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HYDROGEN PRODUCTION IN THE CALCIUM AND MAGNESIUM -

NITRIC ACID REACTIONS (DELETED VERSION)

By

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For greater understanding of possible explosion hazards knowledge is needed of the volume of hydrogen evolved in the calcium and magnesium-nitric acid reactions,

Measurements of evolved hydrogen are presented in this report.

SUMMARY AND CONCLUSIONS

Nearly five liters of hydrogen per mole of calcium are produced when 16 M nitric acid reacts with calcium metal. The hydrogen evolved slowly increases with decreasing nitric acid to below 4 M nitric acid, when a rapid increase occurs. The magnesium-nitric acid reaction produces only one liter of hydrogen per mole of magnesium with 2 M nitric acid, and the volume of hydrogen decreases with increasing nitric acid concentration.

EXPERIMENTAL

Nitric acid of the desired molarity and pure calcium or magnesium metal were placed in a reaction vessel designed to keep the reactants isolated, connected with a gas sample bottle, the system evacuated, and the reactants mixed. The gases were analyzed with an Orsat apparatus, measurements of volumes being made at room temperature.

RESULTS AND DISCUSSION

The reaction between nitric acid and calcium, while not as violent as the calcium-water reaction, is very vigorous. The volume of hydrogen evolved decreases rapidly with increasing nitric acid concentration to 4 M nitric acid, when the decrease becomes much slower, decreasing from 7.5 liters of hydrogen per mole of calcium at 4 M nitric acid to 4.5 liters per mole at 16 M nitric acid. Nitrate concentration is the determining factor, as 1 M aluminum nitrate produced the same volume of hydrogen as 3 M nitric acid.

The exact proportion of other products from the calcium-nitric acid reaction (nitrogen dioxide, nitric oxide) was not determined. However, the amount of these products increase with increasing nitric acid concentration.

The magnesium-nitric acid reaction was much slower than the calcium-nitric acid reaction, and gave considerably less hydrogen production, with only one liter of hydrogen per mole of magnesium at 2 M nitric acid, and 0.7 liter per mole at 6 M nitric acid being produced.

Samples of gas from the slag and crucible dissolvers in Recuplex during the early part of the dissolution under regular operating conditions has shown a maximum of two per cent hydrogen present (the explosive limit in air is four per cent).

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Volume of Hydrogen/Mole Metal (Liters at 760 mm Hg, 25°C)

FIGURE - I

Hydrogen Evolution in the Calcium and Magnesium-Nitric Acid Reactions

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- Calcium - Nitric Acid
- ⊖ Calcium - 1 M $\text{Al}(\text{NO}_3)_3$
- ⊕ Calcium - 1 M $\text{Al}(\text{NO}_3)_3$, 4 M HNO_3
- Magnesium - Nitric Acid

Reaction commenced at room temperature.

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