Material Classification of Basic Oxygen Steel Furnace Slag (SFS) - Inert

Steel Furnace Slag

Steel Furnace Slag (SFS) is produced in the process of refining molten iron and recycled steel in the presence of oxygen and fluxes to produce steel and molten slag in a Basic Oxygen Steelmaking Vessel (BOS).

The lime in the charge melts and fluxes silicates and phosphorus from the molten steel to form slag, while the oxygen blown in reduces the carbon level. At the completion of the blow, slag is drained from the vessel after the steel is tapped. Some molten steel is drained, along with the molten slag, to ensure that no slag inclusions remain in the steel product.

Figure 1 **Basic Oxygen Steel Making Vessel**

Directed into pits adjacent to the BOS plant, molten slag (and residual molten steel) flows out from the point of pouring in comparatively thin layers, depending on the dimensions of the receiving pits. SFS solidifies in a similar manner to lava from a volcano. Its structure is best described as a solid solution of oxides.

As described above the molten slag is accompanied by residual solidified steel (metallics), and when cooled it is excavated by front end loader from the slag bays and transported by road to a metallic separation, crushing and screening plant. Metallics are removed and recycled as ferrous feed or scrap to the iron and steel making processes of the steelworks.

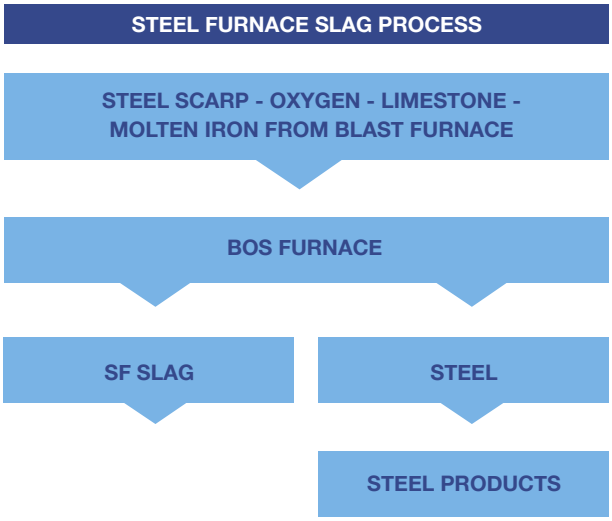

Figure 2 **Steel Furnace Slag Process Streams**

After the separation of metallics, the slag material is transformed into a range of products by conventional crushing and screening processes.

Quality Systems

From the selection of the raw materials to produce the molten iron & selection of recycled steel (scrap) through to the finished aggregates or fine materials, slag products are controlled by a range of quality systems.

Figure 3 **Steel Furnace Slag Aggregate**

These systems include: composition determination prior to production, process and chemical monitoring during and post production. Molten slag chemistry is an important control factor in the production of molten steel. Slag cooling regimes and materials handling (including stockpile management) are carried out under the slag processors quality systems. Aggregates and fine materials are produced to comply with relevant Australian Standards and/or customer requirements.

Figure 4 Steel Furnace Slag use in road construction

Environmental Classification

Whilst slag products are produced, marketed and sold on a commercial basis (equal to virgin raw materials), from an environmental classification perspective, slag is deemed to be 'waste' in most States of Australia.

State Environmental legislation typically deems by-products from any process to be 'wastes' due to outmoded definitions, for example, a substance [by-product] is not precluded from being waste, merely because it can be reprocessed, re-used or recycled.

State Environmental Agencies typically do not classify wastes into categories. The generator determines the classification according to developed Environmental Guidelines where they exist in each State. For example, the NSW EPA operate Environmental Guidelines allocating wastes into one of four categories (inert, solid, industrial, or hazardous) based on the nature and mobility of the chemical species they contain. Each category requires different material handling and management practices.

Figure 5 Steel Furnace Slag Asphalt Sand

Research Results

Numerous research studies have quantified the environmental performance of Steel Furnace Slag. For example, in the 1996 Golder & Associates reported on extensive trials including chemical and ecotoxological studies on experimental leachates from Steel Furnace Slags. Methodology design and conduct of these trials were carried out in agreement with the NSW EPA. **This major study in 1996 found SFS not to exceed accepted environment criteria, in other words, SFS was inert.**

The Golder & Associates study has been validated in a study by Moeyan & Associates conducted during 2003/2004. The aim being: to investigate the chemical nature of iron and steel furnace slags of three different metallurgical processes. Each of these by-products were analysed and the results assessed against the current NSW Environmental Guidelines (EG's).

The methodology consisted of collecting differently aged samples from the product range. Samples were tested for total metal concentrations followed by leachate analysis according to the process contained in the Environmental Guidelines and then assessed against acceptance criteria.

The majority of results for total metals were within the initial total concentration acceptance levels. For those elements exceeding these initial acceptance levels (total concentration), investigations were conducted using the TCLP method.

Using the 95% UCI, all results were found to be below the accepted concentration levels for Inert classification.

These results are consistent with previous investigations by Golder Associates in the mid 1990's, further confirming the stable and consistent nature of the metallurgical processes.

Conclusion

Based on experimental results, SFS can be classified by producers as INERT.

Further reading

A copy of the full Aynsley report, Australasian (iron and steel) Slag Association Inc. Material Classification of Iron and Steel Slag By-product Waste Classification Investigation Report 2004, can be obtained by contacting the Executive Director.

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