Atmospheric Pressure and Its American Unit

Kedar Mhaswade

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Practical Problem: How do you specify 1 atmospheric pressure in the USA?

Solution: We won't go into why the USA keeps the FPS system of measurement, but instead, focus on the problem as it is faced by a young and hapless student of science.

In the USA, pressure, which is force per unit area, is expressed in **pound-force/in^2**, **lbf/in^2**, or **psi** for short. Note that the 'p' in psi stands for *pound-force* and not pound, although informally it is taken that way (i.e. pound/in^2). If you ask a random American, they might say that the unit of pressure there is "psi, *pound* per square inch". Historical aspects of the mess resulting from such perceived equivalence are described in [1].

As if this were not confusing enough, the definition of **1 pound-force** or **1 lbf** was defined as the *weight* of 1 pound *mass*[1] on the surface of earth! This was really short-sighted. Anyway, the weight W in **lbf** of **1 pound mass** (or 454 g or

[1] We feel sorry for those who were taught in a manner to treat mass and weight interchangeably.

0.454 kg) on the surface of earth, is

$$\begin{aligned} W &= mg \ldots [2] \\ &= 1 \times 9.8 \text{ lb m/s}^2 \\ &= 0.454 \times 9.8 \text{ kg m/s}^2 \\ &= 4.4492 \text{ N} \ldots [3] \end{aligned}$$

Thus, **1 lbf** force is equivalent to **4.448** N.

Then,

$$\begin{aligned} 1 \text{ psi} &= 1 \text{ lbf/in}^2 \\ &= 4.4492 \text{ N/in}^2 \\ &= 4.4492 \times 39.37 \times 39.37 \text{ N/m}^2 \\ &= 6896.246 \text{ Pa} \end{aligned}$$

Pascal: Pa is the SI unit of pressure. Since 1 atomospheric pressure is 101325 Pa, from the above we get:

$$\begin{aligned} 1 \text{ atm} &= \frac{101325}{6896.246} \text{ psi} \\ &= 14.693 \text{ psi} \end{aligned}$$

That's it. 1 atmospheric pressure is 14.693 psi. It is enormous pressure that we have evolved to bear easily.

References

[1] François Cardarelli. Encyclopaedia of Scientific Units, Weights, and Measures: Their SI Equivalences and Origins. Springer. 2003.

[2] g on eath is 9.8 m/s^2 = 32.2 ft/s^2

[3] SI unit of force is N (Newton) which is cleanly defined as the force required to accelerate 1 kg *mass* at 1 m/s^2