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Mineral Processing and Extractive Metallurgy, August 2016

Recent advances in iron ore sintering. L. Lu, O. Ishiyama

Sintering is the most economic and widely used agglomeration process to prepare iron ore fines for blast furnace use. Owing to the depleting reserves of traditional high grade iron ore, there have been considerable changes in iron ore resources available throughout the world, especially in steel mills in East Asia. Corresponding to the changes in the availability of iron ore resources, the amount of impurities in iron ore has been slowly increasing. Some of these impurities have been found to have deleterious impacts on sinter quality and sintering performance. In the meantime, an increasing number of large blast furnaces with inner volumes of more than 5000 m$^3$ have been built in East Asia which require more sinter and are often more demanding in terms of the quality requirements of the ferrous materials. Finally, sinter plants are facing increasing pressure due to more stringent regulations regarding their environmental impact. This paper gives an overall review of a variety of technologies developed worldwide to tackle the changing raw material characteristics and mitigate emissions from sintering operations. Given the high sinter usage and volume of their blast furnaces, most of the recent sintering technologies have originated from East Asia, particularly Japan.

The influence of ore composition on sinter phase mineralogy and strength. M. Pownceby, N. Webster, J. Manuel, N. Ware

The physical properties of iron ore sinter are largely influenced by raw material properties, in particular the bulk ore composition and its associated mineralogy. The levels of Fe, SiO$_2$, Al$_2$O$_3$, MgO and other elements, together with the nature of the minerals in the fine ore and associated sintering conditions play a major role in determining the abundance and type of high temperature bonding phases that form during sintering. This study using natural ores combines in situ X-ray diffraction experiments in model sinter systems with laboratory-based compact sinter tests to examine the links between iron ore composition and sintering conditions and their effects on sinter strength. Results help to establish the critical compositional and thermal parameters that control the bonding phase chemistry, which in turn influences the strength, a key sinter quality parameter of the sinter matrix.

Fundamental nucleus assimilation behaviour of haematite and goethite containing ores in iron ore sintering. N. Ware, J. Manuel

The CSIRO laboratory-scale assimilation test is carried out by embedding ore particles into a fluxed matrix of known sinter blend composition. Samples are fired in a tube furnace under controlled conditions simulating the actual sintering process. The aim is to isolate and evaluate the nucleus behaviour of an individual blend component. Measured cross-sections of the resulting fired samples provide a semi-quantitative measure of reactivity, while accompanying photomicrographs allow a qualitative assessment of assimilation properties. Nucleus particles were selected from haematite,
haematite-goethite and goethite ores and embedded in a simulated plant sinter matrix. Drilled core particles of two sizes were tested at fixed temperatures simulating low temperature (1300°C) sintering conditions. The resulting assimilation properties are compared and discussed as a function of particle size, temperature and ore/sinter mineralogy. The implications for the contribution of each component in the prediction of blend sinter quality are also discussed.

**Important acid ferrous burden properties in the cohesive zone of a blast furnace.** C. Loo
The high-temperature behaviour of reducing ferrous materials is quantified using a laboratory softening and melting test. Using a combination of standard, non-standard and quenched tests supported by optical image analysis this work has highlighted some important differences in behaviour between lump, pellets and sinter as well as between the lump ores and the pellets. One lump ore is denser than the other and there is also a denser pellet. In both cases, the denser ore/pellet is also higher in silica content. Densification of the ferrous bed leads to reduced bed permeability. Studies indicate that densification can happen through two mechanisms. Results show that material density and silica content are two key factors causing increased bed densification. Material density influences reduction efficiency and wustite levels while silica influences the level of fayalite formed. Fayalite is formed by reactions between wustite and silica. Results also show that the behaviour of fluxed sinter is superior to ore and acid pellets because lime preferentially reacts with silica to form dicalcium silicate, a high melting temperature compound. Studies using mixtures of fluxed sinter and lump ore indicate that blast furnace burdens can easily accommodate 20% ore.

**Mineralogical quantification of iron ore sinter.** S. Hapugoda, L. Lu, E. Donskoi, J. Manuel
The mineralogy and microstructure of sinter play an important role in determining the physical and metallurgical properties of iron ore sinter. Characterisation of sinter phases is, therefore, a costeffective and complementary tool to conventional physical and metallurgical testing of iron ore sinter in evaluating and predicting sinter quality. Over the years, CSIRO (Commonwealth Scientific and Industrial Research Organisation) has developed a scheme for characterising iron ore sinter which classifies primary sinter phases, such as un-reacted and partially reacted haematite, magnetite and remnant fluxes, and secondary phases including silico-ferrite of calcium and aluminium (SFCA), secondary haematite and magnetite, glass and larnite. Quantification of these phases has traditionally been carried out by manual point counting under a petrographic microscope. However, new technologies based on automated optical image analysis, quantitative X-ray diffraction and scanning electron microscopy are now available for evaluation. In this study, two sinter samples of varying chemistry were prepared and characterised using both point counting and automated optical image analysis. Quantification of sinter phases is a complementary tool for comparing the physical properties of sinter obtained from various sinter blends, and sinter phase quantification results can be used for comparing pot-grate sinter with different metallurgical properties.

**Dependence of flame front speed on iron ore sintering conditions.** J. Zhao, C. Loo
It is well established that flame front speed is an important factor influencing sinter productivity, sinter quality and fuel rate. In this work, the effect of suction, coke addition and mix moisture on flame front speed was studied in a pilot-scale sinter pot and also using a recently developed theoretical model. Airflow through the bed has a large influence on flame front speed. It was found that increasing sintering airflow rate will lead to increased flame front speed, but the increases become smaller at higher airflow rates. Sinter pot test results showed that increasing coke addition decreased green bed permeability and increased flame front temperature, which resulted in increased flame front resistance and decreased flame front speed. Studies also showed
that green bed properties are sensitive to sinter mix moisture level. The changes in green bed properties further influence the flame front properties.

**Granulation behaviour of specularite fines in ferrous sinter mixtures.** D. Zhu, X. Zhou, J. Pan, B. Shi

The granulation behaviour of specularite fines which possess poor ballability was studied with limonite fines as a function of nuclei particles and adhering fines. The results show that the permeability of granules deteriorated as the ratio of specularite fines increased in the mixture, and the optimal granulation moisture content also decreased. The granulation kinetics results demonstrate that the adhering load of specularite fines increased rapidly within 3 minutes and then levelled off. With increasing specularite fines ratio, the adhering rate accelerated but the granulation duration needed to be longer to reach adhering balance. The microstructure of granule quasi-particles indicates that the fine limonite particles act as binders to bond together the specularite particles which are dispersed in the adhering layers. This can improve the adhering strength of the granules. Hence, the granulation behaviour of specularite fines can be improved by blending them with fine limonite ores which have high adhering capabilities.

**Effect of concentrate and micropellet additions on iron ore sinter bed permeability.** A. Nyembwe, R. Cromarty, A. Garbers-Craig

With the depletion of high-grade lump iron ore, concentrates have been identified as an alternative material for sinter making. In this study, the effect of concentrate and micropellet additions on the permeability of the sinter mixture was investigated. Permeability was measured on sinter mixtures containing 10–40% concentrate or micropellets at various moisture contents. The results confirmed that the addition of concentrates to the sinter mix decreases the maximum permeability of the sinter bed. Incorporation of micropellets into the sinter mix reduced the permeability less than concentrate addition. The maximum permeability of sinter mixes containing concentrate is reached at the same moisture content as the sinter mixture without concentrate addition. For sinter mixes containing micropellets, additional water must be added to obtain maximum permeability. Granule size, void fraction and angle of repose were also investigated to evaluate their effects on the permeability of the sinter bed.

**Metallurgical Research & Technology, April 2016**

**Effects of liquid infiltration characteristics of iron ores with a high proportion of limonite on sinter strength.** D. Liu, J. Zhang, Z. Liu, K. Li, Y. Wang, G. Wang

Since the strength of unmelted nuclei ores and the bonding phase are constant under the same conditions of sintering parameters and ore-proportioning structure, sinter strength is largely determined by the bonding degree between unmelted nuclei ores and the bonding phase. The bonding degree is mainly dependent on the infiltration behavior of sintering liquid on nuclei ores. Infiltration tests were carried out using micro-sinter equipment in order to clarify the liquid infiltration characteristics of mixed ores with a high proportion of limonite. The effects of the infiltration area index of the original liquid (IAO), infiltration volume index of the secondary liquid (IVS) and sinter body bonding strength (SBS) on the tumbler index of the sinter (T) are discussed using a laboratory sinter pot test. The results showed that T increased first and then decreased with an increasing IAO and IVS, but increased linearly with increasing SBS. In order to improve the sinter strength with a high proportion of limonite, the IAO and IVS should be controlled within 2.02–2.38 and 0.19–0.21, respectively. Meanwhile, sintering schemes with a high SBS should be chosen during ore-proportioning optimization.

**ABM Week 2015 – Iron Ore Agglomeration Symposium, August 2015**
Study of bark eucalyptus mixtures with coal injection in blast furnace. R. Oliveira, C. de Assis, P. Assis
This work was carried out from the identification of an environmental problem, the high concentration of greenhouse gases. By analyzing the national energy system emissions, it was observed that the segment of the steel industry has an important participation due to the high consumption of metallurgical coal and coke in the energy balance, showing the predominance of integrated steelmaking coke based plants. After identifying some possible solutions to this environmental issue, this project aimed to use barks of eucalyptus in the injection on tuyeres of blast furnaces of steel mills. The use of this material as an energy source (fuel) in the process of reduction of iron ore in blast furnaces, replacing directly coal, presents a viable solution to carbon sequestration. Eucalyptus is a renewable source, unlike coal, and through photosynthesis captures CO2 from the atmosphere, reducing the pollution caused by the blast furnace and participle in the carbon market. Thus the company could participate in the carbon market, which could result in a higher annual profit only by this mechanism. The bark of eucalyptus is rich in carbon and complements the provision of that element to the process of ore reduction.

Reduction of the number of cooling plates burned in blast furnace 2 of CSN. M. Peixoto, M. da Silva, J. Pereira, S. Batista Junior
This paper aim to present the reduction of the number of burning cooling plates in Blast Furnace 2 of the CSN, where the main operational actions implemented for attainment of the results until the present date and the reduction of losses in the cost and increase of productivity are detached.

Stockhouse–based drying and pre–heating of coke and pellets. R. Vaynshteyn, P. Verbraak
In places where Blast Furnaces are usually located, climatic factors may be unfavorable. Raw materials may be exposed to e.g. rain during transport/storage, bringing moisture into the process with consequences for stability and hot metal cost. This paper describes a technology for drying and pre-heating pellets and coke in the stockhouse. It does not require additional handling or logistical equipment and does not introduce extra transfer steps and degradation. Not only can moisture content be reduced, it can be controlled to a stable level by the operator.

Modern mini and compact blast furnaces: operations–based design considerations. E. Engel, V. van Straaten, R. Vaynshteyn
Whereas only a handful of decades ago, typical blast furnace working volumes were below 1000 m³, such furnaces are currently designated compact or even mini blast furnaces. For certain business cases, however, small furnace sizes remain an attractive option. Decades ago, this size blast furnace would have produced a maximum of 0.3 Mtpa with its 600 m³ working volume over a campaign of up to four years. The current state of technology and operational know–how will allow a similarly sized furnace to produce over 0.7 Mtpa while achieving the multiple decade campaigns that have become familiar to steel producers in full sized operations. This level of productivity, but especially the reliability and supply security associated with mature technology, allows for integration into minimills or taking a first step towards a full scale BF–BOF integrated mill. Steel producers considering such scenarios, which are typically attractive for emerging economies, are confronted with fundamental decisions, one of which is for the technological basis for the compact or mini blast furnace to be included in the plant. This article addresses some of these decisions from an operations–based perspective. A small number of case studies is included.

Dry slag granulation with heat recovery. I. McDonald, A. Werner
A new dry atomising technology is being investigated to use air to cool molten slag and recover the lost heat energy. The resultant pelletised slag fulfills the same criteria as wet-granulated slag for use in the cement industry. Phase 1 of the project has now been completed where a technical plant was set up at the University of Leoben in 2012. A series of dry-slag granulation campaigns were carried out using remelted blast furnace slag. The elevated offgas temperatures and the quality of the slag product as verified by the FEhS Building Material Institute have shown the process suitability as an industrial application and the decision was taken to escalate the project from a full size pilot plant. The phase 2 development of this plant is now underway and is scheduled for installation at the site of an industrial partner in early 2016 where full slag flow will be fed directly to the plant from Blast Furnace slag runners. This paper will show the development path taken to date and the planned route to our goal in 2016 of being the first to industrialise the ‘game changing’ process of dry Slag Granulation with Heat Recovery from the slag.

Stoves combustion control improvement. G. Guidugli
The hot blast stoves are a regenerative heat exchange system, accounting for 10 to 20% of the total energy requirement in an integrated steel plant, responsible for the supply of about one-third of the blast furnace heat input and responsible for a constant flow of hot air to the blast furnace, according to the required production. Because of their important role in the hot metal production, a stable operation and an appropriate combustion control is necessary. This paper aims to present the results of an investigation and modifications performed as an operating multi-furnace plant, as well as the parameters considered to ensure thermal equilibrium, improving in the stoves heating cycle.

The breakthrough ironmaking technologies combined with energiron, blast furnace and syngas. H. Ichikawa, T. Nakayama, P. Duarte, A. Martinis
In 2013, Nippon Steel & Sumikin Engineering Co., Ltd. (hereafter referred to as NSENGI), Tenova HYL and Danieli have entered into an agreement to combine ENERGIRON DR technology into blast furnace technology and/or with syngas technologies. This new alliance will allow the three companies to combine research and development activities with their respective expertise in ENERGIRON DR technology, Blast Furnace technology and Syngas (by-pro gas and coal gasification) technology, with the ultimate objective to develop breakthrough iron making technologies and create such EPC projects. This paper introduces the concepts and the features of our breakthrough technologies of combining of ENERGIRON DR technology, Blast Furnace technology and Syngas technology.

New technology of taphole mix for blast furnace to prevent the hot spot on the hearth wall. A. Ribeiro, H. Bassalo, P. Mandaj Filho, A. Ollmann, G. dos Santos, C. Assis, M. Nonato (in Portuguese)
To maintain and extend the blast furnace campaign it is important to check, control and stabilize the temperature of the hot spots on the blast furnace hearth wall. It is well known some practices to control the hot spots including the use of titanium oxide in the burden lump ore and the injection of synthetic titanium oxide through tuyeres to prevent the wear on the hearth wall by creating a protective layer composed by titanium carbonitride. This paper presents a new taphole mix for blast furnace containing synthetic titanium oxide to prevent the hot spot incidence on the hearth wall close to the taphole.

Developments in Ironmaking - overview of ArcelorMittal Flat Carbon South America. J. de Oliveira, F. Donelias, J. de Faria, E. dos Santos, E. Harano (in Portuguese)
The South America Steel Industry is being challenged since the last 2008 financial crisis, as the others plants around the world. The scenario of ferrous raw material continuously
being downgrading and the necessity to reduce production cost to be competitive, providing that around 70% of crude steel cost is related to hot metal, is in the opposite direction and makes the challenge be tougher. To operate a blast furnace with high coal injection (more than 180 kg/t of HM) and low fuel rate (less than 490 kg/t), facing the slag rate increasing due to raw material downgrading as mentioned before (~300 kg/t) is mandatory to have operational stability through good operational practices supported by an adequate reliability centered maintenance (RCM). The aim of this lecture is to show the main ongoing actions at ArcelorMittal Tubarao in order to achieve such.

Development of wear and hot corrosion resistant materials applied to sintering grates. I. Teixeira, E. Albertin, F. Marques (in Portuguese)
Grates are mobile background parts used in sectors of sintering machine strands. Various materials have been used in the manufacture of such parts ranging from heat resistant and stainless steels to high chrome cast iron. Their control parameter in service is either the weight loss or thickness reduction of the grates. The need to increase the operating output of sintering over the years has increased the replacement of grates, impairing sintering productivity. Thus, the suitability of abrasive wear resistance and the minimization of microstructural change in service of the mechanical components from these materials have been the target in the development of materials for such applications. The development of materials used in sintering grates is discussed in this paper, aiming to increase their useful life, based on laboratory tests involving abrasive wear, hot corrosion and thermal fatigue in five alternative alloys. Among the alloys evaluated, the material with ferritic matrix alloyed with elements that forms stable carbides at elevated temperatures and thinner corrosion product layer showed better results. This led to a perspective of increasing the useful life around three times the life in the current condition.

Iron ore pellets represent a significant proportion of the transoceanic market of iron ore, in which companies that operate in Brazil represent an important part. Pellets compete favorably with lump iron ore and sinter in the metallic charge in furnaces, in particular because of their high resistance to degradation during handling and transportation. However, pellets still suffer from this problem, which results in the generation of fines, which are removed before feeding the furnace, or fragments, which can result in the appearance of clusters in the direct reduction furnace. These damaging effects of degradation could be addressed if a proper methodology for pellets and a simulator were available. The present work deals with the development of a novel and innovative methodology for predicting results from pellet degradation, from the pelletizing plant to the steel mill. It was developed as part of a collaboration between the Laboratório de Tecnologia Mineral from COPPE/UFRJ and Samarco Mineração. The work also shows a preliminary validation of the model made on the basis of multiple drop tests conducted in the laboratory, showing very good agreement. A process simulator was developed, which allows inserting the characteristics of the pellets produced, as well the handling flowsheet, allowing to predict the intensity of degradation that will occur in practice.

Influence of gas flow distribution as an approach to the blast furnace hearth phenomena. A. Hirano, B. da Silva, F. Fujihara (in Portuguese)
ThyssenKrupp CSA Blast Furnaces are 3000m³ class furnaces that have an unique profile configuration, which imposes different understandings of hearth conditions. Thereby liquid flow in the hearth has great influence on transport phenomena and fluctuations on the burden descent. Thus, unusual flow should be evaluated in order to control
temperatures and wear. The understanding of these effects is very important to the BF performance and life spam. Therefore, measures to change the philosophy of burden distribution were taken with a focus on control of peripheral flow. This paper shows a brief hearth phenomena review and the results noticed at TKCSA’s Blast Furnaces.

**Theoretical and practical fundamentals description for blowdown on blast furnace 03 of ArcelorMittal Flat Carbon South America.** F. Sathler, R. do Nascimento Junior, C. da Costa, E. Ribeiro (in Portuguese)

Through the effects of seasonality steelmaking market, periods of crisis, besides requirements of equipment repairs, Blast Furnaces are eventually submitted to prolonged stoppages. This activity can be accomplished by a specific procedure named as Blowdown, controlling burden descent until tuyeres for subsequent cleaning and repairs. Operational activities must be correctly planned and executed to guarantee successful Blowdown. Therefore, technical information and operational experiences established the theoretical concepts and plan for Blowdown execution at Blast Furnace 03 in ArcelorMittal FSCA (Tubarão). For preparation, it was improved peripheral flow (skull removal) and hearth permeability (liquids circulation and drainage). Also, it was made preparation of specific equipment and control of operating parameters. The burden lowering was appropriately performed as planned until burden reaches tuyeres elevation, and allowing efficient cleaning of inner walls.

**Application of conveyor belt guidance system and its benefits.** A. Pereira (in Portuguese)

The constant search for the continuous increase of the production and the reduction of the non-programmed stops on belt conveyor has generated a demand for intelligent equipment able of correcting constant problems of misalignment of CBs. The methods that we currently use to correct this problem are mainly passives, which makes impossible a more direct, precise, automatic and effective intervention in the positioning of the belt. This publication describes the functioning and the results achieved with the integration of the Conveyor Belt Guidance System, or only CBGS, in an iron ore belt conveyor with an extensive track record of misalignment. Therefore, the main line of this article shows through practical example the advantages and measured gains by applying the Conveyor Belt Guiding System.

**True hearth lining wear as blast furnace campaign extension tool.** J. Houde, R. Hebel, A. de Oliveira

The Blast Furnace Campaign lifetime is highly depending on the wear progress of the hearth lining. This progress is monitored in general through single and double thermocouples at the cold side of the lining. This type of monitoring becomes ineffective as soon as heat resistance will be formed in the refractory lining. Paul Wurth’s monitoring system, consisting of MTP-Sensor and Heat Flux Probes, is able to identify such heat resistances to give a true hearth lining wear. Since last year Paul Wurth is also able to install safely those MTP-Sensor and Heat Flux Probes on running blast furnace without salamander tapping, thanks to a newly developed cooled core drilling device. Blast Furnaces that are equipped with Paul Wurth’s monitoring system have optimized their campaign lifetime as they received right information upon the true wear lining such as detection of heat flux transfer failure, detection and monitoring of brittle layer or detection of hot spot.

**METEC & 2nd ESTAD, June 2015**

**New Sinterplant #2 at Bhushan Power and Steel Limited.** R. Yadav, R. Pattajoshi, M. Hoffmann, K. Kinzel, G. Nouaille-Degorce, J. Santamaria

Bhushan Power and Steel Limited has decided to build a 450m2 Sinter Plant with a capacity of 4.8 Mtpa in Rengali, Odisha, India. The plant is designed to feed their New Blast Furnace #2 having a capacity of 2015 m³ and the future Blast Furnace #3 also with
a capacity of 2015 m³. The contract for engineering and supply of major plant
equipment for the Sinter Plant was awarded to Paul Wurth and became active in June
2014. The plant is designed as a state of the art sinterplant. High intensive vertical mixer
and nodulizer from the company Eirich are installed in the raw material preparation
area. The sinter strand charging includes the hearth layer charging and is enhanced
with the use of multi-roller technology. Homogenous ignition is ensured by the use of
ignition hood with 2 rows of vertical burners. The annular sinter cooler is featuring the
Paul Wurth rigid ringframe construction which solves the centering problems of
conventional annular coolers, reduces the leakage rate of cooling air and increases
the cooling efficiency. The entire plant process is controlled by the Paul Wurth
developed and supplied SinterXpert Level 2 automation system. Paul Wurth is in charge
of the basic engineering of the plant, as well as selected detail engineering and the
supply of the key components. Paul Wurth is assisting BPSL in the selection, auditing and
technical clarification of the suppliers of remaining equipment, as well as in vetting the
detail engineering performed by BPSL’s subcontractors. Finally Paul Wurth will perform
supervision on site during erection and commissioning of the plant. For strategic
reasons, the project is split into a separate engineering and supply/erection stage. At
this moment the engineering phase is in an advanced stage, with the basic
engineering completed and the detail engineering in good progress. Selection and
technical discussions with the main suppliers is ongoing under the assistance of Paul
Wurth. Fabrication of key equipment has started, with the first deliveries foreseen for
end of 2015

**Hot repairs of hot blast stoves of ArcelorMittal Gent.** F. Van De Velde, T. Van Acker, A.
Daelman, M. Gantenberg, E. Schaub, R. Allmannsdörfer, M. Hilt
Sometimes hot blast stoves suffer from damages in the lower part of the combustion
chamber and the ceramic burner. This is attributed to different reasons. Repairs in this
area normally require the controlled cooling down and heating up of the hot blast
stove after the repair. This is time consuming and the BF has to be operated typically
with a lower performance with the remaining hot blast stoves during this period. In order
to minimize the repair time and with this the impacts on the BF operation, a repair with
local cooling down of the affected areas could be carried out while the other parts of
the hot blast stove remain on high temperatures. ArcelorMittal Gent discovered
damages in these areas of their BF A and BF B hot blast stoves with internal combustion
chamber and decided to carry out a hot repair of these areas together with PAUL
WURTH. The paper describes the background of these repairs, the procedures and the
positive results after commissioning of the stoves, repaired by this method.

**Dome repair of external combustion chamber hot blast stoves.** M. Gantenberg, E.
Schaub, R. Allmannsdörfer, M. Ngassam
Hot Blast Stoves belong to the most important parts in the Blast Furnace process.
Consequently requirements regarding reliability for the hot blast stove are very high and
failures of the stoves lead typically to significant production losses of the Blast Furnace
itself. Hot blast stoves with a so called dome connection pipe – original design of Krupp
Koppers (KK) to overcome the vertical expansion of combustion chamber and checker
shaft – are often facing problems with this dome connection pipe. The design of these
stoves comprises two chambers for combustion and checkers and a connection pipe
between the two domes. In order to overcome the differential thermal movement
between the two chambers the dome connection pipe is equipped with two
expansion bellows. Due to the weakness of these expansion bellows and their position in
the area of highest temperatures and biggest differential movements this area is known
to be critical in regard to hot spots and failures of the bellows themselves. In order
to increase the reliability of such stoves Paul Wurth Refractory & Engineering GmbH
(PWR&E) developed a system to replace these domes by the proven Paul Wurth dome
design. This paper describes the background of dome replacements, some details of
the engineering, some details of the work to be carried out on site and shows the positive results after commissioning of stoves, repaired by this method.

China’s Refractories, July/September 2014
Mathematical model of hearth and bottom erosion in blast furnace. Li Hengxu, Che Yurnan, Zhou Zhe, Wang Qi, Wang Hongtao
Furnace lining erosion is closely related to the operation stability and safety. The detection technology for hearth lining thickness of blast burnace was introduced. By using the data of thermocouples installed in the bottom of furnace hearth, a mathematical model of erosion was established; the real state of the hearth and bottom erosion was studied; the erosion condition was followed, serving for the furnace longevity.

Corrosion resistance of Al₂O₃-C materials to oolitic-hematite reduction melt. Yang Dabing, W Ang Xiong, Ding Baocheng, Xu Jiaxin
Al₂O₃ - C specimens were prepared using fused corundum and flake graphite as starting materials, SiC as antioxidant, and phenolic resin as binder to research their corrosion resistance to oolitic-hematite reduction melt. The tests of slag penetration and corrosion were carried out by static crucible method. The corrosion resistance was presented by the corrosion area and penetration depth. The corroded specimens were investigated by XRD, SEM and EDS. The results show that : ( 1 ) the corrosion resistance of Al₂O₃ - C materials to oolitic-hematite reduction melt is improved obviously by the addition of SiC ; ( 2 ) with the rising of reduction temperature and the prolonging of reduction duration, the corrosion area and penetration depth both increase rapidly; ( 3 ) the corrosion mechanism of the oolitic-hematite reduction melt can be described as that the melt reacts with Al₂O₃ – C materials forming some low melting compounds such as CaO Al₂O₃, 2 SiO₂, CaO : 2 Al₂O₃, and Fe₂SiO₄.

Influencing factors of properties of castables for hot blast stove pipes. Wei Facan
In order to prolong the service life of castables for hot blast stove pipes, effects of SiO₂ micropowder addition and aggregate kind on properties of castables for hot blast stove pipes, and properties of silica sol bonded castables were researched using homogenized bauxite, andalusite particles, andalusite fines, white fused corundum fines, α-Al₂O₃ micropowder, pure calcium aluminate cement, SiO₂ micropowder, and silica. sol as starting materials. The results show that : ( 1 ) as SiO₂ micropowder addition increases, the shrinkage rate of fired specimens increases ; BD increases firstly, reaches the highest at 4 mass% , and then decreases ; CMOR and CCS of all specimens increase gradually; so the appropriate SiO₂ micropowder addition is 4 mass% ; ( 2 ) the specimens with bauxite aggregate have better CCS and volume stability, but specimens with andalusite aggregate have better thermal shock resistance ; ( 3 ) for castables for hot blast stoves wing silica sol as binder, the addition of pure calcium aluminate cement can decrease the linear change rate after treatment at 1 400 °C and can slightly enhance CCS and CMOR, but has very little influence on AP and BD; and the introduction of citric acid worsens the thermal shock resistance of specimens.