

()

(L) ⁽¹⁾

L'

Effect of Rail Dimensions on Railgun magnetic field distribution and Inductance Gradient

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Abstract

Magnetic field distribution in railgun structure is the effective factor that determines its efficiency. This field distribution is affected by rails and armature geometry and dimensions. This paper investigates how the rails dimensions and spaces affect the magnetic field distribution, magnetic flow density and inductance gradient (L'). L' plays an important role in the performance of an Electromagnetic Launcher (EML), and it determines directly the force that accelerate projectile. A finite element method is discussed to simulate two dimensional railgun in this study. Finally L' for various dimensions are tabulated and compared with values obtained from other methods.

Key words: Inductance gradient, Railgun, FEM, Magnetic flow.

1- Railgun
2- Inductance Gradient

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L'

ac

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$$F = \frac{1}{2} L' I^2 \quad ()$$

()

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L'

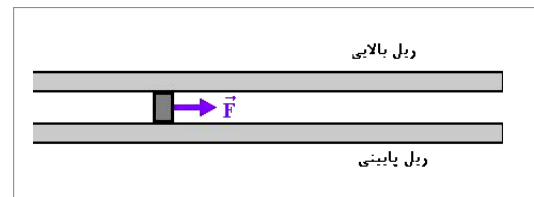
F

I (H/m)

()

$$\sigma = 5.7 \times 10^8 \text{ S/m}$$

y-z x-z



x-z

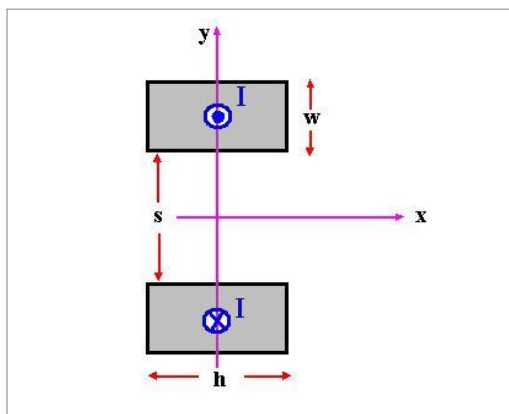
y-z

$$H_t = 0$$

y-z

$$H_n = 0$$

x-z



[]

L'

L'

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L'

w

s

h

dc

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$$\vec{B} = \nabla \times \vec{A} \quad (1)$$

$$F = E_m = \frac{1}{2} \sum_i \frac{1}{\mu_i} |\vec{B}_i|^2 S_i \quad (2) \quad \nabla \times \left(\frac{1}{\mu} \nabla \times \vec{A} \right) + \sigma \frac{\partial \vec{A}}{\partial t} = \vec{J} \quad (3)$$

$$\vec{J} = \sigma \frac{\partial \vec{A}}{\partial t} \quad (4)$$

$$L' = \frac{2F}{I^2} \quad (5) \quad \vec{J}_e = -\sigma \frac{\partial \vec{A}}{\partial t} \quad (6)$$

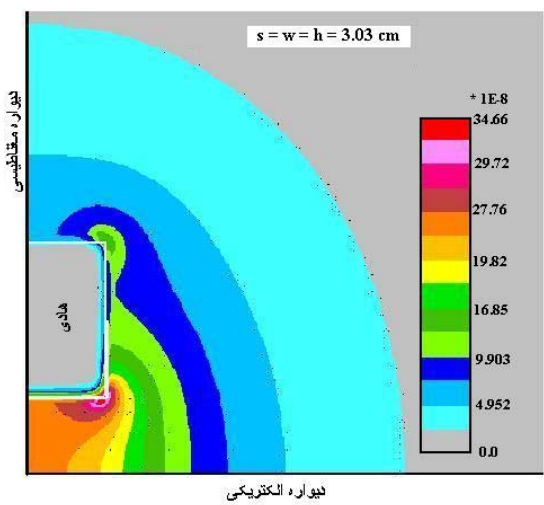
$$\nabla \cdot \left(\frac{1}{\mu} \nabla A \right) - \sigma \frac{\partial A}{\partial t} = -J \quad (7)$$

$$\omega \quad J \quad (ac) \quad j\omega \frac{\partial}{\partial t} \quad (8)$$

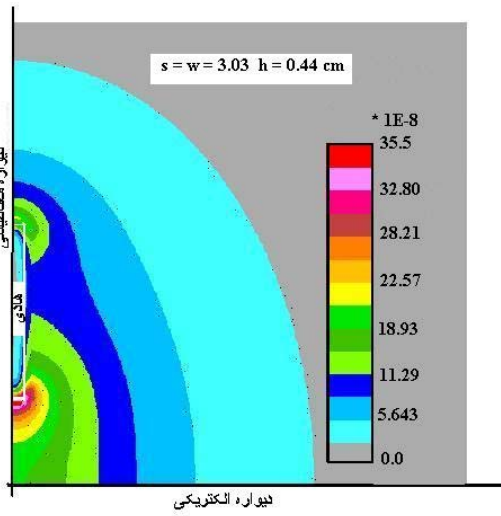
$$\nabla \cdot \left(\frac{1}{\mu} \nabla A \right) - j\omega\sigma A = -J \quad (9)$$

$$\vec{B} \quad (10)$$

$$E_m = \frac{1}{2} \iint \frac{|\vec{B}|^2}{\mu} ds \quad (11)$$



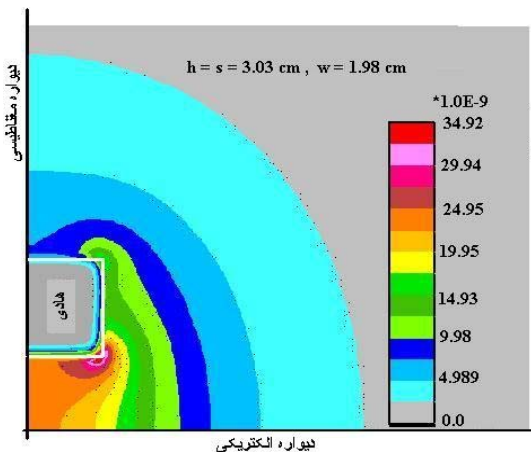
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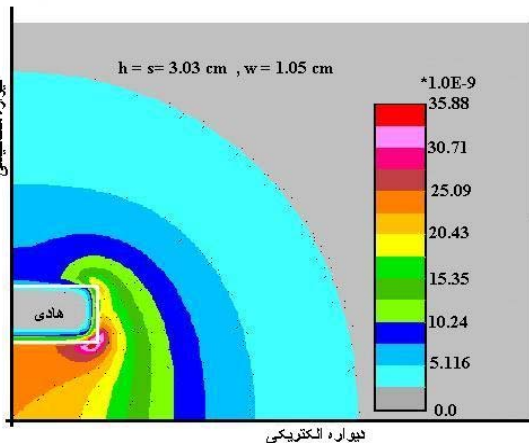
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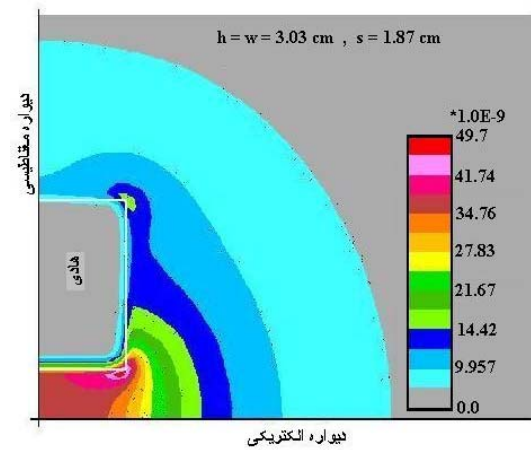
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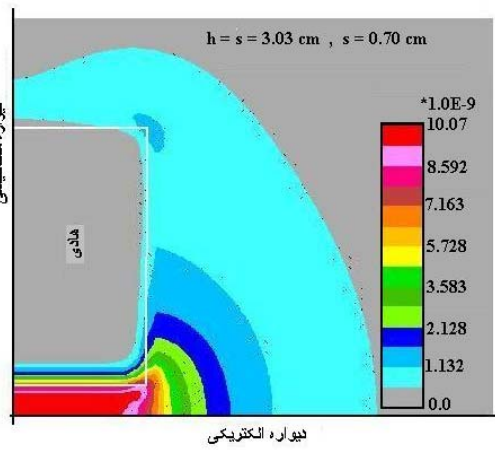
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w

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دیواره الکترونیکی



دیواره الکترونیکی

s

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L' -

h=s= / cm		w=s= / cm		w=h= / cm	
w (cm)	L' (μH/m)	h (cm)	L' (μH/m)	s (cm)	L' (μH/m)
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L' = / μH/m [] L' w=0.5 cm s=h= cm / μH/m []

() L' s L' h w / μH/m []

L' s L' h w () L' s L' h w / μH/m []

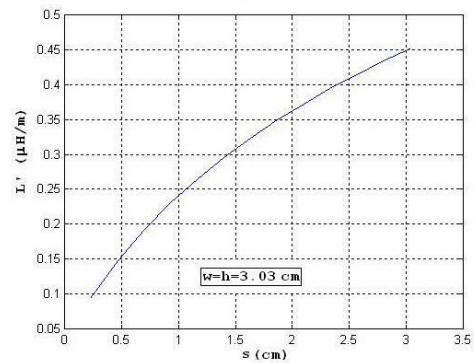
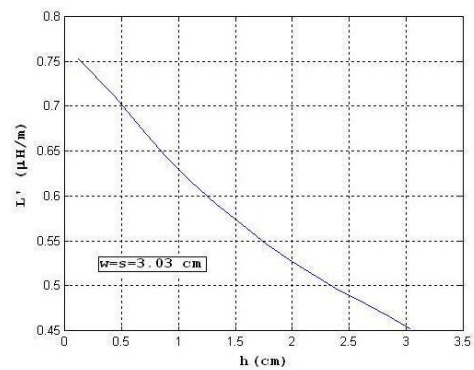
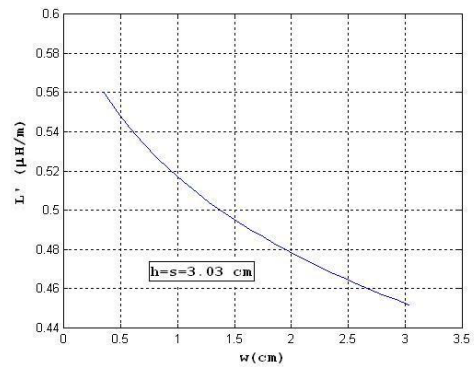
L' L' L' = / L' = / []

$\frac{s}{h} = \frac{w}{h} = 1$ []

s w h L' () L' ()

(h w) L' L' s=h=w= / cm ()

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h w s L' -

L'

L'