REDUCING REFRACTORY COST USING NEW ASCC BRICKS FOR HOT IRON TRANSPORT

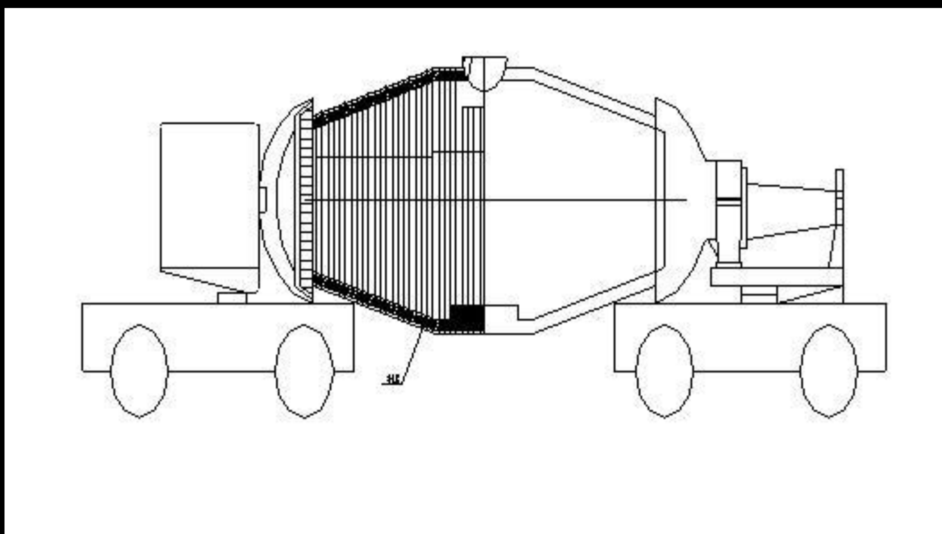
PENG, DEJIANG
HE, ZHONGYANG
YU, TERRY

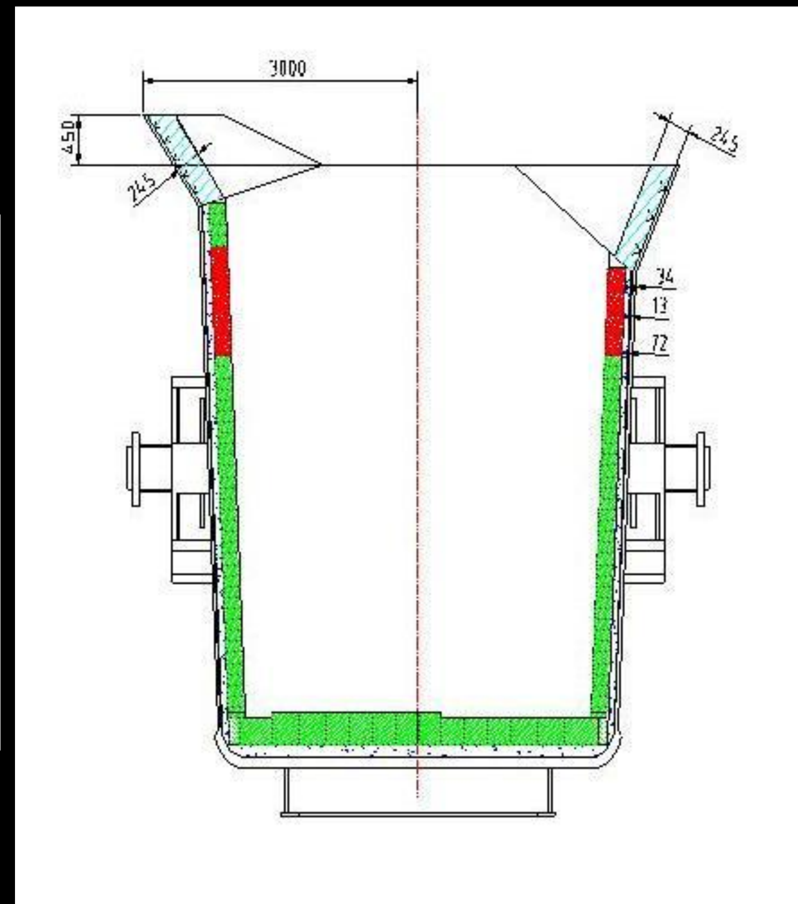
PUYANG REFRACTORY GROUP LTD.

AISTech 2010

The Iron & Steel Technology Conference and Exposition
May 3–6, 2010 • David L. Lawrence Convention Center • Pittsburgh, Pa., USA

Drawings





Outline

- Optimum Design
- Material Selection:
  - Tar-Impregnated High Alumina Brick
  - Alumina Silicon Carbide Carbon Brick
    1. Brown Fused Alumina Based
    2. Bauxite Based

Sample Preparation for Lab Test

- Raw materials: bauxite, brown fused alumina, silicon carbide, flake graphite, silicon, boron carbide and resin as binder.
- Sample Prep: under ambient temperature, mixing 30 minutes
- Size: 25mm×25mm×125mm and Φ50mm×50mm
- Press and treatment: 200 MPA pressure by hydraulic press , then coked at 200℃×24h.

Testing Methods

- Property test:

  HMOR: 1400℃×0.5h & buried into the coke;

  Slag resistance: 1400℃×3h & buried into the coke;

- Slag Test: Blast furnace slag (slag A) and blast furnace with lime added for slag:lime=50:50 (slag B)

  Chemistry of slag A： SiO_2 - 38.8 %; Al_2O_3 - 9.73%; CaO ,- 42.2%, MgO - 6.8%; MnO - 0.52%, FeO -0.58%; S -1.75%; C/S -1.09。

Use slag index to show the slag resistance property:

Index of sample slag resistance =(sectional area after slag eroded – sectional area before slag eroded) / sectional area before slag eroded X 100%.

Testing Results

- Silicon influence on the sample property
- B_4C influence on sample property
- Carbon and SiC influence on the slag corrosion resistance.
- Al_2O_3 content influence on property

Testing Results

✦ Silicon influence on the sample property

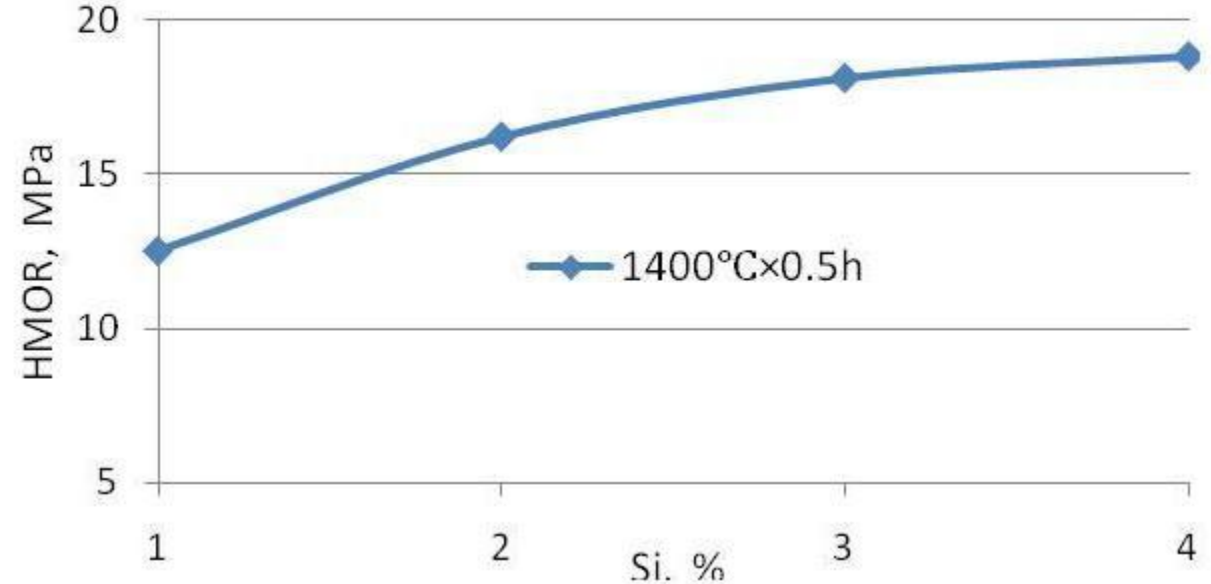


Fig 1: Relation Between Silicon Addition and HMOR

Testing Results

✦ Silicon influence on the sample property

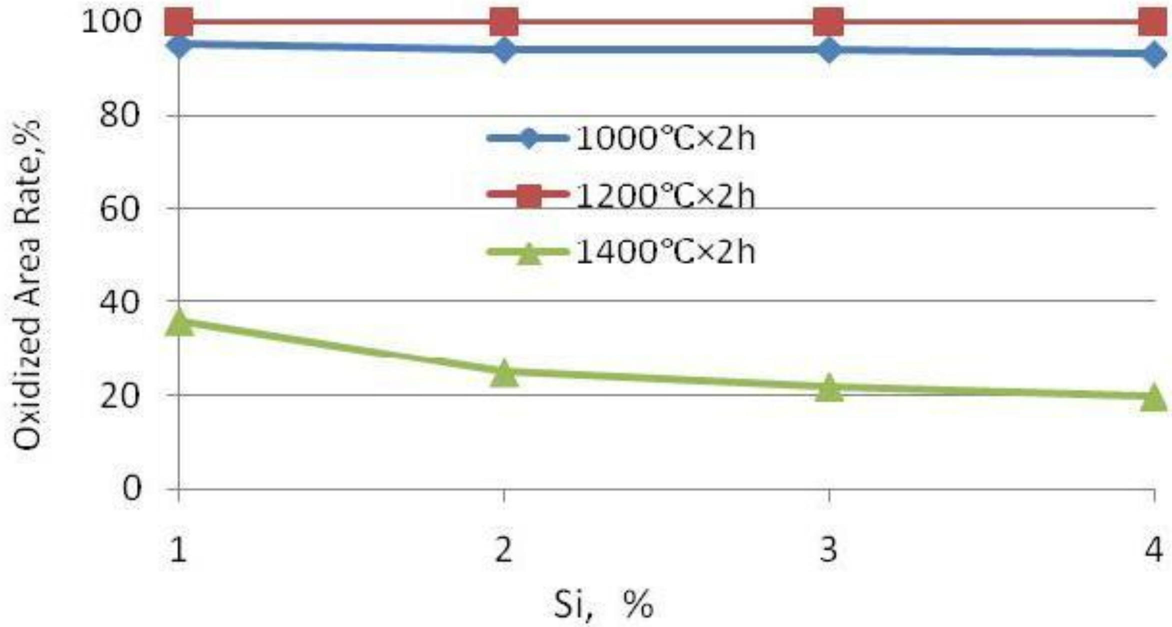


Fig 2: Relation Between Si Addition and Oxidized Area Rate

Testing Results

- B_4C influence on sample property

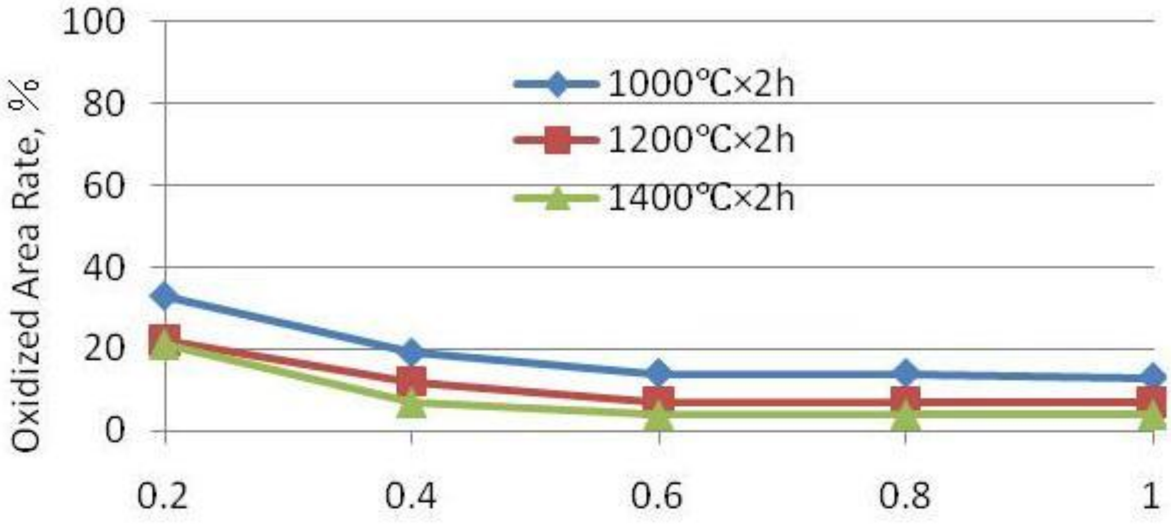


Fig 3 Relation Between B4C and Oxidized Area Rate

Testing Results

- Carbon and SiC influence on the slag corrosion resistance.

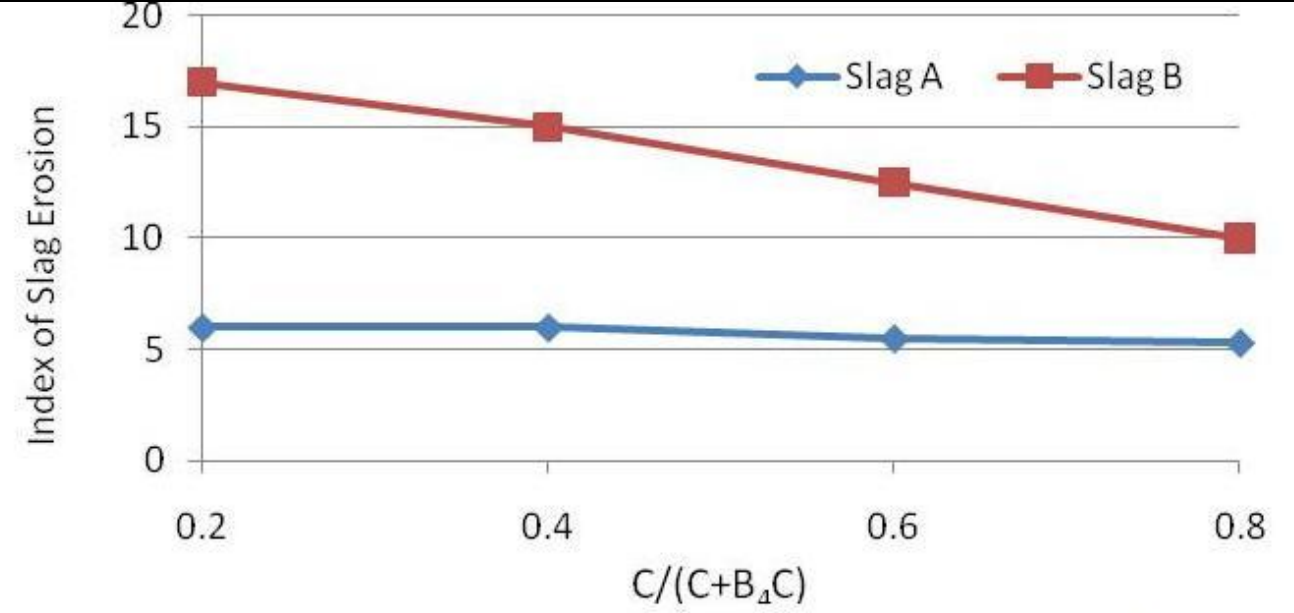


Fig 4 Relation Between C/(C+B4C) and Index of Slag Corrosion

Testing Results

- Al_2O_3 content influence on property

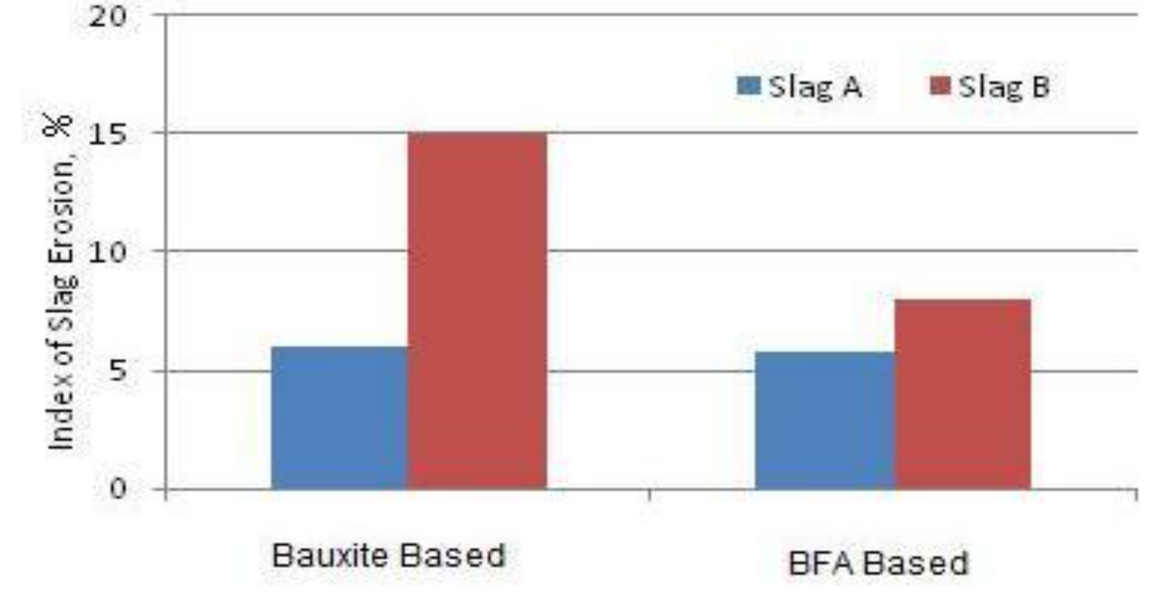


Fig 5 Al2O3 Influence on Index of Slag Corrosion

Industrial Trial

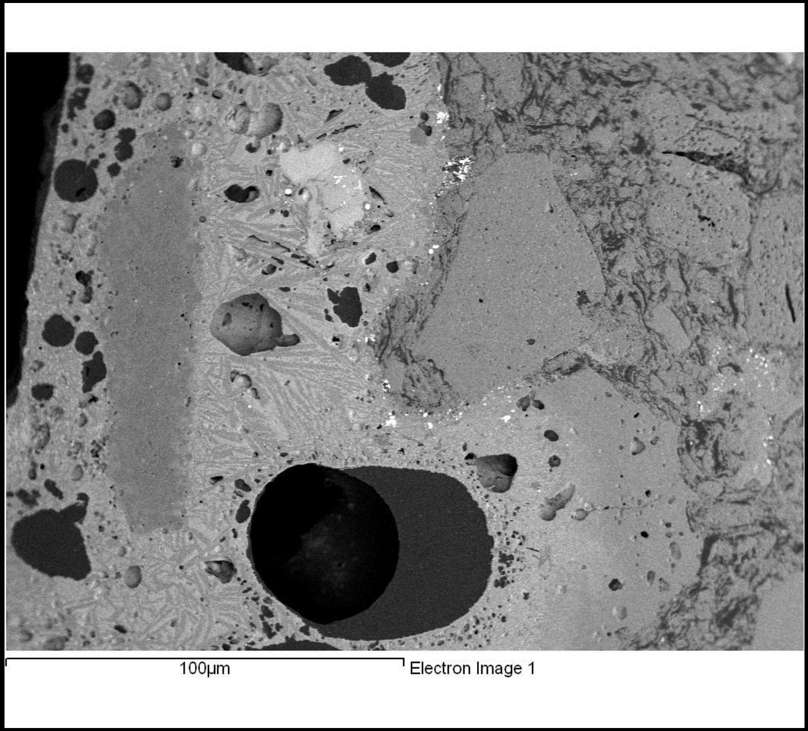
Materials reline in detail:

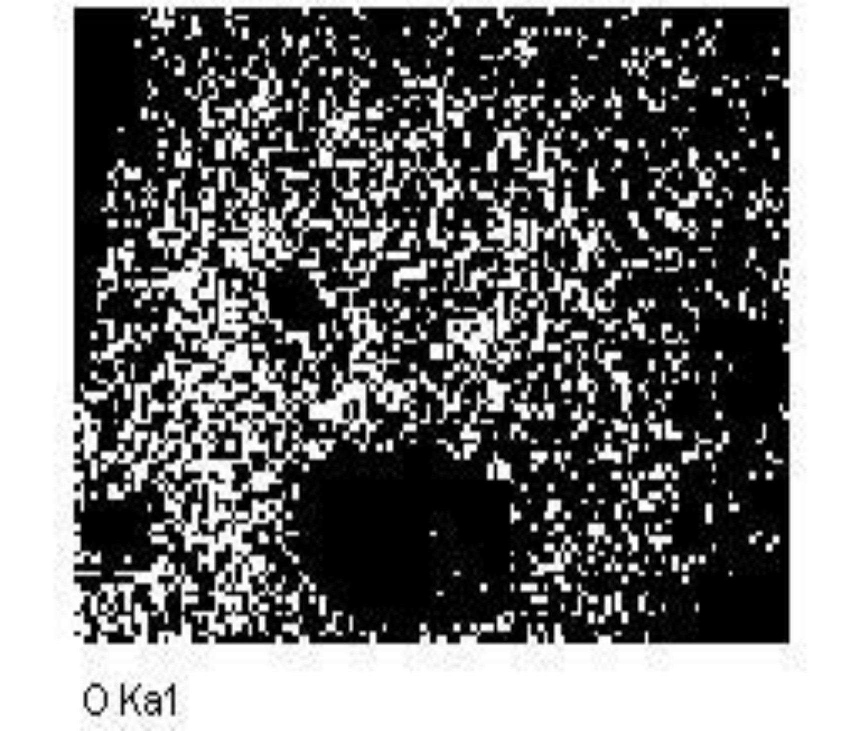
- BFA based materials for slag line and impact zone with total carbon content 12%, SiC 8%, Si 3%, B_4C 0.6%
- Bauxite based materials for other section with total carbon 10％， SiC 10％， Si 2％， B_4C 0.4%; resin as binder

✦ Tested in 300mt torpedo car and 180mt iron charge ladle respectively

✦ Analyzed the microstructures for residual bricks.

Microstructure Analysis



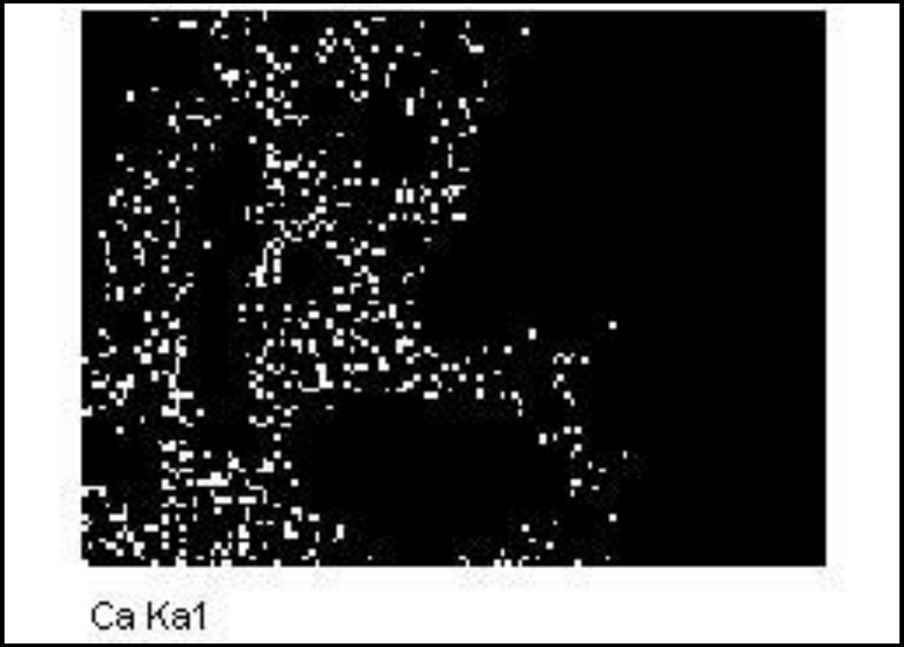


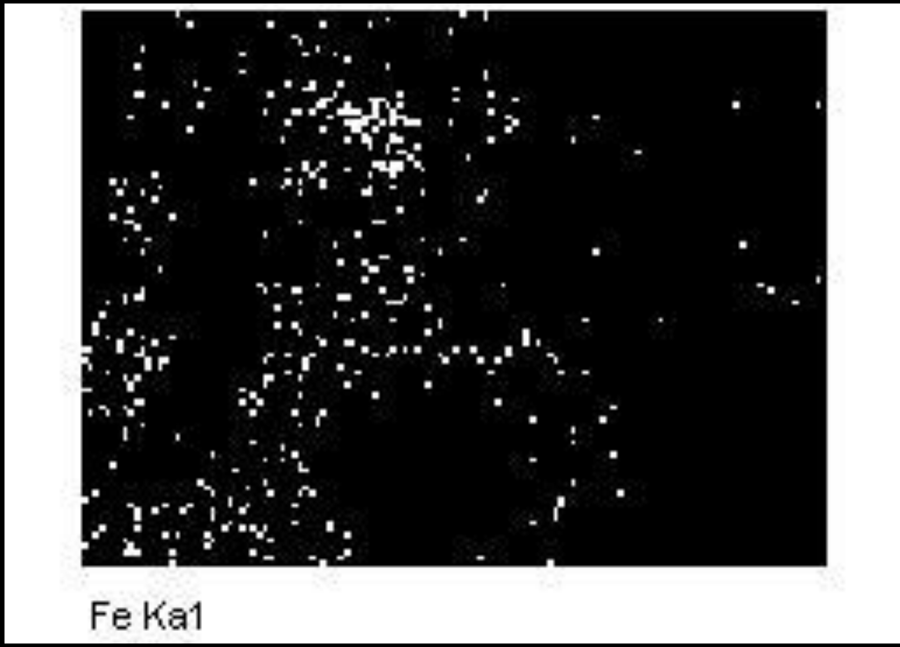
Microstructure Analysis

Al Ka1

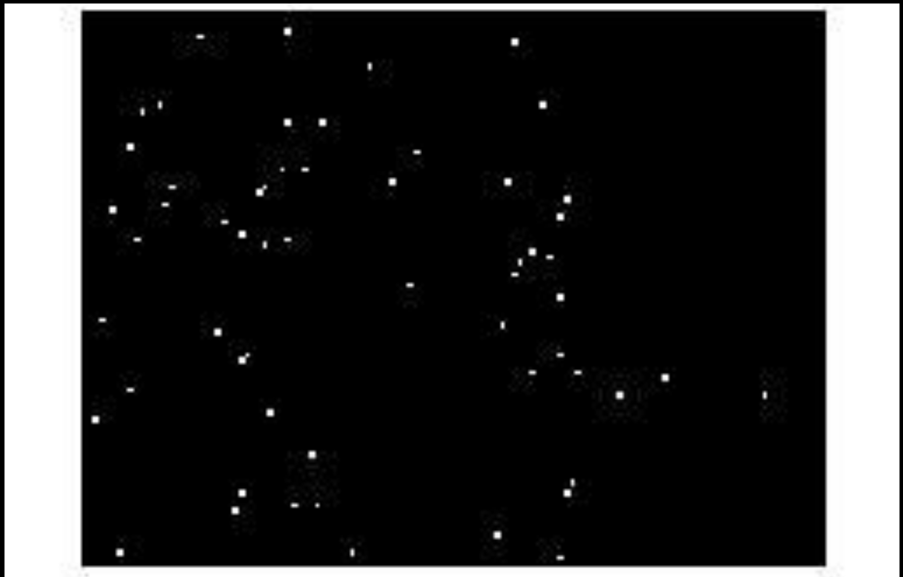
Si Ka1

Microstructure Analysis

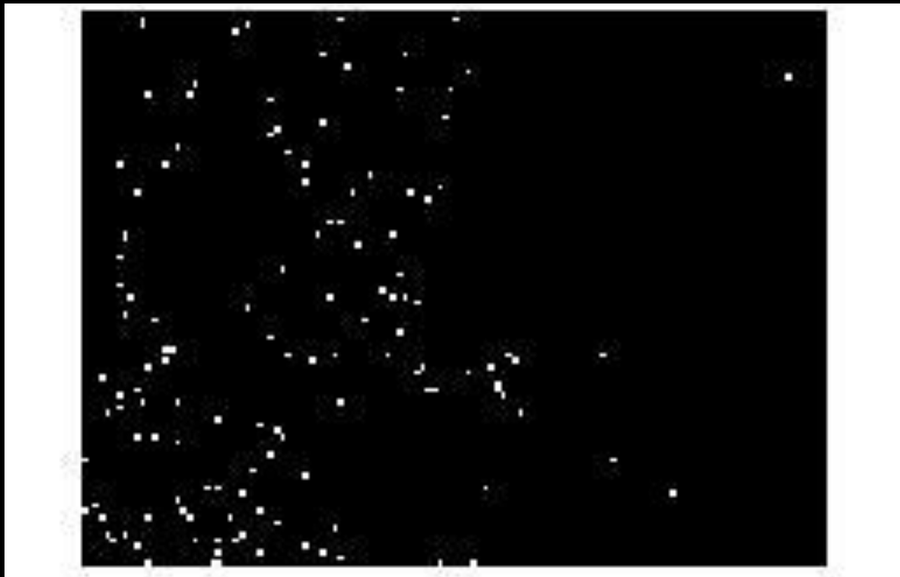




Microstructure Analysis



Mg Ka1_2



Mn Ka1

Microstructure Analysis

- The altered layer is very thin, and the boundary between altered layer and original brick layer is clear. The carbon of altered layer is totally oxidized, SiC is almost completely decomposed, the larger bauxite grains are still present, CaO, MgO, MnO and Fe from slag were penetrated.
- The corrosion procedure is:

Baking and service: carbon and SiC were oxidized ⟶ loose structure ⟶ CaO, MgO, MnO, Fe penetrated and reacted with SiC and Al2O3 ⟶ glass phase ⟶ penetrated to the boundary of brick layer ⟶ further penetration stopped.

Under mechanical wear like de-sulphurization, the altered layer was washed out, carbon and SiC were further oxidized, reaction happened again, and above cycle repeated.

Industrial Result

- The torpedo car's service life (patching the charge zone only) is increased 30% compared to the materials selection with Al2O3-SiC-C as slagline, impact zone, and other section with tar-impregnated high alumina bricks (gunning 5 times, 1.5mt per time)
- The iron charge ladle service life increased 50% compared to the materials with Al2O3-SiC-C as slagline and impact zone, tar-impregnated in other section (gunning 3 times, 0.6mt per time).
- The residual thickness of every section is nearly identical

Industrial Trial Result

Key Points:

1. Improved oxidization resistance
2. Improved wear resistance

Conclusions

- The material with 2-3% Si and 0.4-0.6% B_4C improved oxidization resistance under various temperatures
- Under the same content of total carbon and SiC, increasing carbon content could improve material's slag erosion resistance, but mechanical resistance worsens
- Materials with BFA based have better anti-slag property with higher lime than bauxite based
- Optimum design for different sections could improve the service life greatly, and decrease gunning times and refractory consumption

Thank You!

DEJIANG PENG, Ph.D
PUYANG REFRACTORY GROUP LTD

TERRY YU
PRCO AMERICA, INC.