1.1.27. SIMPLE AND PRECISE INTERPOLATING FORMULAS FOR CALCULATING THE CENTRAL DEMAGNETIZATION COEFFICIENT FOR FERROMAGNETIC BODIES

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A solid and a hollow cylinder, a bar of an arbitrary profile, a plate (fig. 1) made of materials with high ($\mu >> 1$) and low ($\mu \approx 1$) magnetic permeability are the physical models for many industrial and electro technical objects.

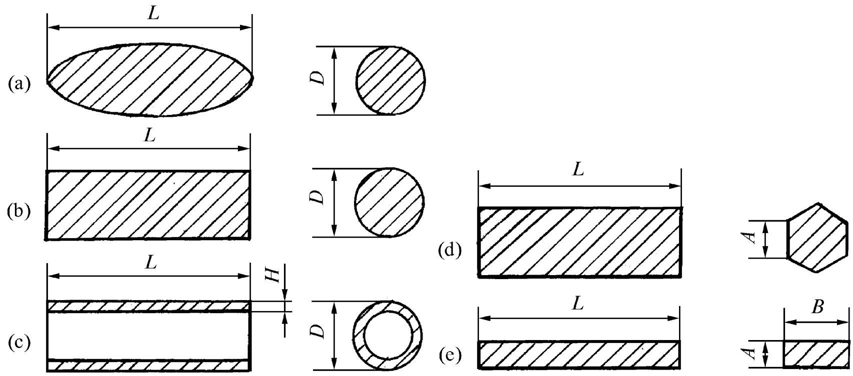

Fig. 1. Longitudinal and transverse sections of the considered ferromagnetic bodies with notations of their geometrical measures

The parameter, which determines the processes of magnetization and functioning of these objects, is their central demagnetization coefficient *N*.

On basis of the author's investigations [1 – 3] and analysis of the known theoretical and experimental results, the simple and precise interpolating formulas are recommended to use for calculating *N* (see the next page).

The shape of the body (figure)	Formula for calculation	Notations, parameters' variation ranges
Rotation ellipsoid	$N = f(\lambda)$ $\lambda = \frac{L}{D}$	$f(\lambda) = \frac{1}{1-\lambda^2}\left[1 - \frac{\lambda}{\sqrt{1-\lambda^2}}\arccos\lambda\right],\ 0 \le \lambda < 1$ $f(\lambda) = \frac{1}{\lambda^2 - 1}\left[\frac{\lambda}{\sqrt{\lambda^2-1}}\ln\left(\lambda + \sqrt{\lambda^2 - 1}\right) - 1\right],\ \lambda > 1$

Cylinder, magnetized longitudinally	$N \approx f(\lambda)\,k(\lambda)$ $\lambda = \frac{L}{D}$	$k(\lambda) = \frac{1 + 2.35\ln\left(1 + 0.137\lambda\right)}{1 + 2.28\ln\left(1 + 0.284\lambda\right)}, \quad \mu >> 1$
		$k(\lambda) = \frac{1}{1 + 2.15\ln\left(1 + 0.326\lambda\right)}, \; \mu \approx 1$
Polyhedron (n-number of faces)	$N \approx f(\lambda_{\text{ef}})k(\lambda_{\text{ef}})$	$\lambda_{\text{ef}} = \frac{L}{A}\sqrt{\frac{\pi \mathrm{tg}\frac{\pi}{n}}{n}}, \; 0 \le \lambda\text{ef} < \infty$
Plate, magnetized along the side L	$N \approx f(\lambda_{\text{ef}})k(\lambda_{\text{ef}})$	$\lambda_{\text{ef}} = \frac{L}{2}\sqrt{\frac{\pi}{AB}}, \; 0 \le \lambda\text{ef} < \infty$
Hollow cylinder, magnetized longitudinally	$N \approx h(2-h)f(\lambda)\times$ $\times k(\lambda)$	$\lambda = \frac{L}{D}; \; h = \frac{2H}{D}, \; 0.2 \le \lambda < \infty, \; 0 \le h \le 1$
	$N \approx \frac{1}{1 + \beta\lambda^{\varepsilon}}$	$\varepsilon = 0.3075\left[1 + \left(\frac{1.41}{h(2-h)}\right)^{-1}\right];$ $\beta = 5^{\varepsilon}\left[\frac{1.41}{h(2-h)} - 1\right], \; \lambda \le 0.3$
Hollow cylinder, magnetized orthogonally to the axis	$N_{\perp} \approx \frac{h}{2}\times$ $\times\left[1 - \mathrm{f}(\lambda)k(\lambda)\right]$	$0 \le \lambda < \infty, \quad 0 \le h \le 1$

References:

1. **Sandomirski S.G.** Recommendations on use in technical calculations of formulas for central demagnetization coefficient of solid and hollow cylinders, bars and plates made of materials with high magnetic permeability (review) // Technical diagnostics and non-destructive testing (Техническая диагностика и неразрушающий контроль). – 2008. – № 3. – P. 38 – 46.
2. **Sandomirski S.G.** Analysis of formulas for calculating the central demagnetization coefficient of hollow cylinders made of a material with high magnetic permeability at magnetization orthogonally to the generatrix // Electrotechnics (Электротехника). – 2008. – № 3. – P. 45 – 51.
3. **Sandomirski S.G.** Computing short hollow cylinders at magnetization parallel to the generatrix // Electrotechnics (Электротехника). – 2009. – № 2. – P. 52 – 55.