metallon
Asistencia técnica y capacitación

LIBRARY SEARCH ON PRODUCTION OF FERROMANGANESE IN BLAST FURNACE

Number of references: 20

1) Technical progress of blast furnace ferromanganese production in China. Tangke Zhang. The Proceedings of INFACON VIII, Beijing, China, June 1998.

The reason for the fast development of Blast Furnace Ferromanganese production in China has been analysed in this paper. The author, based on his brief summarization for the technical progress of blast furnace FeMn process, has given forth some suggestions for the further improvement of the said industry after practically studying the situations faced by the blast furnace FeMn producers.

2) Studies on production of high carbon Ferromanganese in Blast Furnace with high proportion of sinter and improvement in manganese recovery. XIaoxing Xiong, Daolin Liu. The Proceedings of INFACON VIII, Beijing, China, June 1998.

In connection with the characteristics of domestic and imported Mn ores and the acural condiciotns of Xinyu Co., tests on HC FeMN blast furnace production with high proportion of sinter were made. Results from tests shown the feasibility of FeMn production with high proportion of sinter up to 100% and the smooth operation with improved technical and economical indexes.

3) Ferromanganese production - process understanding. Olsen, S E; Lindstad, T; 60th Electric Furnace Conference; San Antonio, TX; USA; 10-13 Nov. 2002.

High carbon ferromanganese is commercially produced by carbothermic reduction of manganese ores. The primary application of manganese is in the steel industry. In the making of ferromanganese two different types of processes are in use, the blast furnace and the electric submerged arc furnace. In the blast furnace the coke serves as reducing agent as well as energy source, whereas in the electric furnace the coke is only used for reduction. Blast furnace production requires about four times as much coke as the electric furnace production. Blast furnace production is still practised to some extent where the cost of electric energy is high compared to that of coke.

4) Carbothermal Solid State Reduction of Manganese Ores: 1. Manganese Ore Characterisation. Ring Kononov, Oleg Ostrovski, Samir Ganguly. ISIJ International, Vol. 49 (2009), No. 8, pp. 1099–1106

The South African Wessels and Australian Groote Eylandt manganese ores were characterized using XRD, optical, SEM and EPMA analyses. Two grades of Groote Eylandt ore were examined, one of them contained a high concentration of silica, 34.4 mass%. Wessels ore had high iron oxide and calcia content, and low concentration of silica. Major manganese-containing phases were bixbyite, braunite, manganite and hausmannite in Wessels ore, and pyrolusite in Groote Eylandt ore; both grades of Groote Eylandt ore contained silica inclusions. In the process of sintering in air and argon at 1 000°C, $MnO2$ was reduced to $Mn2O3$ and $Mn3O4$, while in sintering in hydrogen manganese oxides were reduced to MnO and iron oxides to metallic iron. In the process of sintering of high-silica Groote Eylandt ore at 1 200°C in inert atmosphere, tephroite was formed which was partially decomposed to rhodonite and MnO with increasing sintering time to 30 min. In the ore sintered at 1 200°C in hydrogen for 1 h, major phases identified by XRD analysis were MnO, silica and tephroite.

5) Mathematical modelling of blast furnace process at smelting of non-traditional raw materials. Yu.A. Chesnokov, A.N. Dmitriev. 2007

The offered balance logic-statistical model of blast furnace process is based on use of the material and thermal balances added with calculations of heat- and mass exchange taking into account non-uniformity of gas and burden distribution on radius of the furnace and characteristics of the basic metallurgical characteristics of iron ore raw materials and coke on indices of blast furnace operation. For check of applicability of model the calculations on the most critical parameters of blast furnace process – smelting of ferromanganese and iron nickel with graphic representation of heat- and mass exchange processes, dynamics of oxides reduction on height and radius of blast furnace have been carried out.

6) Production Test of High-Carbon Ferromanganese Using a Shaft Furnace With Coke Packed Bed Injected With Highly Oxygen Enriched Air and a Large Quantity of Pulverized Coal. Kamei, Y; Miyazaki, T; Yamaoka, H. ISIJ International (Japan). Vol. 33, no. 2, pp. 259-266. Feb. 1993.

High-carbon ferromanganese has been produced by electric arc furnace in Japan. But its production cost has increased because of a speedy rising of electricity cost and Japanese ferromanganese has lost competitiveness in the international market. So, for the purpose of decreasing its production cost, high-carbon ferromanganese production tests (production rate = 1.9-4.3t/d) were performed using a melting tests furnace with coke packed bed injected with highly oxygen-enriched air and a large quantity of pulverized coal. Moreover the operation indices of a commercial plant of 170t/d in production capacity were estimated by heat and mass balance model, and following results were obtained. (1) In this test, high-carbon ferromanganese of [Mn] = 75% was produced stably using the coke blended with 56% non-coking coal, with coal rate of 1087 kg/t and productivity of 3.11 t/(d.m exp 3). (2) The total coal consumption of the commercial plant of this method is estimated to be less than that of the blast furnace in spite of higher fuel rate because a large quantity of pulverized coal is used in this process. Through these investigations, this process seems to have a prospect of being available as a ferromanganese production process instead of electric furnace method.

7) Direct Reduction of Mixtures of Manganese Ore and Iron Ore. Karla Ohler-Martins, Dieter Senk**.** steel research int. 79 (2008) No. 11 811-816

This paper presents recent results of direct reduction investigation of different combination of blends of manganese ore, iron ore and coal at the Department of Ferrous Metallurgy (IEHK) of RWTH Aachen University. A mixture of iron and manganese ore in a ratio of 75/25 is a good raw material for steelmaking of high Mn-alloyed grades. The experimental studies consisting of reduction of (a) fine material and (b) agglomerated material (briquettes) were carried out in the range of 1273 to 1673 K. The behaviour of combined reduction of manganese ore and iron ore and the employment in the direct reduction on a coal and gas basis for production of steels with high Mn content were investigated. It was found that a high metallization degree for Mn can be reached at 1273 K with the reduction of manganese ore by hydrogen-containing gas. Addition of carbon monoxide to the reducing gas retarded the reduction process. The addition of coal to manganese ore and iron ore blends increased the degree of reduction. The results of carbothermic reduction of briquettes consisting of a mixture of manganese ore and iron ore combined with coal as reducing agent show that a high temperature, a low Mn/Fe ratio and a high Fe_2O_3 content have a favourable effect on the degree of reduction. In order to obtain a high degree of metallization, the temperature should be higher than 1473 K. The reduction of briquettes at higher temperatures (up 1573 K) has shown a molten phase and the separation of slag and metal.

8) Carbothermal solid state reduction of manganese ores. R. Kononov, O. Ostrovski, S. Ganguly. INFACON XI, 2007, India pp. 258-267.

Carbothermal reduction of manganese oxides and manganese ores in the solid state was studied in hydrogen, helium and argon at different temperatures, ore compositions and carbon to manganese oxide ratios. Wessels ore (South Africa) and two grades of the Groote Eylandt ore (Australia) with different level of impurities were examined. Ores were characterised by XRD, X-ray fluorescence, optical microscopy and scanning electron microscopy. Isothermal and temperature programmed carbothermal reduction experiments were conducted in a fixed bed reactor in a vertical tube furnace, with on-line monitoring of gas composition by the CO-CO_2 infrared sensor. The reduced samples were characterised by XRD, SEM and LECO analyses. Extent of reduction was calculated using data on the off-gas composition, and LECO carbon and oxygen contents in the reduced sample. Manganese oxides in the ore were reduced to a-Mn and carbides $Mn_{23}C_6$ and Mn_7C_3 depending on the carbon to ore ratio. The reduction rate of manganese ores in hydrogen was higher than in helium and argon.

9) An investigation into aspects of liquid phase reduction of manganese and silica containing slag. S. Gaal, K. Berg, G. Tranell, S.E. Olsen, M. Tangstad. VII International Conference on Molten Slags Fluxes and Salts, The South African Institute of Mining and Metallurgy, 2004.

In this study, the reduction behaviours of MnO and SiO2 containing slags by solid carbonaceous materials was investigated in both small and larger-scale laboratory experiments. Five types of carbonaceous material were investigated: 2 graphite, industrial coke, anthracite and eucalyptus charcoal. The effects of the reductant type/properties on the reduction kinetics, metal composition and metal yield, have been quantified. Results show that the reduction rate is highly dependent on the type of carbon used. It was found that the reductant type significantly influenced the SiO2 reduction while it did not seem to have a large effect on the MnO reduction. This may be due to the different CO2 and SiO reactivities of the materials.

10) An overview of current manganese and chromium ferroalloy production in Russia. L.A. Smirnov, V.I. Zhuchkov, E I. Arzamastsev and A.A. Babenko. INFACON X, Cape Town, South Africa, 2004.

A brief analysis is given for state-of-the-art of manganese and chromium ferroalloy production in Russia and their consumption by metallurgy plants. The main causes of low output of manganese and chromium ferroalloys, and ways to resolve the issue of ferroalloy production development are considered.

11) Development of a New Ironmaking Process. VI. Smelting Tests on High-Carbon Ferromanganese. Miyazaki, T; Yamaoka, H; Kamei, Y. Trans. Iron Steel Inst. Jpn. Vol. 27, no. 1, pp. B-3. Jan. 1987.

The melting furnace of the new ironmaking process is suitable for producing ferroalloys because it is easy to expand the high temperature region for smelting reduction by use of oxygen and pulverized coal. Therefore, smelting tests on high-carbon ferromanganese were performed at the pilot plant, and a commercial plant was designed on the basis of the test results.

12) Spiegeleisen manufacturing. Hartmann, H. Geological Report, pp. 71-101.

In this old paper, the Spiegeleisen production is discussed from the point of view of the United States. Manganese ore specifications, blast furnace design and operating practice, as well as metal obtained, are discussed in detail for Russia, Sweden and Germany.

13) Technology for blowing in a blast furnace on ferromanganese. Skuridin, F L; Shepilov, S V; Paren'kov, A E; Yusfin, Yu S; Karabasov, Yu S; Paren'kov, S L; Kosyrev, K L; Bodyagin, E A; Usachev, A B; Mikhin, I V. Metallurgist (USSR). Vol. 50, no. 1-2, pp. 12-14. Jan.-Feb. 2006

When a blast furnace is planned to be blown in on ferromanganese after a class I overhaul, it is necessary to choose the type of pig iron that is to be obtained in the initial taps. Blow-in is usually done on foundry iron, with the furnace then being changed over to ferromanganese during a 2-3-day period. A new method has been developed for blowing in blast furnaces on ferromanganese, the method making it possible to quickly (in no more than 1 day) obtain an alloy with an Mn content up to 70-75% by gradually increasing the concentration of this element.

14) Making blast-furnace ferromanganese with the use of fluxed manganese-bearing sinter. Mischenko, M; Varava, V I; Bondarenko, N M; Malkin, V I; Krizhevskii, A Z. Metallurgist (USSR) (USA). Vol. 44, no. 9-10, pp. 522-526. May 2001.

Blast-furnace production of ferromanganese using a charge of unfluxed and unagglomerated manganese-bearing concentrates (fines 0-5 mm content 40-50%), degrades the production process, consumes excessive coke and results in poor quality. Significant increase in manganese production and decreases in coke consuption might be expected from a charge in which raw manganese concentrates and fluxes are replaced by fluxed manganese sinter. A laboratory dish was used to sinter Mn-bearing oxide concentrate, the fuel consisting of coke fines and the flux was limestone. Results of the laboratory studies showed that coke consumption decreased and the sinter was coarsened, so a commercial batch of 15,000 tons was prepared on a sintering machine from ungraded Mn concentrate as currently used in raw concentrate to make ferromanganese. Sinter made from Bogdanovsk manganese deposits showed improvement (reduced) coke consumption but there wasn't corresponding improvement from the Kamysh-Burunsk sinter. The authors conclude that it is possible to improve the production indices in the blast-furnace production of ferromanganese by adding fluxed manganese sinter to the charge. The abstractor believes the data didn't show much improvement since the fines weren't coarsened by the blast-furnace treatment and the quality of the ferromanganese was closely linked to the source deposits of the the Mn concentrate. Obviously the Ukraine needs manganese, but it doesn't seem like this process will get the job done.

15) Saving power and raw materials in melting ferromanganese in blast furnace. Martynov, V I; Varava, V I; Nekrasov, G E; Shepilov, S B; Popov, O I; Ledovskikh, L V; Brusenko, S V. Metall. Vol. 10, pp. 22. Oct. 1995.

Ferromanganese melting technology was developed and tested under industrial conditions in blast furnaces. The technology proposed assures the total utilization of hot blowing, a decrease of coke consumption and manganese losses. In addition, a phosphorus content in final ferromanganese decreased from 0.45 down to 0.35%. These parameters were attained due to the introduction of 20-40% iron-manganese concentrates into the charge materials.

16) Efficient Blast Regime in the Product of Blast-Furnace Ferromanganese. Kozhemyachenko, Y U N; Pervushin, S I; Varava, V I. Metallurg , no. 12, pp. 9-11. Dec. 1987.

The special features of ferromanganese blast-furnace operation are considered with special reference to the influence of blast factors, such as temperature and oxygen content, on the theoretical combustion temperature. Operating results for a blast furnace with a daily output of about 500 t ferromanganese are compared for two periods with differing blast factors, and the corresponding heat are given and discussed. Optimisation of blast factors enabled waste evaporation of Mn and Si to be reduced, Mn utilisation improved, productivity raised and coke rate to be lowered.

17) Making ferromanganese in blast furnaces. Mulko, G N; Bondar, A A; Zaitsev, V A; Nitskii, E A; Cherkasov, E G. Metallurgist (USSR) (USA). Vol. 44, no. 1-2, pp. 51-55. Sept. 2000.

The blast furnaces at NOSTA are used for making foundry pig irons and were not designed for making ferromanganese (so ferromanganese production is difficult and inefficient). Ores containing mixed manganese oxides are reduced to manganese oxides with greater heat requirement than the reduction of iron oxides to iron. The reduction of MnO at high temperatures forms silicates which must be extracted by adding lime to maximize Mn content by producing calcium silicate. To attain high Mn content in the alloy the Fe content should be minimized (Mn/Fe ratio > =10). The ore should not be finer than 8 mm or coarser than 100 mm because only 75% of the Mn is reduced in a blast furnace while all of the iron is reduced. Coarser Mn fractions have substantially higher Mn contents, so fines should be avoided (to minimize coke consumption and decrease furnace productivity). Not all the Mn enters the pig iron since some Mn remains in the slag as MnO and some is volatilized (as discussed and described in detail in this article). To improve ferromanganese production it is recommended to remove the Mn concentrates finer than 20 mm, keep the Mn/Fe ratio above 6, avoid mixing manganese ores with other materials, scrub the blast furnace with blast furnace and welding slag to precede the ferromanganese production run of no more than five days a month.

18) Slag compositions for ferromanganese making blast furnaces. Bi, X; Zhou, S; Wu, S; Xi, G. Ironmaking and Steelmaking (UK). Vol. 20, no. 6, pp. 476-481. 1993.

The effects of slag chemical composition and reaction temperature on MnO reduction by carbon were studied both in the laboratory and at a ferroalloy plant. Appropriate slag compositions and furnace thermal level for the optimum performance of the blast furnace were determined. The viscosities of slags having different chemical compositions were measured in the laboratory. The determination of appropriate slag compositions is very important for a high rate of recovery of manganese metal and the smooth operation of ferromanganese making blast furnaces.

19) High-Productivity Operation of Shaft-Type Ferromanganese Smelting Furnace. Suzuki, S; Masukawa, M. INFACON 6. Vol. I. Ferroalloys; Cape Town; South Africa; 1992. pp. 149-154.

The ferromanganese smelting process at Mizushima Ferro Alloy Company Ltd. was changed from electric-furnace operation to use of a shaft type of smelting furnace (SF) in an attempt to reduce operating costs. The SF began blow-in in June 1985, and has operated satisfactorily since then. Several operating technologies have been established, including a burden-distribution control method. The SF has an inside volume of 398 m3, and a designed maximum productivity of 270 t/day of ferromanganese. The SF continued normal operation (less than the design maximum productivity) from 1985. From 1988, owing to the increasing demand for ferromanganese, the productivity of the SF was increased through several improvements to the operation. In August 1988, production reached 287 t/day. Oil injection was started in June 1989, with the aim of increasing the production still further by means of oxygen enrichment of the blast air, compensating for the theoretical flame temperature in front of the tuyeres. The oil-injection rate is 53 kg/t, and the O enrichment is 10.9%. The replacement ratio of oil with coke is approx 1.0. By oil-injection and high O enrichment, the productivity of the SF has been increased by 25 t/day over the productivity before the adoption of oil injection.

20) Comparison between the Calculation of Slag-Metal Equilibrium and Measured Characteristics in a Ferromanganese Blast Furnace. Bloise, R. Mem. Etud. Sci. Rev. Metall. Vol. 86, no. 4, pp. 245-249. Apr. 1989.

A calculation model of the metal--slag equilibrium is presented in relation to the production of ferroalloys with Mn addition. Properties of the slag phase are estimated from a model developed by IRSID, those of the metal phase using the model of central atoms proposed by E.H. Foo and C.H.P. Lupis (Acta Metall. , 1973, 21, 1409). In spite of simplifications, the calculated results correlate with those measured on blast furnaces.