Why use a Professional Dryout Company?

"Doing so is a *necessary* step in the quality assurance process to *ensure* that a refractory lining has been treated in a manner conducive to providing *maximum* service life in the application for which it was intended"

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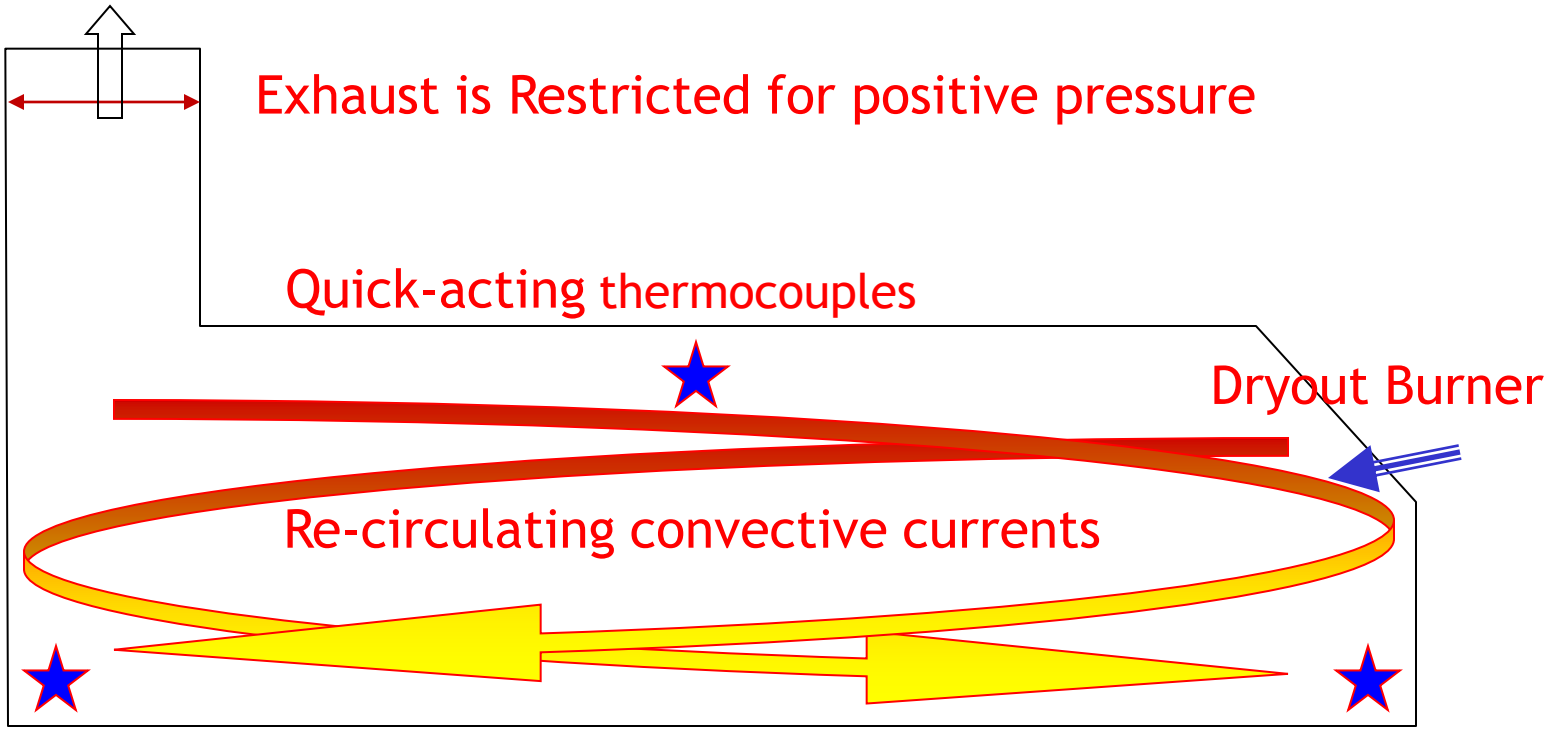
The ideal dryout process uses convective heat and pressurizes the vessel



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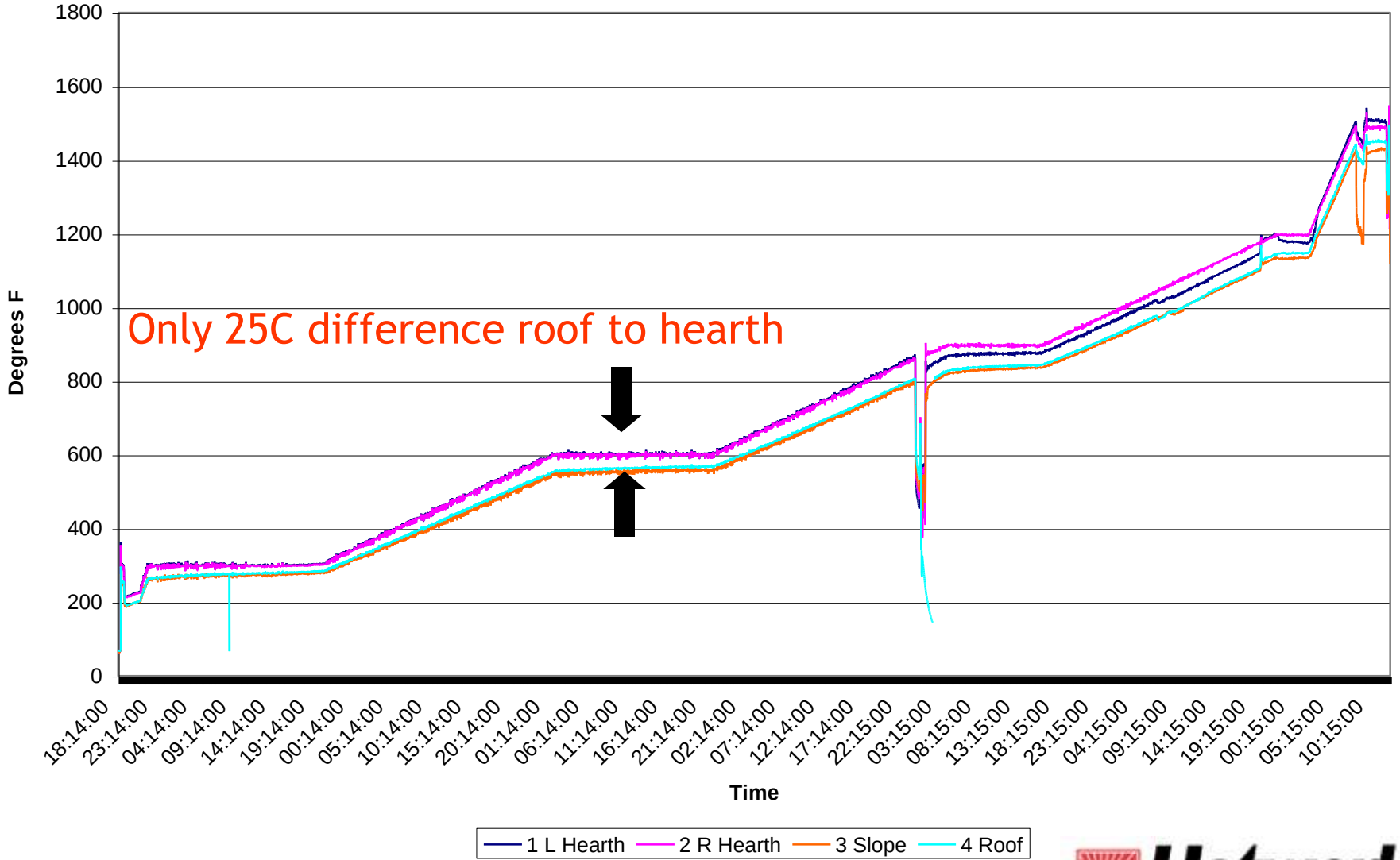
Uniform temperatures provide safe and effective moisture removal



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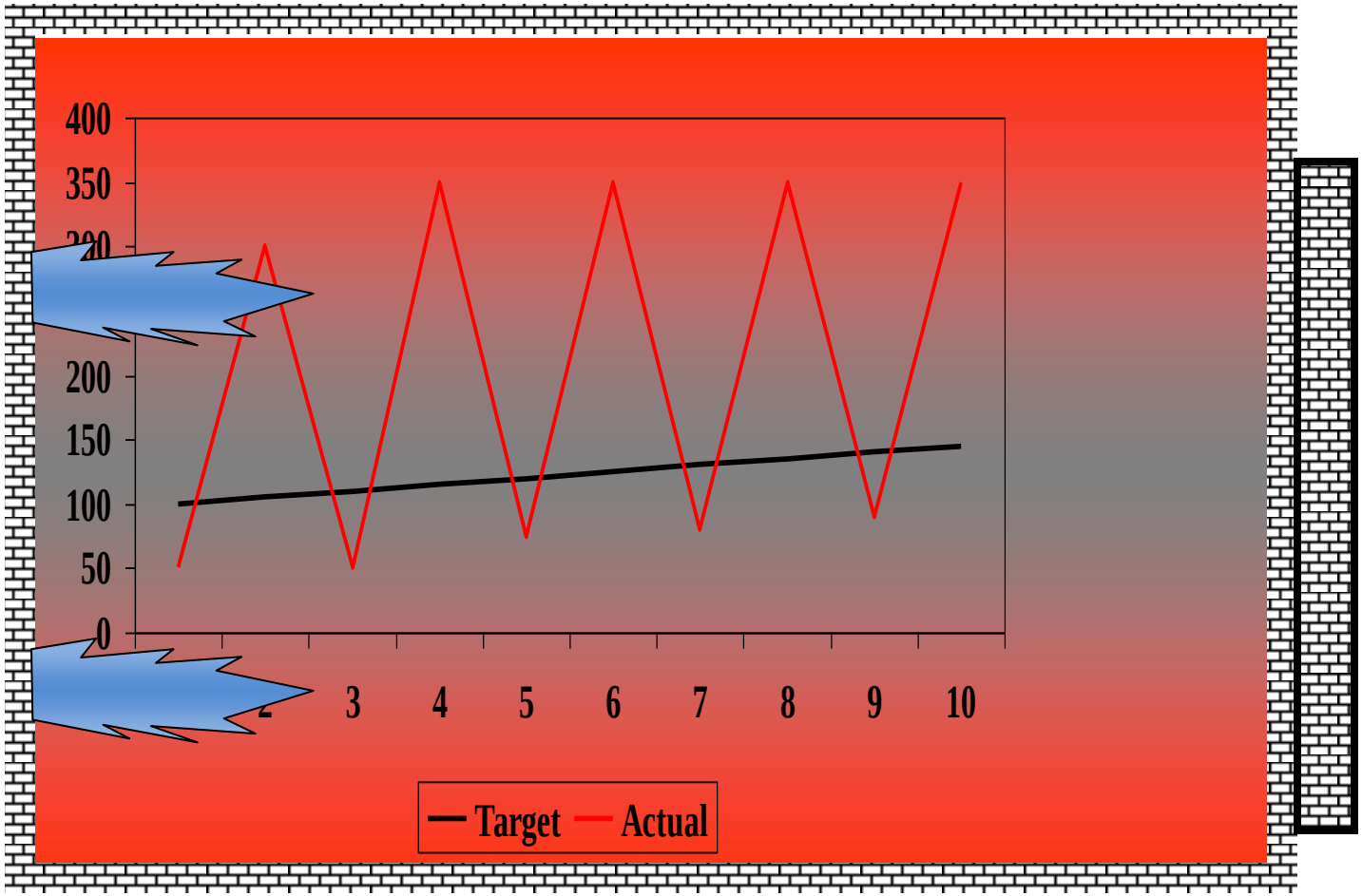
Furnace burners have limited range and often are cycled on and off for temperature control



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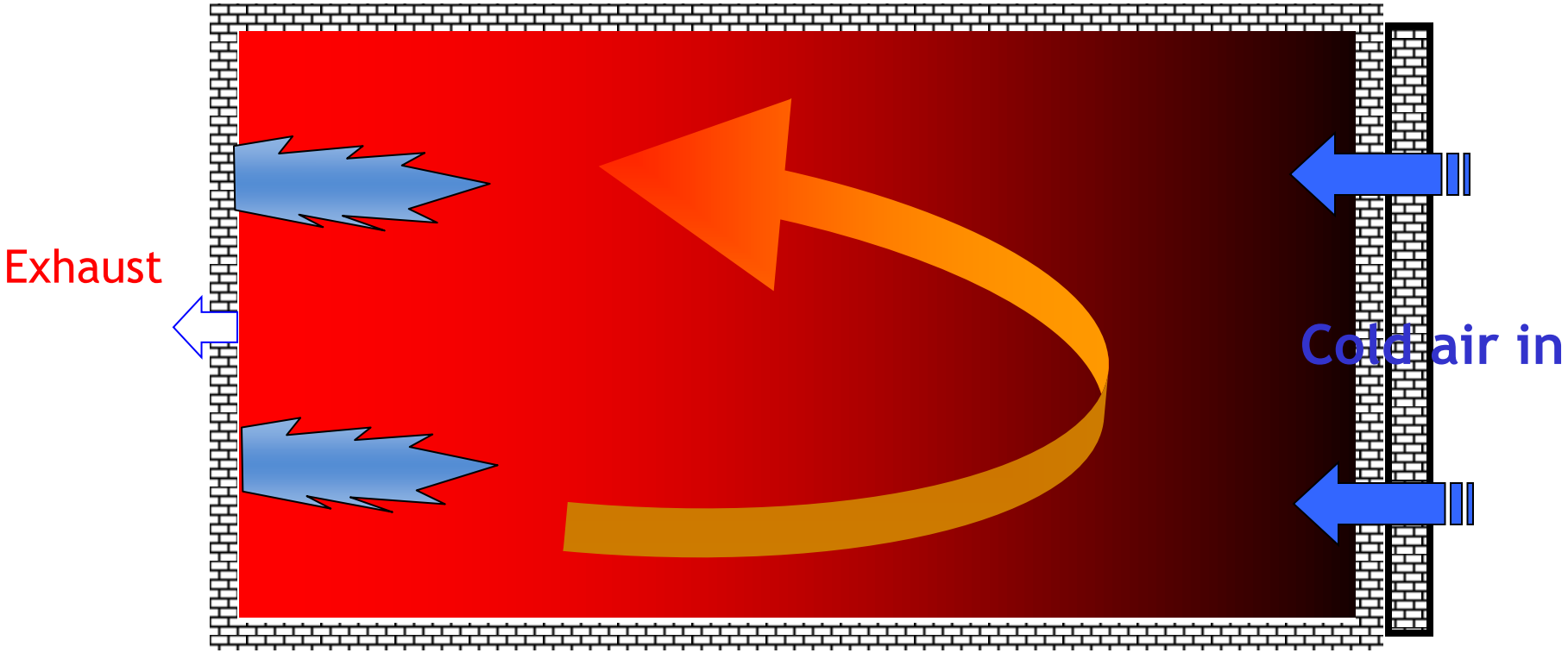
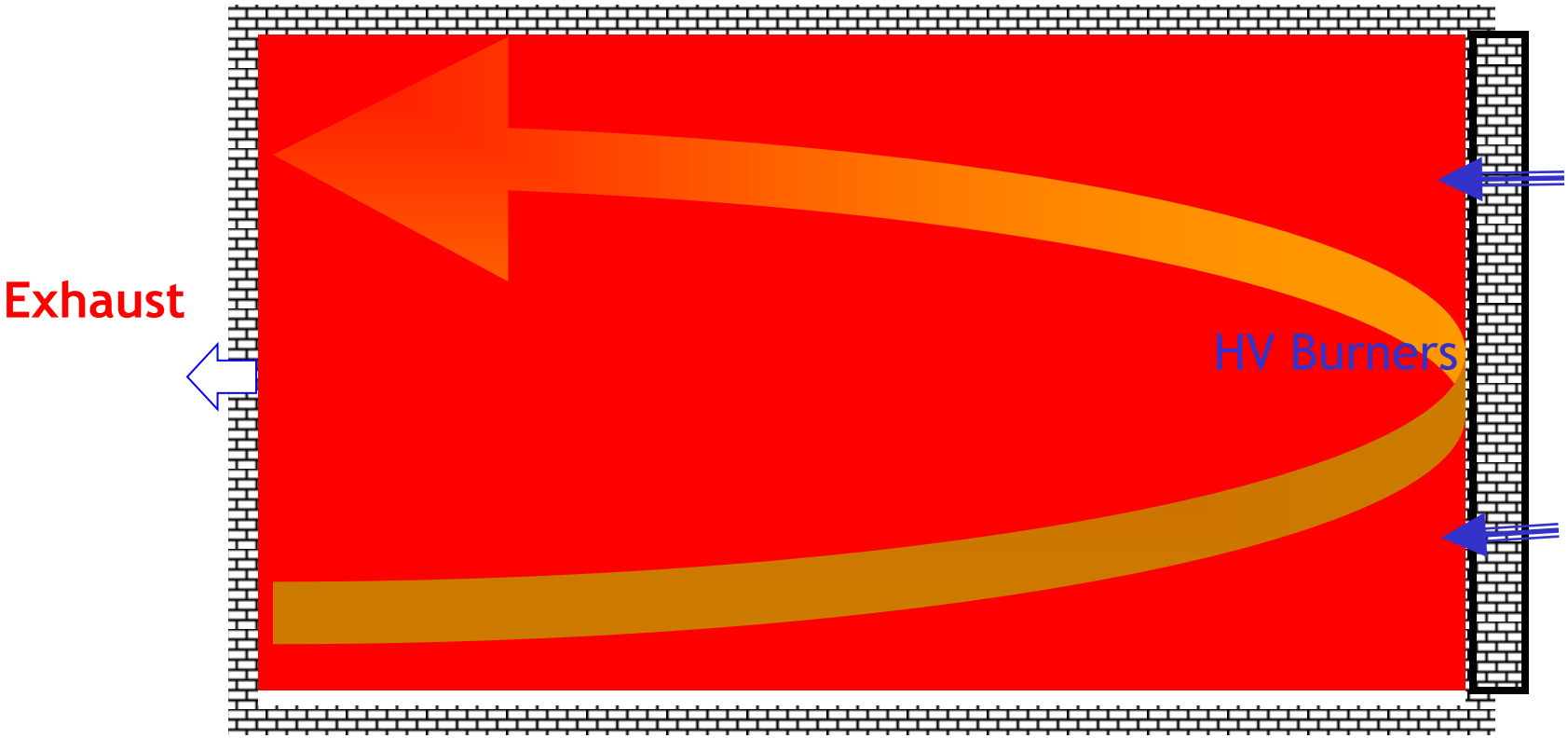
Another common practice is to open the door some at the beginning of the dryout to control the lower temperatures – this delays the drying of the hearth and promotes un-uniform heating .



Using a heating system designed to dry refractory supplies excess air and pressurizes the furnace keeping out cold air and insuring uniformity of temperature across the lining surface



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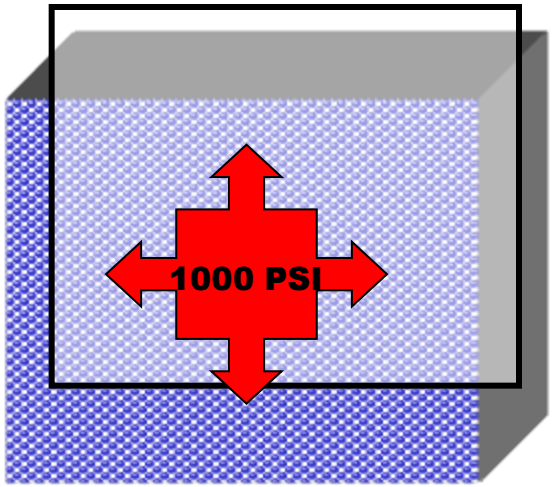
Drying – the inside story

- Castable refractory is susceptible to explosive spalling and micro-cracking.
- Damage from micro-cracking may not be apparent until the first cool-down when the refractory shrinks.



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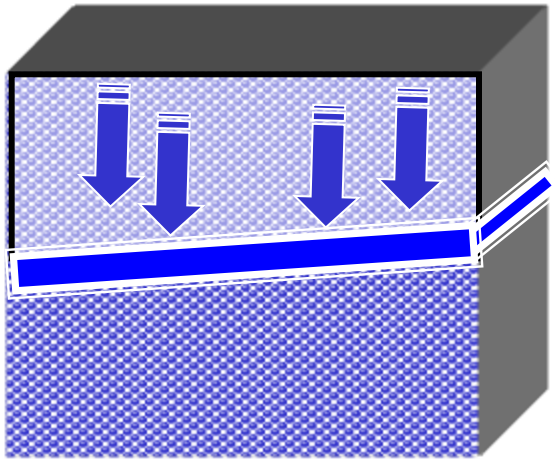
Drying - the inside story

- Plastic refractories can form shear planes if heated too slowly and explode from steam pressure if heated too quickly.



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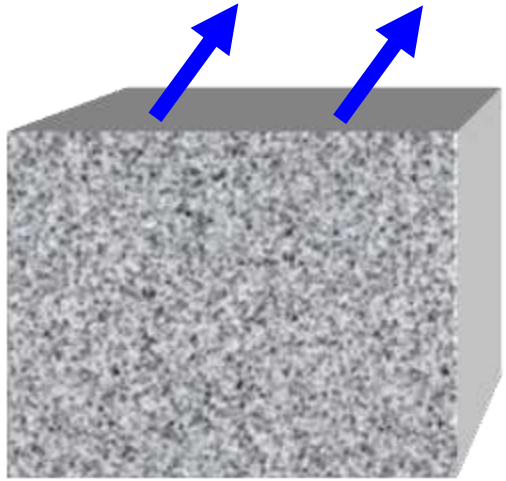
Drying – the inside story

Step one

evaporation



Moisture begins evaporating from exposed surface areas

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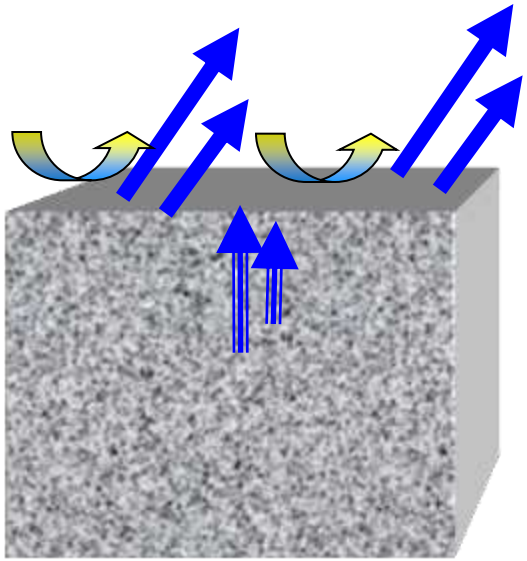
Drying – the inside story

Step One

Evaporation Accelerated



As heat is introduced during the early stages of dryout, moisture is pulled up towards the surface.

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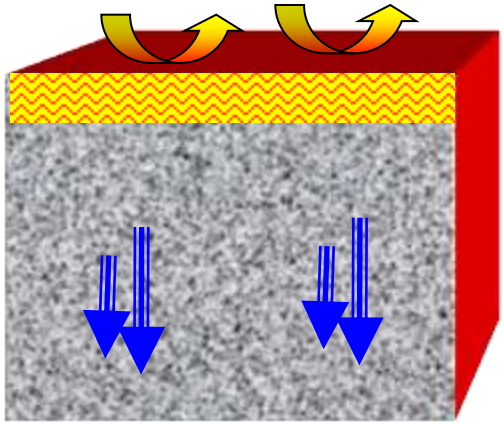
Drying – the inside story

Step Two

Vaporizing



When the surface temperature reaches the boiling point, moisture is pushed by vapor pressure to the cooler areas

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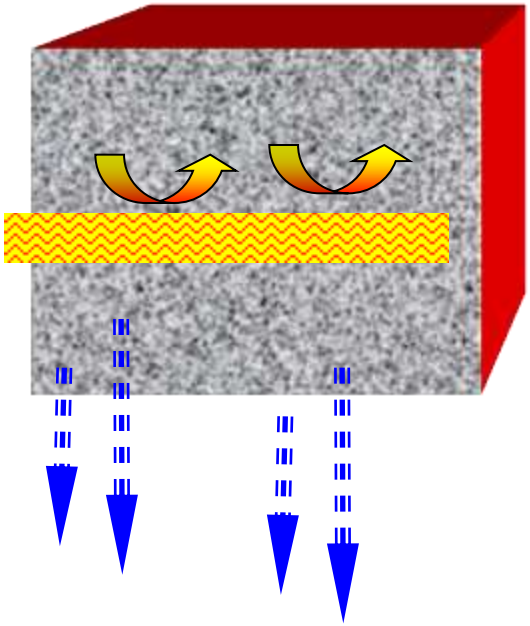
Drying – the inside story

Step Three

Escaping



Driven by vapor pressure the moisture reaches the cold face, where it exits as either steam or liquid.

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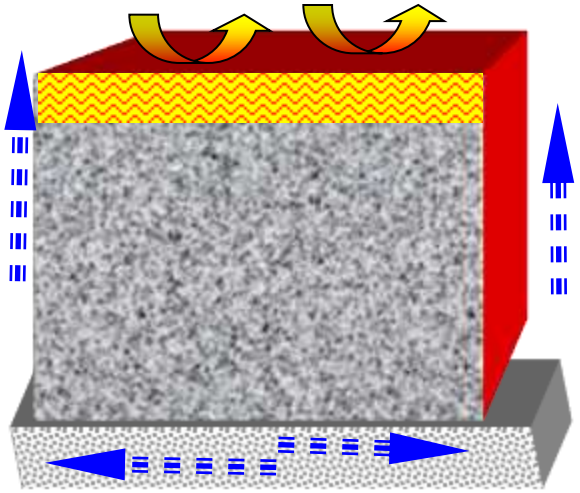
Drying – the inside story

Step Three

Escaping

Alternate Routes



If there is a backup lining or a solid shell the moisture will find other ways to escape.

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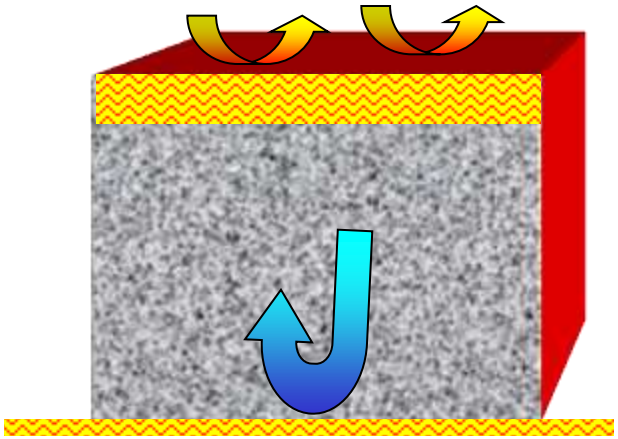
Drying – the inside story

Step Three

Escaping



In some cases the vapor may have to travel back through the refractory to escape from the surface.

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Explosive Spalling

Low Cement Castable Refractories

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What happened to my furnace ?

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Explosive Spall - Feed Hopper, Iron Reduction Facility

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Explosive Spall – Cyclone, Alumina Calciner

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Explosive Spall - Aluminum Melter Hearth

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Explosive Spall - Gas Duct, Iron Reduction facility

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What / what not to do?

- Don’t panic!

- If catastrophic - shut down (safely)

- If isolated spall - reduce temp 100F and hold

- Call client to advise status

- Call Hotwork to advise status

- Wait for further instruction from client / Hotwork

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What / what not to do *(cont'd).*

- Get photos (if possible)

- Get samples of spalled material (if possible)

- Never comment to client or anyone else on site what you think may have caused the problem

- Document precisely what happened and when

- Provide written report only to Hotwork management – we will handle with client

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Pressure Steaming

- **Care must be exercised to identify and address pressure steaming during dryout**

- **To avoid the risk of explosive spalling or waste of time and money due to holding temperature when it is not necessary to do so, requires the knowledge and experience of personnel qualified to make such decisions in the field during dryout**

- **Whisks of steam are not a problem – it is positive indication that the dryout is proceeding successfully and that we are achieving the objective of drying out the lining.**

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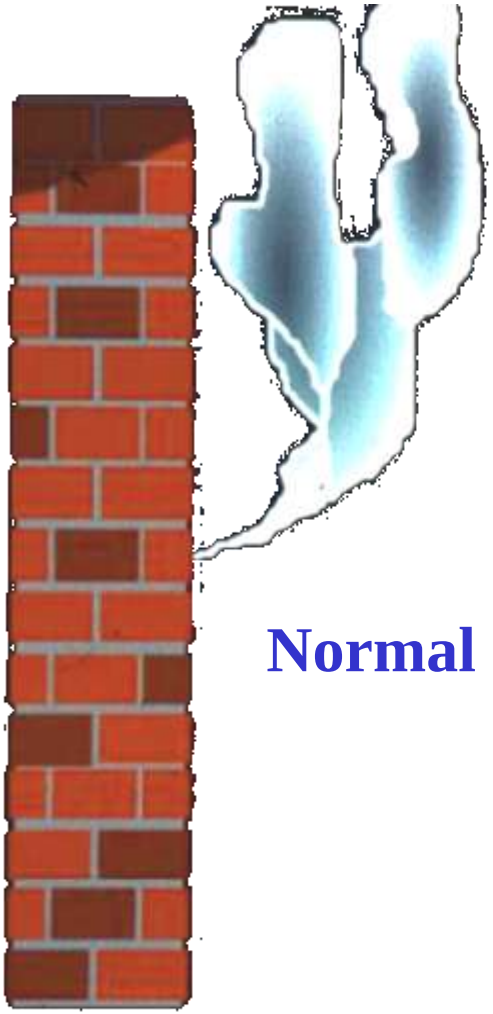
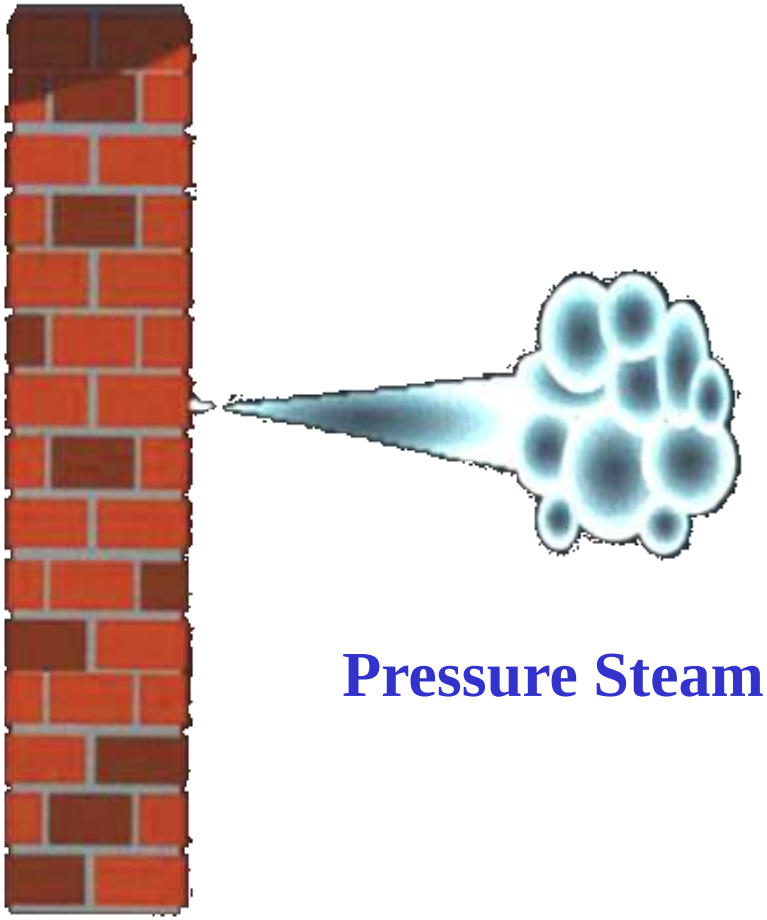


Normal Steam



Pressure Steam

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Pressure Steaming cont'd. (FACTS)

- **Steam is a natural reaction**
- **Steam is subjective and its visibility is influenced by surrounding environmental conditions**
- **Steam will find its way out – even in pressure vessels with no avenue of escape**

"It is not the steam one sees during dryout that causes explosive spalling – it is the unseen trapped steam that does so"

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Pressure Steaming cont'd.

Manufacturers dryout curves typically come with the warning:

"If pressure* steaming occurs temperature should be held until the steaming subsides"

* Does not always state pressure.

The problem with this statement is that it generally comes without any definition and if we were to hold temperature every time steam is visible, the typical dryout could take much longer and add unnecessary cost to the project.

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Considerations (to avoid problems)

- **Dryout curves have to be tailored to what is possible in the field and not what is possible under controlled laboratory conditions**

- **Refractory installers have to strictly adhere to the manufacturers specifications for installation of their products**

  - *Non-compliance changes the physical properties*

  - *Requires change to the dryout curve if explosive spalling is to be avoided*

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Conclusions

- **The one sided drying of a refractory installation has always been and remains a very complex heat and mass transfer phenomena that includes:**

  - **constant chemical reactions**
  - **changes in conductivity**
  - **internal pressure changes**
  - **development of mechanical stresses**

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Benefits and advantages of using the Hotwork system will vary from plant to plant, but will invariably include:

- **The minimization of cracking or spalling.**
- **Shorter plant down-time.**
- **Optimization of refractory campaign life.**
- **Meeting the conditions of refractory suppliers' warranties.**

- **Hotwork has carried out in excess of 20,000 refractory dry-out or heat-up operations worldwide in the past 40 years**

- ***We work for the company that invented and brought refractory dryout to the world - we all must take pride in what we do and do it to the best of our ability***

- **Doing so is a reflection of all of us and the company we work for**

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As a Company we are only as good as the Technicians we have in the field, who are and always have been the heart of Hotwork!

Thank You.

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