Evidently, all three quantities must have the same dimensionality. Since the dimensionality of **M** is that of a frequency -

$$\frac{\text{magnetic dipole moment}}{\text{volume}} =\!\int\!= \frac{\ell^3 t^{-1}}{\ell^3} =\!\int\!= t^{-1}$$

H and **B** would also have to be frequencies. The measure of **H**, therefore, could never be that of a current over a distance s, and would comply instead with the identity $\int \mathbf{H}\, ds = 4\pi\, I_{free}/c$.

If the dimensionality of **H** is that of a frequency, t^{-1}, then the integral becomes dimensionally equivalent to a velocity function:

$$\int \mathbf{H}\, ds = 4\pi\, I_{free}/c =\!\int\!= (\ell^2 t^{-2}/\ell t^{-1}) = \ell t^{-1}$$

Assuming that $\mathbf{H} =\!\int\!= t^{-1}$ also remains consistent with the dimensionality of the curl of **H** in the cgs system:

$$\text{curl}\, \mathbf{H} = \text{curl}(\mathbf{B} - 4\pi\mathbf{M}) = (4\pi/c) * J_{free} =\!\int\!= (\ell^2 t^{-2}/\ell^2)/\ell t^{-1} = \ell^{-1} t^{-1}$$

Furthermore, it is in the same cgs system that one assumes the permeability of ‘the vacuum’ to be unity, such that in ‘a vacuum’ there is no essential distinction between **B** and **H** - as $\mu = 1$, and thus

$$\mathbf{B} = \mu\mathbf{H} = \mathbf{H}$$

and as $\mathbf{M} = 0$, thus

$$\mathbf{H} = \mathbf{B} - 4\pi\mathbf{M} = \mathbf{B}$$

This is, in fact, the reason often cited (2) to explain why Maxwell wrote his equation for vacuum fields employing **E** and **H** and not **E** and **B** and why, likewise, it is customary to use **E** and **H** to describe the functions of electromagnetic waves.

5. To summarize, then: in the SI/mks system(s), the definition of **H** appears to have a definite dimensionality - that of acceleration: