

# Basic principles of vacuum technology, brief overview

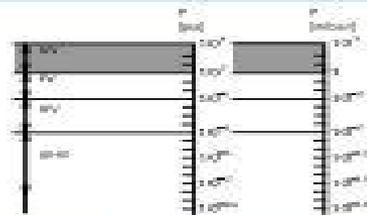
1 Introduction

## Basic principles of vacuum technology

### What is a vacuum?

A vacuum is a space entirely devoid of matter ("absolute vacuum"). In practice we talk about a vacuum when the air pressure in a space lies below atmospheric pressure.

### Vacuum ranges



### Units of measurement

There are a large number of national and international units of measurement. The most commonly used units are Pascal (Pa) and bar.

- 100 Pa = 1 hPa
- 1 hPa = 1 mbar
- 1 mbar = 0.001 bar

The vacuum level is often expressed as a % value. However, these are always relative values.

- 0.2r = Rough vacuum
- 1r = Medium vacuum
- 10r = High vacuum
- 0.1HV = Ultra-high vacuum

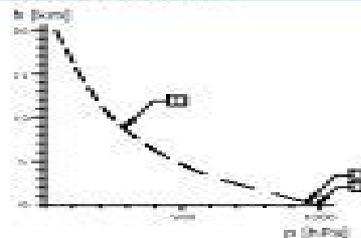
### What is a vacuum used for?

The vacuum plays a vital role in research in the fields of chemistry, biology and physics. It is also indispensable in many industrial processes.

### Measuring the pressure of vacuum

In the rough vacuum range, the pressure gauges used are mainly mechanical, but some digital pressure gauges are also used. In the high and ultra-high vacuum range, highly sensitive pressure gauges are used.

### Atmospheric pressure



1. Mount Everest
2. Festo
3. Sea level

## Understanding vacuum

Air is a gas mixture with agencies.  $10^{25}$  particles per  $m^3$  of air at one bar air pressure.

Particles exert pressure or force on the walls of a defined space. The fewer particles there are in the space, the lower the force exerted on the walls.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

100% vacuum would mean that there are no particles present. Pressure = 0.

### Vacuum specification options

A vacuum can be specified as an absolute value, i.e. with a positive sign from 1 to 0 bar, with 0 as absolute zero. Or it can be specified as a relative value with a negative sign from 0 to -1 bar, with 0 as a reference point, or as a %.

### Effects of changes on vacuum technology

As altitude increases, the air pressure in the atmosphere falls. This same effect reduces the attainable vacuum level of an ejector. Nevertheless, the performance level of 80% remains unchanged in this case.

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**M Lipman**



## **Basic Principles Of Vacuum Technology Brief Overview Festo:**

**Control Engineering** ,1982      **Expert Resumes for Engineers** Wendy S. Enelow,Louise Kursmark,2009 Expert Resumes for Engineers features an impressive collection of more than 180 pages of professionally written resume samples for all of the most prevalent types of engineers including civil mechanical industrial electrical electronics computer and more Plus top professional resume writers Enelow and Kursmark share tips and strategies for writing outstanding engineering resumes and finding the best jobs      Britannica Book of the Year ,1993      *The New Encyclopaedia Britannica: Micropaedia* ,1993      *Robotics Today* ,1985      **The Engineer** ,1959      **Vacuum Technology and Applications** David J. Hucknall,2013-10-22 Vacuum Technology and Applications reviews the most commonly encountered methods for the production containment and measurement of subatmospheric pressure This book also outlines a number of very important applications of this technology This text is organized into eight chapters and begins with a brief survey of the fundamental principles of vacuum technology The succeeding chapters deal with the pumps used for the production of rough medium and high ultra high vacua These chapters specifically cover their principles performance and applications These topics are followed by a discussion of the devices for residual gas analysis and partial pressure measurement Other chapters consider the aspects of leak detection using He specific mass spectrometer and the materials components and fabrication of vacuum devices The final chapters explore the application of vacuum technology in critical areas of industrial activity such as thin film technology semiconductor metallurgy and chemical industry This book will prove useful to practicing mechanical chemical and design engineers      **Introduction to Vacuum Technology** David M. Hata,2008 The approach taken in this book is to approach vacuum systems from a pressure regime viewpoint That is after covering some basic chemistry the first pressure regime covered is the rough vacuum regime Within the study of rough vacuum systems the following topics are covered the gas load the pumping mechanism pressure measurement and vacuum system construction The discussion of rough vacuum is then followed by the study of high vacuum systems The same topics are revisited but this time from a high vacuum perspective Once both rough vacuum and high vacuum systems are covered then the topics of leak detection and residual gas analysis are introduced This approach lends itself to laboratory experimentation During the review of gas laws from chemistry there are a number of experiments and demonstrations that can be performed to reinforce basic laws and concepts Then during the study of rough vacuum systems pumpdown times can be calculated and pumpdowns performed in the laboratory Likewise during the study of high vacuum systems pumpdowns as well as other lab exercises such as outgassing and residual gas analysis can be conducted Coverage of vacuum systems from a pressure regime viewpoint rather than from a topical viewpoint Focus on the fundamental science behind vacuum system components This book is written for users of vacuum systems especially the technicians that are responsible for maintaining them      Vacuum Technology ,2004 The environmental condition called vacuum is created any time the pressure of a gas is reduced compared to atmospheric

pressure On earth we typically create a vacuum by connecting a pump capable of moving gas to a relatively leak free vessel Through operation of the gas pump the number of gas molecules per unit volume is decreased within the vessel As soon as one creates a vacuum natural forces in this case entropy work to restore equilibrium pressure the practical effect of this is that gas molecules attempt to enter the evacuated space by any means possible It is useful to think of vacuum in terms of a gas at a pressure below atmospheric pressure In even the best vacuum vessels ever created there are approximately 3 500 000 molecules of gas per cubic meter of volume remaining inside the vessel The lowest pressure environment known is in interstellar space where there are approximately four molecules of gas per cubic meter Researchers are currently developing vacuum technology components pumps gauges valves etc using micro electro mechanical systems MEMS technology Miniature vacuum components and systems will open the possibility for significant savings in energy cost and will open the doors to advances in electronics manufacturing and semiconductor fabrication In conclusion an understanding of the basic principles of vacuum technology as presented in this summary is essential for the successful execution of all projects that involve vacuum technology Using the principles described above a practitioner of vacuum technology can design a vacuum system that will achieve the project requirements

**Industrial Vacuum 101 - Second Edition** Dan Bott,2011-10-01 The first of a three part series designed to highlight the principles of Vacuum Science and Technology This book is written for those who are new to vacuum and covers many of the topics that are used in industrial rough vacuum applications such as pressure conversions flow conversions pumpdown of closed systems vacuum technologies filtration and vacuum piping Readers will gain a working fluency of the words terms and concepts used in sizing and applying vacuum pumps to industrial and manufacturing processes In addition this book provides tips on the application and installation of vacuum pump accessories This book is complete with a glossary of common terms and a chapter dedicated to sample problems on major topics

**Overview of Vacuum Technology** Timothy A. Gessert,2021 Overview of Vacuum Technology provides the reader a broad treatment of typical systems and components used in the critical field of vacuum technology It demonstrates where and why certain vacuum components are used in this rapidly evolving area of science It develops the reader s understanding of how to effectively establish vacuum equipment that will meet both their present and near future needs This important reference offers guidance on costs of ownership concerns for initial purchase and other less understood costs related to operation and maintenance This foundation will allow technologists and researchers to acquire vacuum equipment capable of producing a required level of reproducibility as well as maintain the vacuum equipment within the research and production budgets This important book Provides definitions and use cases principles and key applications procedures and data evaluation Discusses the development of gas laws the transport of gas molecules and vacuum chamber outgassing Presents descriptions and selection advice for critical components such as gauges pumps valves chambers feedthroughs and flanges Scientists engineers and technologists in semiconductor electronics photovoltaics energy and materials science will find this

an invaluable reference Educators and researchers interested in vacuum technology will also find this book a useful resource

**Basic Vacuum Technology, 2nd edition** A. Chambers,1998-01-01 Vacuum technology is widely used in many manufacturing and developmental processes and its applications grow in scope and sophistication It is an inter disciplinary subject embracing aspects of mechanical electrical and chemical engineering chemistry and materials science while having a broad foundation in physics In spite of its technological importance and perhaps because of its cross disciplinary nature substantial teaching and training is not widely available Basic Vacuum Technology aims to give readers a firm foundation of fundamental knowledge about the subject and the ability to apply it This book is an introductory text on how to use vacuum techniques It provides a good grounding in the basic scientific principles and concepts that underlie the production and measurement of vacua The authors describe how these are applied in representative low medium high and ultra high vacuum systems and explain the most important practical aspects of the operation of a large variety of pumps components and measuring instrumentation The book introduces numerical methods for analysis and prediction of the behavior of vacuum systems in terms of the properties of their individual elements and enables readers to recognize and resolve problems with malfunctioning systems

**Basic Vacuum Technology**, A. Chambers,R. K. Fitch,B. S. Halliday,1989 The use of vacuum techniques is currently increasing to such an extent that they now find application in many areas of industrial development and production and academic research as well as fulfilling an important teaching role in undergraduate laboratories Basic Vacuum Technology addresses the need of undergraduate and postgraduate students engineers and technicians for a concise and up to date introduction to this subject Emphasising the underlying physics this book provides all the information required by new users of vacuum systems Its coverage is wide ranging from the behaviour of gases at low pressures through methods of vacuum production and measurement to system design and testing Basic Vacuum Technology will be particularly useful for newcomers to the subject since it contains all the necessary background material for a full understanding of vacuum systems It will also be of value to the growing number of industrial users of vacua particularly in the microelectronics and semiconductor industries and to researchers in surface science thin film studies electron microscopy atomic and nuclear physics and solid state science

*A Users Guide to Vacuum Technology* John F. O'Hanlon,Timothy A. Gessert,2023-10-16 A USERS GUIDE TO VACUUM TECHNOLOGY Choose and understand the vacuum technology that fits your project s needs with this indispensable guide Vacuum technology is used to provide process environments for other kinds of engineering technology making it an unsung cornerstone of hundreds of projects incorporating analysis research and development manufacturing and more Since it is very often a secondary technology users primarily interested in processes incorporating it will frequently only encounter vacuum technology when purchasing or troubleshooting There is an urgent need for a guide to vacuum technology made with these users in mind For decades A User s Guide to Vacuum Technology has met this need with a user focused introduction to vacuum technology as it is incorporated into semiconductor

optics solar sell and other engineering processes With an emphasis on otherwise neglected subjects and on accessibility to the secondary user of vacuum technology it balances treatment of older systems that are still in use with a survey of the latest cutting edge technologies The result promises to continue as the essential guide to vacuum systems Readers of the fourth edition of A User s Guide to Vacuum Technology will also find Expanded treatment of gauges pumps materials systems and best operating practices Detailed discussion of cutting edge topics like ultraclean vacuum and contamination control An authorial team with decades of combined research and engineering experience A User s Guide to Vacuum Technology is essential for those entering emerging STEM programs engineering professionals and graduate students working with a huge range of engineering technologies

**Vacuum Technology** David J Hucknall, Alan Morris, 2007-10-31 An accessible and applicable guide to quantitative problem solving in vacuum technology this book is aimed at newcomers students and the experienced practitioner It contains essential information and worked examples for those using vacuum technology in chemical applications and who are involved in the design and operation of vacuum equipment Using step by step solutions of example calculations and formulae Vacuum Technology Calculations in Chemistry sets out to encourage readers to quantify their own systems so that they can ensure efficient operation and fault finding Whilst emphasising the use of appropriate units in calculations and using well known expressions in vacuum technology throughout the book includes formulae necessary for quantitative vacuum technology commonly required data for common gases in tabulated form schematic diagrams of systems and layouts This book is certain to be a confidence inspiring publication for use in both research and industry

**Vacuum Technology, Thin Films, and Sputtering** R. V. Stuart, 2012-12-02 Vacuum technology is advancing and expanding so rapidly that a major difficulty for most companies in the field is finding qualified technicians needed for expansion and as replacements The only recourse for most companies is to hire capable though untrained people to train them in house One of the problems in this course of action is that it repeatedly draws on the valuable time of experienced personnel to explain fundamental concepts to a trainee Provides a variety of exercises in eac

**Fundamentals of Vacuum Science and System Design for High and Ultrahigh Vacuum, Volume 1** J.R. Gaines, Matthew Healy, 2024-10-17 Fundamentals of Vacuum Science and System Design for High and Ultrahigh Vacuum Volume 1 Introduction to Vacuum and Systems details the important practical considerations in design of vacuum systems for various vacuum deposition technologies Topics covered include an introduction to vacuum and end uses molecular density in vacuum molecular flow in various vacuum regimes characteristics of gas composition at various molecular densities general principles of gas solid interactions vacuum pump technology pressure sensors leak detection and the impact of fundamental design decisions and operating practices on vacuum system performance The introductory sections are designed to introduce the reader to basic concepts in vacuum technology More detailed sections provide fundamental descriptions of basic vacuum pumps and pumping mechanisms in current practice and provides insight into the various pros and cons for each approach System

design assembly maintenance and trouble shooting are reviewed in detail The book also describes a wide range of pressure measurement approaches and includes several key characterization techniques example applications on systems for rough vacuum high vacuum and ultrahigh vacuum as well as trade offs in system design These perspectives will allow the reader to develop an understanding of all the elements required for a successfully designed assembled and operating system Covers vacuum pump technology taking a system from atmosphere down to high or ultra high vacuum Discusses the fundamental descriptions of vacuum pumps and pumping mechanisms in current practice and provides insight into the various pros and cons for each approach Provides an overview of practical vacuum system operating techniques that will ensure optimal performance and troubleshooting methods to identify system deficiencies

Vacuum Technology Alexander Roth,1990  
Vacuum Technology: an Introduction L. G. Carpenter,1970      Vacuum Technology L. G. Carpenter,1983-01-01

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the relay is a dpdt relay the power supply is a 9v battery the timer is configured in the astable mode this means that it will generate a square wave output

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web jun 5 2022 upon application of input voltage the time delay t1 begins at the end of the time delay t1 the output is energized and remains in that condition for the time delay t2 at the end of this time delay t2 the output is de energized input voltage must be removed to reset the time delay relay

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web a special class of electromechanical relays called time delay relays provide delayed action either upon power up or power down and are commonly denoted in ladder logic diagrams by td or tr designations near the coil symbols and arrows on the contact symbols here is an example of a time delay relay contact used in a motor control

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web dec 31 2020 circuit diagram of the 555 timer latch circuit the schematic of the 555 timer based on off switch is given below in the circuit pin 2 and pin 6 are connected and pins 4 and 8 are also connected the output of the voltage divider circuit is

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web also called normally closed off delay relays one shot timers provide a single contact pulse of specified duration for each coil energization transition from coil off to coil on recycle timers provide a repeating sequence of on off contact pulses as long as the coil is maintained in an energized state

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