Wind/Flow

Content

Wind and Flow

Flow

Flow signifies the movement of liquids or gases. The laws of flowing liquids apply also to flowing gases, provided that the velocity of flow remains below the speed of sound, that is that the flowing gases can be considered to be practically incompressible. Flow arises among other causes from gravity and pressure differences.

Flow field, steady flow

At every given moment, each particle of a flow has a certain velocity in quantity and direction. The space that the flowing particles fill is known as the flow field. Stream lines are used to identify the direction of velocity of the particles. The tangent at any point along the stream line indicates the direction of flow at this point. The conditions are particularly clear when the paths of the particles correspond to the stream lines. This type of flow is known as steady flow.

Inviscid flow

In the absence of vortex formation and above all inner friction, the terms "ideal liquid" and "ideal flow" are used.

Laminar flow

Laminar flow occurs when there is inner friction but no vortex formation. Inner friction is a consequence of the force effect between molecules. In contrast to outer friction, which arises between the surfaces of two bodies, inner friction is found only within the flowing medium, between neighbouring liquid strata of different velocities.

Beaufort

Wind speed is usually indicated with the aid of the Beaufort Scale. The following table lists the Beaufort wind strengths together with the associated wind speeds and the metrological identification:

Beaufort Wind Strength	Wind Velocity in Knots	Wind Velocity in m/s	Wind Velocity in km/h	Identification
0	0-1	0-0.2	0-1	Still air
1	1-3	0.3-1.5	1-5	Light draught
2	4-6	1.3-3.3	6-12	Slight breeze
3	7-10	3.4-5.4	12-19	Light breeze
4	11-15	5.5-7.9	20-28	Moderate breeze
5	16-21	8.0-10.7	29-38	Fresh breeze
6	22-27	10.8-13.8	39-49	Strong wind
7	28-33	13.9-17.1	50-61	Stiff wind
8	34-40	17.2-20.7	62-74	Stormy wind
9	41-47	20.8-24.4	75-88	Storm
10	48-55	24.5-28.4	89-102	Heavy storm

11	56-63	28.5-32.6	103-117	Gale force
12	>64	>32.7	>117	Hurricane

Radiation

Every body, whose temperature lies above absolute zero, i.e. -273Â°C or also 0Â°K, radiates energy in the form of electromagnetic radiation. This fact goes back to quantum theory, i.e. through the magnetic interaction of the inner charge energies between atomic core and electrons, self-induced vibrations are produced in the spatial grid, which are emitted as electromagnetic radiation. At -273Â°C there arises no further electromagnetic radiation and this point is therefore defined as absolute zero. Infrared radiation is a part of the total electromagnetic spectrum. Since, according to Planck, the intensity of radiation especially in the infrared range is a reliable measure for the absolute temperature of the radiating object, only this range is used for contactless temperature measurement.

Laws of radiation

Kirchhoff's Law

Kirchhoff's Law establishes the relationship between a black emitter and a real emitter. The radiation duty of an emitter is compared with that of a black emitter of the same surface area, at the same solid angle and for the same wavelength range. The coefficient of emission is the ratio of the real emitter to the black emitter. Here, *M(sk)* is the specific radiation of the black emitter at an absolute temperature *T*.

$$\varepsilon = \frac{M(T)}{Msk(T)}$$

It is true for all bodies that, dependent on temperature *T* and wavelength λ, the coefficient of emission ε is equal to the coefficient of absorption α.

$$\varepsilon(\lambda, T) = \alpha(\lambda, T)$$

Stefan Boltzmann's Law

The radiation emitted by a body on the basis of its temperature has a duty *P* (a radiation flow F), which is proportional to the size of the radiating surface *A* and the body temperature T to the power of 4. The proportionality factor is described as the Stefan Boltzmann constant.

$$\sigma = 5{,}67051 \times 10^{-8} \frac{W}{m^2 K^4}$$

The following therefore applies:

$$P = \sigma\varepsilon A T^4$$

Planck's Law of Radiation

This describes the radiation duty of a black emitter as a function of temperature *T* and wavelength l .

The following applies:

$$dP_\lambda = \frac{2\pi h {c_0}^2}{\lambda^5} \frac{A}{e^{\frac{hc_0}{k\lambda T}} - 1} d\lambda$$

where:

dPl = Radiated duty in the wavelength range l to l +*dl*

h = Planck's quantum effect (= 6.626×10^{-34} Js)

c_0 = Speed of light (= 2.998×10^{8} m/s)

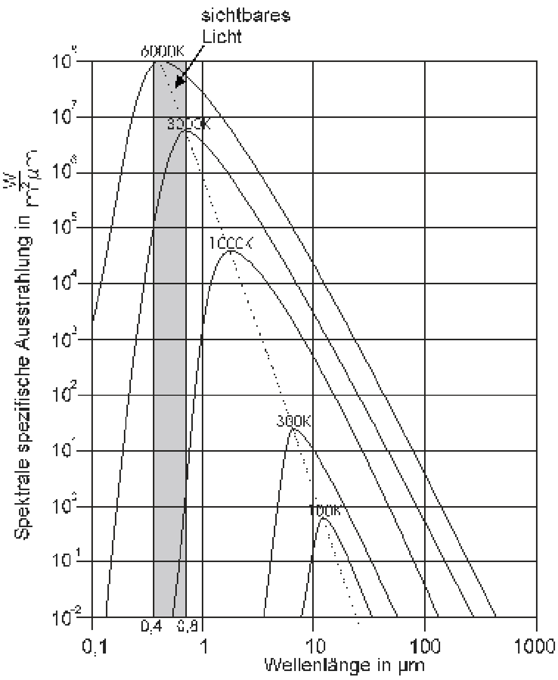
λ = Wavelength of the radiation

dl = Interval width

k = Boltzmann constant (= 1.381×10^{-23} J/K)

T = Temperature of the emitter

A = Surface of the emitter



As can be seen from the above chart, with increasing temperature the maximum of the specific radiation changes to shorter wavelengths.

Wiensch's Law of Displacement

Wiensch's Law of Displacement may be derived by differentiating Planck's Law of Radiation. Accordingly, the emitted radiation duty of a black body has a maximum as a function of the wavelength, whose position depends on the temperature of the emitter. With increasing temperature, the energy of the radiation increases and the maximum of the radiation changes to shorter wavelengths. The following relationship exists between the temperature and the wavelength of the radiation maximum:

$$\lambda_{\max} = \frac{2898 \mu m}{T_K}$$

Dataloggers

Dataloggers are instruments that are used in both environmental measurement technology and industrial applications. These data collectors can be operated in fixed locations (mains operation) or mobile. The various types offer a multiplicity of recording and evaluation options. It is possible to store the data in the instrument (offline mode), or, using appropriate software, to display the data directly on a PC (online mode).

The LUFFT Company is a manufacturer of these dataloggers.

The following instruments belong to this range: OPUS I, OPUS II, OPUS 200(i)/300(i), OPUS 208 and OPUS 10. These instruments offer a variety of connection and storage possibilities in all price classes.