

The stored energy in an inductance in engineering notation is

$$E = \frac{1}{2} LI^2$$

Where L is the inductance and I the current .The stored energy in physics notation is

$$E = \frac{1}{2} \int_{vol} \mathbf{H} \cdot \mathbf{B} dV = \frac{\mu\mu_0}{2} \int_{vol} H^2 dV$$

where μ is the relative permeability. Equating the two and dividing by I gives

$$L = \mu\mu_0 \int_{vol} \left[\frac{H}{I} \right]^2 dV$$

So how can we have infinite inductance? I cannot visualize the volume going to zero, or the ratio H/I going to infinity, in part because $H = NI$. I cannot also visualize the permeability of free space going to infinity (which would require the speed of light to go to zero), so let's choose an infinite relative permeability. In this case we are not requiring H going to infinity, or I going to zero.

Having such an inductance would solve a lot of problems related to alternative energy and energy storage, but it implies the ability to store an infinite amount of energy in a small volume, which sooner or later will run into some physics limits. What would happen if the current was ever disconnected, for example? $V = L \cdot dI/dt$ implies an infinite voltage out.