A fine coil of wire with $N$ turns is wound on a washer composed of a magnetic material, as sketched above. The inner and outer radii of the washer are $a$ and $b$, respectively. The thickness of the washer is $c$. A current $I = 1$ amp is established in the wire.

The magnetic material is a special material that has a nearly rectangular hysteresis loop. An example of the $B$ vs. $H$ curve for such a material is shown on the right. We will approximate it in this problem by the rectangular hysteresis loop shown on the left for which the magnitudes of $B$ and $H$ are bounded by $B_0$ and $H_0$, respectively.

(a) Determine $H(\rho)$ at a point inside the washer at distance $\rho$ from the center in terms of $I$ and $N$.
(b) Determine the smallest value of $N$ needed to produce $B = B_0$ at every point in the washer. We will call this the saturated state of the washer.
(c) What is the magnetization $M$ in the washer after it has been saturated fully and the coil current, subsequently, reduced to zero? Give both magnitude and direction.
(d) The current in the wire is cycled from 1 amp to -1 amp and back to 1 amp. Calculate the energy dissipated in the saturated washer. Neglect the electrical resistance in the coil.