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Displacement current :-

For static electro magnetic field, by Ampere's circuital law:-

$$\nabla \times \overline{H} = \overline{J} \quad \text{--- (1)}.$$

taking divergence

$$\nabla \cdot (\nabla \times \overline{H}) = \nabla \cdot \overline{J}$$

but ∇ product of any vector is zero.

$$\therefore \nabla \cdot (\nabla \times \overline{H}) = \nabla \cdot \overline{J} = 0 \quad \text{--- (3)}.$$

$\because$ Continuity eqn says that.

$$\nabla \cdot \overline{J} = \frac{-\partial \rho_v}{\partial t} \quad \text{--- (4)}.$$

$\therefore$ eqn (3) & (4) are incompatible for time varying fields.

$$\therefore \nabla \times \overline{H} = \overline{J} + \underline{\underline{J_d}}$$

(adding of new component)

$$\therefore \nabla \cdot (\nabla \times \overline{H}) = \nabla \cdot \overline{J} + \nabla \cdot \overline{J}_d = 0.$$

by applying continuity eqn

$$\nabla \cdot \overline{J}_d = -\nabla \cdot \overline{J} = \frac{\rho_v}{\partial t}$$ → apply ~~stokes's~~ gauss

$$\therefore \nabla \cdot \overline{J}_d = \frac{\partial}{\partial t} (\nabla \cdot D)$$