B Density

Density of air

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The density of air or atmospheric density, denoted ?, is the mass per unit volume of Earth's atmosphere at a given point and time. Air density, like air pressure, decreases with increasing altitude. It also changes with variations in atmospheric pressure, temperature, and humidity. According to the ISO International Standard Atmosphere (ISA), the standard sea level density of air at 101.325 kPa (abs) and 15 °C (59 °F) is 1.2250 kg/m3 (0.07647 lb/cu ft). This is about 1?800 that of water, which has a density of about 1,000 kg/m3 (62 lb/cu ft).

Air density is a property used in many branches of science, engineering, and industry, including aeronautics; gravimetric analysis; the air-conditioning industry; atmospheric research and meteorology; agricultural engineering (modeling and tracking of Soil-Vegetation-Atmosphere-Transfer (SVAT) models); and the engineering community that deals with compressed air.

Depending on the measuring instruments used, different sets of equations for the calculation of the density of air can be applied. Air is a mixture of gases and the calculations always simplify, to a greater or lesser extent, the properties of the mixture.

Probability density function

In probability theory, a probability density function (PDF), density function, or density of an absolutely continuous random variable, is a function whose

In probability theory, a probability density function (PDF), density function, or density of an absolutely continuous random variable, is a function whose value at any given sample (or point) in the sample space (the set of possible values taken by the random variable) can be interpreted as providing a relative likelihood that the value of the random variable would be equal to that sample. Probability density is the probability per unit length, in other words. While the absolute likelihood for a continuous random variable to take on any particular value is zero, given there is an infinite set of possible values to begin with. Therefore, the value of the PDF at two different samples can be used to infer, in any particular draw of the random variable, how much more likely it is that the random variable would be close to one sample compared to the other sample.

More precisely, the PDF is used to specify the probability of the random variable falling within a particular range of values, as opposed to taking on any one value. This probability is given by the integral of a continuous variable's PDF over that range, where the integral is the nonnegative area under the density function between the lowest and greatest values of the range. The PDF is nonnegative everywhere, and the area under the entire curve is equal to one, such that the probability of the random variable falling within the set of possible values is 100%.

The terms probability distribution function and probability function can also denote the probability density function. However, this use is not standard among probabilists and statisticians. In other sources, "probability distribution function" may be used when the probability distribution is defined as a function over general sets of values or it may refer to the cumulative distribution function (CDF), or it may be a probability mass function (PMF) rather than the density. Density function itself is also used for the probability mass function, leading to further confusion. In general the PMF is used in the context of discrete random variables (random variables that take values on a countable set), while the PDF is used in the context of continuous random variables.

Relative density

Relative density, also called specific gravity, is a dimensionless quantity defined as the ratio of the density (mass of a unit volume) of a substance

Relative density, also called specific gravity, is a dimensionless quantity defined as the ratio of the density (mass of a unit volume) of a substance to the density of a given reference material. Specific gravity for solids and liquids is nearly always measured with respect to water at its densest (at 4 °C or 39.2 °F); for gases, the reference is air at room temperature (20 °C or 68 °F). The term "relative density" (abbreviated r.d. or RD) is preferred in SI, whereas the term "specific gravity" is gradually being abandoned.

If a substance's relative density is less than 1 then it is less dense than the reference; if greater than 1 then it is denser than the reference. If the relative density is exactly 1 then the densities are equal; that is, equal volumes of the two substances have the same mass. If the reference material is water, then a substance with a relative density (or specific gravity) less than 1 will float in water. For example, an ice cube, with a relative density of about 0.91, will float. A substance with a relative density greater than 1 will sink.

Temperature and pressure must be specified for both the sample and the reference. Pressure is nearly always 1 atm (101.325 kPa). Where it is not, it is more usual to specify the density directly. Temperatures for both sample and reference vary from industry to industry. In British brewing practice, the specific gravity, as specified above, is multiplied by 1000. Specific gravity is commonly used in industry as a simple means of obtaining information about the concentration of solutions of various materials such as brines, must weight (syrups, juices, honeys, brewers wort, must, etc.) and acids.

Force density

\mathbf {B} } , where ? {\displaystyle \rho } is the charge density, E is the electric field, J is the current density, c is the speed of light, and B is the

In fluid mechanics, the force density is the negative gradient of pressure. It has the physical dimensions of force per unit volume. Force density is a vector field representing the flux density of the hydrostatic force within the bulk of a fluid. Force density is represented by the symbol f, and given by the following equation, where p is the pressure:

f

=

?

?

p

{\displaystyle \mathbf {f} =-\nabla p}

.

The net force on a differential volume element dV of the fluid is:

d

F

=

f

d

V

{\displaystyle d\mathbf {F} =\mathbf {f} dV}

Force density acts in different ways which is caused by the boundary conditions. There are stick-slip boundary conditions and stick boundary conditions which affect force density.

In a sphere placed in an arbitrary non-stationary flow field of viscous incompressible fluid for stick boundary conditions where the force density's calculations leads to show the generalisation of Faxen's theorem to force multipole moments of arbitrary order.

In a sphere moving in an incompressible fluid in a non-stationary flow with mixed stick-slip boundary condition where the force of density shows an expression of the Faxén type for the total force, but the total torque and the symmetric force-dipole moment.

The force density at a point in a fluid, divided by the density, is the acceleration of the fluid at that point.

The force density f is defined as the force per unit volume, so that the net force can be calculated by:

F

=

?

f

(

r

)

d

3

r

{\displaystyle \mathbf {F} =\int f(\mathbf {r})d^{3}\mathbf {r} }

.

The force density in an electromagnetic field is given in CGS by:

f

=

?

E

+

J

c

×

B

{\displaystyle \mathbf {f} =\rho \mathbf {E} +{\frac {\mathbf {J} }{c}}\times \mathbf {B} }

,

where

?

{\displaystyle \rho }

is the charge density, E is the electric field, J is the current density, c is the speed of light, and B is the magnetic field.

Density meter

density either has the units of k g / m 3 {\displaystyle kg/m^{3}} or l b / f t 3 {\displaystyle lb/ft^{3}} . The most basic principle of how density

A density meter (densimeter) is a device which measures the density of an object or material. Density is usually abbreviated as either

?

{\displaystyle \rho }

or

D

{\displaystyle D}

. Typically, density either has the units of

k

g

/

m

3

{\displaystyle kg/m^{3}}

or

l

b

/

f

t

3

{\displaystyle lb/ft^{3}}

. The most basic principle of how density is calculated is by the formula:

?

=

m

V

{\displaystyle \rho ={\frac {m}{V}}}

Where:

?

{\displaystyle \rho }

= the density of the sample.

m

{\displaystyle m}

= the mass of the sample.

V

{\displaystyle V}

= the volume of the sample.

Many density meters can measure both the wet portion and the dry portion of a sample. The wet portion comprises the density from all liquids present in the sample. The dry solids comprise solely of the density of the solids present in the sample.

A density meter does not measure the specific gravity of a sample directly. However, the specific gravity can be inferred from a density meter. The specific gravity is defined as the density of a sample compared to the density of a reference. The reference density is typically of that of water. The specific gravity is found by the following equation:

S

G

s

=

?

s

?

r

{\displaystyle SG_{s}={\frac {\rho _{s}}{\rho _{r}}}}

Where:

S

G

s

{\displaystyle SG_{s}}

= the specific gravity of the sample.

?

s

{\displaystyle \rho _{s}}

= the density of the sample that needs to be measured.

?

r

{\displaystyle \rho _{r}}

= the density of the reference material (usually water).

Density meters come in many varieties. Different types include: nuclear, coriolis, ultrasound, microwave, and gravitic. Each type measures the density differently. Each type has its advantages and drawbacks.

Density meters have many applications in various parts of various industries. Density meters are used to measure slurries, sludges, and other liquids that flow through the pipeline. Industries such as mining, dredging, wastewater treatment, paper, oil, and gas all have uses for density meters at various points during their respective processes.

Charge density

electromagnetism, charge density is the amount of electric charge per unit length, surface area, or volume. Volume charge density (symbolized by the Greek

In electromagnetism, charge density is the amount of electric charge per unit length, surface area, or volume. Volume charge density (symbolized by the Greek letter ?) is the quantity of charge per unit volume, measured in the SI system in coulombs per cubic meter (C?m?3), at any point in a volume. Surface charge density (?) is the quantity of charge per unit area, measured in coulombs per square meter (C?m?2), at any point on a surface charge distribution on a two dimensional surface. Linear charge density (?) is the quantity of charge per unit length, measured in coulombs per meter (C?m?1), at any point on a line charge distribution. Charge density can be either positive or negative, since electric charge can be either positive or negative.

Like mass density, charge density can vary with position. In classical electromagnetic theory charge density is idealized as a continuous scalar function of position

x

{\displaystyle {\boldsymbol {x}}}

, like a fluid, and

?

(

x

)

{\displaystyle \rho ({\boldsymbol {x}})}

,

?

(

x

)

{\displaystyle \sigma ({\boldsymbol {x}})}

, and

?

(

x

)

{\displaystyle \lambda ({\boldsymbol {x}})} are usually regarded as continuous charge distributions, even though all real charge distributions are made up of discrete charged particles. Due to the conservation of electric charge, the charge density in any volume can only change if an electric current of charge flows into or out of the volume. This is expressed by a continuity equation which links the rate of change of charge density

?

(

x

)

{\displaystyle \rho ({\boldsymbol {x}})}

and the current density

J

(

x

)

{\displaystyle {\boldsymbol {J}}({\boldsymbol {x}})}

.

Since all charge is carried by subatomic particles, which can be idealized as points, the concept of a continuous charge distribution is an approximation, which becomes inaccurate at small length scales. A charge distribution is ultimately composed of individual charged particles separated by regions containing no charge. For example, the charge in an electrically charged metal object is made up of conduction electrons moving randomly in the metal's crystal lattice. Static electricity is caused by surface charges consisting of electrons and ions near the surface of objects, and the space charge in a vacuum tube is composed of a cloud of free electrons moving randomly in space. The charge carrier density in a conductor is equal to the number of mobile charge carriers (electrons, ions, etc.) per unit volume. The charge density at any point is equal to the charge carrier density multiplied by the elementary charge on the particles. However, because the elementary charge on an electron is so small (1.6?10?19 C) and there are so many of them in a macroscopic volume (there are about 1022 conduction electrons in a cubic centimeter of copper) the continuous approximation is very accurate when applied to macroscopic volumes, and even microscopic volumes above the nanometer level.

At even smaller scales, of atoms and molecules, due to the uncertainty principle of quantum mechanics, a charged particle does not have a precise position but is represented by a probability distribution, so the charge of an individual particle is not concentrated at a point but is 'smeared out' in space and acts like a true continuous charge distribution. This is the meaning of 'charge distribution' and 'charge density' used in chemistry and chemical bonding. An electron is represented by a wavefunction

?

(

x

)

{\displaystyle \psi ({\boldsymbol {x}})}

whose square is proportional to the probability of finding the electron at any point

x

{\displaystyle {\boldsymbol {x}}}

in space, so

|

?

(

x

)

|

2

{\displaystyle |\psi ({\boldsymbol {x}})|^{2}}

is proportional to the charge density of the electron at any point. In atoms and molecules the charge of the electrons is distributed in clouds called orbitals which surround the atom or molecule, and are responsible for chemical bonds.

Bulk density

In materials science, bulk density, also called apparent density, is a material property defined as the mass of the many particles of the material divided

In materials science, bulk density, also called apparent density, is a material property defined as the mass of the many particles of the material divided by the bulk volume. Bulk volume is defined as the total volume the particles occupy, including particle's own volume, inter-particle void volume, and the particles' internal pore volume.

Bulk density is useful for materials such as powders, granules, and other "divided" solids, especially used in reference to mineral components (soil, gravel), chemical substances, pharmaceutical ingredients, foodstuff, or any other masses of corpuscular or particulate matter (particles).

Bulk density is not the same as the particle density, which is an intrinsic property of the solid and does not include the volume for voids between particles (see: density of non-compact materials).

Bulk density is an extrinsic property of a material; it can change depending on how the material is handled. For example, a powder poured into a cylinder will have a particular bulk density; if the cylinder is disturbed, the powder particles will move and usually settle closer together, resulting in a higher bulk density. For this reason, the bulk density of powders is usually reported both as "freely settled" (or "poured" density) and "tapped" density (where the tapped density refers to the bulk density of the powder after a specified compaction process, usually involving vibration of the container.)

Density gradient

Density gradient is a spatial variation in density over a region. The term is used in the natural sciences to describe varying density of matter, but can

Density gradient is a spatial variation in density over a region. The term is used in the natural sciences to describe varying density of matter, but can apply to any quantity whose density can be measured.

Area density

The area density (also known as areal density, surface density, superficial density, areic density, column density, or density thickness) of a two-dimensional

The area density (also known as areal density, surface density, superficial density, areic density, column density, or density thickness) of a two-dimensional object is calculated as the mass per unit area. The SI derived unit is the "kilogram per square metre" (kg·m?2).

In the paper and fabric industries, it is called grammage and is expressed in grams per square meter (g/m2); for paper in particular, it may be expressed as pounds per ream of standard sizes ("basis ream").

A related area number density can be defined by replacing mass by number of particles or other countable quantity, with resulting units of m?2.

Energy density

In physics, energy density is the quotient between the amount of energy stored in a given system or contained in a given region of space and the volume

In physics, energy density is the quotient between the amount of energy stored in a given system or contained in a given region of space and the volume of the system or region considered. Often only the useful or extractable energy is measured. It is sometimes confused with stored energy per unit mass, which is called specific energy or gravimetric energy density.

There are different types of energy stored, corresponding to a particular type of reaction. In order of the typical magnitude of the energy stored, examples of reactions are: nuclear, chemical (including electrochemical), electrical, pressure, material deformation or in electromagnetic fields. Nuclear reactions take place in stars and nuclear power plants, both of which derive energy from the binding energy of nuclei. Chemical reactions are used by organisms to derive energy from food and by automobiles from the combustion of gasoline. Liquid hydrocarbons (fuels such as gasoline, diesel and kerosene) are today the densest way known to economically store and transport chemical energy at a large scale (1 kg of diesel fuel burns with the oxygen contained in ? 15 kg of air). Burning local biomass fuels supplies household energy needs (cooking fires, oil lamps, etc.) worldwide. Electrochemical reactions are used by devices such as laptop computers and mobile phones to release energy from batteries.

Energy per unit volume has the same physical units as pressure, and in many situations is synonymous. For example, the energy density of a magnetic field may be expressed as and behaves like a physical pressure. The energy required to compress a gas to a certain volume may be determined by multiplying the difference between the gas pressure and the external pressure by the change in volume. A pressure gradient describes the potential to perform work on the surroundings by converting internal energy to work until equilibrium is reached.

In cosmological and other contexts in general relativity, the energy densities considered relate to the elements of the stress–energy tensor and therefore do include the rest mass energy as well as energy densities associated with pressure.

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