WEDNESDAY, AUGUST 25, 2004, A.M.

SESSION 38: FOURTH INTERNATIONAL SYMPOSIUM ON ADVANCES IN REFRACTORIES FOR THE METALLURGICAL INDUSTRIES

COPPER (I)
Sponsors: Materials Science and Engineering, The Metallurgical Society of CIM, The Refractory Ceramics Division of the American Ceramic Society and The Canadian Ceramic Society.
Room: Webster A
Chairmen: F. GOLESTANI-FARD, Iron University of Science and Technology, Narmak, Tehran, Iran, and G. OPREA, University of British Colombia, Vancouver, British Columbia, Canada

PAPER 38.1 — 8:30
CORROSION MECHANISM AND DEGRADATION OF REFRACTORIES IN COPPER SMELTING FURNACES AT SARCHESHMEH COPPER COMPLEX.
H. NAMAVARI and A. RAHIMI, Sarcheshmeh, Rafsanjau, Kerman, Iran

The smelting factory at Sarcheshmeh Copper complex commenced working with two reverbatory furnaces, four pierce smith converters, two anode furnace and one holding furnace having a known capacity of 420 metric tons of anodic copper according to the initial design in 1982 (1361 Iranian calendar). During the period from the commencement date up until now, the smelting factory has undergone changes for improvement and enhanced production by substituting holding furnace with another anode furnace, installing the fifth converter and utilizing oxyfuel burners on the ceiling of the reverberatory furnace. This paper deals with various corrosion mechanism and degradation of utilized refractory materials in copper smelting furnaces. According to the different operational processes in reverberatory, converter and anode furnaces different types of corrosion mechanisms and degradation can be observed in the refractories of these furnaces.

PAPER 38.2 — 8:55
INTERACTION BETWEEN OXYSULPHIDE MELTS AND REFRACTORIES.
T. UTIGARD, A. WARCZOK, University of Toronto, Ontario Canada,
N. BEHNOOD, Process Technology Materials Consultant Inc., Montréal, Québec, Canada, and
M. ZAMALLOA, Noranda/Falconbridge Ltd., Sudbury, Ontario, Canada

The objective of this investigation was to investigate interactions between high-grade copper mattes/oxysulphides and Rexal 60DB bricks. The infiltration and attack of Rexal 60DB bricks by copper matte and copper continuous converter matte was investigated in laboratory tests at temperatures up to 1300°C. The brick dissolution and infiltration tests did not show any significant difference between the reactor and converting mattes. More metallic copper was visible in the pores in the case of the converting matte. The oxygen potential seems to be an important factor determining matte infiltration. With increasing oxygen (magnetite) content, the surface tension of the copper matte decreases and the amount of Cu_2O increases, enhancing the infiltration process. An important mechanism for magnesiachrome brick destruction is that oxysulphides start to infiltrate the brick, followed by slow oxidation of the matte producing metallic copper and cuprous oxide, which then reacts with MgO and Cr_2O_3, primarily attacking the sintered bonds of the brick.

PAPER 38.3 — 9:20
REFRACTORIES FOR SMELTING FURNACES.
D. FOWLER, P. LAUZON, C. GAUBERT, F. TOBER, HATCH, Mississauga, Ontario, Canada

High intensity cooling and dynamically loaded binding systems have been used extensively in non-ferrous smelting furnaces during the past 10 years. The resulting higher furnace power density has resulted in greater throughput AND efficiency, significantly reducing capital and operating expenditure requirements per unit production. Maintenance costs have also been reduced through cooled refractory lining design, principally by greatly increasing furnace life and comensurately reducing furnace re-lining frequency. New operating processes, possible only in high power density furnaces, have also emerged, greatly increasing the range of ore types that can be smelted economically. The increase in furnace intensity has resulted in a fundamental change in refractory design. Furnace integrity and reliability has become of prime importance, not only for cost efficiency and asset security, but also for personnel safety. This paper outlines recent changes in furnace design and particularly refractory design, and presents challenges to be met to further increase furnace reliability.

PAPER 38.4 — 9:45
STUDY OF TUYERE ZONE REFRACTORY DESTRUCTION IN THE SARCHESHMEH CONVERTERS.
S. KASHANI-NEJAD, McGill University, Montréal, Québec, Canada,
M.H. PARSA, Tehran University, Tehran, Iran, and
M. ASKARI, Shariff University of Technology, Tehran, Iran

Sarcheshmeh refractory consumption rate is about 7.5 - 8 kg/ton of the produced copper, which is almost three times higher than the other smelters practice. High destruction rate of tuyere zone refractory controls vessel productivity and operational lifetime. In this research with the aid of cold model and computational fluid dynamic (CFD), melt recirculation pattern and gas - liquid plume properties in the wide range of gas blowing conditions were studied. Results revealed that in addition to the well-known mechanical refractory destruction mechanism, fast tuyere zone refractory destruction could also be related to the cold bubble cluster formation near tuyere tips and introducing severe thermal shock to the refractory surface. Removing accretion and its strong bonds to the refractories around tuyere tip, causes refractory mechanical destruction and increases tuyere diameter. Increased tuyere diameter, in turn assists gas discharge in the bubbling regime. Air blowing in the bubbling regime result in the formation of big bubble clusters, bubble breakup and back attack occurrence which all found to have major impact on the refractory lifetime. Outcomes of this research, contributed to the plant converting management, blowing hardware and instrumentation improvement.

COFFEE BREAK — 10:10 – 10:40

PAPER 38.5 — 10:40
SECONDARY EFFECTS OF CHROMIUM-BEARING REFRACTORY DISSOLUTION IN IRON-RICH NON-FERROUS SMELTING SLAGS.
M. BROTHERS, G. RICHARDS, Teck Cominco Metals Ltd., Trail, British Columbia, Canada,
G. OPREA, W. LO, M. CHEN and T. TROCZYNSKI, University of British Columbia, Vancouver, British Columbia, Canada

Magnesia-chrome and chrome-magnesia are the most used refractories in contact with iron-rich non-ferrous smelting slags. The corrosion by slag always brings chromium oxide into the slag, causing the precipitation of crystalline phases at the process temperature. This secondary effect of the chromium-bearing refractory dissolution was studied in this work, emphasizing the effect of the other chemical components of the slag at various temperatures. The experimental results showed that the presence of chromium and lead contribute, although in different ways, to the formation of complex spinel phases and their precipitation at temperatures in the range of 1250-1400˚C. The XRD and SEM/EDS results were discussed for refractory-slag mixes containing 0-20% Cr_2O_3 and 0-11% PbO.

PAPER 38.6 — 11:05
SPINEL DIRECT BONDED REFRACTORY FOR COPPER CONVERTERS.
C.A. RODRÍGUEZ GONZÁLEZ, Pedro de Alba S/N Cd. Universitaria, San Nicolás de los Garza, México
W.F. CALEY, Dalhousie University, Halifax, Nova Scotia, Canada,
R.A.L. DREW, McGill University, Montréal, Québec, Canada

This work addresses the need of new refractories for copper converters. Technological improvements and environmental regulations for chromium containing refractories have generated this need. Chemical interactions, mechanism of penetration and the effect of oxygen potential and temperature in the system Cu_2S-FeS-SiO_2-O_2 are presented for two refractories: a burned magnesite chrome brick (typically used by the copper industry) and a chrome-free spinel direct bonded brick. The main difference determined in the refractory performance was the blister copper penetration resistance; burned magnesite chrome brick is penetrated while direct bonded brick is not. These results are very promising since blister copper penetration has been reported as the major cause of refractory wear. The results are explained in terms of refractory porosity and wetting characteristics.

PAPER 38.7 — 11:30
HYDRATION STUDIES ON MAGNESIA-CHROME BRICKS.
J. RIGBY, RHI Canada Inc., Burlington, Ontario, Canada,
P. LAUZON, Hatch Associates Ltd., Mississauga, Ontario, Canada,
M. BROTHERS, Teck Cominco Metals Ltd., Trail, British Columbia, Canada,
S. ZHOU, C. OPREA, T. TROCZYNSKI and G. OPREA, University of British Columbia, Vancouver, British Columbia, Canada

Hydration of basic refractories could occur during storage, drying after installation or in use. In order to assess the hydration resistance of various commercially available magnesia-chrome bricks, hydration tests were performed in steam at 110, 120, 130 and 150°C. The changes of the modulus of elasticity by the impulse excitation method, apparent porosity, air permeability, average pore size and pore size distribution were correlated with the hydration data. Mineralogical and microstructural changes were also studied on selected specimens by XRD and SEM/EDS. The

hydration mechanisms were discussed in correlation with the chemical and mineralogical compositions of the experimental bricks, in particular with the nature of the mineralogical phases at the grain boundaries.