Corus Port Talbot
Casthouse Training Module

9th March 2010

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Blast Furnace Casthouse Floor

- Repair Techniques
- Wear Mechanisms
- Casthouse Practices

Repair Techniques

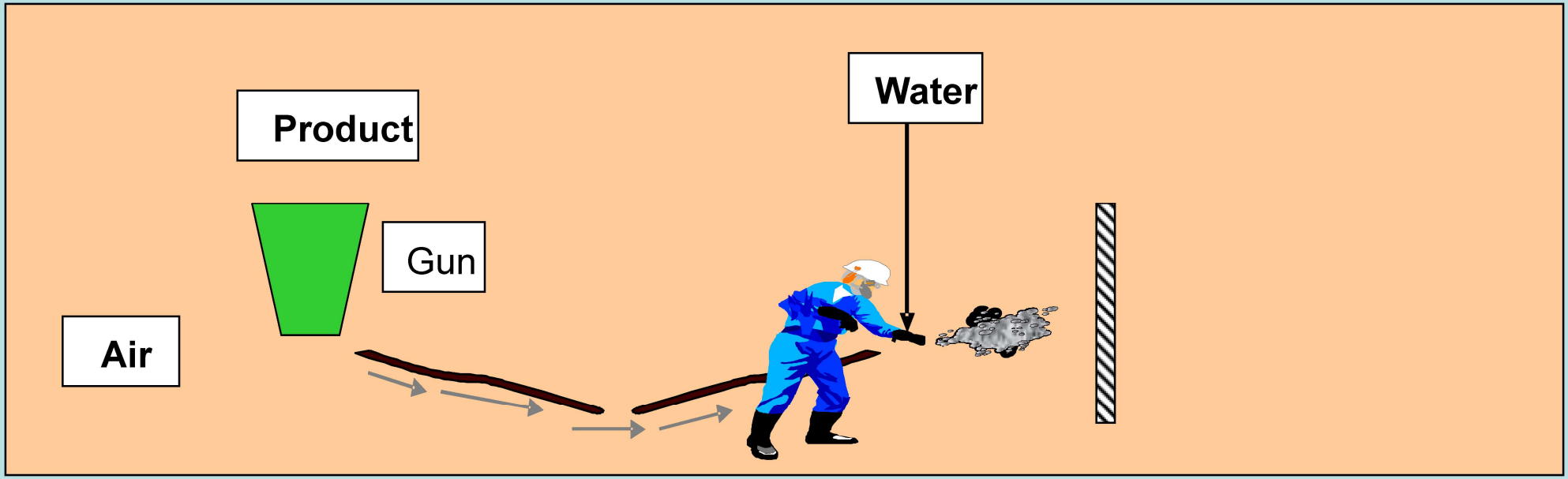
Runner Repair Techniques

- 5 Different Methods
  - ⇒ Casting
  - ⇒ Dry Gunning
  - ⇒ Shotcreting
  - ⇒ High Density gunning
  - ⇒ Dry Vibratable/Ramming

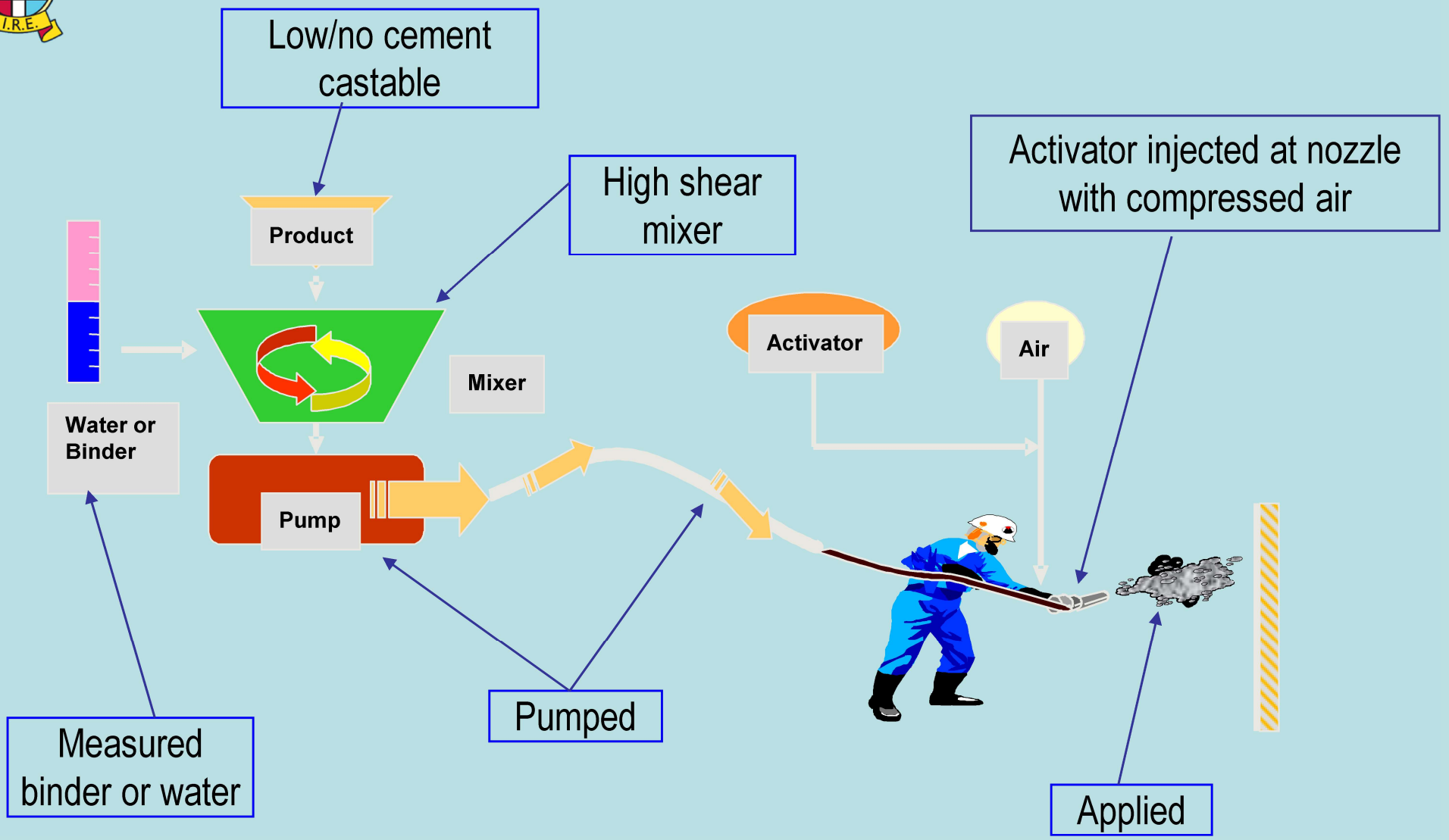
Runner Repair Techniques

Casting will be addressed in greater detail later in the presentation

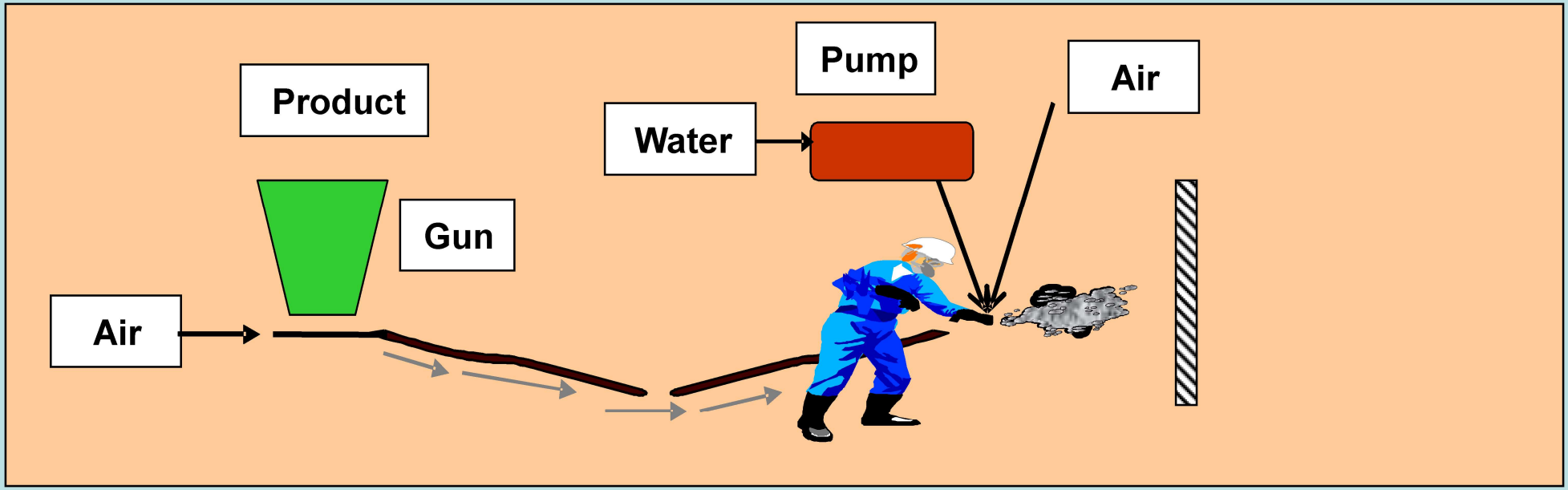
Runner Repair Techniques – Dry Gunning



Runner Repair Techniques - Shotcrete



Runner Repair Techniques – High Density Gunning

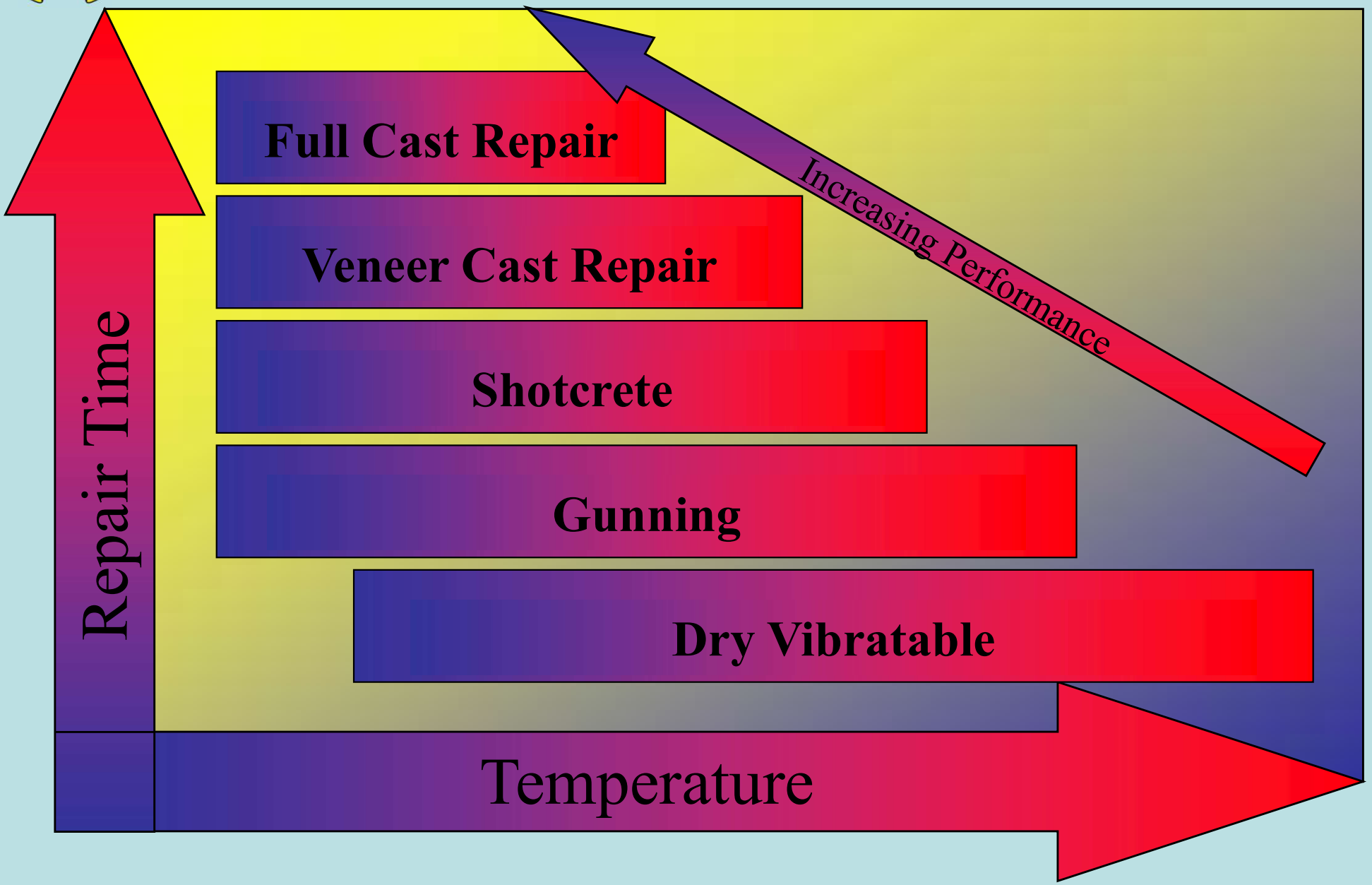


Runner Repair Techniques - Comparison

Method	Dry Gunning	Shotcreting	High Density Gunning	Casting
Characteristics				
Bond Technology	Conventional	Low Cement	Low Cement	Low Cement
Handling (easy)	+++	+	+++	++
Application Speed	5t/h	10t/h max	5t/h	15t/h
Physical Properties	+	+++	+++	+++
Rebound Rate	> 10%	7% max	7% max	Not Applicable
Equipment	+	+++	++	+++
Performance	+	++	++	+++

Performance Level

Frontside Repair Techniques



Wear Mechanisms

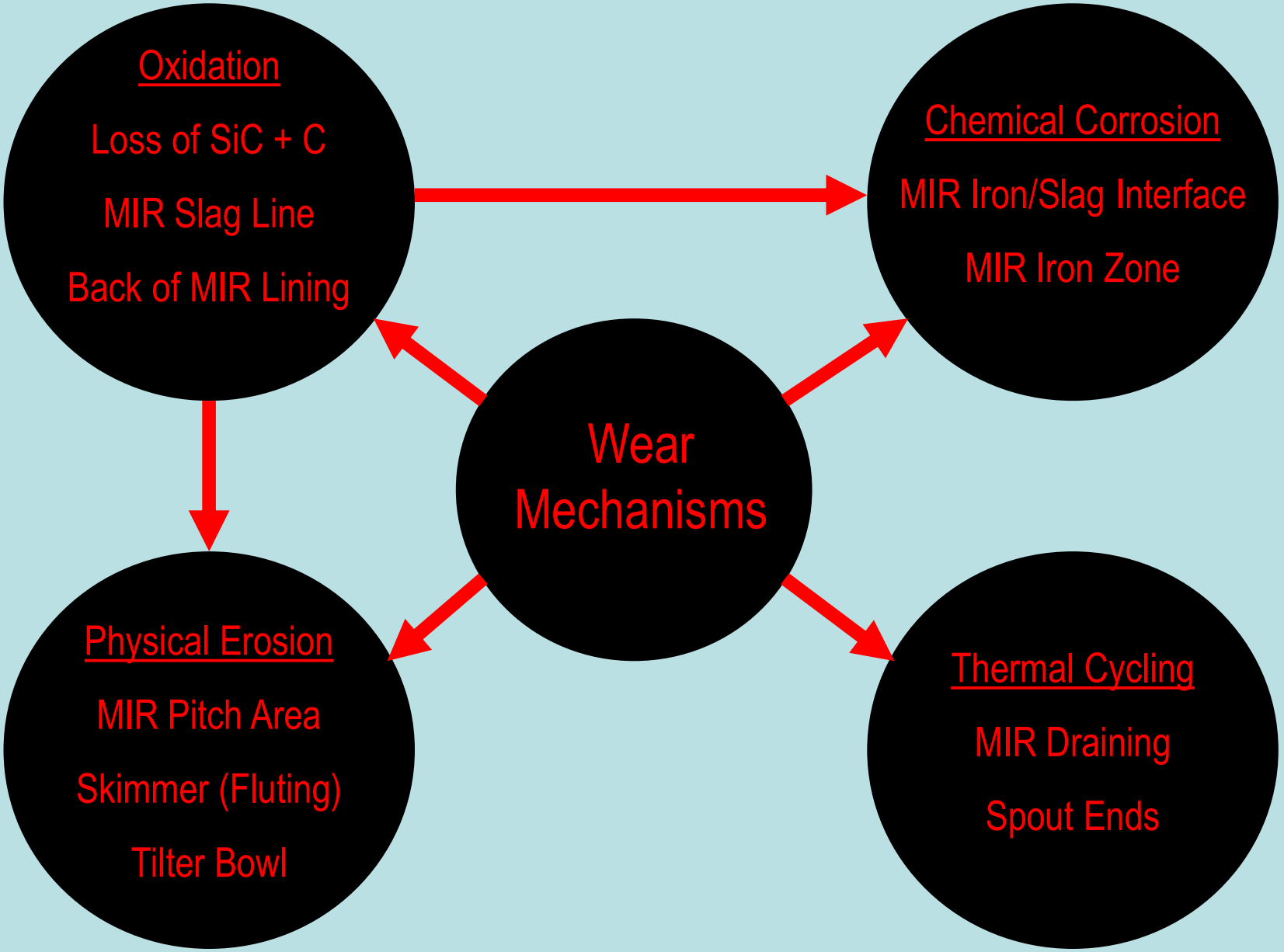
VESUVIUS

What are the conditions in casthouse runners?

- High temperature : slag up to 1600°C.
- Mixture of iron and slag in the same pool, turbulences.
- High velocity liquid flow : Up to 10t/min.
- High corrosion by slag.
- Thermal cycles : during & after casts, drainages, covers or no covers.
- Water : sprayed after casts.
- Physical stresses : liquids weights, wrecking machines.

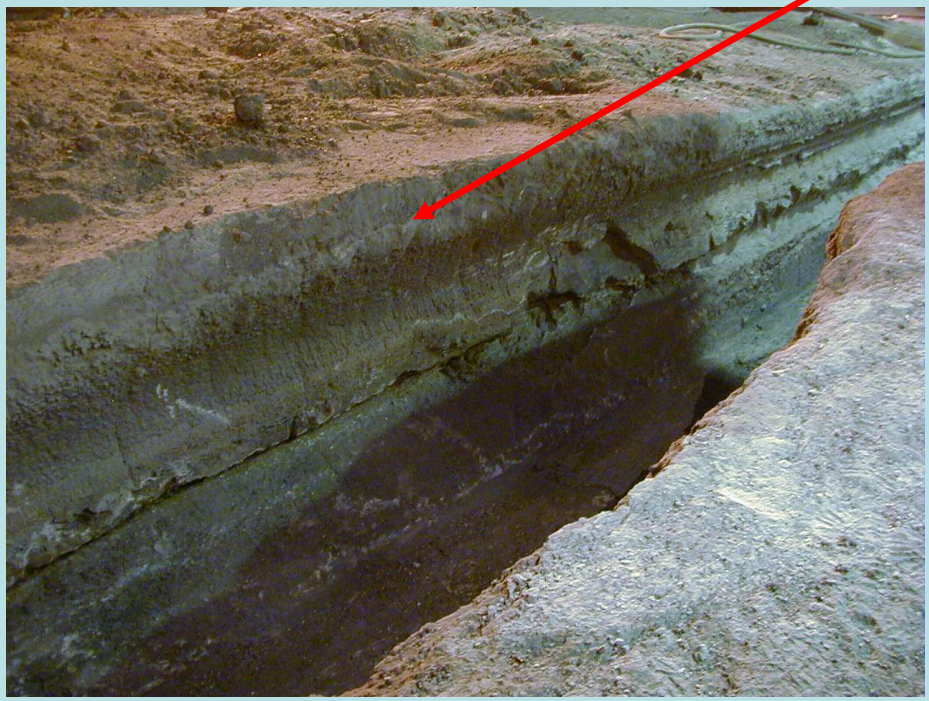
VESUVIUS

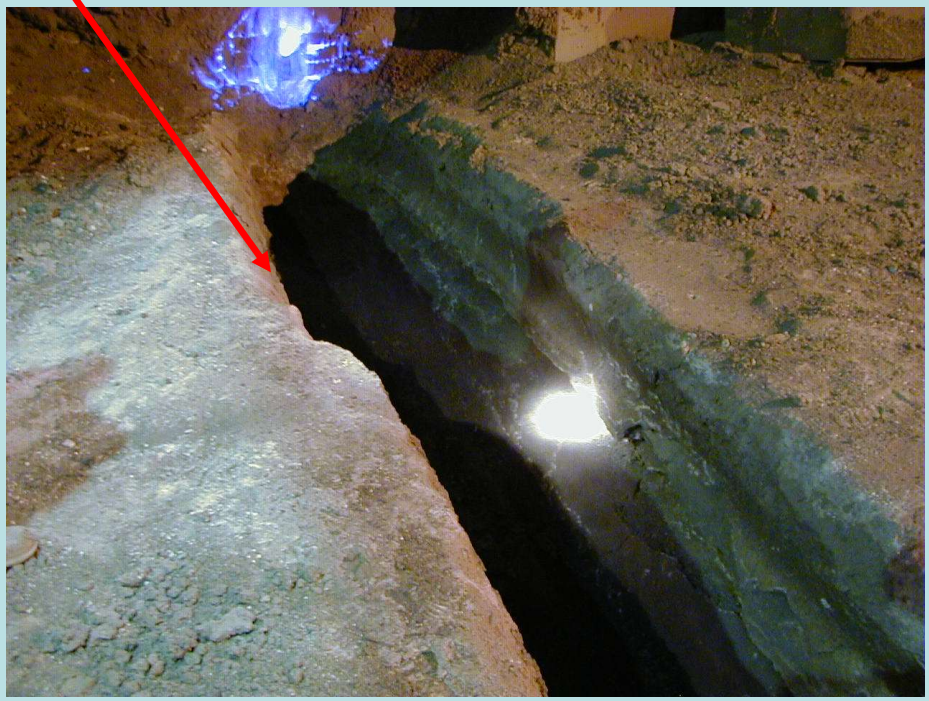
Wear Mechanisms



Wear Mechanisms - Examples

Increased wear due to physical erosion of melt stream



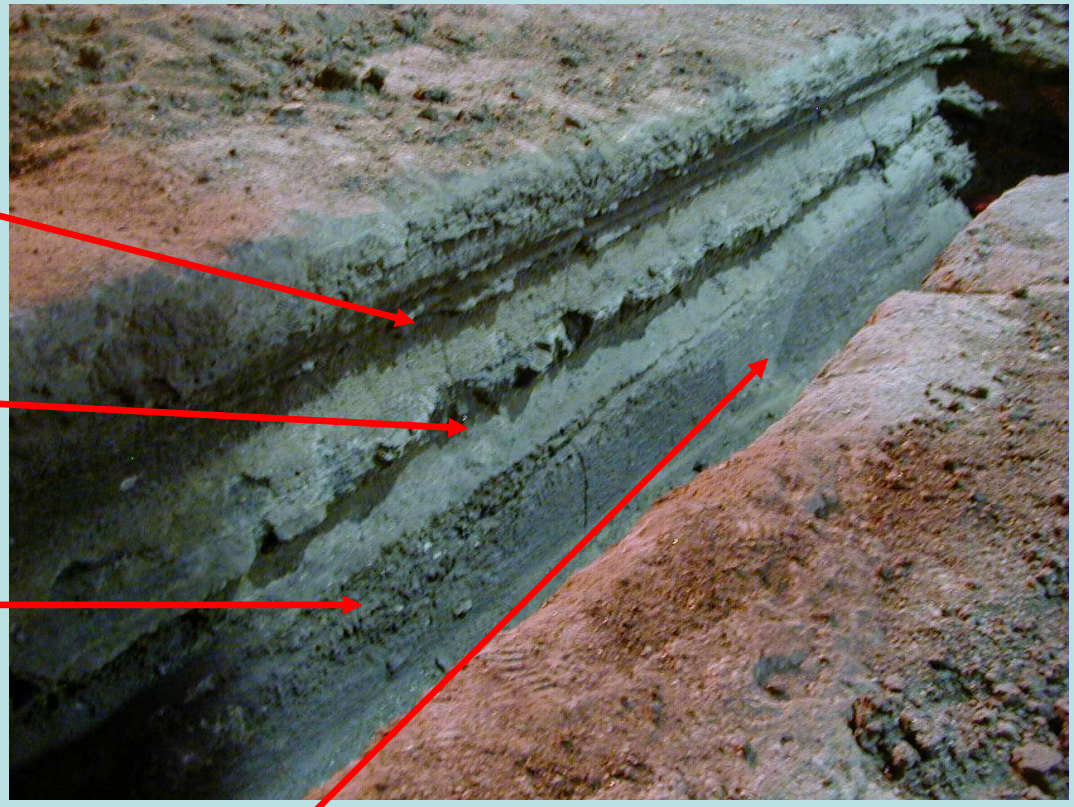


Wear Mechanisms - Examples

Wear in slag line (oxidation + chemical corrosion)

Wear at iron/slag interface (chemical corrosion)

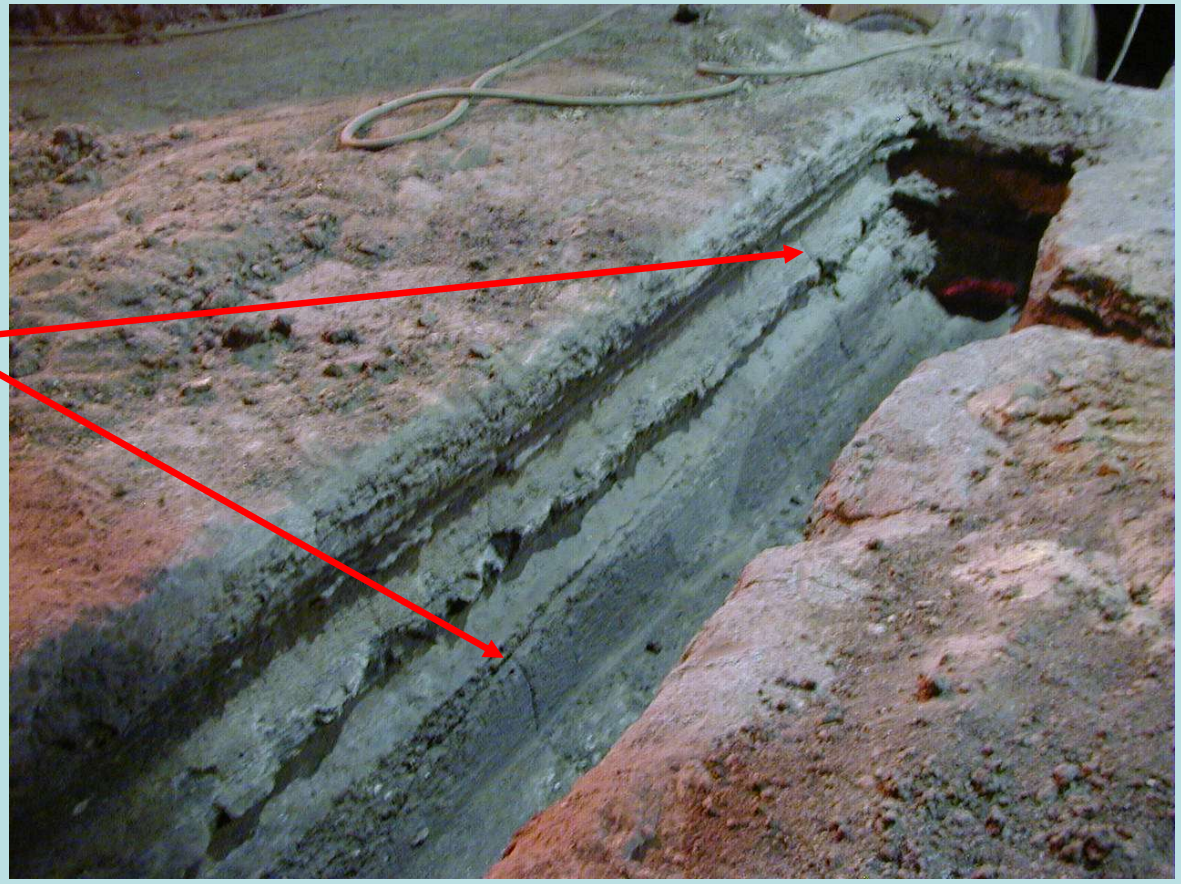
Scoring in iron line (erosion)



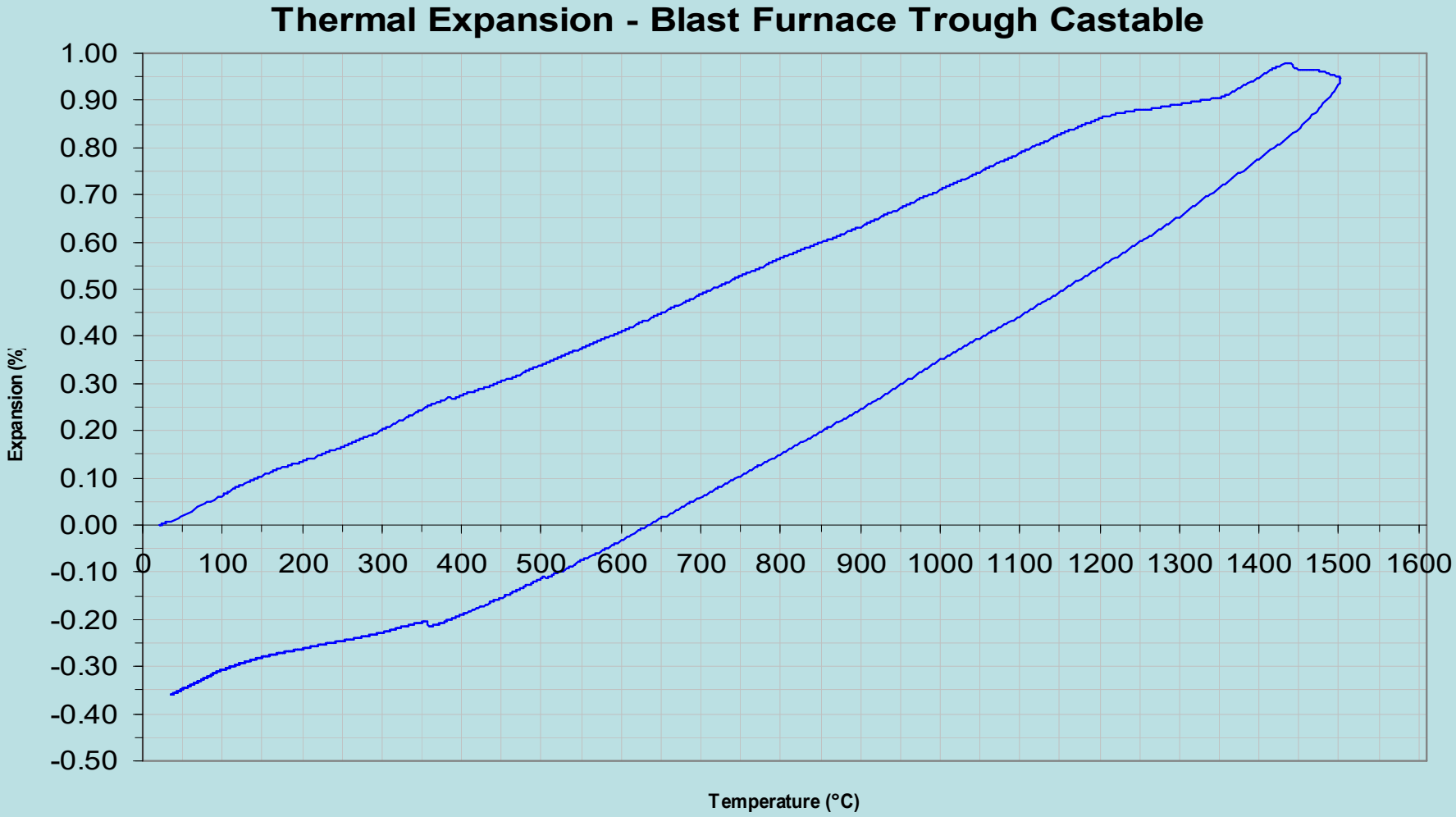
Reduced wear in iron line towards skimmer

Wear Mechanisms - Examples

Cooling cracks due to draining runner (thermal cycling)

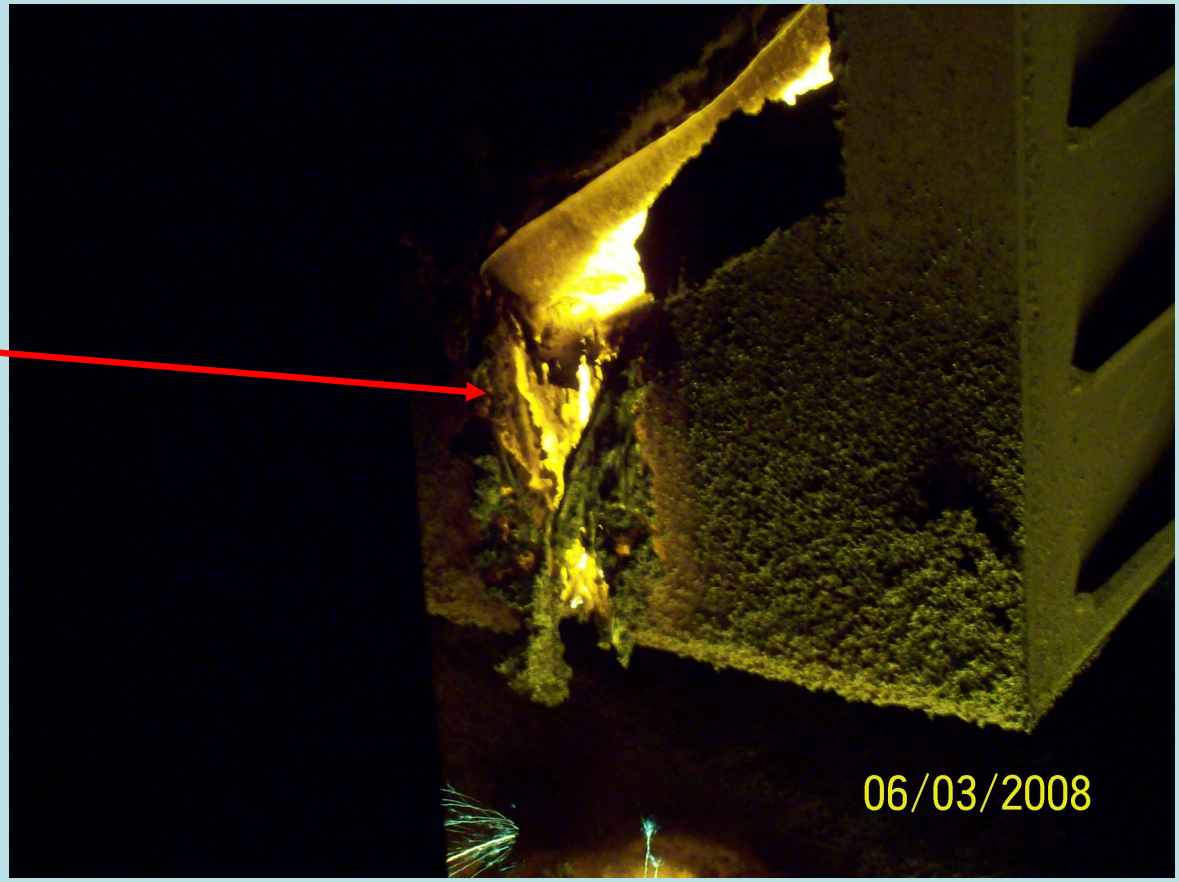


Wear Mechanisms - Examples



Wear Mechanisms - Examples

Cracked SIR Spout End (Thermal Cycling or Expansion)



Casthouse Practices

MIR Drainage

The Main Iron Runner must be fully drained.

Using O_2 lances or special drilling machine, the drainage hole has to opened as big as possible in order to drain the runner as quick as possible.

No molten iron or slag should remain in the runner after drainage as it would affect the quality and timing of wrecking.

MIR Cooling

Cooling of the runner must be carried out in conjunction with Corus procedures.

Water sprayed directly on the runner will affect the runner performance.

Air/Water combination (mist) gives good cooling of the runner.

MIR Wrecking

Purpose of the wrecking operation:

- ✓ To remove all particles of iron and slag in sidewalls.
- ✓ To break all necessary areas in order to reprofile the runner with new castable.
- ✓ Bottom should be treated same way as sidewalls
- ✓ For veneer repairs clean back to black castable

MIR wrecking can be carried out manually or mechanically :

1. Manually : Using Jack Hammers
2. Mechanically : Using Jack Hammers or a grinder (strawberry).

Casthouse Practices

MIR Wrecking

MIR Wrecking

The MIR has to be cleaned removing all scrap (in and on the edges of the runner.)

Wear profile has to be measured in critical areas (slag line in impact area / skimmer) and recorded.

The wrecking machine should not straddle directly on refractories (working and/or safety lining or skimmer).

A steel plate must be placed across the runner in order to spread the machine pressure and vibrations on casthouse.

Wrecking tools must always be kept as sharp as possible. They should be cooled in a water tank/barrell during the wreck.

At the end of the operation, after having removed all wrecked scraps, wrecked profile has to be measured and recorded.

Casthouse Practices

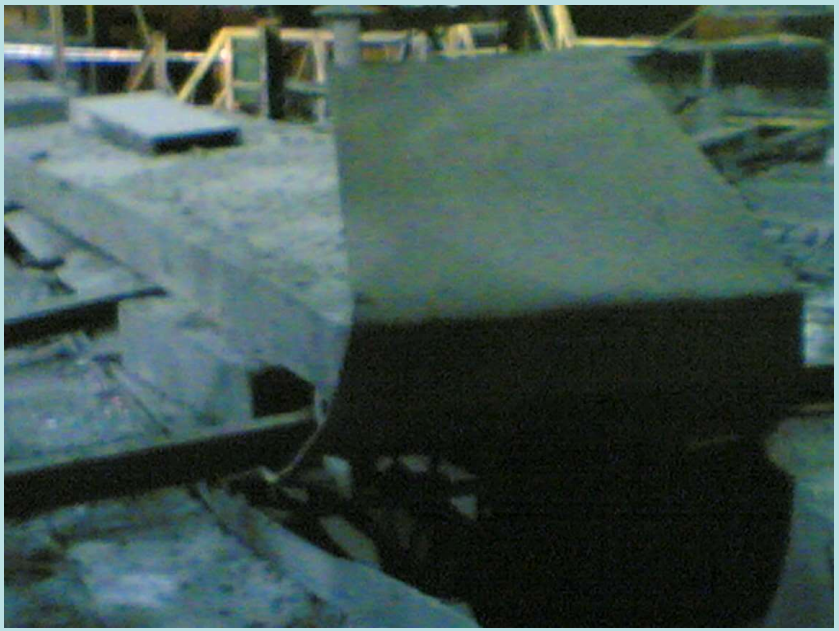
Setting Formers

- Formers have to be cleaned from any sticked particles, can be greased and must be opened on top.
- They should be positioned and aligned correctly (using centre point on taphole axis and fixed point on casthouse)
- They should be clamped on casthouse or weighted in order to avoid any lifting while casting.

Typical casthouse castables give off H2 gas - Formers must be opened top to prevent any H2 build up while and after casting. No welding or sparks in the area around the runner.

Casthouse Practices

- The H-Bomb!
  - Working lining castables normally contain metallic aluminium powder
  - Liberates hydrogen gas on reaction with water
  - Can collect in enclosed spaces to form explosion hazard



Installation where H_2 collected inside former.
Explosion ripped former apart and shattering nearby windows.

Casthouse Practices

- The H-Bomb Hazard!
  - Explosive limits for hydrogen in air is between 4% and 75%.
  - Build up of hydrogen gas in enclosed spaces or in the formers must be prevented
  - Use suitable formwork design and adequate ventilation in the working area
  - Ventilate overhead roof spaces if necessary
  - No welding, naked flames in the area

Casting (1)

ULCC's are high density, low porosity castables, they require high intensive mixers for their preparation such as :

- Planetary Mixer
- Mixer/pump

Their capacity and amount on site depend on installation conditions (mainly casting rate and sidewalls residual temperature) as laminations must be avoided

$\Rightarrow$ T° < 250°C : 10 t/h

$\Rightarrow$ T° > 250°C : 15 t/h

Casting (2)

To ensure efficient mixing and optimum properties, the mixer should be;

- Well maintained
- Scrapers and paddles correctly aligned
- Clean
- No dead spots
- Water meter to be calibrated
- Mixing cycles sufficient to allow proper dispersal of additives without being over-wet

Casting (3)

The optimum casting rate is 12t/h using 1ton Big Bag.

If the residual sidewall T° is high, then a casting rate of 15t/h can be achieved using 2 ton Big Bag or 2x1t mixer.

In order to respect the casting rate and avoid laminations, the mixer should be positioned close to the runner, straddling across, or just beside

Casting (4)

❖ **Water addition** : Mixing water should not come from industrial network (for cooling devices)

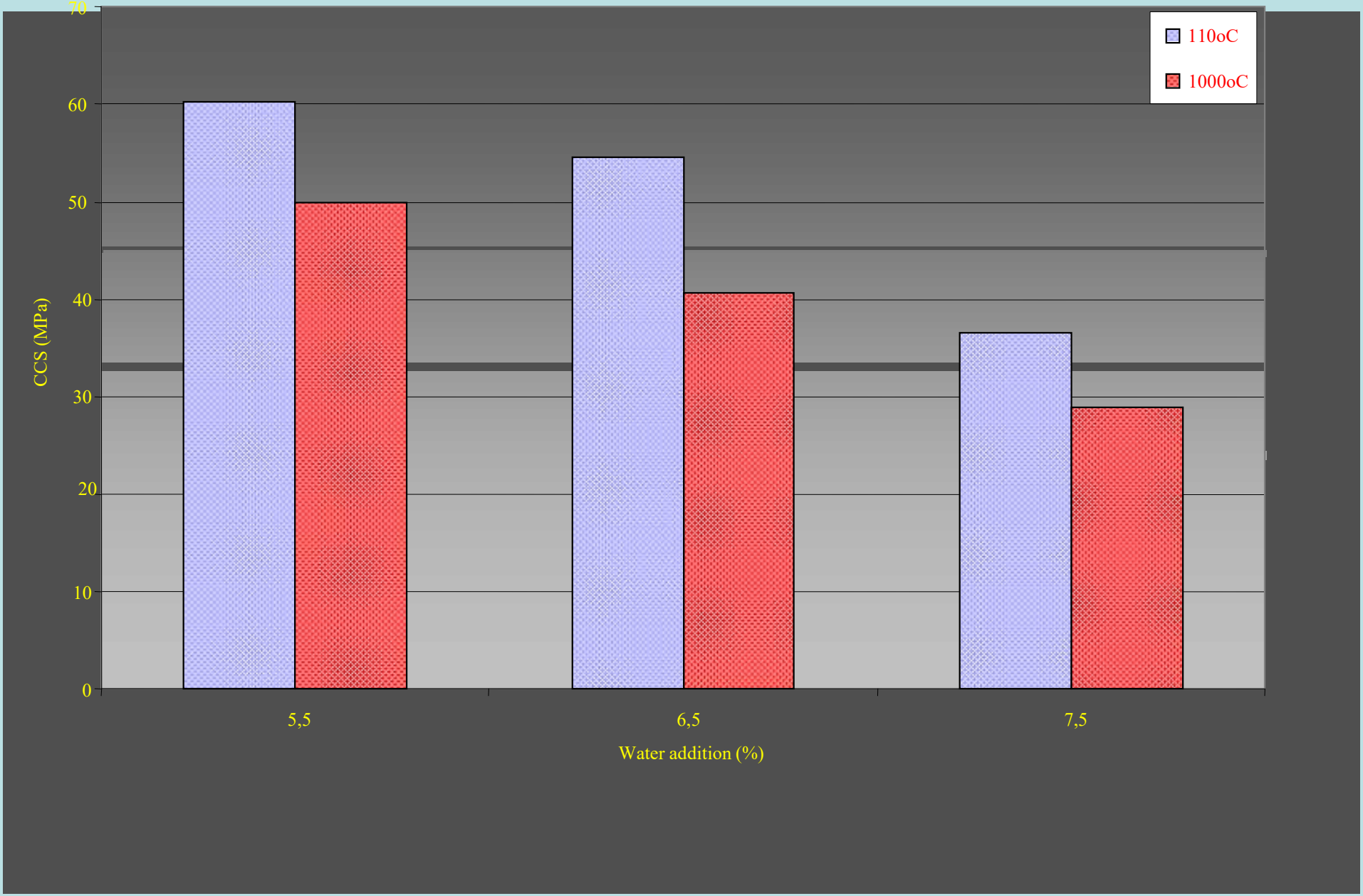
Do not jeopardize performance, bad water could affect castable setting time.

⇒Use clean water (even drinkable). If in doubt, take a sample and get an analysis made.

❖ Refractory castables have a **shelf life** up to 6 months if stored in a dry and cool area. However, FIFO rule will prevent poor performance.

❖ **Each batch should be recorded** on the appropriate report (including product name, manufacturing date, BB #, water content and potential comment)

Effects of Excess Water on Physical Properties



Casting / Vibration

1) Use proper tools (compressed air or electric)
2) Air should be dry and pressure constant (7 bars)
3) Use adapted diameter (mainly 50 and 64 mm) pokers.
4) **Effect of vibration does not exceed 1m diameter**

⇒ Ensure material is vibrated until no air bubbles can be seen coming from surface
⇒ Do not pull pokers to quickly.
⇒ Do not use pokers to pull castable (use a pump or a trolley).

Setting

Casting a quantity of 50 tons in a MIR represents approx a sidewall thickness of 300 mm :

- If residual temperature was < 250°C => Setting time will be 12 hours.
- If residual temperature was 500°C => Setting time will be < 2 hours.
- Setting time also dependant on ambient temperature and amount being installed
- Samples can be taken at different times during casting for checking setting time

H_2 will be generated while setting especially if casting was at low temperature. No open flames allowed in the area.

Dry out (1)

Once the moulds are removed from runner, Dry out sequence could take place considering the following :

- ❖ Runners system should be ready for service as soon as possible (almost immediately for Single Taphole BF / within a couple of days for multi Taphole BF)
- ❖ ULCC contains Carbon

=> No direct flames on castables.

=> No prolonged high temperatures (800°C)

To protect refractory wall, spray a low Al_2O_3 product or put steel plates in front of walls.

Dry out (2)

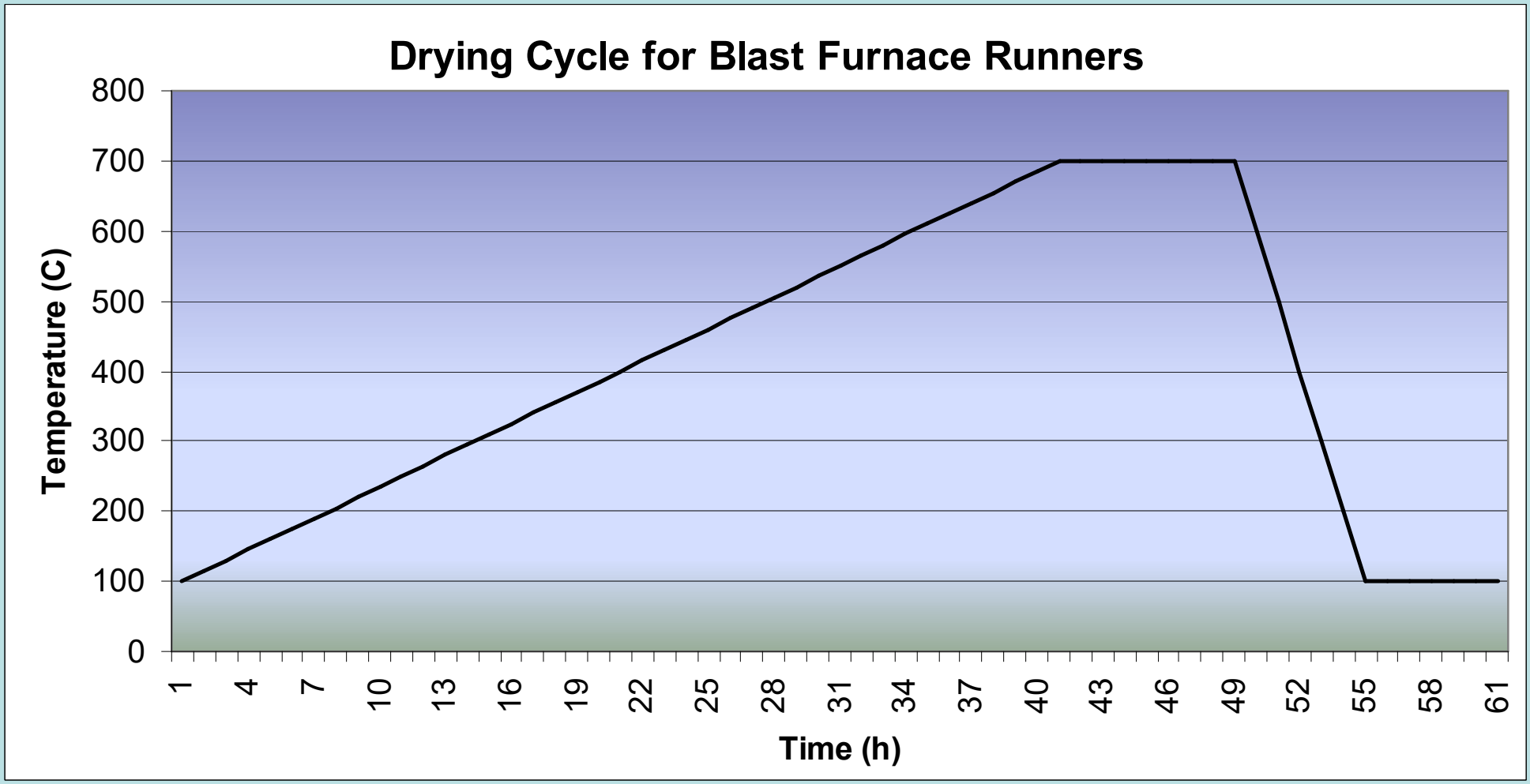
- Use adequate source (Natural Gas, Coke Gas or specific drying installation) No wood.
- If possible, use thermocouples to monitor heating curve
  - Inserted between working and safety linings in the pitch area in slag line &
  - Under skimmer
  - In Flame.
- Do not start drying with runner completely covered.
- Allow adequate ventilation for removal of moisture
- Drying curves :
  - The initial sidewalls temperature is around 50°C as Al powder generated an exothermic reaction which initiated setting.
  - 3 main temperatures within temperatures evolution :

    => 150°C where mixing water evaporates.

    => 400°C where “chemically combined” water evaporates.

    => 800°C where C starts to burn.

Dry out (3)



Heating Rate 15°C/hr