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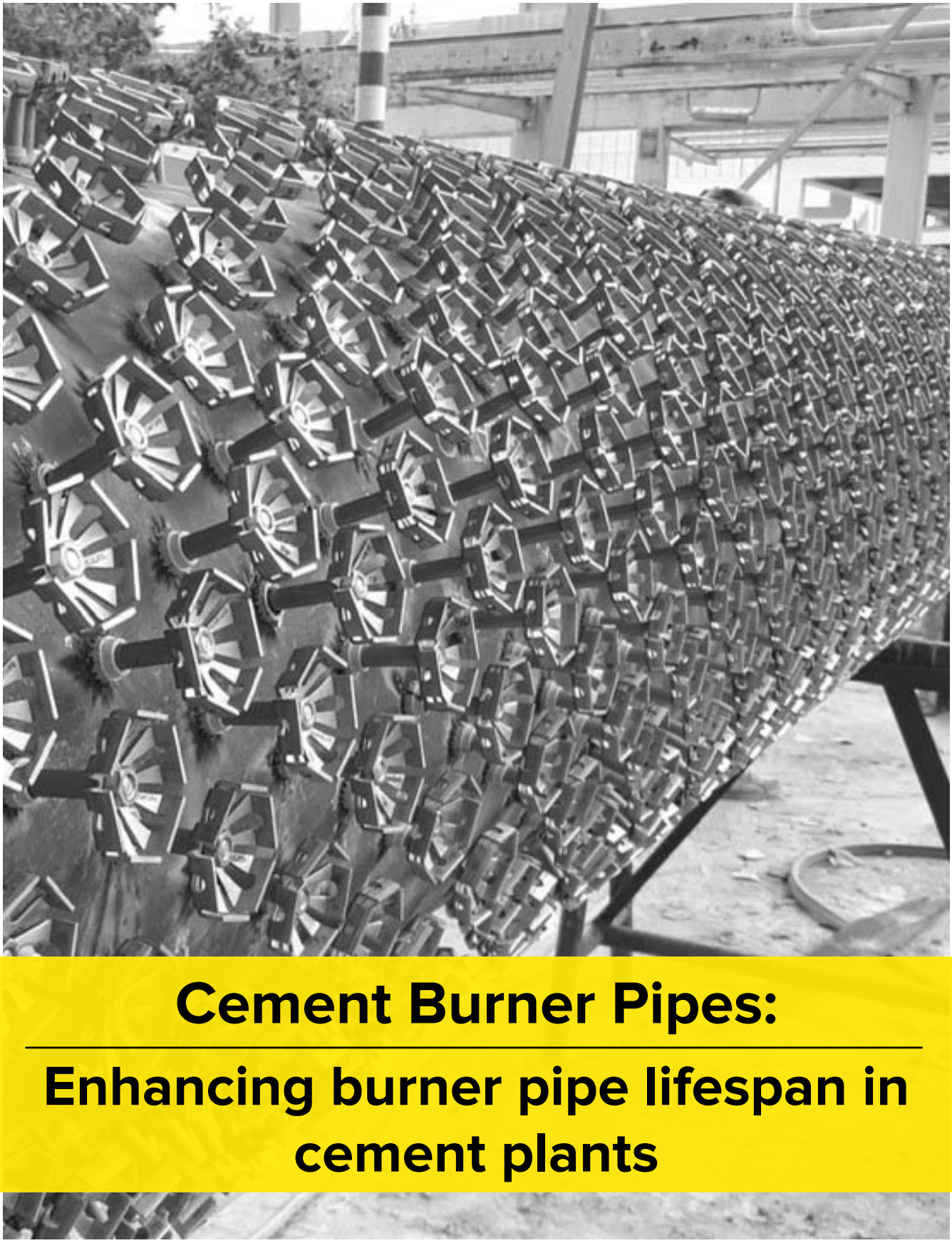
Your partner for all refractory anchoring solutions

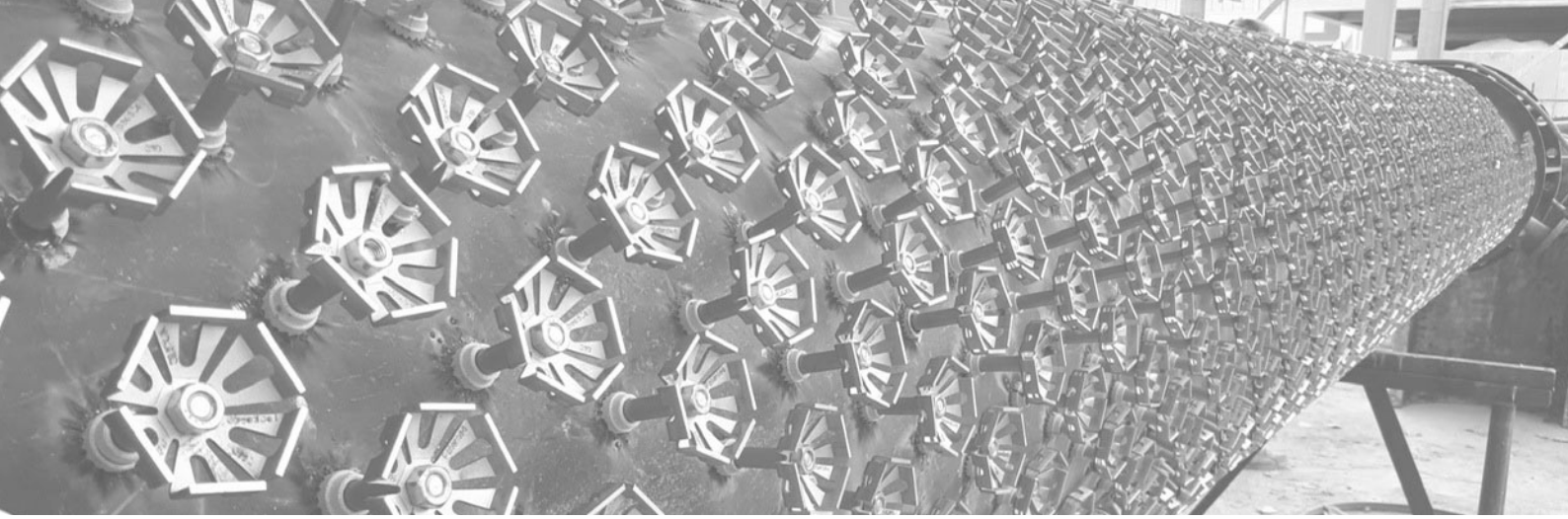


Cement Burner Pipes:

Enhancing burner pipe lifespan in cement plants

Contents

Patents – Protective design
SpeedCell® 2G + SpeedCell® 3G
The Netherlands: 1036914
Europe: 2425192
United States of America: 9,127,890
Brasil: PI1016125-2



Introduction

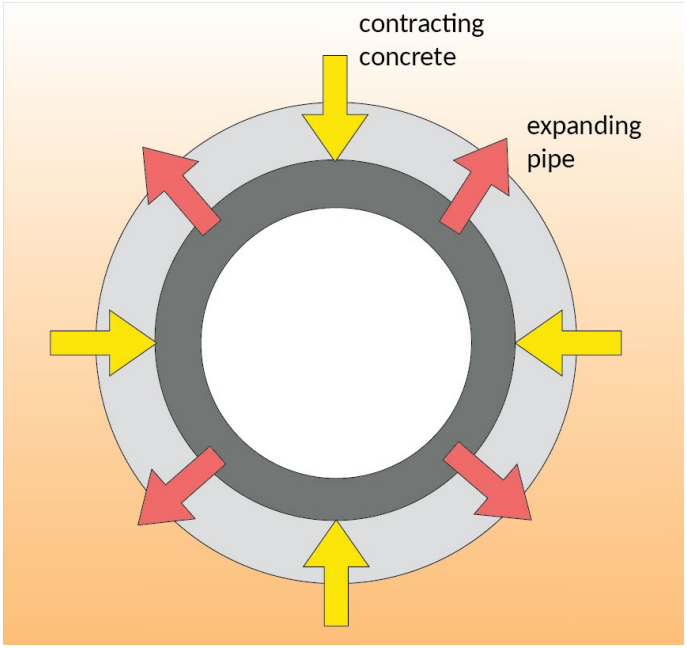
In most cement manufacturing plants, the burner pipes that heat the kilns have a lifespan of 3-12 months before they become so damaged and degraded that they need repairing or replacing. In this White Paper, I will examine the factors that govern the lifespan of these burner pipes and suggest that there is a method the industry could apply to significantly extend the burner pipe lifespan.

Let us look first at the principal reasons for degradation in burner pipes.

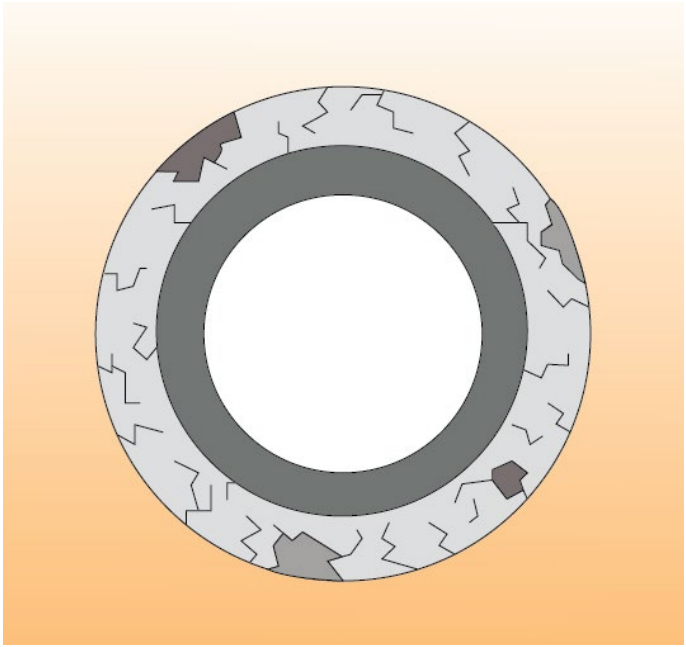
The problems

The pipe is made of steel and covered with a high temperature refractory material. Immediately, the dynamics of these two materials present a problem. The steel will tend to expand when exposed to heat, and the refractory will tend to shrink during curing. The inevitable result is that the refractory will tighten around the burner pipe, creating pressure that increases the incidence of cracking. Theoretically, the pre-service curing process should minimize this effect, but nevertheless the refractory will be under greater stress as it is subjected to sustained heat.

The illustrations below illustrate the tensions between the pipe and the refractory.



As heat increases, the refractory contracts and the pipe expands.



Eventually the resultant stress will lead to cracking in the refractory, leading ultimately to corrosion and damage to the pipe.

Corrosion on burner pipes

Our research and experience reveals that the failure pattern remains consistent over time. The hot end of the burner pipe always shows the highest degree of damage to the refractory, with the incidence of cracking becoming less pronounced as we move further away from the burner itself. In many cases, the cracks become so large that the heat is able to penetrate the cracks and attack the anchors that hold the refractory in position, resulting in an exponential failure of the anchors and refractory materials. When we inspect burner pipes during turnarounds, we frequently find that large chunks of refractory material have simply broken off, exposing the steel pipe to temperatures as high as 1250 deg C. When we remove all the damaged refractory, the anchors are usually burned or oxidized to such a degree that they have to be replaced.

Figure 1. Total erosion of the lining at the burner end. Anchors have disappeared.

Figure 2. The worst damage occurs at the bottom of the burner, exposing the V anchors.

Figure 3. Damage showing the inability of the standard V (or Y anchors) to hold the refractory in place. Damage can reach at least 2 meters or more back from the burner end.

The right anchor design

While nowhere near as badly damaged as the burner end, the remaining two-thirds of the burner pipe still needs to be refurbished. We have studied how best to rectify this damage, specifically by looking at the design of the refractory anchors in relation to the cracking pattern. A common anchoring method is to use V anchors (see fig 4) , welded directly to the casing or made movable by tack welding through a washer. Either way, a V-shaped form is commonest choice for the purpose of holding the refractory together.

But this method has often proved to be incapable of lasting a complete turnaround and early replacement is frequently required. Thermal cycling is not beneficial to the cement manufacturing process as it tends to propagate cracks in the refractory material. V anchors are seldom able to hold the refractory materials together on the outside of units. They are more suitable for use on inner diameters or flat surfaces, either in the horizontal or vertical positions.

Figure 4. Typical V anchor installation on burner pipes.

Identifying the right materials

To improve performance, we need to understand the temperature gradient across the length of the burner pipe (see fig 5). This enables us to identify alloys that are appropriate for the exact heat conditions under which they will be expected to function. Thanks to our specialist metallurgist knowledge and onsite experience, we know that AISI 330 is the most effective alloy at extreme high temperatures purely because of its relatively high melting temperature and strength compared to other commercial alloys such as Inconel 601, Incoloy 800, 253MA, 310 and 304, all of which are widely used in the cement industry. Incoloy DS has a very similar composition to AISI 330, and its properties make it appropriate for similar extreme temperature operations.

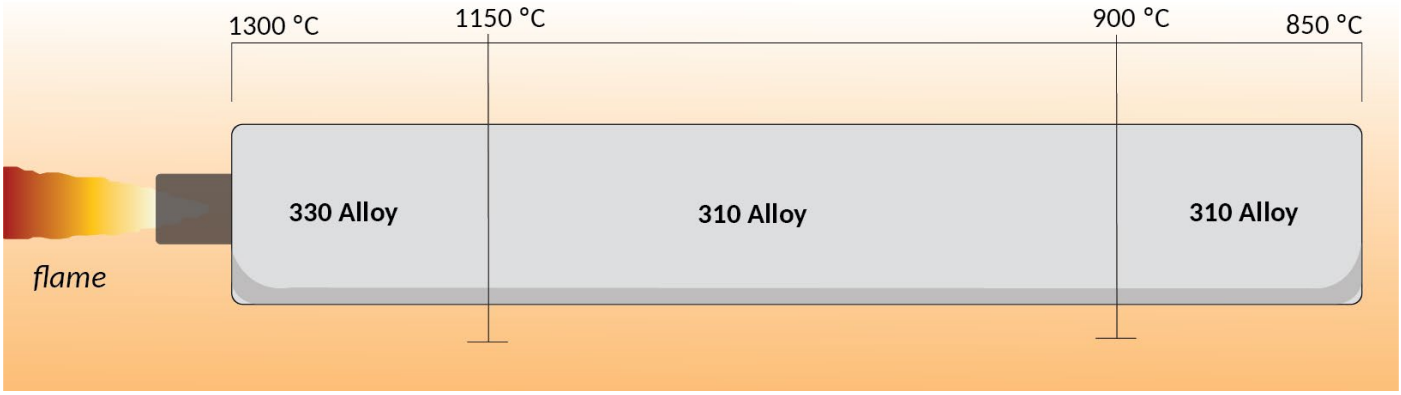


Figure 5. The above illustration depicts the recommended alloys for the burner pipe based on their high temperature properties and availability.

From previous experience in the petrochemical industry, we know that SpeedCells® can be used successfully to anchor thin linings that showed similar cracking characteristics. The shape and layout of SpeedCells® means that each one creates an island effect, holding back that area directly around it. Tests revealed that this holding power was optimum when 180-200 SpeedCells® were installed per square meter. These practical findings enable us take a similar approach for burner pipe applications. With knowledge of alloy properties and the heat gradient across the length of the burner, we can estimate exactly how far down the pipe each alloy type can be applied. In tests we have found that the initial 1.5 meters is exposed to the highest temperatures - up to 1300 deg C on the hot face of the refractory down to approximately 900 deg C towards the back end of the burner. Since no stainless alloy can resist the temperature levels at the hot end, we had to embed the SpeedCells® system below the hot face and position this where the temperature would be approximately 1150-1200 deg C maximum. This was found to be roughly 3/4 to 2/3 below the hot face. As mentioned above, the best alloy for resisting such a high temperature is AISI 330, having the highest melting temperature among common heat resistant alloys. AISI 310S could be used for the cooler sections of the burner where the temperatures did not exceed 1000 deg C.

SpeedCell® vs V anchors

The tulip-shaped SpeedCell® is purpose designed to work as a high performance refractory anchor. Positioned on a threaded stud, the SpeedCell® fixes the cracked refractory to such a degree that the heat cannot find a path to reach the steel liner or damage the anchoring system. Thanks to its shape, the SpeedCell® forms a real composite by design. Unlike a standard V anchor, the SpeedCell® 'hugs' the refractory. The refractory material spreads itself through the open pattern of the Cell, cannot be dislodged, and is held in position rigidly. It is even capable of withstanding the high vibrations encountered in burner operations. This vibration phenomenon is frequently overlooked as a source of damage to the refractory, but is in fact a major cause for refractory breakup when simple V anchors are used.

Fig 6 shows how the SpeedCell® system holds back the refractory lining.

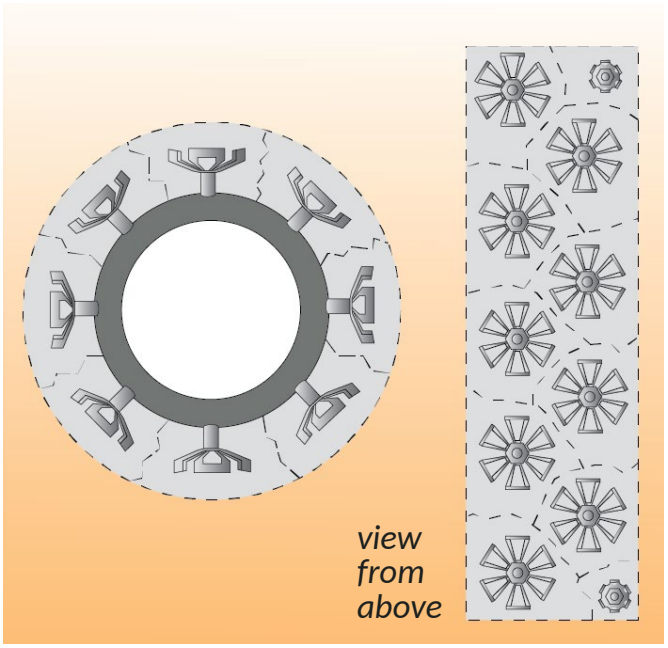


Figure 6. Even cracked refractory will be held in position thanks to the design of SpeedCell® anchors.

Figure 7. It can be seen that the SpeedCell® system has the ability to hold together the full refractory structure during operation, including the absorbing all the vibration.

Installation

The SpeedCell® 2G system is applied with a specialized welding technology called Rapid Arc Welding (RAW) (Fig 8 and 9). This is a fast welding technology that welds each stud within half a second. The weld is initiated from the center of the stud and melts the lower portion of the stud, leaving no cracks or crevices. After the stud has been welded to the steel casing, the SpeedCell® is screwed on tightly. Once the whole burner is fully welded, it can be cast in a special mold as shown in Fig 10.

Figure 8. Rapid Arc Welding - Attaching a stud within 0.5 secs

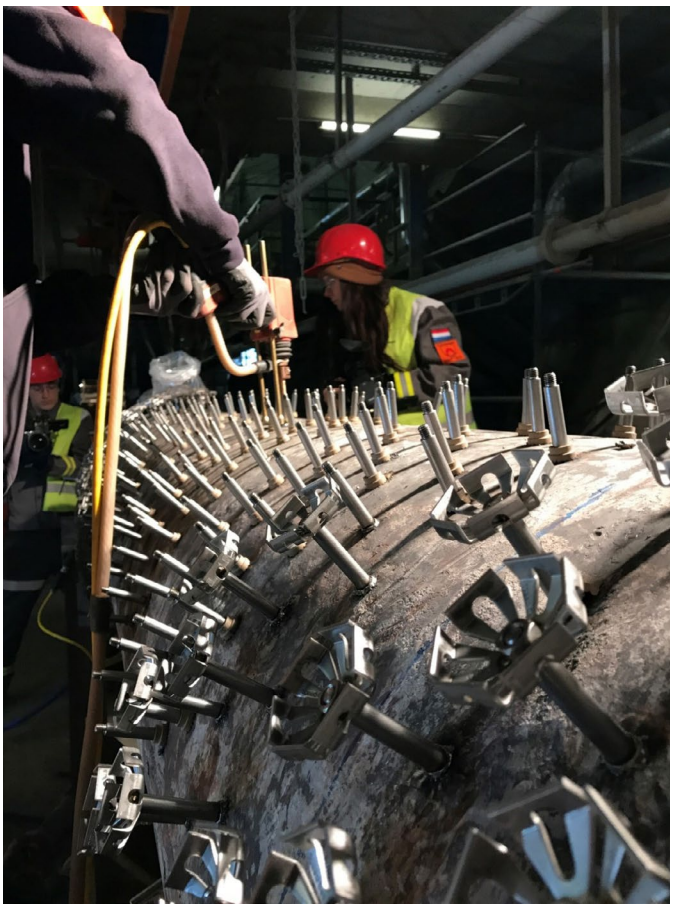


Figure 9. Commonly 180-200 SpeedCells® are applied per M2.

The picture above shows a fully welded stud where the stud forms a single entity with the steel shell, with total homogeneity between stud and plate.

Once the SpeedCells® are mounted, the full pipe is placed in a form to cast the refractory material. Expansion joints help to avoid extreme tension occurring in the lining.

Additional attention also needs to be given to the quality of the refractory and the way it is applied. The composition and curing technology itself will also contribute to the lifespan of the burner pipe. Although the refractory anchor only contributes a part to the improved lining lifespan, other aspects of the process such as burner operation, flame direction and thermal all play a major role in determining the longevity of the refractory. What the SpeedCells® actually do in all cases is enhance those other prevalent conditions that may be difficult to alter due to design or conservatism in operation procedures and offer the end user confidence that the burner will last a full turnaround cycle.

Figure 10. A fully welded pipe with SpeedCells® ready for refractory casting.

Click here or on the picture to watch a more in dept explanation of the process and find out what is so unigue about the SpeedCell® system (Heidelberg Geseke Jobsite).

Benefits

An example of the costing applied to this system compared to the application of simple V anchors also reveals interesting benefits, aside from the longer unit lifespan.

Example: 6 meter pipe, 800 mm diameter. Total surface area 15,072 m2. 100 mm Lining

V anchors 64 per sqm. In diameter 8 mm - height 75 mm – in alloy AISI 310.

Total 964 pcs @ Eur. 1,45/pc	= 1397,80
Welding electrodes 400 pcs @ Eur. 0,65	= 260,00
Welding/Marking man hours 56 @ Eur. 75,00	= 4200,00
Total	= 5857,00

SpeedCells® 180 per sqm. Height 75 mm

Total 2700 pcs @ Eur. 3,25/pc	= 8775,00
No electrodes needed	= 0,00
Welding/Marking man hours 18 @ Eur. 75,00	= 1350,00
Total	= 10125,00

This shows that the SpeedCells® might be more expensive as a replacement for damaged anchors, b**ut since our system at least doubles the lifespan of your burner, it is easy to see that, with the savings made in downtime, an extra repair cycle and not to mention a new refractory lining, SpeedCell® is a winner for any cement plant.** Very often the repairs only involve the hot section of the burner and the back section gets another 2-3 cycles prior to replacement.

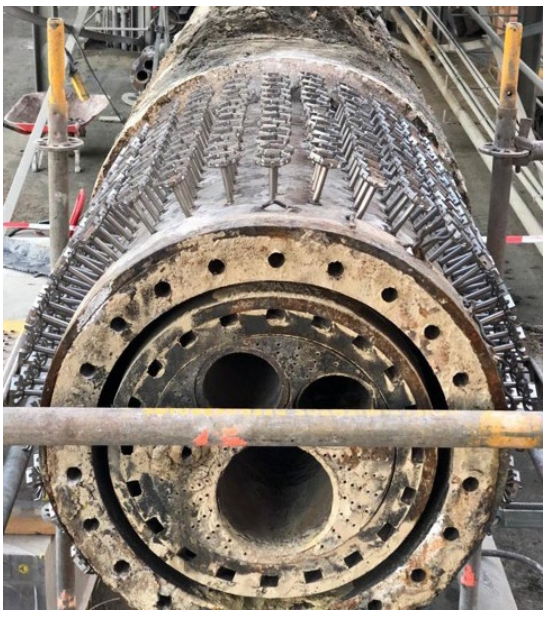
In summary, since the SpeedCells® last at least 2 times as long, the true sum of this example will be the following:

2 x 5857	= 11714,00
Demolition and preparation costs 20 man hours @ 75,00	= 1500,00
Total (EUR)	**= 13214,00**

NB : This does not include the cost of loss of production for the duration the burner pipe needs to be replaced.

Estimation	= **75000,00**

It is often difficult to grasp the benefits of a new technology, especially when it involves significant change to tried and trusted methods. It's always easier to stick with an existing methodology. But unless people are willing to try new ideas, none of us will achieve progress. We recognize that it is vital for end users to fully understand the technical and cost benefits of new ideas. Few companies understand as well as us the technicalities of refractory anchors and the conditions in which they operate. We are experts in this narrow field, backed by more than 40 years experience and a fierce determination to enhance the performance of our products. The important thing, in my view, is to move forwards in small steps so that we maintain trust at all times. We pride ourselves on being a trusted technical resource for our customers and the industry as a whole.



Conclusion

- The performance of refractory material can be enhanced by anchor design
- It is possible to obtain a full turnaround life cycle or longer with a single repair
- The SpeedCell® system will deliver a definite positive return on investment
- Greater reliability and predictability from burner pipe performance
- Applicable with most refractory materials. You can experiment with lower cost refractories
- Fast installation
- Readily available

Our SpeedCell® system fulfils all these criteria. It is a proven system (5 years of return on experience) that continues to surprise and impress our customers (such as Cemex or Heidelberg) – and saves them hundreds of thousands of dollars/euros.

The author

Wouter Garot
CEO SILICON

SILICON Headquarters
Monsterseweg 2
2291 PB Wateringen
The Netherlands
T +31 (0) 174-225522
info@silicon.nu

SILICON Rapid Arc Welding Contracting and Services
25702 Aldine Westfield Road,
Unit 701
Spring, TX 77373, USA
T +1(832) 762 50 66
info@silicon-usa.com

SILICON Asia Co. Ltd.
5-29-8 Higashiogu,
Arakawa-Ku.
Tokyo, Japan 116-0012
T +81-70-8383-9253
info@silicon-asia.com