Stabilization of Line Tied Resistive Wall Kink Modes Using Rotating Walls*

C. C. Hegna and C. B. Forest
Dept. of Engineering Physics, University of Wisconsin
Madison, WI 53706-1687

Abstract

A method for stabilizing the resistive wall mode (RWM) in a line tied screw pinch equilibrium is investigated. Following the original suggestion of Gimblett [1], two differentially rotating, radially separated walls are included in the analysis. If both walls are inside the critical radius for stabilization of the external ideal kink mode and the walls are separated, sufficiently large rotation of the wall is capable of stabilizing the RWM.

What distinguishes this work from prior investigations [2] is the effect of line tied boundary conditions. This axial boundary condition provides a substantial stabilizing effect [3]. Unlike the case of a periodic cylinder, where the linear response of magnetic perturbations can be represented by a single Fourier harmonic, $\tilde{\mathbf{B}} \sim e^{im\theta - in\zeta}$, line tied boundary conditions require that the eigenmode satisfy a partial differential equation. In the periodic cylinder case, the ideal kink becomes very unstable when the edge q value lies just below a low order rational. In this case, it is very difficult to stabilize the configuration with differentially rotating walls. For the case of line tied boundary conditions, instability is only present when the edge q drops below unity. Differentially rotating walls allow access to the $q_a < 1$ regime with the stability region growing with increasing differential rotation. As in the periodic cylinder case, for a given equilibrium, there is an optimal placement of the second rotating wall relative to the first wall.

References

[1] C. G. Gimblett, Plasmas Phys. Controlled Fusion **31**, 2138 (1989).
[2] C. C. Hegna and C. B. Forest, "Stabilization of Resistive Walls Modes with Rotating Walls," UW-CPTC Report 00-03 (2000).
[3] D. D. Ryutov, R. H. Cohen, and L. D. Pearlstein, Bull. Am. Phys. Soc. **48**, 167 (2003).

*Research supported by U. S. DoE under grant no. DE-FG02-86ER53218.