DEVELOPMENT OF LADLE LININGS FOR LONG RESIDENCE TIMES

Progress in Ladle linings and Slag Control

LADLE LIVES IN SHEFFIELD FORGEMASTERS

- IN 2005 LADLE LIVES FELL

FROM THE TRADITIONAL LEVEL OF 20 WITH A NEW SLAGLINE AT 10

DOWN TO 14 WITH A NEW SLAGLINE AT 7

POTENTIAL CAUSES

- QUALITY OF REFRACTORIES
- INEFFICIENT PREHEATING
- METAL PENETRATION THROUGH JOINTS
- INSUFFICIENT THICKNESS IN HIGH WEAR AREAS
- LONGER RESIDENCE TIMES
- HIGHER STEEL TEMPERATURES
- ARC FLARE IN VAD
- POSITION OF ARGON BUBBLER
- AGGRESSIVE SLAGS

QUALITY OF REFRACTORIES

- MOVE FROM UK MANUFACTURE TO EASTERN EUROPE AND CHINA
- INCREASE IN RAW MATERIAL PRICES
- SPALLING OF 80%ALUMINA BRICKS

INEFFICIENT PREHEATING

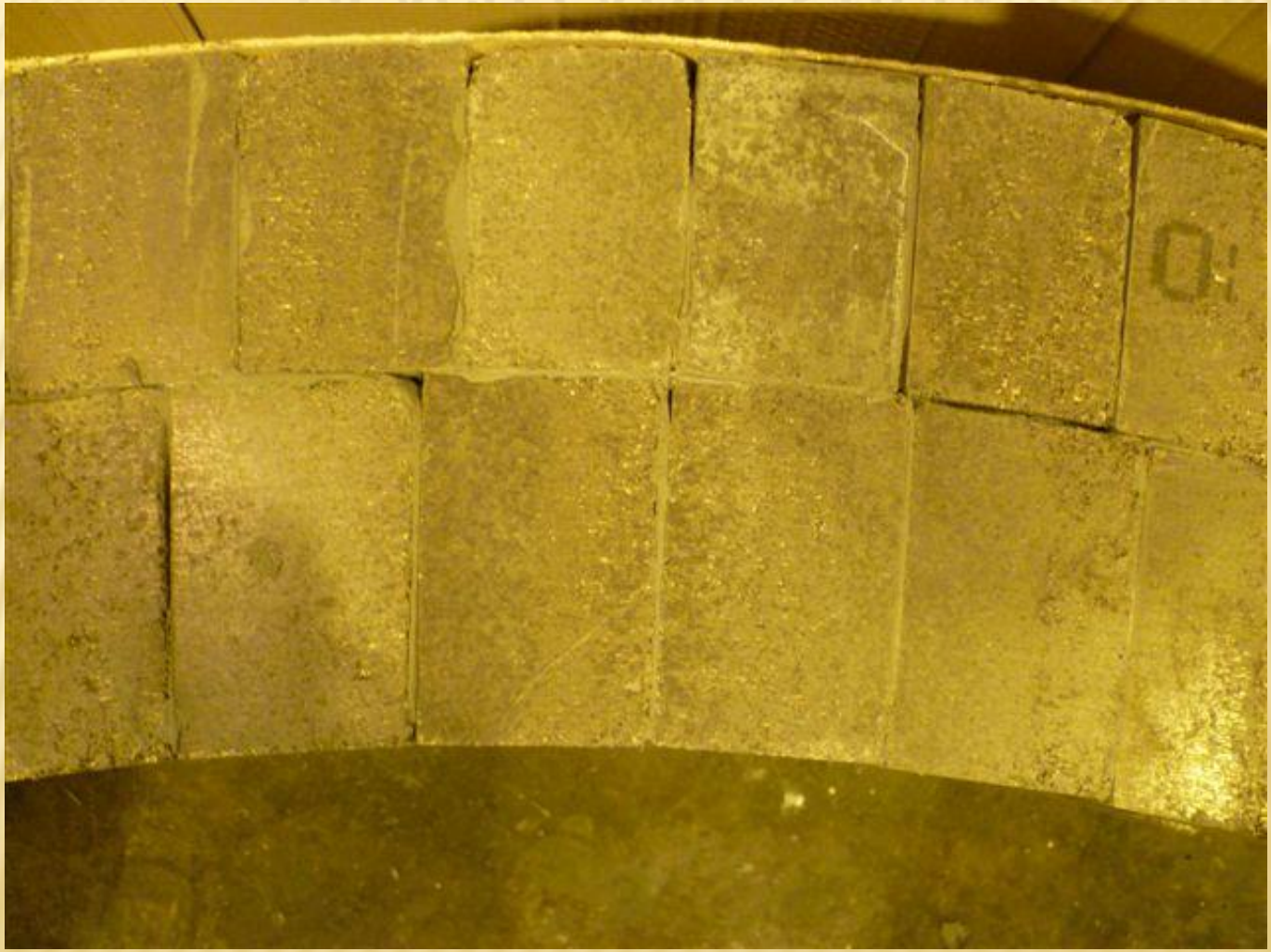
- ONLY THREE PREHEATERS
- PREHEATED ON SIDE
- ALL IN NEED OF MODERNISATION
- LADLES USED WHEN REQUIRED

METAL PENETRATION THROUGH JOINTS

- BRICKING PATTERN CREATED LINED-UP JOINTS
- CEMENT USED ON BOTH WORKING LINING AND BACKING LINING
- USED CRUSHED BRICK BETWEEN WORKING LINING AND BACKING LINING

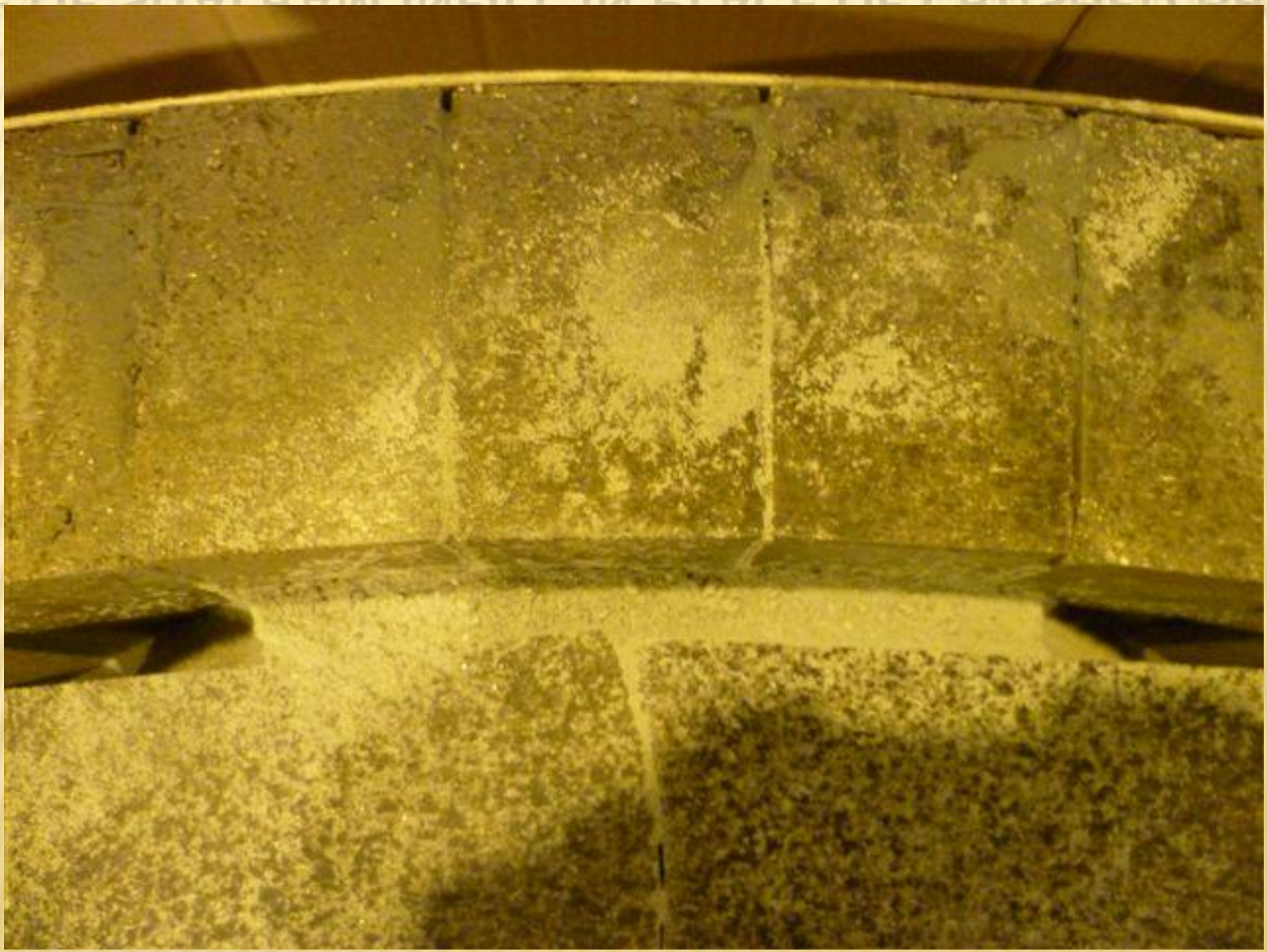
ORIGINAL BRICKING PATTERN IN 2005
SIDE ARCH 80% ALUMINA BRICKS IN SOLDIER COURSES

TOP VIEW OF SIDE ARCH BRICKS SHOWING LINED-UP JOINTS GIVING PATH FOR METAL TO REACH LADLE SHELL

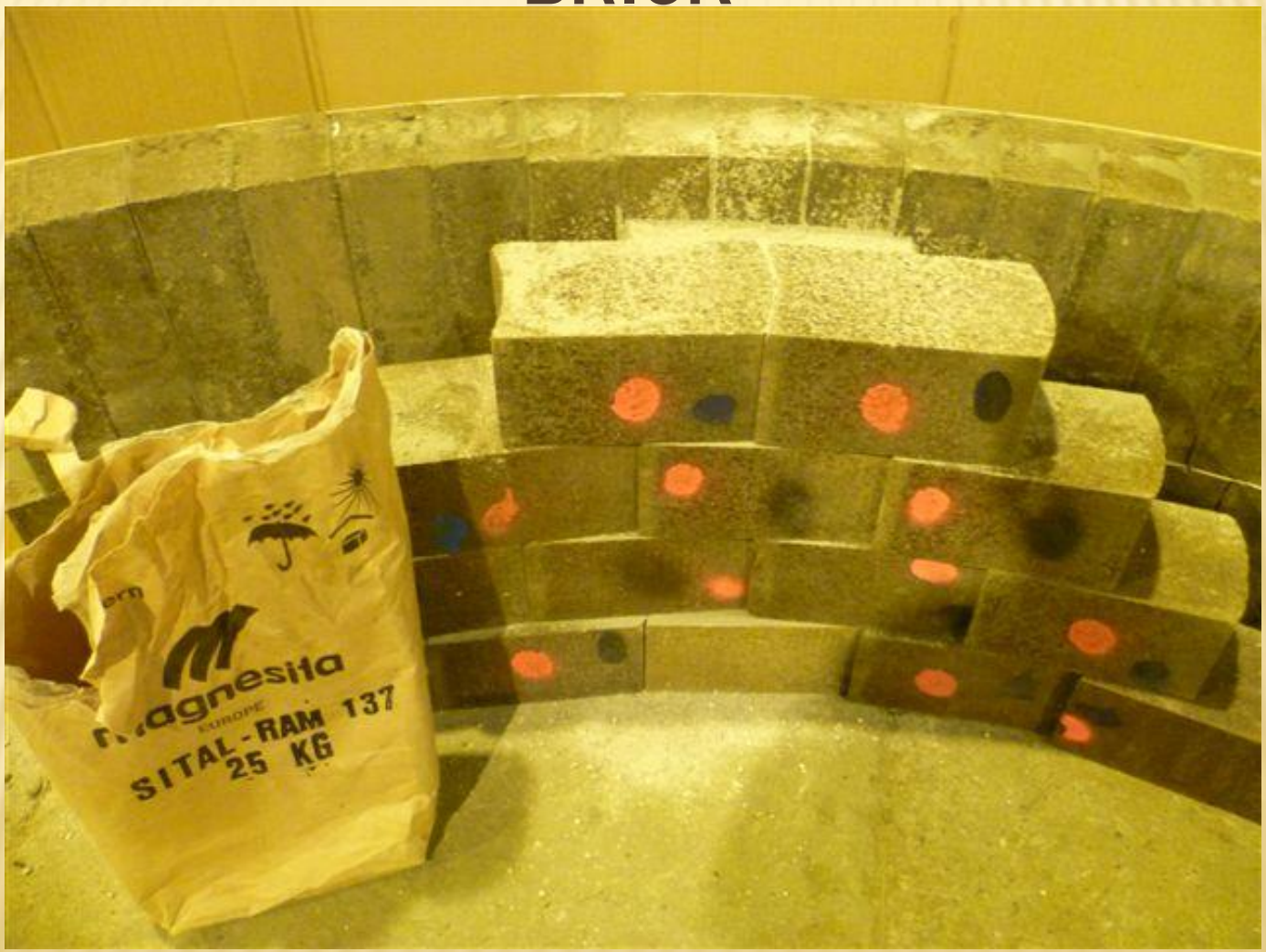


SEMI-UNIVERSAL WORKING LINING WITH SIDE ARCH BACKING LINING SHOWING LONGER METAL PATH, NO CEMENT ON WORKING LINING AND FEWER LINED-UP JOINTS

USE OF SITALRAM INFILL IN PLACE OF CRUSHED BRICK



CHANGE FROM 80% ALUMINA TO ALUMINA-SPINEL TO REDUCE SPALLING WITH SITALRAM INFILL IN PLACE OF CRUSHED BRICK

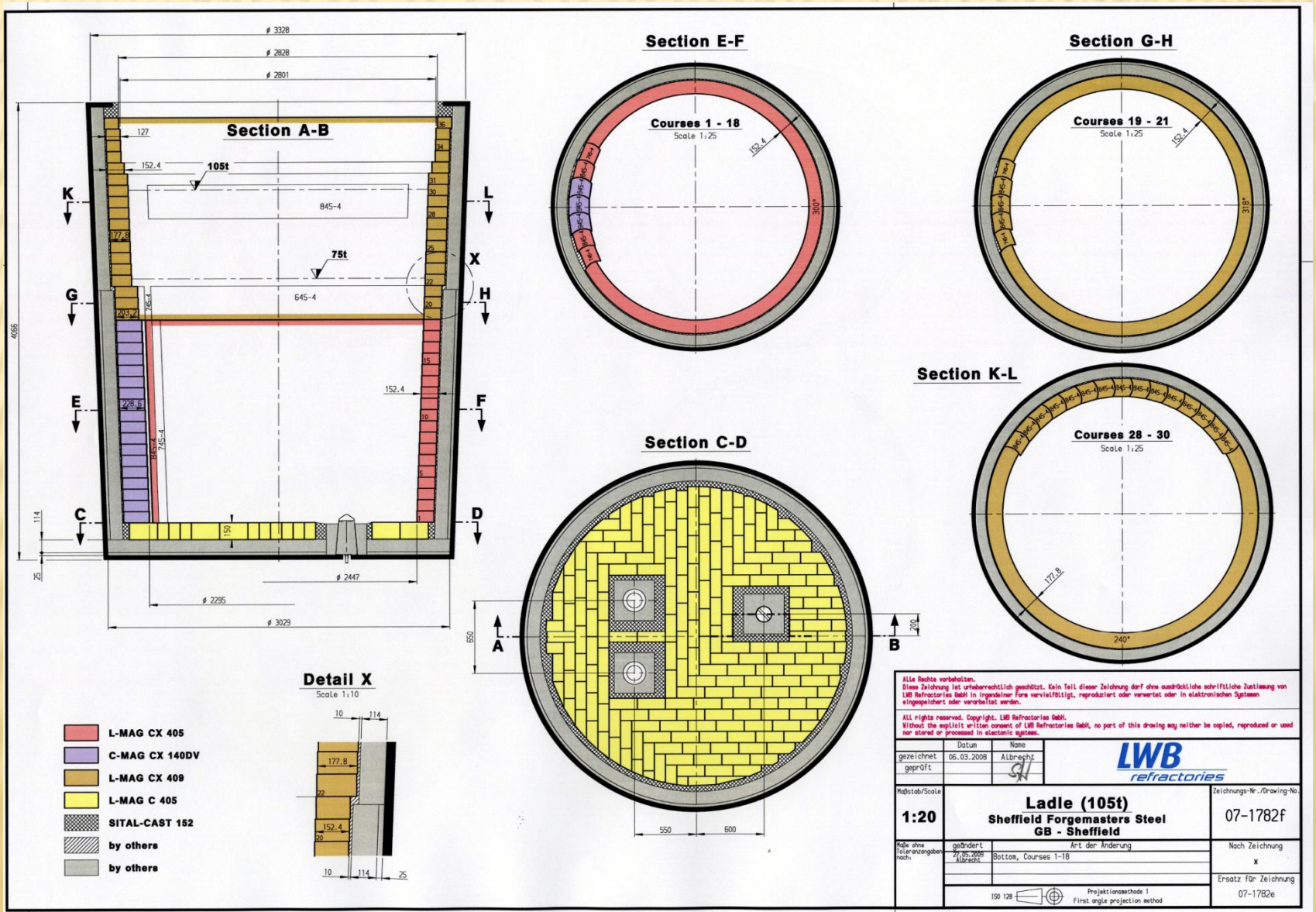


CHANGE FROM ALUMINA SPINEL TO MAG-C

INSUFFICIENT THICKNESS IN HIGH WEAR AREAS

- OBSERVED LADLES AT KNOCKOUT AND MEASURED THICKNESS OF BRICK IN DIFFERENT AREAS OF SLAGLINE AND BARREL THICKNESS INCREASED IN HIGH WEAR AREAS

MODIFIED BRICKING PATTERN



LONGER RESIDENCE TIMES UP TO 24 HOURS

- MORE COMPLICATED STEELS WITH LOWER SULPHUR SPECIFICATIONS
- MORE MULTI-LADLE CASTS
- INTRODUCTION OF 280T INGOT
- MANUFACTURE OF CASTINGS OVER 500T

MULTI-LADLE CASTS

HIGHER STEEL TEMPERATURES

- ONLY TWO SSU'S FOR FIVE LADLES SO MORE SUPERHEAT REQUIRED TO MAINTAIN TEMPERATURE
- HIGHER POURING TEMPERATURES FOR CLEANNESS

ARC FLARE IN VAD

- ARC LENGTHS WERE CHECKED AND FOUND TO BE OK

AGGRESSIVE SLAGS

- OCCASIONAL AGGRESSIVE SLAGS CREATED SEVERE PROBLEMS WITH LADLE LIFE AND AVAILABILITY AND POTENTIAL FAILURE TO MAKE MULTI-LADLE CASTS

AGGRESSIVE SLAGS ATTACKING SLAGLINE

SLAGLINE BREAKOUT

POTENTIAL CAUSES OF SLAG ATTACK

- SUPERHEATED SLAG FROM CLOSE TO ELECTRODES WASHED ONTO SLAGLINE REFRACTORY
- UNCONTROLLED FLUORSPAR ADDITIONS TO SLAG
- HIGH ARGON FLOW ERODING REFRACTORY
- SLAG COMPOSITION

TYPES OF SLAG USED ON VAD

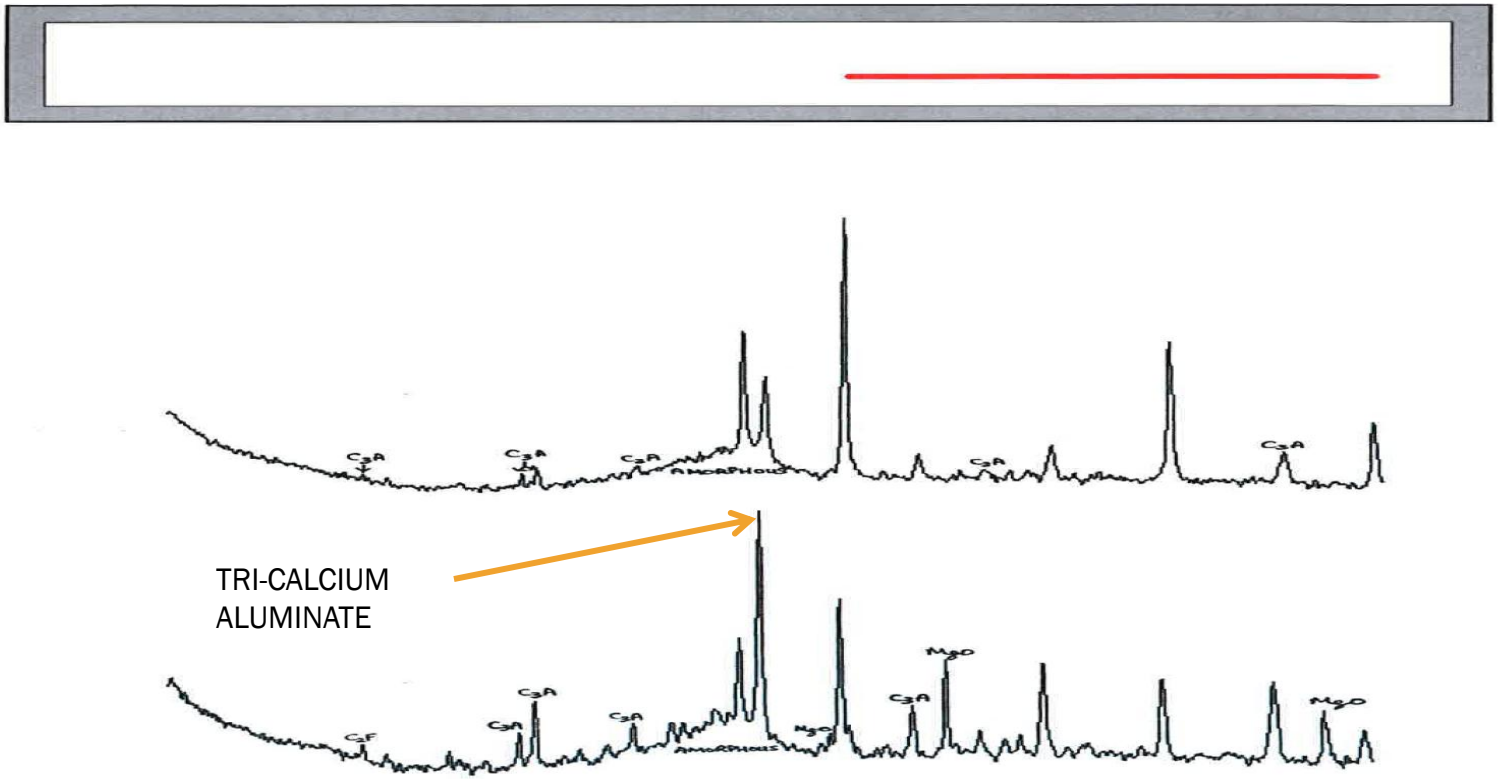
- AT THE TIME WE USED THREE TYPES OF SLAG
- TWO SYNTHETIC SLAGS CONTAINING CaO+MgO+ Al_2O_3+ FLUORSPAR WHERE LOW SULPHUR WAS REQUIRED
- CHARGE LIME (CaO) + FLUORSPAR WHERE SULPHUR ADDITIONS WERE MADE

- FLUORSPAR CONTENT OF SYNTHETIC SLAGS WAS REDUCED AND FLUORSPAR ADDITIONS CEASED

INVESTIGATION INTO AGGRESSIVE SLAGS

- SLAG TAKEN FROM BREAKOUT LADLE REVEALED HIGH LEVEL OF TRICALCIUM ALUMINATE
- A FULL MONTH INVESTIGATION INTO FURNACE AND LADLE SLAGS IN CONJUNCTION WITH STEETLEY DOLOMITE CONFIRMED THE SOURCE OF THE PROBLEM

XRF SLAG PATTERN SHOWING TRI-CALCIUM ALUMINATE



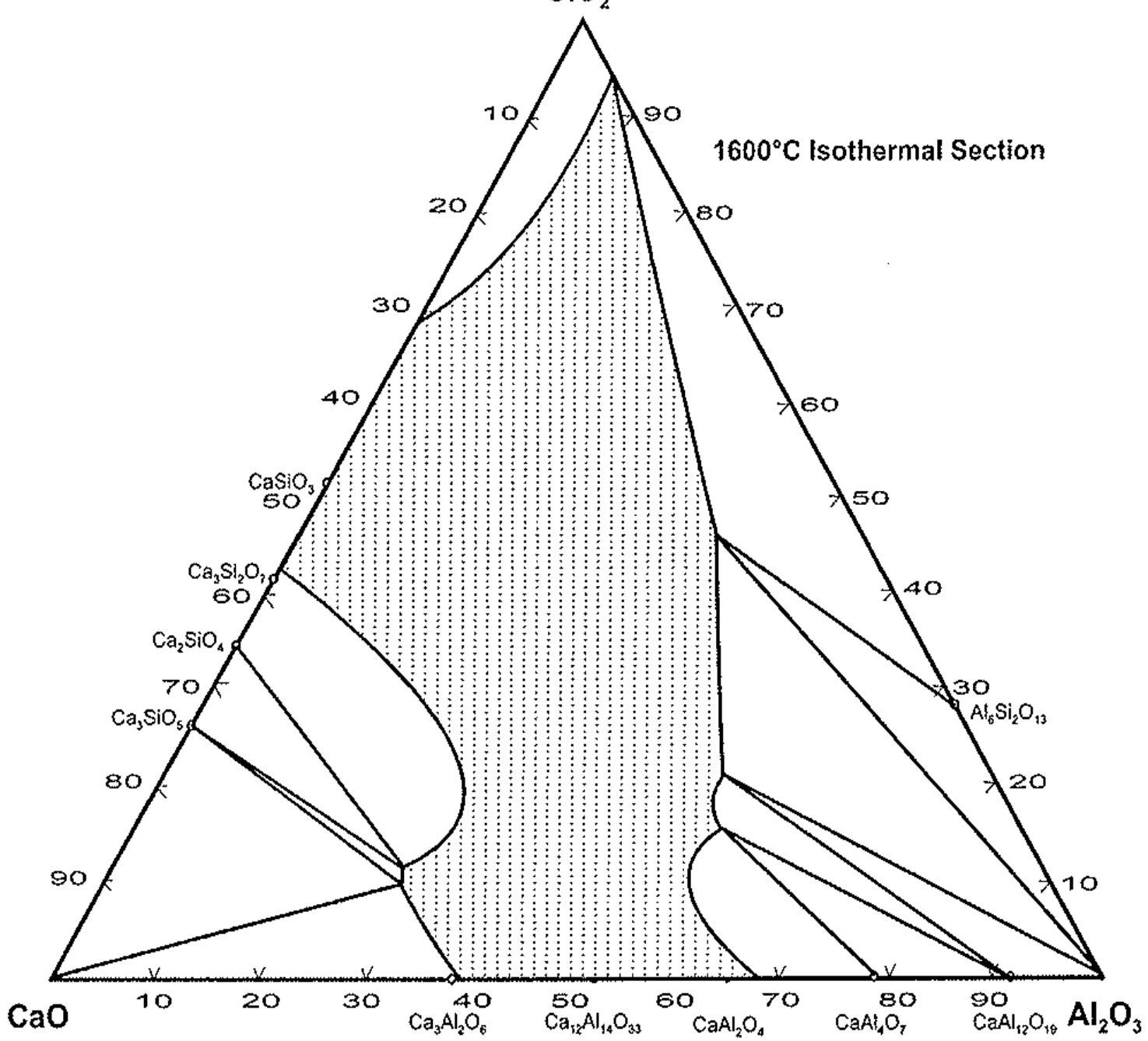


Figure 7.20 The 1600°C Isothermal section through the CaO-Al_2O_3-SiO_2 system

SOURCE OF TRICALCIUM ALUMINATE

- DURING TAPPING OF THE FURNACE Al BARS ARE THROWN INTO THE TAPPING STREAM
- USUALLY THE Al GOES INTO THE STEEL BUT SOMETIMES IT GOES INTO THE SLAG IF NO MgO IS PRESENT IT FORMS LOW MELTING POINT LIQUID.

SOLUTIONS TO PROBLEM

- DOLOMET F (60% CaO+38%MgO) IS ADDED TO THE FURNACE TO REDUCE LINING WEAR
- DOLOMET F IS USED IN PLACE OF CHARGE LIME ON CONTROLLED SULPHUR CASTS MgO CONTENT PREVENTS LOW MELTING POINT LIQUID FORMING

FUTURE DEVELOPMENTS

- CONTROLLED ARGON FLOW THROUGH BUBBLER TO REDUCE EROSION
- MULTI-USE BUBBLERS
- LASER MEASUREMENT OF LADLE IN SERVICE TO ASSESS WEAR AND OPTIMISE BRICKING PATTERN

PERFORMANCE

- CURRENT AVERAGE SLAGLINE LIFE IS ~ 20
- CURRENT AVERAGE BARREL LIFE IS ~ 35
- BEST BARREL WAS 60 LIVES ON TRIAL Mg/Al_2O_3 SPINEL WE HAVE TWO MORE TRIALS ARRANGED WITH THIS MATERIAL
- BEST SLAGLINE WAS 29
- WITH LASER MEASUREMENT WE SHOULD ACHIEVE THIS AS AN AVERAGE

INSULATION OF LADLES

- Long residence times led to ladle shell becoming too hot >500C so microporous insulation board was introduced.
- This had two benefits:-
- It reduced steel shell temperatures to <300C
- We saved £100,000 in gas over a year.