryexpert.com and I will try to address them.