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Pressure
Basic Definitions, Units

DIN 1314

Druck; Grundbegriffe, Einheiten

1 Scope

The stipulations in this Standard apply to the pressure in liquids, gases and vapours.

2 Basic definitions

2.1 The physical magnitude pressure p is the quotient of the normal force F_N acting on a surface divided by said surface A:

$$p = \frac{F_N}{A}$$

2.2 In the field of engineering, various pressure magnitudes are commonly used; in the majority of cases, these represent the difference between two pressures, but in engineering parlance they are again referred to as "pressure". In order to avoid any misunderstandings, it is therefore recommended to adopt the denominations according to Sections 2.2.1 to 2.2.3 below.

2.2.1 Absolute pressure

The absolute pressure p_{abs} is the pressure vis-à-vis the pressure zero in a vacuum.

2.2.2 Pressure difference, differential pressure

The difference between two pressures p_1 and p_2 is called pressure difference $\Delta p = p_1 - p_2$, or, if it happens to be the measured variable, it is called differential pressure $p_{1,2}$.

2.2.3 Atmospheric pressure difference, overpressure

The difference between an absolute pressure p_{abs} and the prevailing (absolute) atmospheric pressure p_{amb} is the atmospheric pressure difference p_e; it is called overpressure:

$$p_e = p_{abs} - p_{amb}.$$

The overpressure p_e is positive if the absolute pressure is higher than the atmospheric pressure; it is negative if the absolute pressure is lower than the atmospheric pressure.

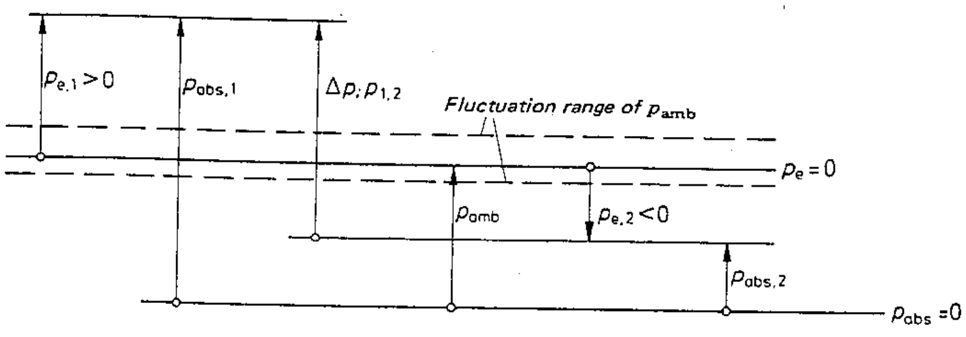
Note 1: Previously the term "overpressure" was only used in cases where the absolute pressure was higher than the atmospheric pressure; in cases where it was lower, the magnitude defined by the difference $p_{amb} - p_{abs}$ was called "underpressure" or "partial vacuum". As from now, the zone of underpressure will be characterized by negative values of overpressure.

The word "underpressure" or the expression "partial vacuum" shall in future no longer be used to denominate a magnitude, but only in connection with the qualitative designation of a state or condition, for example: "Low pressure (underpressure) chamber"; "A partial vacuum reigns in the suction pipe".

In the case of composite words which incorporate the word "overpressure", the "over" part of the word may be omitted in cases where the associated magnitude is clearly defined as an overpressure. Examples: Bursting pressure, blood pressure, sonic pressure, tyre pressure.

Note 2: The pressure zone below atmospheric pressure is also referred to as vacuum zone (see DIN 28 400 Part 1). In the vacuum technology, pressures are always given in the form of absolute pressures.

Note 3: The graphic representation below illustrates the relationship between the various pressure magnitudes.



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Note 4: The suffixes (indices) used in the formula symbols are derived from latin words:

abs	*absolutus*	*detached, independent*
amb	*ambiens*	*surrounding*
e	*excedens*	*exceeding*

3 Units

(See DIN 1301)

3.1 The SI unit of pressure is the Pascal (unit symbol: Pa):

$$1\ \text{Pa} = 1\ \text{N/m}^2$$

3.2 The tenth part of a megapascal (unit symbol: MPa) is called the bar (unit symbol: bar):

$$1\ \text{bar} = 0.1\ \text{MPa} = 0.1\ \text{N/mm}^2 = 10^5\ \text{Pa}.$$

Note: It has been considered useful and desirable to have a unit of pressure of the order of magnitude of atmospheric pressure at one's disposal; this is the reason for adopting the bar.

3.3 No additional marking shall be appended to the unit symbols for the purpose of differentiating between an absolute pressure and an overpressure. The distinction must be clearly expressed by means of the denomination of the magnitude and/or by means of the formula symbol adopted.

Appendix A

Conversion of pressure units no longer admissible for use into Pascal and bar.

The previously used pressure units kilopond divided by square centimetre (kp/cm^2), technical atmosphere (at), physical atmosphere (atm), Torr (Torr), conventional metre column of water (mWS) and conventional millimetre column of mercury (mmHg) shall be converted into the SI unit Pascal and into the unit bar in accordance with the conversion factors below:

$$1\ \text{kp/cm}^2 = 1\ \text{at} = 98\,066.5\ \text{Pa} = 0.980\,665\ \text{bar}$$

$$1\ \text{atm} = 101\,325\ \text{Pa} = 1.013\,25\ \text{bar}$$

$$1\ \text{Torr} = \frac{1\ \text{atm}}{760} = 133.322\ \text{Pa} = 1.333\,22\ \text{mbar}$$

$$1\ \text{mmHg} = 133.322\ \text{Pa} = 1.333\,22\ \text{mbar}$$

$$1\ \text{mWS} = 9\,806.65\ \text{Pa} = 98.0665\ \text{mbar}$$

Other relevant standards

DIN 1332	Acoustics; formula symbols
DIN 1343	Standard condition, standard volume
DIN 2401 Part 1	Pipelines; pressure ratings, definitions, nominal pressures
DIN 2401 Part 1	Structural components exposed to internal or external pressure; pressure and temperature concepts; definitions, nominal pressure rating stages (at present circulating as draft)
DIN 5492	Formula symbols used in fluid mechanics
DIN 16 109 Part 1	Dials for service pressure gauges, single graduation; 50 to 250 mm housing diameter; graduation scales and inscriptions
DIN 19 201	Flow measurement technique; concepts, instrument characteristics for flow measurement in accordance with the differential pressure method
DIN 24 312	Fluidics; pressure; pressure stages, definitions (at present circulating as draft)
DIN 28 002	Pressures and temperatures in vessels and appliances; concepts, rating of stages
DIN 28 400 Part 1	Vacuum technology; denominations and definitions; basic definitions, units, vacuum zones, vacuum characteristic magnitudes, fundamental principles
DIN 43 615	Electrical switchgear plant; nominal pressures and pressure ranges for compressed gas plants
DIN 43 691	Electrical switchgear plant; compressed air technology, pressure concepts
DIN 66 037	Kilopond per square centimetre – bar; bar – kilopond per square centimetre; conversion tables
DIN 66 038	Torr – millibar; millibar – Torr; conversion tables

A standard dealing with the mechanics of ideal elastic bodies (definitions, magnitudes, formula symbols), in which the relationship between the mechanical stress in solid bodies and the allround pressure in liquids is examined and discussed, is in course of preparation.

Explanations

In the DIN standard 1314 "Pressure; definitions, units" of December 1971, overpressure and underpressure were defined in the form of differences in relation to a reference pressure (usually the atmospheric pressure) in such a way that both these magnitudes were positive. The result was that it was impossible to distinguish from the readings of the figures on the dials of pressure gauges whether an overpressure or an underpressure was in fact being measured. In order to make sure that the correct result was being read without having to resort to any additional observations, most of the people interested in DIN standard 1314 expressed the desire for underpressure to be designated by negative values.

This could only be achieved by introducing a common and single magnitude (with corresponding positive and negative value zones) for both the zone of overpressure (i.e. for pressures above atmospheric) and the zone of underpressure (i.e. for pressures) situated between atmospheric pressure and zero pressure). Several requirements had to be satisfied in connection with the selection of a suitable name for this magnitude: the denomination had to be clear-cut and unequivocal, and not liable to confusion with any other denomination already in use; it had to be suggestive and therefore easily acceptable; it had to be brief and not liable to cause difficulties during the change-over. Many suggestions were discussed in this respect over a period of time; they include the following (in alphabetical order):

Active pressure
Differential pressure
Effective (or actual) pressure
Exceeding pressure
Excessive (or excess) pressure
Relative pressure
Overpressure, positive and negative

In the draft DIN standard 1314 of August 1974, the denomination "overpressure" was proposed for the entire zone of atmospheric pressure differences. This proposal did not at first meet with universal approval, particularly because the concept of underpressure was being replaced by an overpressure with a negative value. Consequently, at the meeting of the competent AEF Advisory Committee "Pressure" (AEF = Committee on Units and Formula Magnitudes) of 10th April 1975, the denomination "effective pressure" was proposed in conjunction with the objectors to the draft standard. During the ensuing discussion, it was however pointed out that this proposed denomination might easily be confused with the effective (or actual) value of an alternating magnitude called "effective pressure" for short in acoustics for instance, and more correctly designated "effective value of sound pressure".

At a further meeting of the competent AEF Advisory Committee jointly with the objectors to the draft standard, held on 26th November 1975, it became clearer than had been evident in previous discussions that a new word would meet with strong opposition from industry. It was therefore agreed to revert to the solution already proposed in the draft DIN standard 1314 of August 1974, and the expression "overpressure" was stipulated as the sole denomination for all atmospheric pressure differences.

Various advantages are ascribed to the denomination "overpressure". First and foremost, by far the greatest number of pressure measurements concerns pressure above atmospheric; in this case, nothing has been altered. In vessel and apparatus engineering and in the licensing of appliances, the word "overpressure" has already been adopted, e.g. by the TÜV (Technical Control Board) in the form of a "service overpressure". The appliance standards have already adopted the negative sign to characterize the zone of underpressure. On the other hand, certain disadvantages are enumerated, e.g. that the scope of a definition which has been in use for a long time is being altered, that the word "overpressure" implies a direction (i.e. that it designates a pressure situated above a given limit), and finally that the ambiguity which has always existed between a pressure difference vis-à-vis a reference pressure and a pressure difference vis-à-vis the permissible operating pressure is confusing. As regards the latter definition, the choice of a suitable denomination should be the concern of those bodies dealing with safety problems. The expression "danger pressure" might perhaps be usefully adopted.

Concurrently with the German expression "overpressure" (Überdruck), it has been proposed on the international level to use the words "gauge pressure" in the English language and "pression effective" in the French language with the same scope as applies to the German expression.

The word "underpressure" used as the denomination of a magnitude will now disappear as a result of the solution selected. This word may now only be used in conjunction with the qualitative description of a state or condition, as mentioned in the examples in Section 2.2.3. It remains to be seen whether the overpressure with a negative value (minus sign) will become generally accepted.

The decision to adopt the overpressure with a changed scope did not meet with unanimous approval, however the majority in favour of its adoption was very large, both among the participants to the meeting and among the objectors. In view of the wide variety of processes which use and measure pressure, it is hardly surprising that no solution can be found which will please everybody; the difficulties encountered in drafting the revised version of DIN standard 1314 prove this point.

Attention should be drawn to a basic difference between the new version of the present Standard and the December 1971 version. Previously, any arbitrary reference pressure could be selected as the datum line for defining overpressure and underpressure. In the new version, however, the overpressure is now defined in terms of a pressure difference vis-à-vis the atmospheric pressure. When it comes to comparing two arbitrary pressures, one must now talk in terms of pressure differences.

The problem of atmospheric pressure differences lies at the heart of the new version of DIN 1314. Another problem, which was not considered quite so complicated, was the one associated with the plurality of meanings of the word "pressure". On the one hand, particularly in the physicist's sphere of work, the word "pressure" is synonymous with the absolute pressure as defined in Section 2.2.1 of this Standard. On the other hand, mainly in the engineering jargon, the word "pressure" is used as a blanket definition which encompasses all pressure magnitudes, irrespective of their individual definition. The reason for this difference in approach lies in the fact that pressure to the physicist is a state variable which determines many of the properties of matter, whereas to the engineer and technician it represents a control magnitude which has to be monitored; it hardly needs saying that these two viewpoints represent opposite extremes. Because of these differences in approach, no attempt has been made to give headings to Sections 2.1 and 2.2. The physicist can thus continue to refer to "pressure" where he means absolute pressure, whilst on the other hand the measured variables in the industrial field are more clearly differentiated than heretofore. Industry is mainly concerned with pressure differences; even the absolute pressure can be conceived as the difference between two pressures, one of which is equal to zero. This representation is in keeping with measuring technique; the fact that absolute pressure was not defined in this way in the Standard is due to the introduction of the concept of pressure difference later on. In this conception, the denomination "absolute" might appear to the physicist at least to be inappropriate, in view of the meaning of the word. However the Standard stipulates quite clearly what is meant.

A pressure difference is of course a pressure once again. It is however necessary to make a distinction between pressure and pressure difference in order to pinpoint quite clearly the datum point of the latter magnitude and thus the point of origin of the pressure graduation scale used. A concession was made to certain desires expressed on this subject, and the concept of differential pressure was accordingly incorporated in the Standard. In this connection, it should be borne in mind that the differential pressure is obtained as a direct measurement reading on differential pressure measuring instruments incorporating a venturi or an orifice plate. The wording of Section 2.2.2 makes it perfectly clear that the denomination "pressure difference" is the preferred one.

The fact that the "over" portion may be omitted in composite words which include the word "overpressure" is the result of a quest for a simplification in terms commonly used. Although the last paragraph of Section 2.2.3 may not read quite as clearly as had been hoped, it should be adequate to dispel any misunderstandings.

The zone of overpressures with negative values (minus sign) coincides (in the manner in which it has been defined) with the vacuum zone as laid down in DIN Standard 28 400 Part 1: "A vacuum within the context of vacuum technology is the state of a gas, the pressure of which is lower than atmospheric pressure". In usual engineering parlance, this is hardly ever the case, as no one, or hardly any one is likely to refer to an absolute pressure of say 0.7 bar as a "vacuum", the latter term being reserved to describe very low and extremely low pressures. The qualification "within the context of vacuum technology" which was appended should however be adequate to differentiate the application ranges of the two words.

The graphic representation of overpressure, absolute pressure and pressure difference or differential pressure was incorporated in the Standard at the express desire of a large number of objectors, despite the fact that the relationships of the various pressure magnitudes to one another are so simple that a graph hardly seemed necessary.

The pressure units in force today and the conversion calculations for units which are no longer admissible for use have been incorporated in the present Standard as a result of a majority vote, despite the fact they already appear in DIN 1301 "Units; names and symbols"

The reason for adopting the "bar" has been included in the present Standard, because it seemed desirable to do so in view of the discussions concerning its future use which took place at the ISO, and which has raised doubts in the minds of users of the present Standard. There should be no objections to the further use of the "bar".