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掲載記事概要

Preparation and Beneficiation

Effect of reduction rate on the swelling behaviour of iron ore pellets
By T. SHRMA *et al.*

In the present investigation an attempt has been made to determine the effect of reduction rate on the swelling behaviour of iron ore pellets. For this purpose two Indian iron ore fines from Bailadila and Noamundi deposits and chemically pure iron oxide were used. The effects of parameters like, temperature, time, reducing gas partial pressure and flow rate have been studied.

From the results obtained, it has been observed that swelling of iron ore pellet is controlled by the rate of reduction of iron oxide. The growth of iron whiskers is also controlled by reduction rate.

Sintering properties of iron ore mixes containing titanium
By N. J. BRISTOW *et al.*

Titanium containing compounds are valuable materials for addition to the blast furnace to extend operational campaigns. However, the addition of these materials via the sinter plant has been known to create problems. This study investigates the effect of adding a titanomagnetite to two sintering ore blends, containing 10 and 20% pisolitic limonite respectively. The addition of up to 2% titanomagnetite did not affect the sintering parameters or sinter quality. Increasing the titanomagnetite levels to greater than 3% also had no significant influence on sintering but a significant deterioration in sinter RDI was recorded. Results also showed that the deterioration in RDI was greater for greater for the blend containing more pisolitic limonite.

SEM studies carried out on the product sinters found most of the titanium in the glass phase. The mechanical properties of the glass was characterised using indentation fracture mechanics. Although some difficult was experienced, due to the small and disperse nature of the glass, addition studies using artificially manufactured glass indicated that the fracture toughness of the glass decreased with increasing titanium levels. It is postulated that because glass is the weakest phase in sinter and is widely dispersed any reduction in its fracture toughness will increase the vulnerability of the sinter to crack propagation, thereby increasing sinter RDI. It is also postulated that increasing the pisolitic level increased melt formation and the dispersion of the glass phase, resulting in a further deterioration in sinter RDI.

Measurement and modeling of thermal conductivity for dense iron oxide and porous iron ore agglomerates in stepwise reduction
By T. AKIYAMA *et al.*

緻密で純粋なヘマタイト、マグネタイトおよびウスタイトの熱伝導率をレーザーフラッシュ法を用いて測定した。これらの値は基礎的熱物性値として重要であり、 $k=1/(AT+B)$ の経験式の形で整理できた。格子欠陥のため、ウスタイトの熱伝導率は他の酸化鉄に比べ小さく、温度依存性も小さかった。3つの酸化鉄の伝熱抵抗 $1/k$ の温度依存性は、タンマン温度を境に2つの直線で記述可能であった。

CO-CO₂ および H₂ ガスにより、マグネタイト、ウスタイトおよび金属鉄まで還元した焼成ペレット、非焼成ペレ

トおよび焼成鉄の有効熱伝導率を、室温から 1273 K までの温度範囲で系統的に測定した。還元率の進行にともない気孔率は 20 から 62% まで増加したため、測定された有効熱伝導率は緻密で純粋な試料にくらべかなり小さい値であった。金属鉄およびヘマタイトの有効熱伝導率は、ウスタイトに比べ強い温度依存性を示した。試料の還元率にともない、有効熱伝導率は減少しウスタイトで最小値を取り、再び金属鉄で 5~10 倍に増加した。しかし、1273 K における段階還元処理により生成した、マグネタイト、ウスタイトおよび金属鉄状態では試料間の相違は小さくなった。

修正単位胞モデルにより得られた測定データをうまく説明することができた。このモデルでは、固相は核と連結部は 2 つから構成されると仮定し固体の連続性に注目するため、従来の気孔率のみに基づくモデルとは異なり、塊成化プロセスや還元率の相違から生じる固体構造の差異をより定量的に評価することができた。

Process characteristics of a commercial-scale oxygen blast furnace process with shaft gas injection

By Y. OHNO *et al.*

シャフト部への予熱ガス吹込みを特徴とする新しい酸素高炉プロセスを開発した。プロセスの開発にあたって、試験高炉を用いた試験操業を行い、このプロセスが銑鉄製造プロセスとして適用できることを実証した。数学モデルによるシミュレーションも行い、商用規模でのプロセスの特性を、熱風送風の高温プロセスとの比較の上で明らかにした。

試験高炉操業の解析および数学モデルによるシミュレーションから、このプロセスは以下の特徴を持つことが判った。(1) 装入物の昇温と還元は予熱ガス吹込みにより炉全体にわたって確保される。(2) 低燃料比を実現する予熱ガス吹込みの適正条件は、炉上部での熱流比が 0.74-0.90 となる予熱ガス量で、予熱ガスの温度は 600-1200°C である。(3) 予熱ガスの組成の影響は小さい。(4) 予熱ガスの吹込み位置は熱交換が確保される範囲でシャフト上部が適している。(5) 実操業での燃料比の範囲は広く、500 kg/t (予熱ガス吹込み有り) - 1200 kg/t (予熱ガス吹込み無し) である。

Smelting and Refining

A mathematical model for thermal tracking and on-line control in continuous casting
By K-H. SPITZER *et al.*

A mathematical model has been developed to calculate the three dimensional and instationary temperature field in the strand during continuous casting. The numerical algorithm and the computer program were tested by application to the Neumann problem for which an analytical solution is available. It was found that this analytical solution is reproduced quite closely even if relatively coarse finite difference meshes are used. An algorithm based on the solution of the inverse heat conduction problem is applied to adjust the heat transfer coefficients for the computer model using the results of surface temperature measurements. Another algorithm was developed to calculate the material data from the steel composition. This algorithm is applicable to steel grades with low contents of alloying elements. The model fulfills the requirements concerning computing time consumption and accuracy for an on-line application. Results obtained with the model which is installed at several casters are presented.

Microstructure

The effective viscosity and effective diffusivity of bubbles in an air-water vertical bubbling jet
By M. IGUCHI *et al.*

底吹き円筒容器内の気泡噴流部における液体の有効動粘