Mon-Mo-Po1.10-09 [117]: Quadratic Approximation Method for the Limit Value of Magnetic Stiffness in a High Temperature Superconducting Levitation System
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INTRODUCTION

- The PM can be stably levitated over the HTS.
- Nonlinearity and hysteresis is important to evaluate the magnetic stiffness system.
- the slope of a minor hysteresis loop in large force-distance curves is often employed in experiments and analysis. Up to now, there is no accepted value for small hysteresis distance and unified judgment standard for the accuracy of magnetic stiffness results.

THEORY

\[ \nabla \times B = \mu_0 J_c \]

\[ J_c(B_i) = \frac{\mu_0}{B_0 + |B|} \]

Frozen condition: \[ B_{\text{tr}}(\rho, \zeta) = B_{\text{tr}}(\rho, \zeta) \]

Levitation Force: \[ F_z = \int V J_c \times B_i dV \]

An implicit equation to solve penetration depth of shielding currents in HTS:

\[ B_{\text{tr}}^2(\rho, \zeta) + 2B_0B_{\text{tr}}(\rho, \zeta) + \text{sign}(J_c)2\mu_0B_0J_c(\mu_{\text{sc}} - \mu_0)(1 - N) - (2B_0B_{\text{sc}} - B_{\text{sc}}^2) = 0 \]

\[ k_z = \lim_{\Delta z \to 0} \frac{\Delta F_z}{\Delta z} \neq \frac{dF_z}{dz} \]

For an irreversible system

RESULTS AND DISCUSSIONS

- First approximation to the distance increments of seven minor loops from 0.05 mm to 3 mm at levitation height 5 mm ↓

- Quadratic approximation to above results corresponding to difference distance increments

<table>
<thead>
<tr>
<th>Category</th>
<th>Unit</th>
<th>The limit value of MS</th>
<th>First approximation result to distance increment ( \Delta z )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N/m</td>
<td></td>
<td>0.05 mm</td>
</tr>
<tr>
<td>Value</td>
<td>578.2</td>
<td>578.1 574.6 570.4 561.8 545.9 511.8 476.6</td>
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<tr>
<td>Deviation</td>
<td>%</td>
<td>0.02 0.63 1.35 2.84 5.59 11.49 17.57</td>
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</tr>
<tr>
<td>Good results</td>
<td></td>
<td></td>
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<tr>
<td>Bad results</td>
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</tbody>
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I will be here from 9:15 to 10:15, and from 10:15 to 11:15 welcome to Mon-Mo-Po1.09-04 [100]