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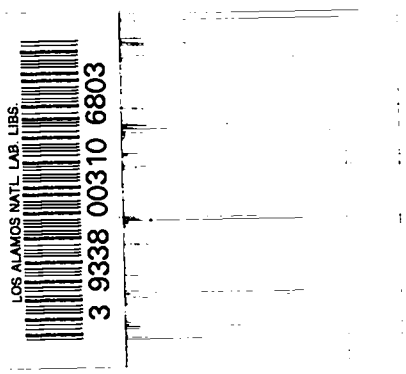
Permeation and Diffusion of Nitrogen, Oxygen, and Rare Gases Through Stainless Steel: A Bibliography



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Permeation and Diffusion of Nitrogen, Oxygen, and Rare Gases Through Stainless Steel: A Bibliography

Compiled by

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PERMEATION AND DIFFUSION OF NITROGEN, OXYGEN, AND RARE GASES THROUGH STAINLESS STEEL: A Bibliography

INTRODUCTION

Searching for this bibliography included basically the period 1947 to the present. Sources checked and the abbreviations used to indicate them in the bibliography are as follows:

Abstracts of Classified Reports (no relevant material found not located elsewhere) Vol. 1 (1947) - Vol. 23, No. 10 (Oct. 31, 1967)

Chemical Abstracts (CA) Vol. 41 (1947) - Vol. 67 (1967)

Nuclear Science Abstracts (NSA) Vol. 1 (1948) - Vol. 21 (1967)

Review of Metal Literature (RML) Vol. 2 (1945) - Vol. 23 (1966) (excluding Vols. 20 and 21 for which there were no indexes)

LASL Report Library Catalog (RL)

Entries are arranged roughly in reverse order of publication. Citations only are given when the source of reference is Chemical Abstracts or the Review of Metal Literature. Abstracts are taken from Nuclear Science Abstracts or the LASL Report Library Catalog as noted.

In general no material dealing with reactions of the gas with the steel or simple absorption of the gas was included. Some general works (including bibliographies) which dealt with diffusion and permeation of gases through metals have been included even though abstracts did not specifically mention stainless steel.

THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 438-12.
Cox, Thomas B. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering) June 1967. Contract AT(40-1)-3208. 14p. EURAEC-1902.

The results from stress corrosion tests performed in Type 304 stainless steel plates are presented. The plates were subjected to various N_2 bearing atmospheres for 24 hr at 538°C. To make certain that the specimens were homogeneous in nitrogen content, they were encapsuled individually under a vacuum in quartz tubing and held at an elevated temperature for annealing. Annealing results for 1800°F and 2000°F are presented.
NSA 21:39546

NITRIDING PURE IRON.
Bohnenkamp, Konrad (Max-Planck-Inst. Eisenforsch., Duesseldorf, Ger.) Arch. Eisenhuettenw. 38(3), 229-32 (1967) (In German)
CA 67:5169e

INVESTIGATION OF BIMETALLIC LIQUID METAL SYSTEMS. Final Report.
(General Motors Corp., Indianapolis, Ind. Allison Div.) Sept. 30, 1966. Contract AT(30-1)-3643. 124p. GMAD-3643-8

An examination and analysis was made on material from bimetallic (AISI 316 SS and Nb-1%Zr) liquid metal (K) systems as a continuation of previous work to better define design limits for these materials in long-life system applications. The systems operated between 1200 and 1500°F for times up to 8000 hr. Results indicate that phase changes in the AISI 316 SS involve formation of complex carbides ($Cr_{35}C_5$) and chi phases. Stress rupture testing of loop-exposed specimens shows a decrease of about 65% in life at a given stress (or about 25% in stress value for a given life) after 3000 to 8000 hr of exposure. Exposing control specimens to 1500°F in air prior to stress rupture testing did not affect stress-rupture life. Exposure to liquid metal at 1350 and 1450°F caused a consistent, but not large, decrease in low-cycle fatigue life. Analyses of N_2 gradients in the stainless steel containment showed that although N_2 diffused into the loop through the high temperature AISI 316 SS, no area of outward diffusion of N_2 through the stainless steel was found. Detailed chemical and metallurgical analysis of a loop which operated for 8000 hr was used for kinetics analysis of N_2, C, and O_2 transport. Approximate diffusion coefficients were obtained for C and N_2 in AISI 316 SS. Diffusion coefficients for C in stainless steel were orders of magnitude greater than those in the refractory alloy. C transport from the high temperature portion of the loop was limited only by solid-state diffusion in the AISI 316 SS and not by surface reaction or liquid metal solubility. Qualitative examination of air-side surfaces indicated no catastrophic oxidation of stainless steel surfaces when surface temperatures did not exceed 1500°F. Ni fins became embrittled (probably due to O_2 diffusion) after 8000 hr of operation at 1350 to 1500°F.
NSA 21:14820

INVESTIGATION OF BIMETALLIC LIQUID METAL SYSTEMS. Progress Report, February 1-May 31, 1966.
(Allison Div., General Motors Corp., Indianapolis, Ind.) June 20, 1966. Contract AT(30-1)-3643. 66p. (EDR-4719) GMAD-3643-5.

Examination and analysis of material from bimetallic (AISI 316 SS and Nb-1% Zr) liquid K systems are being conducted. These systems operate between 1200 and 1500°F for times up to 8000 hr. Results to date indicate that phase changes in the AISI 316 SS involve formation of complex carbides ($Cr_{23}C_6$) and chi phases. Stress rupture testing of loop-exposed specimens shows a decrease in this property. Low cycle fatigue testing is proceeding. N_2 gradients in the stainless steel containment were obtained and are providing the basis for kinetics analyses of N_2 transport. No area of outward diffusion of N_2 through the stainless steel was found. Detailed chemical and metallurgical analyses of a loop which operated for 8000 hr is also being used for kinetics analysis of N_2, C, and O_2 transport. Preliminary results of kinetics correlations show diffusion coefficients for C in stainless steel to be at least an order of magnitude greater than those in the refractory alloy. Qualitative examination of air-side surfaces indicated no catastrophic oxidation of stainless steel surfaces when surface temperatures did not exceed 1500°F. Ni fins became embrittled (probably due to O_2 diffusion) after 8000 hr of operation at 1400 to 1500°F.

NSA 20:41419

WALL PENETRABILITY OF METAL TUBES FOR HELIUM.
Lupakov, I. S. and Kuzmichev, Yu. S. At. Energ. (USSR), 17, 49-52 (July 1964). (In Russian)

Results are presented from studies of helium penetration through pipe walls at temperatures to 800°C and helium pressures to 100 atm. By direct studies using a leak detector it is shown, and by indirect methods (by investigation of structure and determination of protracted strength) it is confirmed, that helium at temperatures to 800°C and pressures to 60 atm does not diffuse from the gas phase through steel.

NSA 18:39920

HYDROGEN AND HELIUM PERMEABILITY OF STEEL AND OF NICKEL, COPPER, ALUMINUM, GOLD, PLATINUM AND THEIR ALLOYS. A BIBLIOGRAPHY.
Macpherson, Florence, Comp. (Sandia Corp., Albuquerque, N. Mex.) May 1, 1963. Contract AT(29-1)789. 72p. SCL-B-107.

References (241) are given to reports and U. S. and foreign journals published from 1947 to 1963. A separate author index is included.

NSA 17:37492

DETERMINATION OF THE PERMEABILITY OF TUBE WALLS FOR HELIUM.
Lupakov, I. S., Kuz'michev, Yu. S., and Zakharov, Yu. V. At. Energ. (USSR) 15(1), 79-80 (1963).
CA 59:13644c

DETERMINATION OF NITROGEN DIFFUSION CONSTANTS IN AUSTENITIC STAINLESS STEEL BY INTERNAL FRICTION MEASUREMENTS.
Manning, Jr., Charles R. NASA (Natl. Aeron. Space Admin.). N62-12640, 41p. (1962)
CA 60:11675h

PULSED THERMAL DESORPTION FROM STAINLESS STEEL NS-22S IN ULTRAVACUUM.
Peterman, L. A., Lux, B., Degras, D. A., and Schram, A. Helv. Phys. Acta 35(7-8), 696-714 (1962) (In French)
CA 59:8405g

INTERNAL FRICTION PRODUCED BY THE DIFFUSION OF NITROGEN ATOMS IN THE FIELD OF ELASTIC STRAINS IN γ SOLID SOLUTIONS OF FERROUS ALLOYS.
Verner, V. D. (Inst. Steel and Alloys, Moscow) Fiz. Metal. i Metalloved. 14, 880-9 (1962)
CA 58:5315h

BEHAVIOR OF NITRIDED STEELS AT HIGH TEMPERATURES.
Pogrebetskaya, T. M., Yurgenson, A. A., and Kostenko, A. V. Metalloved. i Term. Obrabotka, Materialy Konf., Odessa 1960, 245-57 (Pub. 1962)
CA 57:16236i

STUDY OF THE INTRODUCTION AND DIFFUSION OF RARE GASES IN METALS.
Adda, Y., Brébee, G., and Levy, V. (Centre d'Etudes Nucleaires, Saclay, France). Mém. sci. rev. mét 58, 743-56 (Oct. 1961) (In French)

Various methods than can be used to introduce rare gases into metals are considered. The diffusion coefficients of the gas in the metal are determined by heating the rare-gas-saturated metals in vacuum and measuring the quantities of rare gas extracted. Precipitation of rare gas bubbles during heat treatments is also studied.

NSA 16:5736

NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT, JANUARY 1-APRIL 30, 1960.
(Brookhaven National Lab., Upton, N. Y.) Feb. 1961. 94p. (BNL-S-55) BNL-618.

... Chemistry and Chemical Engineering. ... The diffusion of Xe through 2S Al, 304 stainless steel, and Piqua fuel element cladding of thicknesses on the order of 0.02 to 0.03 in. at various high temperatures was studied; the results indicate that diffusion is negligible. ...

NSA 15:19077

DEGASSING AND PERMEATION OF GASES IN TUBE MATERIALS.
Collins, R. H. and Turnbull, J. C. Vacuum 11, No. 2, 114-18 (1961).
CA 56:12320c

DIFFUSION OF XENON THROUGH ALUMINUM AND STAINLESS STEEL.
Castleman, A. W., Hoffmann, F. E., and Eshaya, A. M. (Brookhaven National Lab., Upton, N. Y.) July 1960. Contract AT(30-2)-Gen-16. 22p. BNL-5113

Studies on the diffusion of xenon through aluminum, stainless steel, and the Piqua fuel element cladding by a radioactive tracer technique are reported. Xenon was not found to diffuse through aluminum in the temperature range 295 to 473°C. Stainless steel specimens showed no evidence of xenon diffusion up to 610°C. A maximum value for xenon permeability through the Piqua fuel element cladding is given; however, since the experimentally determined values lack correlation with temperature, they appear to be anomalous.

NSA 16:29368

DIFFUSION OF XENON THROUGH ALUMINUM AND STAINLESS STEEL.

Castleman, A. W., Hoffmann, F. E., and Eshaya, A. M. (Brookhaven National Lab., Upton, N. Y.) 11p. BNL-624

Studies on the diffusion of xenon through aluminum, stainless steel, and the Piqua fuel-element cladding (0.143-in.-thick finned Al + 0.0005-in. Ni bond) by a radioactive-tracer technique are reported. Xenon was not found to diffuse through aluminum as thin as 0.010 in. at 295 to 473°C. Stainless-steel specimens (0.020 in. thick) showed no evidence of xenon diffusion up to 610°C. A maximum value for xenon permeability through the Piqua fuel-element cladding is given; however, since the experimentally determined values lack correlation with temperature, they appear to be anomalous.

NSA 15:3075

THE BEHAVIOR OF INERT GASES IN METALS.

Ells, C. E. Canadian Mining and Metallurgical Bulletin 53, 885-892 (Nov. 1960)

RML 18:99-N

PERMEATION OF GASES THROUGH SOLIDS. AN ANNOTATED BIBLIOGRAPHY.

Nagel, B. H. (Autonetics. Div. North American Aviation, Inc., Downey, Calif.) Oct. 12, 1959. 161p. (EM-5883; [AD-242210]) NP-11440.

A collection of annotated references on permeation of gases through solids is presented. Emphasis is placed upon information concerning the gases, H and He, and the solids, metal and glass. Data on many other gases and solids are also included. The abstracts are arranged chronologically by year followed by a subject and author index. The literature search includes publications from 1900 through June 1959.

NSA 16:14688

MARITIME GAS-COOLED REACTOR PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING JUNE 30, 1959.

(General Atomic Div., General Dynamics Corp., San Diego, Calif. and General Dynamics Corp. Electric Boat Div., Groton, Conn.) GA-1099. 197p. Contract AT(04-3)-187.

... Materials Development: ... An experiment to determine whether or not helium penetrates through the walls of 1-1/4 Cr - 1/2 Mo steel piping was conducted. ...

NSA 14:19973

APPARATUS FOR STUDYING THE DIFFUSION OF RARE GASES IN STAINLESS STEEL.

Stohr, J. A. and Alfille, L. (Centre de'Études Nucléaires, Saclay, France) p.73-8 of "Colloque sur la Diffusion a l'État Solide (Symposium on Solid State Diffusion. Organisé a Saclay les 3, 4 et 5 Juillet, 1958". Saclay, France, Centre d'Études Nucléaires, (North Holland Publishing Co.) 1959. 178p.

An apparatus for measuring the diffusion of gaseous fission products and other gases across thin metallic walls at high temperatures is described.

NSA 14:7822

INTERGRANULAR OXIDATION IN TYPE 310 STAINLESS STEEL.

Keith, R. E. (General Elec. Co., Schenectady, N. Y.), Siebert, C. A., and Sinnott, M. J. (Title of book: Symposium on basic effects of environment on strength, scaling and embrittlement of metals at high temperatures). Am. Soc. Testing Materials, Spec. Tech. Publ. No. 171, 49-60, discussion 60-4 (1955).

CA 50:10633a

CONTAINMENT OF HELIUM IN STAINLESS STEEL AND INCONEL AT THE 1500°F+ RANGE.

Wischhusen, E. (Oak Ridge National Lab., Y-12 Area) Oct. 16, 1951. 11p. (ANP-72)

He permeation through seamless type-316 stainless-steel and inconel tubing of 0.030-in. wall thickness has been investigated. The He was pressured into the annular space between the outer wall of the tubing to be tested and the inner wall of the "IPS" jacket. Modified Swagelok tubing-to-pipe male connectors were used to seal the jacket to the tubing. The jacketed tubes were put into an electric furnace and maintained at 1600°F for 150 hr, the He being under 54 psi static pressure differential. A He leak detector capable of detecting one part He in 3.2×10^6 failed to find any He within the tested tubing.

NSA 6:272

TESTS ON THE PERMEABILITY OF THE COMPONENTS OF WATER THROUGH CLAD PLATE.

Moyer, William H. (Babcock and Wilcox Co. Research and Development Dept., Alliance, Ohio) Feb. 1, 1951. 19p. For Westinghouse Electric Corp. Atomic Power Div. Subcontract 14-302. BW-5404

A description is given of an apparatus to measure the permeability of the components of water through thin metal sections at temperatures up to 650°F and a pressure of 2500 psi. Results are given for SA 212, AISI 347, and SA 212 clad with AISI 347. The clad plate used for these tests was AISI Type 347 on SA 212 by the Lukens method.

NSA 13:15345

PERMEABILITY OF METALS TO ARGON AND HELIUM.

(British Non-Ferrous Metals Research Assn.) Oct. 1946. 7p. Declassified. BI-101.

The present experiments were designed to cover diffusion of argon through stainless steel and mild steel at 1000° ...

RL