HYDROGEN GAS EVOLUTION FROM WET SIMN AND FESI

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Key Works: ferrosilicon, silicon manganese, hydrogen, rate of gas evolution, US DOT Code

ABSTRACT

Ferrosilicon when wet evolves hydrogen. The hydrogen gas evolution of FeSi75 was investigated as a function of particle size and surface weathering of the FeSi when it is exposed to normal atmospheric conditions. Hydrogen evolution was determined from freshly ground FeSi for three different particle sizes (i.e, less than 0.50 mm; from 2.36 to 1.70 mm; and larger than 9.50 mm, respectively). Hydrogen gas evolution increased with decreasing particle size probably due to its larger surface area available for the following reaction to take place.

$$Fe_{(in\ FeSi)} + 2H_2O_{(l)} = Fe(OH)_{2\ (s)} + H_{2\ (g)}$$

A decrease in the amount of hydrogen gas evolved was observed for FeSi samples that were weathered. This decrease in hydrogen gas evolution indicates that the ferrous hydroxide layer formed out of an aqueous solution is more permeable to water than that formed out of a gaseous environment. Therefore, the evolution of hydrogen gas from wet FeSi alloys can be characterized by the ferrous hydroxide layer covering the surface of the alloys. The hydrogen gas evolution from wet FeSi75 alloy is less than that specified by the United States Department of Transportation (US DOT) code. The rate of hydrogen gas evolution is expected to be less than 0.02 liters/kg-hr from the commercial FeSi75 alloy. The evolution of hydrogen from wet FeSi can be further reduced by minimizing the fine particles generation during handling and transportation, and by allowing the FeSi to weather under normal atmospheric conditions before shipment. No hydrogen gas evolution was detected from silicon manganese.

INTRODUCTION

The tendency for ferrosilicon alloys to evolve flammable and toxic gases (i.e., H_2 and PH_3) has been known since the beginning of the 20th century [1]. Recently, the United States Department of Transportation (DOT) has classified ferrosilicon as a "hazardous when wet" material [2]. This new regulation has added to the cost of storage and transportation of ferrosilicon and consequently renewed interest in determining the amounts of hydrogen evolved.

Previous work [3] had shown that 99% of the gases evolved from ferrosilicon was hydrogen. The hydrogen gas evolution was attributed to ferrosilicon's high aluminum and calcium contents. Trots and Maksimenko also claimed that partially weathered and oxidized ferrosilicon samples evolved less hydrogen than freshly ground samples[3]. Kurnakow et al.[4] showed that the gases evolved from ferrosilicon and humidity in the air were mostly hydrogen with small amounts of phosphine and arsine.

Hydrogen evolution is mainly attributed to the reaction between moisture in the atmosphere and iron in ferrosilicon as shown in Reaction (1).