New Applications for Iron and Steelmaking Slag

Tatsuhito Takahashi* and Kazuya Yabuta**

* Chief Engineer, Dr., Steel Technology Center
** Manager, Dr., ...

612148.066 Tw(NewNo.( )).( )spplicationNo.(*)).( )afor is a C06186lfEVI5148p1C3 99854907.84611518.066 Tof thNo.(1(e iTw(NewNo.(1r)3..( )spplicationNo.(1r)pNo.(1r
has strengthened.

Table 1 Quality of fine concrete aggregate

3. BF slag sand-capping material

3.1 Outline of sand-capping

Sand-capping is a marine environment improvement technology that covers organic sea-bottom sediments such as sludge layers with sand in order to suppress the elution of nutrient salts that cause eutrophication of seawater, and hydrogen sulfide that cause blue tides (**Fig.1**). Sand-capping suppresses the lowering of the amount of oxygen dissolved in seawater, which is caused by the decomposition of organic matter contained in the bottom sediments. It also improves the grain size of seabed sand. These aspects help create an environment that is conducive to organisms living on the seabed. In the past, mostly natural sand was used for sand-capping. However, excavation of natural sand causes environmental destruction. Hence, a new material for sand-capping has been sought.

Fig.1 Scheme of sand-capping on the seabed

3.2 Sand-capping properties of BF slag sand

(1) Hydrogen sulfide generation suppression properties

In an experiment, BF slag sand and beach sand were laid over bottom sediment. Hydrogen sulfide concentrations in interstitial water within each type of sand layer were compared with that in an untreated bottom sediment layer[5]. The results are shown in **Fig.2**. The hydrogen sulfide concentration in the interstitial water in the slag sand layer remained at levels markedly lower than that in the untreated bottom sediment or beach sand layers over a two-year period. The pH value of the interstitial water in the slag sand layer remained at levels of 8.2 to 8.6[5]. This result is supposed to be attributable to the effect of BF slag in suppressing the activity of a certain type of bacteria whose function is to redox sulfuric acid ions in seawater[6]. Thus, BF slag sand has a greater ability than natural sand in suppressing the generation of hydrogen sulfide that causes blue tides.

Fig.2 Changes of H_2S in seawater

(2) Effect of feeding silicate

Black acrylic containers were placed, opening down, on BF slag sand laid over the bottom sediment. Silicate concentrations of the seawater in

affected by sand grain size. It is reported that more ben-

gate the growth of large-sized marine plants and other organisms (**Photo 5**). It was observed that a large number of fish gathered in the space created by the slag blocks on which marine plants were growing (**Photo 6**).

Photo 5 A pile of carbonated slag blocks

Photo 6 View of the space created by carbonated slag blocks

4.4 Marine environment improvement by combined use of slag products

Shoals have disappeared in many coastal areas of Japan

siliconization station in the hot metal pre-treatment process, hot metal is first subjected to desiliconization treatment and then, potassium carbonate (K_2CO_3) is continuously added into the hot metal ladle from the hopper above the ladle while agitating the hot metal using nitrogen gas (**Fig.6**). Uniformly melted slag is recovered from the hot metal ladle, solidified by cooling, and crushed into a granular form.

5.2 Fertilizing properties

The chemical composition of the slow-release potassium silicate fertilizer developed by NKK is shown in **Table 2**. Potassium (K_2O) originating from potassium carbonate and silica (SiO_2) originating from slag are the main constituents. 93% of the total potassium content and 75% of the total silica content have a slow-release property. It also contains other slow-release constituents originating from slag such as CaO, MgO, MnO, and FeO[13].

tlio4h3r veofIn eve (oworir deve

This fertilizer is composed of the vitric portion, and crystalline portion such as K

References

1) Tanaka, H. et al. “Establishment of Zero Slag New Steelmaking Process”. NKK Giho. No.169, pp.6-10 (2000).
2) Mitsufuji. H. et al. “Development of Consolidation Inhibitor for BF Slag Fine Aggregate for Concrete”. Material & Process, Proceedings of the 139th Symposium of the Iron and Steel Institute of Japan, Vol.13, No.1, p.101(2000).
3) Shiroishi, T. et al. “Effect of Temperature on Consolidation of BF Slag Fine Aggregate for Concrete”. Material & Process, Proceedings of the 140th Symposium of the Iron and Steel Institute of Japan, Vol.13, No.4, p.851(2000).
4) Takahashi, T. et al. “Development of Consolidation Inhibitor for BF Slag Fine Aggregate”. Collection of Summary Papers of the 54th Japan Cement Technology Symposium, pp.66-67(2000).
5) Miyata, Y. et al. “Granulated BF Slag Sea Bottom Laying Experiment”. Collection of Summary Papers of the 15th Ocean Engineering Symposium, the Society of Naval Architects of Japan, pp.339-346(2000).
6) Seki, M. et al. “1982 Survey on Effects of Ago Bay Pearl Cultivation Farm Improvement Project”. Mie Prefectural Hamashima Fisheries Experimental Station Annual Report 1982, pp.28-44(1984).
7) Numata, T. et al. “Sea Area Compatibility Granulated BF Slag”. Collection of Summary Papers of the 52nd Symposium of the Society of Sea Water Science Japan, pp.43-44 (2001).
8) Kakumina, S. et al. “Oceanographic Chemistry: Solve the Sea by Chemistry”. Edited by Nishimura, M., Sangyo-Tosho, p.286(1983).
9) Imai, I. “Control of Red Tide Organisms”. Collection of Summary Papers of Red Tide Seminar: Red Tide Mechanism and Countermeasures, West Japan Branch of the Society of Sea Water Science Japan, pp.49-68 (1997).
10) Kitamori, R. “Changes of Macro-benthos Phase”. Environmental Science of Inner Bays, Vol.2, Edited by Saijo. Y., Baihu-kan, pp.93-115(1984).
11) Goto, M. et al. “Solidification of Calcium Silicate by Carbonization”. Inorganic Materials, No.5, pp.22-27(1998).
12) Isoo, N. et al. “Evaluation of Carbonated Solid Block as Artificial Reef Material”. Journal of the Japanese Society of Fisheries Science, No.66, pp.647-650(2000).
13) Watanabe, K. et al. “Features of Slow-release Potassium Silicate Fertilizer Made from Steelmaking Slag”. CAMP-ISIJ. No.13, p.859(2000).
14) Yao, Y. et al. “Effect of Potassium Silicate Fertilizer Made from Steelmaking Slag”. Journal of the Japanese Society of Soil Science