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Basic Research on Magnesium Metal Production Using Substance Driven from Bitter

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Summary

Magnesium alloy is thought a promising material leading to the weight reduction of a transportation equipment because of its superior properties, such as lightness and high specific strength. However, its wider use is restricted by the supply anxiety due to the exclusive possession on primary metal production by China, and by the total amount of exhausted CO_2 during its life cycle. Accordingly, an innovative production process of Mg metal, which uses domestic Mg resource and enables to reduce exhausted CO_2 amount, is desired. The authors focus the Mg metal production using the substance driven from bittern, and have been carrying out the basic research to develop the process. In this study, some subjects on the Si reduction and molten salt electrolysis were studied. The worth of the proposed process was also investigated from the views of the Mg demand in Japan and the world, and of the potential amount of domestic Mg resource.

Three subjects, such as the preparation condition of MgO-CaO-Si mixture, the possibility of reducing CaO amount and the influence of $MgCl_2$ and NaCl contamination in MgO, were examined. Mixing MgO with CaO at the stage before their dry, that is, in aqueous solution, was effective, and the short-term pre-sinter of MgO-CaO-Si mixture bettered the reduction rate. From the result using Ca_2SiO_4 in place of CaO, it was suggested that the CaO amount could be reduced remarkably, though the reduction of CaO amount and the use of Ca_2SiO_4 instead of CaO caused the MgO loss remarkably. The contamination of 1%-$MgCl_2$ in MgO did not influence the reduction rate, whereas the $MgCl_2$ contamination more that 1% worsened the rate. The NaCl contamination deteriorated the reduction rate even when 1% NaCl was added in MgO. Calcium chloride was detected in the reduction residue when $MgCl_2$ or NaCl was added; it is considered that melting of formed $CaCl_2$ depended on the deterioration in the reduction rate. It was also shown that the contamination of $MaCl_2$ and NaCl caused the chlorine contamination in the deposited Mg metal.

The influence of MgO contamination in $MgCl_2$, which is planned to be produced from bittern, was studied to perform the efficient Mg metal production by molten salt electrolysis. Only a small amount of MgO solved in molten $MgCl_2$-KCl-$CaCl_2$ melt. The MgO contamination in the melt scarcely affected the Mg metal deposition; the current efficiency and the purity of Mg metal did not change with MgO contamination clearly. The anodic behavior of $MoSi_2$ in the melt with the saturated MgO was examined as a candidate of the so-called inert anode. The dense surface film consisting of SiO_2 and $MgSiO_3$ was synthesized by electrolysis, and the further anodic consumption was prevented. To use $MoSi_2$ as an inert anode, however, it is necessary to improve the electric conductivity of the surface film as well as the protection property.

The overall demand of Mg in the world is increasing year by year, while the demand in Japan is stagnant. The situation on the demand for Mg alloys is similar; the use of Mg alloys has not been expanded in Japan though the demand of Mg alloys is steadily increasing in the world. To extend the Mg demand in Japan, the production of primary Mg metal with less-environmental load in Japan should be necessary. From the bittern drained from the salt production facility in Japan, a considerable amount of Mg resource can be recovered; 20 thousand ton per year can be extracted without bad influence on salt production, that is, a half of the Mg demand in Japan can be supplied by the domestic resource.