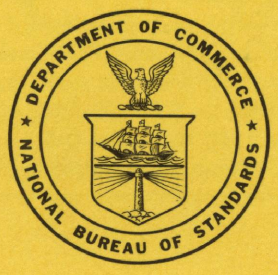
NBS MONOGRAPH 35

Bibliography and Index on Vacuum and Low Pressure Measurement



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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A complete listing of the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 ($1.25), the Supplement to NBS Circular 460, July 1947 to June 1957 ($1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (includes titles of papers published in outside journals 1950 to 1959) ($2.25); available from the Superintendent of Documents, Government Printing Office, Washington, D.C.

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Errata to Accompany National Bureau of Standards Monograph 35, Bibliography and Index on Vacuum and Low Pressure Measurements By W. G. Brombacher

Page	Column	Line	Now reads in part	Should read
7	2	3407	(1934)	(1937)
10	2	4102	Higginbotham	Higinbotham
24	1	5378	Dobke	Dobbe
26	2	5484	in vacuum.	in vacuum tubes.
43	1	5979	K G Muller	K G Mueller
53	1	-	Dobke	Dobbe
53	2	-	Ehlbeck 6010	Ehlbeck 6019
54	2		Gote	Goto
55	2	-	Higginbotham	Higinbotham
56	2	-	Knutsishvili	Khutsishvili
58	2	-	Moench	delete
58	2		Moeneh	Moench
58	2	-	Muller	Mueller K G
59	2	-	Ramaswamy 3312	Ramaswamy 3212
60	2	-	Schmidt W 50139	Schmidt W 60139
60	2	-	Schneiderreit 50117	Schneiderreit 60117
64	1	20	Adsorption	Absorption
66	2	48-49	Insert	Pump oils, rate of 5754
66	2	49	Rate B491	Rate B491 5754

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Page	Column	Line	Now reads in part	Should read
67	1	30-31	Insert	Rate 5754
75	1	15	5635 5823	5635 5754 5823
85	1	8	Design 5448	Design 5121 5448
85	2	28	Flat closure 2801	Flat closure 2801 4615
85	2	46	(Vacustope)	(Vacustat)
85	2	49	Oil type 5819	Oil type 4301 5819
85	2	64	Capillary pressure	capillary measures pressure
86	1	11	Boyles low	Boyles law
86	1	13	Condensable gases B391	Condensable gases B491
95	1	20	Tritium 5818	Tritium 58118

6.2
April 28, 1964

UNITED STATES DEPARTMENT OF COMMERCE • Luther H. Hodges, *Secretary*
NATIONAL BUREAU OF STANDARDS • A. V. Astin, *Director*

Bibliography and Index on Vacuum and Low Pressure Measurement

W. G. Brombacher

National Bureau of Standards Monograph 35

Issued November 10, 1961

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 60 cents

Foreword

Preparation of this bibliography and index on vacuum and low pressure was undertaken to fill the need of scientists, engineers, and other users for sources of information. It was originally planned to include a critical review of vacuum and low pressure measurement with the bibliography. In order to avoid undue delay in the publication of the bibliography it was found advisable to omit the review which, however, will be prepared for separate publication.

This bibliography was prepared as part of the work on vacuum standards which is now in progress in the Mechanics Division under the supervision of D. P. Johnson, Chief of the Pressure and Vacuum Section.

A. V. Astin, Director,

Contents

BIBLIOGRAPHY AND INDEX ON VACUUM AND LOW PRESSURE MEASUREMENT

W. G. Brombacher

The bibliography contains 1538 references, of which 52 are on books. About 550 of the periodical references are specifically on pressure measurement including both vacuum gages and micromanometers. The balance are on vacuum technology, including adsorption, degassing, vacuum pumps, controlled gas leaks, valves, seals and vacuum systems, all of which bear on the technique of vacuum measurement. The indices consist of an author index and an index of the subject matter of the listed references.

1. INTRODUCTION

Vacuum technology has been advancing at a rapidly accelerating rate during the past few years in response to the needs of science and industry. To meet the need for means of locating technical information, abstracts of current literature on vacuum technology are available in a number of the publications. Notable among those specifically on vacuum technology are: a) Vacuum (since 1951), The international journal and abstracting service for vacuum science and technology. Pergamon Press, London. b) Le Vide (since 1946), Société Française des Ingénieurs des Techniciens du Vide, Paris, France. Other abstract journals or publications containing a significant number of abstracts on vacuum measurement include c) Physical abstracts, Section A of Science abstracts, Institution of Electrical Engineers, London. d) Chemical abstracts, American Chemical Society, Columbus, Ohio. e) Engineering index, Engineering Societies, New York. f) Physikalische Berichte, Deutsche Gesellschaft für technische Physik, Braunschweig.

Excellent surveys of vacuum measurement are given in Dushman's "Scientific foundations of vacuum technique" (1949) and in Leck's "Pressure measurement in vacuum systems" (1957) but the references are incomplete and do not include the flood of papers published since. The preparation of an up-to-date bibliography, undertaken here, appears to fill a need for a source of readily available information. This paper consists essentially of a) a bibliography, b) an author index, and c) an index of the subject matter of the bibliography. While the primary objective is to focus on vacuum measurement, it was believed essential to include in the bibliography articles on vacuum technology in some measure accessory or essential to vacuum measurement. For maximum usefulness, an index of the subject matter of the references has been prepared. The abstract publications listed in the previous paragraph have been freely drawn upon in preparing the bibliography.

Neither surveys nor bibliographies appear to be available on micromanometers, covering absolute pressure measurements just above the high vacuum range or on sensitive, small differential pressure measurement. This instrumentation is of interest principally to workers in scientific and industrial laboratories. References to micromanometers are listed in the bibliography and are indexed similarly as described in the preceding paragraph.

It was originally planned to include a critical review of vacuum and low pressure instrumentation with emphasis on possible standard instruments and on calibration methods. Preparing and including this review would delay publication unduly. Since the bibliography and indices will adequately meet the needs of many of those interested in the field, it was decided to issue the bibliography as promptly as possible. The review will be prepared and issued separately.

Standard vacuum terminology has been proposed by the American Vacuum Society [58148] and the British Standards Institution [58104]. In the subject index the American proposed classification of degrees of high vacuum has been adhered to. This is

Condition	Pressure range, Torr
High vacuum	10^{-3} to 10^{-6}
Very high vacuum	10^{-6} to 10^{-9}
Ultra-high vacuum	10^{-9} and below

The Torr equals 1/760 of an atmosphere of pressure (1013.250 millibars) or at pressures in the vacuum range, one millimeter of mercury for all practical purposes.

The term micromanometers is rather generally used to designate designs of liquid or mechanical type pressure measuring instruments which are an order more sensitive than designs considered more or less standard. More specifically, micromanometers may be defined as instruments of the liquid or mechanical type used to measure absolute or differential pressure in the range from about 10^{-4} to 10 mm of mercury, with the ability to detect pressure changes of less than about 0.01 mm of mercury. It also includes water or oil manometers used to measure differential pressure, with a pressure change of less than about 0.01 inch of water detectable.

2. BIBLIOGRAPHY

The references are divided into a list of books and a list of papers and reports, all listed chronologically, by years. Books are designated by the letter "B" followed by two digits indicating the year of publication and by a single digit identifying the order of listing. For example B592 indicates a book published in 1959, listed second in the book list. Papers and reports are designated by four digits or five, where necessary, the first two indicating the year of publication or issue, and the last two or three the order of listing. Thus 58122 indicates 122d in the list for 1958.

The bibliography contains 1538 references, of which 52 are books. About 550 of the periodical references are specifically on pressure measurement. The period covered is up to January 1, 1961.

A reasonable effort was made to list all significant references on vacuum and low pressure instrumentation, particularly those published since 1949. Extensive, but not necessarily complete, references to vacuum technology and phenomena were included, since making valid vacuum measurements involve the effect of such phenomena as adsorption, degassing etc. References are therefore included on adsorption, degassing, outgassing, surface reaction, mechanical and diffusion pumps, leak detection, controlled gas leaks, and on hardware such as seals, valves, gaskets and vacuum systems. References on methods of calibrating vacuum gages and on standards of measurement are also listed.

Papers on micromanometers, both liquid and mechanical types, are listed. The criterion for inclusion of those measuring absolute or differential pressure is stated in the Introduction.

With minor exceptions neither catalogs, nor announcements in trade journals of new instruments without technical data, nor patents, are listed. Papers covering applications of vacuum technology are of necessity omitted, unless of some significance in vacuum measurement.

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Goto

4. SUBJECT INDEX

The subject index covers the material in the references as completely as possible, based mostly on a perusal of the reference, in some cases on an abstract and rarely only on the title.

The headings require some discussion. Outgassing and degassing are indexed under "Degassing" for convenience, since the phenomena are in many cases too closely related to be easily separated. For the same reason, papers on permeability and diffusion are indexed under "Diffusion of gases".

Gettering action has been covered under five headings: "Getters," under which gettering materials are covered; "Ion pumps" and "Getter-ion pumps," under which specific designs are covered; "Gettering action, ionization gages," the importance of which seemed to warrant a separate heading; and last, "Clean-up of gases, electrical," under which gettering action not otherwise covered is indexed.

Micromanometers cover the class of low pressure instrumentation which it is desired to discuss. Two headings are used, "Micromanometers, liquid type" and "Mechanical pressure and vacuum gages." The latter heading is preferable to "Micromanometers" because many designs of mechanical micromanometers have possible application to the vacuum range.

Finally, a distinction has been made between gaskets and seals. Mainly the design or physical properties of the gaskets are covered under "Gaskets," and the application and assemblies under "Seals."

In using the index, note that under the heading "Pressure measurement" all types of vacuum gages and micromanometers are listed under the various nomenclatures in use, with a reference to the heading under which it may be located in the index. The same has been done for pumps under the heading "Pumps."

Pump oils, rate of 5754

* U.S. GOVERNMENT PRINTING OFFICE : 1961 O—613308

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The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

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Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-Ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics. Electrolysis and Metal Deposition.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Crystal Growth. Physical Properties. Constitution and Microstructure.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Digital circuitry. Digital Systems. Analog Systems. Applications Engineering.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Solid State Physics. Electron Physics. Atomic Physics.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Molecular Kinetics. Mass Spectrometry.

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Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services.

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Interval Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

Radio Systems. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.