November 1968

Brief 68-10414

AEC-NASA TECH BRIEF

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Titanium–Nitrogen Reaction Investigated for Application to Gettering Systems

A study of the rate of reaction between titanium-metal sponge and nitrogen in an argon–nitrogen mixture was reported in "Kinetics of the Titanium–Nitrogen Reaction with Application to the Design of Gettering Systems," ANL-7167, April 1967, by M. L. Kyle, L. F. Coleman, R. D. Pierce, and J. D. Arntzen, Argonne National Laboratory, Argonne, Illinois. Additional mathematical relationships, developed to permit the design of titanium gettering systems, are also presented.

Titanium is one of several gettering materials that are available for removing nitrogen from inert gases. Titanium possesses several advantages over the more commonly used gettering materials such as calcium and zirconium. Titanium-metal sponge is relatively low in cost, is commercially available in a high-surface-area form, and requires no pretreatment before use as a gettering material. Both the oxide and nitride reaction products of titanium are nonpyrophoric, nontoxic, and easily handled in air. As a consequence, titanium-metal sponge has a relatively low cost per mole of nitrogen-removal capacity.

The reaction rate of titanium-metal sponge and nitrogen in argon–nitrogen mixtures was studied at 900°C. The rate was found to depend upon the partial pressure of nitrogen in the gas phase. At least three titanium–nitrogen solid phases are formed as the reaction proceeds, and the rate-controlling mechanism is believed to be the diffusion rate of atomic nitrogen through the TiN_x (δ) phase. Early reaction kinetics can be described by the conventional parabolic relationship, but this relationship is not valid for extended periods of time. A single relation has been developed to describe the reaction kinetics at nitrogen partial pressures from 100 to 50,000 ppm (by volume) and times up to 1000 hr.

Mathematical relationships were also developed to permit design of titanium gettering systems. These relationships apply to the following conditions: (1) nitrogen concentrations in argon from 50 to 50,000 ppm, (2) a reacting temperature of 900°C, (3) total pressure near 1 atm, (4) titanium-metal sponge of a surface area near 800 cm^2/g, and (5) low ($\approx$1 ppm) oxygen and water content of the gas. Under these conditions, the relations presented should permit the design of a gettering system with an uncertainty of about $\pm 10\%$ in the required titanium bed size and useful life. At 900°C, the amount of nitrogen that can be reacted with titanium sponge varies from a conversion, N-atoms/Ti-atoms, of 0.32 with a reacting gas concentration of 50 ppm nitrogen to a conversion of 0.68 for 50,000 ppm nitrogen in argon.

Notes:

1. The report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price $3.00 (microfiche, $0.65.).
2. This information may be of interest to any industry using inert atmospheres.
3. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B68-10414

Source: M. L. Kyle, L. F. Coleman,
R. D. Pierce, and J. D. Arntzen
of the Chemical Engineering Division
(ARG-10208)

(continued overleaf)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
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Argonne, Illinois 60439