Mass Spectrometric Analysis of the Vapors Produced by Dephosphorization Reaction of Solid Iron Using Na₂CO₃ or K₂CO₃-KCl Flux*

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Synopsis

The vapors produced by dephosphorization reaction of iron using Na₂CO₃ or K₂CO₃-KCl flux were mass spectrometrically analyzed. When solid Fe-P alloy was treated by K₂CO₃-KCl flux, KP was found in the vapor. When Fe₃P was treated by Na₂CO₃, NaP was found in the vapor.

When molten iron was subjected to the treatment by Na₂CO₃ or K₂CO₃-KCl flux, evaporation loss of phosphorus was observed. The mechanism of this evaporation, however, has not been clarified yet. In this study, the vapors evolved when a dephosphorizing agent reacted with a solid Fe-P alloy or Fe₃P were analyzed with a mass spectrometer.

The experimental apparatus is shown in Fig. 1. The sample was heated by the use of a tungsten heater which was wound into a corn like shape and coated with alumina. A quadrupole mass spectrometer (Anelva Corp., AGA-360) equipped with a large diffusion pump (2 400 l/s) was used for the analysis of the vapor evaporated from the sample.

The Fe-P alloy was made by melting together electrolytic iron and Fe₃P (Kojundokagaku Corp., 99.9 % pure) in hydrogen atmosphere. The purities of Na₂CO₃ (Kantokagaku Corp.), K₂CO₃ (Kantokagaku Corp.) and KCl (Wakojunyaku Corp.) used in this study were analytical reagent grade. The amounts of the samples are shown in Table 1.

The dephosphorizing flux was placed on the alloy or Fe₃P, and mass spectrometric analyses were made for increasing temperature sequence from room temperature to a maximum about 1 360 °C which is close to the melting temperature of Fe-5%P alloy.

The temperature of the sample could not be measured during the experiment, and it was estimated from the electric current which flew through the tungsten heater. The relation between the current and the temperature of the furnace was determined beforehand; the temperature was determined by the use of an infrared pyrometer. The mass spectra were taken in the mass range from 1 to 260, and the time needed for scanning was 3 sec.

The following results were obtained.

1. Fe-P alloy and Na₂CO₃

In these experiments, P was observed when the temperature of the sample was raised higher than 860 °C (experiment No. 1) or 700 °C (experiment No. 2).

2. Fe-P alloy and K₂CO₃-KCl flux

The vapors of KP and P were observed when the temperature of the sample was raised higher than 700 °C. The mass spectrum obtained with this system when the intensity of KP⁺ was at its maximum is shown in Fig. 2.

3. Fe₃P and Na₂CO₃

The vapors of NaP and P were observed and other gaseous species containing P was not observed. The mass spectrum obtained with this system when the...
The intensity of NaP\textsuperscript{+} was at its maximum is shown in Fig. 3. The change of the intensities of NaP\textsuperscript{+} and P\textsuperscript{+} ions with time is shown in Fig. 4. In Fig. 5, the maximum intensities of NaP\textsuperscript{+} and P\textsuperscript{+} ions at various temperatures are shown. Royen studied on solid NaP.\textsuperscript{3} Gaseous NaP and KP which were found in these experiments, however, have not been reported yet.

In this study, the dephosphorization reaction occurred under vacuum, and this condition is different from that under which actual dephosphorizing reaction of iron occurs. The experimental results obtained in this study, however, suggest the possibility of vaporization of NaP, KP and P during dephosphorization process.

REFERENCES

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