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Determination of Biconical Cavity Eigenfrequencies Using Method of Partial Intersecting Regions and Approximation by Rational Fractions

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Abstract—The paper considers the problem of determining the eigenfrequencies of biconical cavity making it possible to simplify the eigenfrequency-based design of devices. We used the solving of the excitation problem for biconical cavity using the method of partial intersecting regions in combination with the collocation method. Based on the concept of the search of quasisolution for determining eigenfrequencies, it was proposed to apply the fractionally rational approximation of cavity response obtained as a result of solving the problem of resonator excitation. The efficiency of finding eigenfrequencies of biconical cavity was substantiated by using the fractionally rational approximation based on the chain fraction interpolation of cavity response calculated only at collocation points. Using the above approach, we have obtained the relationship of eigenfrequencies of azimuth-symmetric oscillations of biconical cavity as a function of the aperture angle, and the typing of lower azimuth-symmetric transverse electric modes of biconical cavity has been performed.

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1. INTRODUCTION

Resonators coupled with the open space through holes in their walls are widely used in communication systems and in charged particle accelerators, for measurements and diagnostics of materials [1]. Open resonators are of particular interest because they possess both wide capabilities of tuning the resonance frequency and the possibility of placing samples in resonance electromagnetic field [2–6].

The resonance systems based on sections of evanescent-mode waveguides [7–9] combining the advantages of both closed cavity resonators and open resonators are a compromise solution. One of such resonators is biconical resonator (BCR) representing the cavity limited by two conical surfaces [10, 11].

A key point in using BCR is the possibility of determining the resonator eigenfrequencies by the simplest possible method. In the general case, strict analytical methods are complicated and cumbersome. Therefore, the approximate calculations involve the need of using different variants of the transverse section method [11–13]. However, they do not provide sufficiently accurate estimates of resonance frequencies of BCR, resulting in unacceptable errors in BCR sensors.

The use of universal approaches on the basis of the finite element method at uniform division of space for the decision of an edge problem to determine the eigenfrequencies of BCR with acceptable accuracy is not always justified due to significant resource costs. Adaptive partitioning of space for acceleration of calculations not taking into account specificity of the considered structure, as a rule, is inefficient and can lead to divergence of the solution.

Alternative theoretically justified methods of solving considered electrodynamic problems are required for verification of solutions obtained by universal numerical methods. As result, the application of

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ADDITIONAL INFORMATION

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