Computational Optimization Aberration Coefficients of an Einzel Lens Operated Under Zero Magnification

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***Abstract**: In this researcher has been studied to design an einzel lens and this present researcher, Which concerted about the design of electrostatic potential lens for focused charge particle beam by using inverse method in designing to electrostatic lens ,the paraxial ray equation was solved using Rung - Kutta method ,The spherical and chromatic aberration coefficient Cs and Cc, respectively have been computed using Simpsons rule. The shape of the electrode of the electrostatic lens were determined by solving Laplace's equation, in this research, the results showed low values of spherical and chromatic aberrations which are considered as good criteria for good design Electron Optics, einzel Lens.*

***Keywords:** Electrostatic Lens, spherical aberrations, chromatic aberrations*

I. INTRODUCTION

Electrostatic lenses are the principal components in the over whelming majority of electron optical devices, electrostatic lenses are used to focus charge particles. The electrostatic lenses may be classified according to the number of their electrodes, in classical texts of electron optics electrostatic lenses were classifiable in to groups according to the relationships between their electrode. The present work been mainly concentrated on the design of two electrode type electrostatic electron lenses , the trajectory of electron beam through an axially symmetric electrostatic lens[3], Progress in the calculation of electron optical properties in recent years have been reviewed by [4] and [5].

II. THEORY

The present work has been mainly concentrated on the design of two electrode type electrostatic lenses using inverse problem, Laplace equation.

$$\nabla^2 V = 0 ----(1)$$

The paraxial-ray equation in rotationally symmetric field is give By (2).

$$r''(z) + r'(z)\frac{V'(z)}{2V(z)} + r(z)\frac{V''(z)}{4V(z)} = 0 -------(2)$$

Where r is the radial displacement of the beam from the optical axis z, and the primes denoted a derivate with respect to z.

$$Cs_0 = \frac{V^{-1/2}(z_o)}{16 r_o'^4}\int_{zo}^{zi}\left\{\left[\frac{5}{4}\left(\frac{V''(z)}{V(Z)}\right)^2 + \frac{5}{24}\left(\frac{V'(Z)}{V(z)}\right)^4\right] r^4(z) + \frac{14}{3}\left(\frac{V'(Z)}{V(z)}\right)^3 r'(z) r^3(z) - \frac{3}{2}\left(\frac{V'(z)}{V(Z)}\right)^2 r'^2(z) r^2(z)\right\} V^{1/2}(z)\, dz ---------------(3)$$

$$Cc_0 = \frac{V^{1/2}(z_o)}{r_o'^2}\int_{zo}^{zi}\left[\frac{1}{2}\frac{V'(Z)}{V(z)} r'(z) r(z) + \frac{V''(Z)}{4V(z)} r^2\right] V^{-1/2}(z)\, dz --------(4)$$

In the image space , the spherical aberration coefficient **Csi** and chromatic aberration coefficient Cci is expressed in a similar form of equations (3) and (4 The integration was performed using Simpson rule, the present work has been program in Fortran 77 language.

III. RESULTS AND DISCUSSION

The electrostatic lens were determined by solving Laplace's equation [7], The spherical and chromatic aberrations are dominant in an electrostatic lens [8]. The axial potential distribution obtained from the solution of the paraxial ray equation are plotted in figure (1) Figure (2) . this figure shows the trajectory of charged particles beam traversing the electrostatic lens field. And figures (3),(4) shows the relative spherical and chromatic aberration as function of the voltage ratio (Vi/Vo) this figure indicates that the relative aberration coefficient decrees with increasing the voltage ratio it is seen that as Csi/f=2.5 at Vi/Vo=10 and Cci/f=0.27 at the voltage ratio.

The coefficients of spherical aberration and chromatic aberration referred to the object space Cso and Cco expressed in the following form [9].

Table (1) Shows the Optical Properties the Electrostatic Einzel Lens Operated Under Zero Magnification

Voltage ratio(Vi/Vo)	Csi/f	Cci/f
10	2.5	0.27

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Table (2) Shows the Comperation Between Searchers the Electrostatic Einzel Lens Operated Under Zero Magnification

Cs/f	Cc/f		searcher
2.5	0.27		Present study
106.79	2.17		(Munro,1975)
3.6	0.79		(Al -Meshhdany,2002)
2.68	0.6		(Al- Khashab 2009)

IV. COCLUSION

1-The spherical aberration coefficient is decreased, and the chromatic aberration is decreased.
2- It appears from the present investigation that it is possible to design of electrostatic lens with small aberrations operated under different potential ratios.
3- It has been found that it is possible to design an einzel lens with small aberration.
4- From the result it has been found that the aberration coefficient decreases.
5-The best optical properties in this research that are in zero magnification condition.

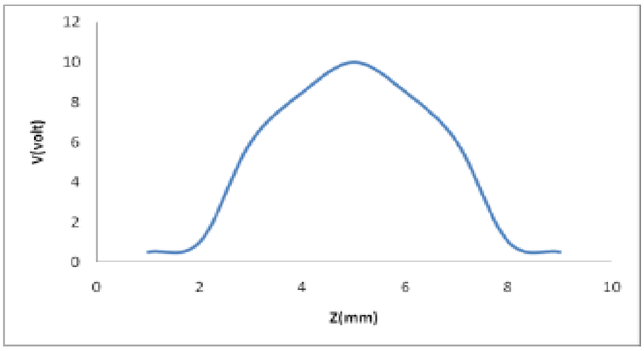

Figure. No. (1) The Axial Potential Distribution V (Z) of Two Electrode Einzel Lens

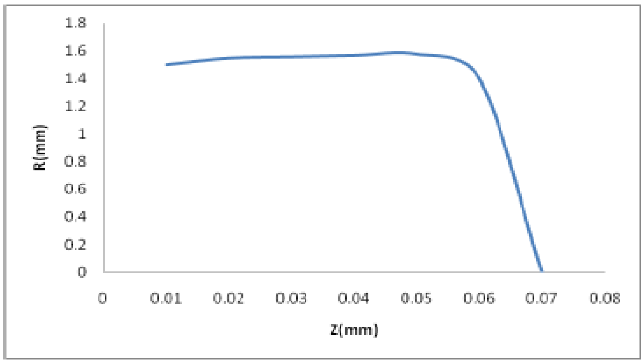

Figure. No. (2)Trajectory of Charge Particles in the Electrostatic Einzel Lens

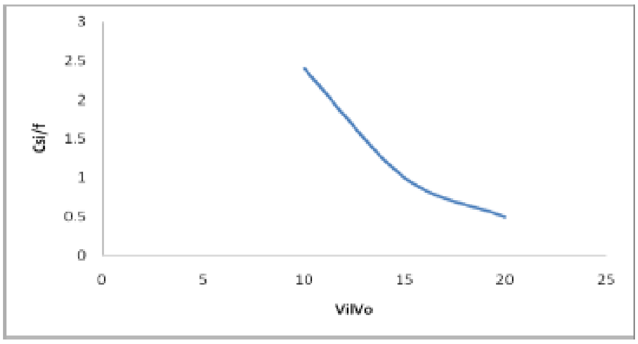

Figure. No. (3) The Relative Spherical Aberration Coefficient Csi/f as Function of Voltage Vi/Vo

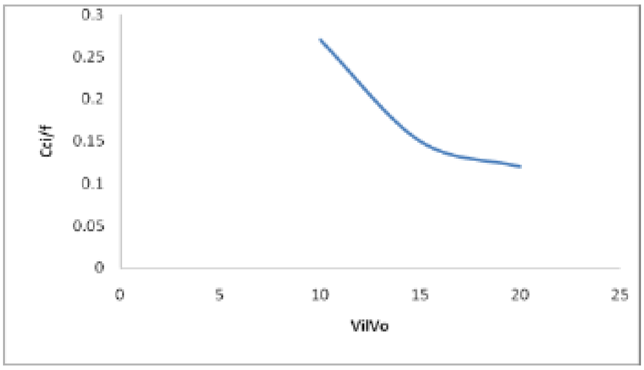

Figure (4): The Relative Spherical Aberration Coefficient Cci/f as Function of Voltage Vi/Vo

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