

WEDNESDAY, AUGUST 25, 2004, P.M.

**SESSION 51: FOURTH INTERNATIONAL SYMPOSIUM ON ADVANCES IN
REFRACTORIES FOR THE METALLURGICAL INDUSTRIES**

MISSOURI ROLLA - ECOLE POLYTECHNIQUE – SECOND MEETING

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 C

Chairmen: J. SMITH, University of Missouri-Rolla, Rolla, Missouri, U.S.A., and
M. RIGAUD, École Polytechnique, Montréal, Québec, Canada

PAPER 51.1 — 14:00

EFFECT OF DISPERSANTS ON RHEOLOGICAL BEHAVIOR OF BAUXITE-BASED LOW-CEMENT
CASTABLES

X. ZHOU, K. SANKARANARAYANANE, M. RIGAUD, École Polytechnique,
Montréal, Québec, Canada,

N. ZHOU, Henan University of Science and Technology, Luoyang, Henan, China, and
S. ZHANG, Henan Gengsheng Refractories Co. Ltd., Gongyi, Henan, China

The effect of amount and type of dispersants on the rheological behaviour of bauxite-based low-cement castables has been studied in detail. The rheological properties: flow resistance and torque viscosity, as measured by a rheometer, are found to be strongly influenced by the amount and type of dispersants. In the present investigation, a mix containing sodium hexametaphosphate, at an optimal level, is observed to be rheologically superior at the given experimental conditions.

PAPER 51.2 — 14:25

SPINEL FORMATION IN CORELESS INDUCTION FURNACE LININGS.

A.D. SAIKIA, J.M. SOTO, K.D. PEASLEE, J.D. SMITH, University of Missouri –
Rolla, Rolla, Missouri, U.S.A.

Spinel-forming refractories reduce penetration of metal and slags through a tightening of the lining resulting from the volume expansion associated with spinel formation. Sintered spinel is often added to reduce the overall volume increase that results. Tests were carried out to evaluate the difference between performance in spinel-forming and spinel-containing refractory mixes. Eight refractory linings, one (1) pure magnesia, three (3) magnesia-base spinel-forming and four (4) alumina-base spinel-containing dry vibratable mixes, were tested for four hours in contact with a low-carbon, low-manganese steel in a coreless induction furnace at temperatures in excess of 1600°C. Afterwards, sample were cut and wear and penetration were measured. For magnesia-based mixes wear was minimized using 20-30wt.% spinel formation although further experiments are required to determine the optimal value. For alumina-based mixes, there seemed to be an optimal ratio of spinel added to spinel formed that minimized penetration and wear at the slag line. Sidewall accretion occurred and the accretion was the highest for the mix with the ratio of spinel formed to spinel added near the optimum value. Therefore to design an optimum refractory mix the benefits of higher ratios of spinel added to reduce penetration and wear at the slag line will need to be balanced with the tendency to form accretions on the sidewalls of the furnace.

PAPER 51.3 — 14:50

RHEOLOGY OF ALUMINA-BASED GRAPHITE-CONTAINING CASTABLES.

F. YE, M. RIGAUD, École Polytechnique, Montréal, Québec, Canada,

Q. JIA and X. ZHONG, Zhengzhou University, Zhengzhou, China

In this work, the rheological behavior of ultra-low cement alumina-based castables with addition of flake graphite and extruded graphite pellets has been investigated. Emphasis has been laid on the influence of the type and amount of carbon additions and the results are compared with corresponding alumina castable samples without any carbon addition. It is found that alumina-based castables with extruded graphite pellets have good rheological behavior and flowability with lower water demand (< 6.3%), and no segregation during the shearing of castable.

COFFEE BREAK — 15:15 – 15:45

PAPER 51.4 — 15:45

PREVENTION OF NOZZLE CLOGGING BY THE REDUCTION OF REFRACTORY PERMEABILITY
O.J. RAJTORA III, D. VAN AKEN and J.D. SMITH, University of Missouri – Rolla,
Rolla, Missouri, U.S.A.

A research effort sponsored by the Department of Energy (DOE) and several steel producers, is investigating the benefits of coating steelcasting nozzles with various materials. Coatings were applied to casting simulation nozzles made from industrial tundish nozzles (primarily of magnesia) and industrial submerged entry nozzles (SEN's) (primarily of alumina-graphite) in order to extend casting time prior to nozzle clogging. Nozzles were coated by air plasma spray (APS) using a 9M series APS system from Sulzer-Metco. The ability of these coatings to provide protection from clogging was evaluated using a steel casting simulation. Substrate-coating compatibility was characterized using optical and SEM microscopy.

PAPER 51.5 — 16:10

INFLUENCE OF CASTABLE DESIGN ON THE BINGHAM TO DILATANCY TRANSITION.
K. SANKARANARAYANANE, X. ZHOU and M. RIGAUD, Ecole Polytechnique,
Montréal, Canada

The effect of varying fine alumina/ultra-fine alumina ratio on the Bingham to dilatancy transition in alumina based, self-flowing refractory castables has been studied in detail employing rheological tests and particle size distribution measurements. Analysis of flow resistance and torque viscosity values has shown that Bingham to dilatancy transition is strongly influenced by fine alumina/ultra-fine alumina ratio in the castable, as well as by the nature of ultra-fine alumina. The calculated values of rheological constants and the viscosity coefficient were found to increase at higher fine alumina/ultra-fine alumina ratios.

PAPER 51.6 — 16:35

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF MOLTEN ALUMINUM PENETRATION
INTO POROUS STRUCTURES.
E. HERNY, S. AFSHAR and C. ALLAIRE, École Polytechnique of Montréal, Montréal,
Québec, Canada

Corrosion of refractory linings by molten metals is controlled by interactions between penetration and chemical reaction. Corrosion of aluminosilicates by molten aluminium is no exception. The early stage of corrosion can be described as a particular case of reactive wetting over a porous medium. Although the reactivity between aluminium and silica is great, which should improve wetting and penetration, the presence of air and the formation of a protective oxide layer disfavours initial penetration. This paper presents the results of an exploratory study on the effect of some parameters on the initial stage of aluminium penetration. Penetration kinetics and metal intrusion tests have been performed on alumina and silica powders with pure aluminium and Al-5%Mg. Capillary models are used as tools of interpretation.

Penetration kinetics tests had a poor reproducibility and the kinetics itself can not be explained very well by the capillary-tube-bundle model. On the other hand, a capillary model initially developed for ice intrusion into freezing soils produced predictions in reasonably good agreement with intrusion pressure measurements. The effect of particle size and alloy composition can be predicted using this model. However, the effects of temperature and powder chemistry need additional interpretations to be rationalised.

An unusual resistance to penetration of silica powder by molten aluminium have been observed in a series of experiments. This led the authors to the strange conclusion that oxygen should be seen as an excellent non-wetting agent and that there might be ways to use it in industrial applications.