An analysis of the essence of the Bernoulli effect in perspective of thermodynamics

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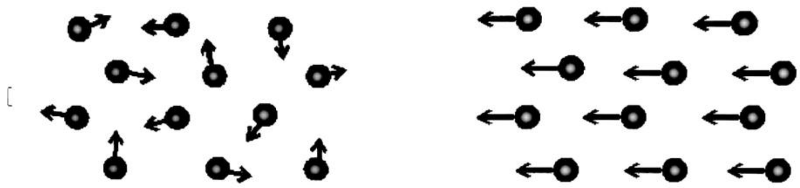
Abstract: Boltzmann gave us the answer to temperature and Bernoulli summarized the laws of motion of fluids. So is there a connection between temperature and the motion of fluids? The answer is yes. Fluids that move in different ways exhibit different temperatures.

Keyword : Thermal order,The entropy theory,The Bernoulli effect is in essence

As in Figure 1-1, for the ideal gas, assuming that the average kinetic energies of molecules A and B are equal, what is the temperature and pressure of B?



A　　　　B

$P = \frac{2}{3} n\bar{E}$　　$T = \frac{2}{3k}\bar{E}$　　　　$P=?$　　$T=?$

Figure 1-1

1. Before answering this question, let us introduce a concept: "order"

Order, the degree of order, corresponds to the concept entropy. Entropy, the degree of chaos, refers to the degree of randomness. The entropy is not equivalent to the entropy of entropy increase theory.

For thermal motion, the thermal order and thermal entropy are introduced.

Thermal entropy:

$$S_h = \frac{Q}{E_t}$$

Q is the heat and E_t is the total translational energy. The total translational energy is the sum of the disordered translational energy and the ordered translational energy. Therefore, the thermal entropy represents the proportion of the translational energy that is purely randomly generated heat.

Thermal order：

$$O_h = 1 - S_h$$

denotes the degree of ordering of the flat moving particles

For figure B, since the thermal entropy is 0, the temperature is:

$$T = \frac{2}{3k}\overline{E}\,S_h = \frac{2}{3k}\overline{E} \times 0 = 0$$

Temperature only represents a representation of the average kinetic energy of disordered molecules. The average kinetic energy of ordered molecules is not expressed as a temperature.

We then deform the formula for the pressure of an ideal gas to give:

Transverse pressure

$$P = \frac{2}{3} n \overline{E} S_h$$

Longitudinal pressure

$$P = \frac{2}{3} n \overline{E} O_h$$

For gases here the transverse and longitudinal pressures are the static and dynamic pressures of Bernoulli's equation and have a more fundamental formulation than Bernoulli's equation. For incompressible fluids, the hydrostatic and kinetic pressures are in fact the conversion of potential and kinetic energy, independent of the thermal order.

As a result, it can be found that the static pressure in diagram B is 0 and the dynamic pressure: $P = \frac{2}{3} n \overline{E}$

Thermal order is suitable for all compressible media.

2. In the case of heat engines, the conversion of thermal energy into mechanical energy is actually the conversion of disordered energy into ordered energy.

Example:

Work done by balloon expansion:Take a micro-element at the non-centre of the balloon, then the total probability of motion of the particles within that micro-element will be in a certain direction (a ray from the centre in a certain direction). Therefore, the gas expansion does work disordered translational energy becomes smaller ordered translational energy becomes larger and S_h becomes smaller. And because $Q = E_t S_h$, thermal energy becomes lower and the temperature drops.

Work done by compressing the gas: the thermal entropy of the gas remains the same before and after compression, both being 1, while the total translational energy E_t increases. because of the absorption of translational from external work, which is initially transformed for the ordered motion. So, because of $Q = E_t S_h$, E_t becomes larger, Q increases and the temperature rises.

3. **Conclusion:**

Order is the essential description of the Bernoulli effect, and also provides a more rational explanation for the transformation of energy forms, and is also useful for various medium force fields. Furthermore, there are phase and space order, which will be discussed later.

references:

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