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Research on electric field strength of the longitudinal transverse collecting plates in electrostatic precipitator

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ABSTRACT

The longitudinal transverse collecting plates in electrostatic precipitator provided with better characteristics. The potential formulas of the calculation voltage, which was engendered by space electric charge from the longitudinal transverse collecting plates in ESP, were derived in the paper. According to image charge methods, both the potential calculation, and the calculation of electrostatic field intensity were deduced. The measurement results from not only the plate current density in collecting plate, but also the average strength from electric field in collecting plate, were in accordance with individual electric field intensity distribution in the electrostatic precipitator with longitudinal transverse collecting plates. The results showed that inference course was believable.

KEYWORDS

Electrostatic precipitator (EPS); Electrostatic fields strength; Image charge methods; Electric potential.

The electrostatic precipitator with longitudinal transverse collecting plates had excellent features and its collecting mechanism was more complex. The electrostatic precipitator (ESP) with longitudinal transverse collecting plates, whose the plate current density and gas velocity distribution were more uniform than those of the convention wire-plate ESP, and collecting efficiency was higher than the latter in the same condition. Based on the experiment and theory, the electrostatic precipitator with longitudinal transverse collecting plates lowered steel and shortened volume[1]. But the strength of electric field was one of the main factors which affected the electrostatic precipitator performance. It was more difficult to derive the calculation formula of strength of electric field. The image charge method was used to present a calculation method of electric potential and the strength of electric field was generated at this paper. When the strength of electric field in the electrostatic precipitator was measured, the experimental results were consistency with the theoretical analysis; the study was enrich the type of electrostatic precipitators and developed the theory of electrostatic collection.

CALCULATION FORMULA OF POTENTIAL AND STRENGTH OF ELECTRIC FIELD IN THE ELECTROSTATIC PRECIPITATOR WITH LONGITUDINAL TRANSVERSE COLLECTING PLATES

The electrostatic precipitator with longitudinal transverse collecting plates had a special structure, that was to say, in a dust collection unit, the longitudinal transverse collecting plates were composed of a horizontal section of a square cuboid and the * type prickle of corona wire were placed in the center axis of the cuboid[2]. The electric fluxline were generated by both the * type prickle of corona wire and the longitudinal transverse collecting plates in the vertical direction distribution, as in Figure1.

In the theoretical analysis of electric field, not only the impact of space charge, but also the impact on space electrostatic field was considered. Namely, space electric field of electrostatic precipitator could be composed of the superposition of the dynamic electric field and electrostatic field.

The analysis of electric field was divided into two steps. Firstly, the electric potential and the strength of electric field were generated by the space charge at any point in an electric field. Secondly, the potential electrostatic field was calculated by image charge method. Then the two kinds of electric field were superimposed as the formula of the electric field strength of the electrostatic precipitator with longitudinal transverse collecting plates.

Calculation of the space charge

Space voltage and current characteristics between the electrodes of the electrostatic precipitator had a significant impact, when a lot of dust entered the ESP. High-speed movement of gas ions were surrounded by the movement of dust around, which reduced the velocity of the charge carriers. The space charges caused by the dust and by the gas ion were as the same, and they must be taken into account, because they had had an impact on the strength of electrostatic field and the strength of electric field generated by the charge near the collecting plate. If the free electron was considered, the plate current density was generated by the charge transfer of ions and charged dust. Its relationship was as follows:

$$J_T = E_a \rho_i b_i + E_a \rho_p b_p = E_a \rho_T b_e \quad (1)$$

Where:

J_T—Total current density between the plates, A/m^2;

E_a—Average strength of electric field between the plates, v/m;

P_i—Charge density of ions, c/m^3;

b_i—Ion mobility,$m^2/v.s$;

ρ_p—Charge density of charged dust, c/ m^3;

b_p—Charged dust mobility, m^2/v.s;

ρ_T—Total space charge density, c/ m^3;

b_e—Effective mobility of ions and charged dust, m^2/v.s.

Then, the effective mobility of ions and charged dust was obtained by formula (1), which was as follows:

$$b_e = (\rho_i b_i + \rho_p b_p) / \rho_T$$

Besides, the formula was deduced by formula (1) as follows:

$$\mathbf{J_\rho / J_T = E_a \rho_\rho b_\rho / (E_a \rho_\rho b_\rho + E_a \rho_i b_i) = J_\rho / (J_\rho + J_i)} \quad \mathbf{(2)}$$

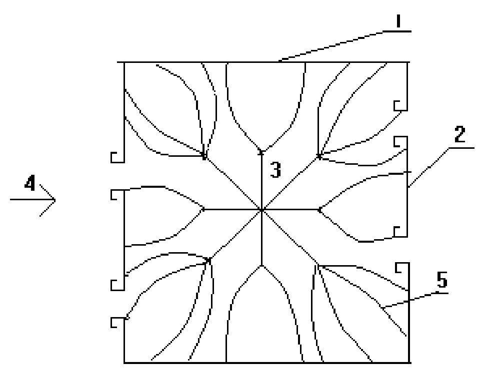
Where : J_ρ—Current density generated by the charged dust, A/m^2;

j_T—Current density generated by the ion, A/m^2.

Current density of the dust transmission was accounted for only a small fraction of the total current density ($j_{T>>}J_\rho$), and the ionic charge mobility was average of 200 times that of dust mobility 's, $b_i=200b_\rho$, so it was easy to get as follows:

$$\mathbf{b_e = b_i [J_T / (200 J_\rho + J_T)]} \quad \mathbf{(3)}$$

By formula (3) the b_e was obtained, which reflected the impact of space charge, in the fact it was to make the movement of ions and dust these two kinds of charge carried in the electric field with an average effective mobility to be reflected.



1. longitudinal collecting plates, 2. transverse collecting plates, 3. corona wire, 4. flow direction, 5. electric fluxline.

Figure 1 : Distribution of electric fluxline which was generated by the * type prickle of corona wire and the longitudinal transverse collecting plates

Electric potential generated by the space charge

Because the charged dust uniformly was distributed within a dust collection unit of the electrostatic precipitator with longitudinal transverse collecting plates, the electric potential was only generated by the space charge. As it was shown in Figure2, on the x axis, if the distance between the point of O and one point was A, and the strength of the point in the electrostatic fields was E, so the formula was obtained by the Gauss Theorem as follows:

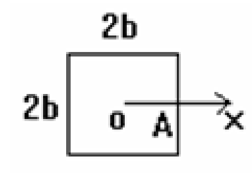


Figure 2 : Electric potential generated by the space charge

$$dE/dx=\rho_T/\varepsilon_0 \quad (4)$$

By formula (1), it was gotten as follows:

$$\rho_T=J_T/E_a b_e \quad (5)$$

The average strength of electric field E_a was replaced approximately by the field strength E of the A of Figure2 in formula (5). The J_T which was electric current density of collecting plates was substituted by electric current density (6), which was approximately equal to formula as follows:

$$\rho_T=\frac{J_T}{Eb_e}=\frac{J_o}{Eb_e} \quad (6)$$

Based on the formula (6), the formula was integral as follows:

$$E^2=-\frac{2J_o x}{\varepsilon_o b_e}+C \quad (7)$$

T he strength of electrostatic fields was made as a boundary condition in X = b (b was half of the distance between the same plates). Because a lot of theoretical and experimental study had shown that in the case of the space charge density was not large, the strength of electrostatic fields near the plates was approximately equal to a constant.

In the X = b, there was the approximate formula[3]:

$$E^2=\frac{2J_o b}{\pi\varepsilon_o b_e} \quad (8)$$

Where: E——Strength of electric field (v/m);

Jo——Average current densities on collecting plates (A/m^{2});

ε_o ——Dielectric coefficient of air, in normal temperature, $\varepsilon_o\approx 8.85\times10^{-12}$c/v·m;

b_e——Ionic mobility, dry air, negative corona, $b_e=2.1\times10^{-4}m^2/v\cdot s$.

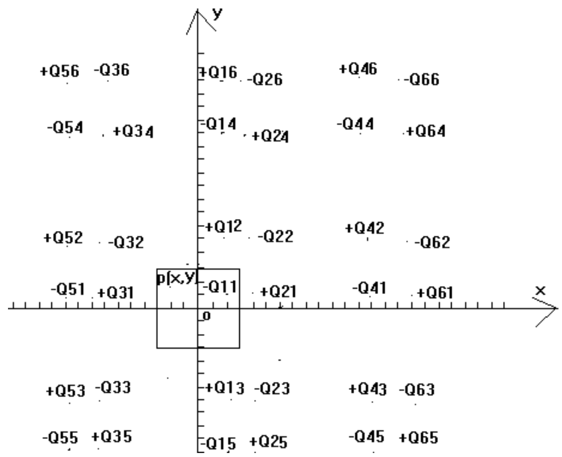


Figure 3 : Image charge groups generated by the charge simulation

The constant C was determined by (8).

$$C = \frac{2J_o b}{\pi \varepsilon_o b_e}(1 + \frac{1}{\pi}) \quad (9)$$

Based on formula (9) and (7), the strength of electric field was obtained as follows:

$$E^2 = \frac{2J_o b}{\varepsilon_o b_e}[-x + b(\frac{1}{\pi} + 1)] \quad (10)$$

According to the definition of the electric potential, the formula was obtained as follows:

$$U_A - U_o = \int_A^o E dx \quad (11)$$

Based on formula (10), formula (11) was integrated as follows

$$U_A = U_o + \frac{2}{3}\sqrt{\frac{2J_o}{\varepsilon_o b_e}} \cdot [-x + b(\frac{1}{\pi} + 1)]^{3/2} \quad (12)$$

The boundary conditions were as follows: when x = b $U_A = 0$, by the above equation formula (12) was gotten as follows:

$$U_0 = -\frac{2}{3}\sqrt{\frac{2J_o}{\varepsilon_o b_e}}(\frac{b}{\pi})^{3/2} \quad (13)$$

The potential for space charge in the electric field at any point was as follows:

$$U = -\frac{2}{3}\sqrt{\frac{2J_o}{\varepsilon_o b_e}}(\frac{b}{\pi})^{3/2} + \frac{2}{3}\sqrt{\frac{2J_o}{\varepsilon_o b_e}}[-x + b(\frac{1}{\pi} + 1)]^{3/2} \quad (14)$$

Formula of electric potential of electrostatic field and formula of strength of electric field in prickle corona wire

In the electrostatic precipitator with longitudinal transverse collecting plates, because the horizontal slotted polar plates' gap was very small, it was negligible. The * type prickle of corona wire and the longitudinal transverse collecting plates produced uniform electric field in the vertical direction, and the electric fiuxline distribution was shown in Figure 1. So the calculation of electric field distribution of the * type prickle of corona wire was simplified to make two-dimensional problem. As the structure of the * type prickle of corona wire was complex, and the potential of the electrostatic field was difficult to derive the analytical formula. The potential was calculated by method of charge simulation base on electric fluxline distribution of electrostatic precipitator with longitudinal transverse collecting plates.

Electromagnetic field theory[4,5] indicated that some kinds of parallel fields or axis- symmetrical fields which had particular symmetrical structure could use the image charge method to be solved.
Outside the field, a group of charges was assumed artificially to replace those continuous distributed ones on the surface of actual electrodes. The image charge method was a kind of special method to solve the electrostatic field boundary value problems, and its theoretical foundations were uniqueness theorem and superposition principle of the electrostatic field. This method's characteristic of solving problems lay in not to solve the Poisson equation that satisfied the electric potential, but to use assumed charges to replace the induced ones on the surface of conductor and influence electric potential. Inside the electrostatic precipitator with longitudinal transverse collecting plates, corona wire was put in the center of the longitudinal transverse collecting plates, and the collecting plate connects the ground, forming four zero-potential surfaces of an unit, so it could be made simulated charges inside the corona electrode to produce innumerable image charge groups correspond to zero-potential, as it was shown in Figure3.
The electric potential of the infinite line charge at anywhere A in space was obtained base on the charge simulation with the infinite line by the Gauss theorem as follows:

$$\varphi_A = \int_A^o E dl = \frac{p}{2\pi\varepsilon} \ln \frac{r_o}{r_A} \quad (15)$$

Where : p——Charge linger density;
r_o——Point O's electric potential was zero (The point was distant from the wire);
r_A——Distance between the point and the wire.

Variation of the image charge of the charge simulation (x_i,y_i) on the X, Y coordinates were as follows:

$$x_{4n+1} = -4nb + x_i \quad (16)$$

$$x_{4n+2} = (4n+2)b - x_i \quad (17)$$

$$x_{4n+3} = -(4n+2)b - x_i \quad (18)$$

$$x_{4n+4} = (4n+4)b + x_i \quad (19)$$

$$y_{4n+1} = -4nb + y_i \quad (20)$$

$$y_{4n+2} = (4n+2)b + y_i \quad (21)$$

$$y_{4n+3} = -(4n+2)b + y_i \quad (22)$$

$$y_{4n+4} = (4n+4)b + y_i \quad (23)$$

Because the longitudinal transverse collecting plates was as a symmetric, electric potential of i infinete line charge and its image charge group at P (x,y) was calculated after repeatedly imaging reflection as follows:

$$Vi(x,y)=\frac{P_i}{2\pi\varepsilon_o}\sum_{n=0}^{\infty}\ln\left[\frac{D(4n+1,4n+2)D(4n+1,4n+3)D(4n+2,4n+1)D(4n+2,4n+4)}{D(4n+1,4n+1)D(4n+1,4n+4)D(4n+2,4n+2)D(4n+2,4n+3)}\cdot\frac{D(4n+3,4n+1)D(4n+3,4n+4)D(4n+4,4n+2)D(4n+4,4n+3)}{D(4n+3,4n+2)D(4n+3,4n+3)D(4n+4,4n+1)D(4n+4,4n+4)}\right] \quad (24)$$

Where: D (4n+1,4n+2) was the distance between the first of (x_{4n+1},y_{4n+2}) charge simulation image point and the point P (x,y),others similar, decided by the following formula:

$$D(4n+1,4n+2)=[(-4nb+x_i-x)^2+((4n+2)b-y_i-y)^2]^{1/2} \quad (25)$$

$$D(4n+1,4n+1)=[(-4nb+x_i-x)^2+(-4nb+y_i-y)^2]^{1/2} \quad (26)$$

$$D(4n+1,4n+3)=[(-4nb+x_i-x)^2+((4n+2)b+y_i+y)^2]^{1/2} \quad (27)$$

$$D(4n+1,4n+4)=[(-4nb+x_i-x)^2+((4n+4)b+y_i-y)^2]^{1/2} \quad (28)$$

$$D(4n+2,4n+1)=[((4n+2)b-x_i-x)^2+(-4nb+y_i-y)^2]^{1/2} \quad (29)$$

$$D(4n+2,4n+2)=[((4n+2)b-x_i-x)^2+((4n+2)b-y_i-y)^2]^{1/2} \quad (30)$$

$$D(4n+2,4n+4)=[((4n+2)b-x_i-x)^2+((4n+2)b+y_i-y)^2]^{1/2} \quad (31)$$

$$D(4n+2,4n+3)=[(((4n+2)b-x_i-x)^2+((4n+2)b+y_i+y)^2]^{1/2} \quad (32)$$

$$D(4n+3,4n+1)=[((4n+2)b+x_i+x)^2+(-4nb+y_i-y)^2]^{1/2} \quad (33)$$

$$D(4n+3,4n+2)=[((4n+2)b+x_i+x)^2+((4n+2)b-y_i-y)^2]^{1/2} \quad (34)$$

$$D(4n+3,4n+4)=[((4n+2)b+x_i+x)^2+((4n+4)b+y_i-y)^2]^{1/2} \quad (35)$$

$$D(4n+3,4n+3)=[((4n+2)b+x_i+x)^2+((4n+2)b+y_i+y)^2]^{1/2} \quad (36)$$

$$D(4n+4,4n+2)=[((4n+4)b+x_i-x)^2+((4n+2)b-y_i-y)^2]^{1/2} \quad (37)$$

$$D(4n+4,4n+1)=[((4n+4)b+x_i-x)^2+(-4nb+y_i-y)^2]^{1/2} \quad (38)$$

$$D(4n+4,4n+3)=[((4n+4)b+x_i-x)^2+((4n+2)b+y_i+y)^2]^{1/2} \quad (39)$$

$$D(4n+4,4n+4)=[((4n+4)b+x_i-x)^2+((4n+4)b+y_i-y)^2]^{1/2} \quad (40)$$

If the number of simulation line charge was M, then the electric potential at p (x,y) was as follows:

$$V(x,y)=\sum_{i=1}^{M}V_i(x,y)=\sum_{i=1}^{M}\left[\frac{P_i}{2\pi\varepsilon_0}\sum_{n=0}^{\infty}\ln\left[\frac{D(4n+1,4n+2)D(4n+1,4n+3)D(4n+2,4n+1)D(4n+2,4n+4)}{D(4n+1,4n+1)D(4n+1,4n+4)D(4n+2,4n+2)D(4n+2,4n+3)}\cdot\frac{D(4n+3,4n+1)D(4n+3,4n+4)D(4n+4,4n+2)D(4n+4,4n+3)}{D(4n+3,4n+2)D(4n+3,4n+3)D(4n+4,4n+1)D(4n+4,4n+4)}\right]\right] \quad (41)$$

According to E=－▽V, let (41) seek partial derivative and was added a negative sign on x, y respectively ,then the component value of the field strength of electrostatic field on the X, Y direction were gotten as follows:

$$E_x(x,y) = -\frac{\partial V(x,y)}{\partial x} \tag{42}$$

$$E_x(x,y)=\sum_{i=1}^{M}\Bigg[\frac{P_i}{2\pi\varepsilon o}\sum_{n=0}^{\infty}\Big(\frac{x+4nb-x_i}{D^2(4n+1,4n+1)}-\frac{x+4nb-x_i}{D^2(4n+1,4n+2)}$$
$$+\frac{x+4nb-x_i}{D^2(4n+1,4n+4)}-\frac{x+4nb-x_i}{D^2(4n+1,4n+3)}+\frac{x-(4n+2)b+x_i}{D^2(4n+2,4n+2)}-\frac{x-(4n+2)b+x_i}{D^2(4n+2,4n+1)}+\frac{x-(4n+2)b+x_i}{D^2(4n+2,4n+3)}-\frac{x-(4n+2)b+x_i}{D^2(4n+2,4n+4)}+\frac{x+(4n+2)b+x_i}{D^2(4n+3,4n+2)}$$
$$-\frac{x+(4n+2)b+x_i}{D^2(4n+3,4n+1)}+\frac{x+(4n+2)b+x_i}{D^2(4n+3,4n+3)}-\frac{x+(4n+2)b+x_i}{D^2(4n+3,4n+4)}+\frac{x-(4n+4)b-x_i}{D^2(4n+4,4n+1)}-\frac{x-(4n+4)b-x_i}{D^2(4n+4,4n+2)}+\frac{x-(4n+4)b-x_i}{D^2(4n+4,4n+4)}-\frac{x-(4n+4)b-x_i}{D^2(4n+4,4n+3)}$$

Similarly

$$E_y(x,y) = -\frac{\partial V(x,y)}{\partial y} \tag{43}$$

$$E_y(x,y)=\sum_{i=1}^{M}\Bigg[\frac{P_i}{2\pi\varepsilon o}\sum_{n=0}^{\infty}\Big(\frac{y+4nb-y_i}{D^2(4n+1,4n+1)}-\frac{y-(4n+2)b+y_i}{D^2(4n+1,4n+2)}+\frac{y-(4n+4)b-y_i}{D^2(4n+1,4n+4)}-\frac{y+(4n+2)b+y_i}{D^2(4n+1,4n+3)}+\frac{y-(4n+2)b+y_i}{D^2(4n+2,4n+2)}$$
$$-\frac{y+4nb-y_i}{D^2(4n+2,4n+1)}+\frac{y+(4n+2)b+y_i}{D^2(4n+2,4n+3)}-\frac{y-(4n+4)b-y_i}{D^2(4n+2,4n+4)}+\frac{y-(4n+2)b+y_i}{D^2(4n+2,4n+2)}-\frac{y+4nb-y_i}{D^2(4n+3,4n+1)}+\frac{y+(4n+2)b+y_i}{D^2(4n+3,4n+3)}$$
$$-\frac{y-(4n+4)b-y_i}{D^2(4n+3,4n+4)}+\frac{y+4nb-y_i}{D^2(4n+4,4n+1)}-\frac{y-(4n+2)b+y_i}{D^2(4n+4,4n+2)}+\frac{y-(4n+4)b-y_i}{D^2(4n+4,4n+4)}-\frac{y+(4n+2)b+y_i}{D^2(4n+4,4n+3)}\Big)\Bigg]$$

The total electrostatic field strength was as follows:

$$E(x,y)=[E_x^2(x,y)+E_y^2(x,y)]^{\frac{1}{2}} \tag{44}$$

Because the point potential of the corona wire surface was equal to the applied voltage, and everywhere they were equal, then by (41) the applied voltage was calculated as follows:

$$V(x,y)=\sum_{i=1}^{M}\left[\frac{Pi}{2\pi\varepsilon o}\sum_{n=0}^{\infty}\ell n\left[\frac{D(4n+1,4n+2)D(4n+1,4n+3)D(4n+2,4n+1)}{D(4n+1,4n+1)D(4n+1,4n+4)D(4n+2,4n+2)}\right.\right.$$
$$\left.\left.\frac{D(4n+2,4n+4)D(4n+3,4n+1)D(4n+3,4n+4)D(4n+4,4n+2)D(4n+4,4n+3)}{D(4n+2,4n+3)D(4n+3,4n+2)D(4n+3,4n+3)D(4n+4,4n+1)D(4n+4,4n+4)}\right]\right] \quad V_o \tag{45}$$

Where : V_o—Applied voltage.

From equation (45), the charge simulation of a point P_i was proportional to the impressed-voltage V_0. To determine P_i, Ordered V_o = 1kv, multiply voltage V_0 by P_i was obtained the charge simulation of every the load voltage. The N points were taken on the * type of prickle corona wire, and list of N multi-linear equation of $P_{i,}$ simultaneous equations were established. If the charge simulation amount of P_i was determined, the electric potential size of any point within the electric field was calculated by formula (44).

1.4 Formula for field strength generated by the * type prickle of corona wire and the space charge in the gas

By (10) and (45), the formula for field strength was generated by the * type prickle of corona wire and the space charge in the gas as follows:

$$E^{!} = \{E(x,y)^2 + \{\frac{2J_o b}{\varepsilon_o b_e}[-x + b(\frac{1}{\pi} + 1)]\}^2\}^{\frac{1}{2}} \quad (46)$$

Where : E!——the field strength which was generated by the * type prickle of corona wire and the space charge in the gas

MEASURED RESULTS OF CURRENT DENSITY AND AVERAGE ELECTRIC FIELD STRENGTH OF PLATE

Determination method for plate electric current density

Used split detection method to determine the plate current density, current meter was equipped with calibration for 3.9×10^{-8}A/mm galvanometer[6], and the transfer switch was made the measured region access to galvanometer, while the no measured region of plate electric current were accessed to ground.

Determination results of the electrode current density

The determination of current density were determined on the condition that the working voltage of collecting plate was 50kv, the length of the * type prickle of corona wire was 90mm, the distance of plates was 400mm, and no-load. The measured results of current density and average electric field strength for plate of this electrostatic precipitator and conventional electrostatic precipitator were show in TABLE 1.

TABLE 1 : The measured results of current density and average electric field strength of plate

Types			Current density (mA/m²)		Uniformity of current densityδ		Average electric field strengthofPlate (kv/cm)
Electrostatic Precipitator with Longitudinal Transverse collecting Plates	Longitudinal Collecting Plates		0.586	0.566	0.364	0.367	2.73
	The width of the transverse plate	138mm	0.548		0.369		
		138mm	0.597		0.365		
		70mm	0.534		0.368		
Conventional ESP			0.525 mA/m²		0.419		2.45

In the TABLE 1, the average current density of longitudinal transverse collecting plates was 0.566mA/m², which is better than the conventional electrostatic precipitator that was 0.525 mA/m²; The uniformity of current density for longitudinal transverse collecting plates was 0.367, which was larger than the conventional electrostatic precipitator that was 0.419. The average electric field strength of the plate for longitudinal transverse collecting plates was 2.73kv/cm, which was larger than the conventional electrostatic precipitator that was 2.45kv/cm.

Test results showed that longitudinal groove shape matched the *-type prickle of corona wire changing the distribution of electric field, eliminating the pole line borderline, eliminating the "zero" current area on the collecting plate, and forming a reasonable uniform distribution of power line, as in TABLE1. According to the Sigmond[7] saturated current density calculation of was $i_s=\varepsilon_0\mu v^2/H^3$ (H was wire length), electrode current density was inversely proportional of the cubic of the power wire length, in other words, under the same voltage, a point electrode current density mainly depends on the distance from the corona area. That was the similar expression of formula (45), if they could make as much power wire length equal, then the plate current densities were equal, the most uniform distribution at this time, equal to the average electric field intensity on the surface of the plate, field strength was also largest, to improve collection efficiency.

CONCLUSIONS

(1)Space charge in the electric field at any point in the potential was as follows:

$$U = -\frac{2}{3}\left(\frac{2J_o}{\varepsilon_o b_e}\right)^{1/2}\left(\frac{b}{\pi}\right)^{3/2} + \frac{2}{3}\left(\frac{2J_o}{\varepsilon_o b_e}\right)^{1/2}\left[-x + b\left(\frac{1}{\pi}+1\right)\right]^{3/2}$$

(2) The calculation formula of the electric potential generated by electrostatic field was as follows:

$$V(x,y) = \sum_{i=1}^{M}\left[\frac{P_i}{2\pi\varepsilon o}\sum_{n=0}^{\infty}\ell n\left[\frac{D(4n+1,4n+2)D(4n+1,4n+3)}{D(4n+1,4n+1)D(4n+1,4n+4)}\frac{D(4n+2,4n+1)D(4n+2,4n+4)D(4n+3,4n+1)D(4n+3,4n+4)D(4n+4,4n+2)D(4n+4,4n+3)}{D(4n+2,4n+2)D(4n+2,4n+3)D(4n+3,4n+2)D(4n+3,4n+3)D(4n+4,4n+1)D(4n+4,4n+4)}\right]\right]$$

(3)The electrostatic field strength of an arbitrary point within field region was as follows:

$E\ (x,y)=[E_x^2(x,y)+E_y^2(x,y)]^{1/2}$

(4)The formula for field strength which was generated by the * type prickle of corona wire and the space charge in the gas was as follows:

$$E^{!} = \{E(x,y)^2 + \{\frac{2J_o b}{\varepsilon_o b_e}[-x + b(\frac{1}{\pi}+1)]\}^2\}^{\frac{1}{2}}$$

(5) The average current density of longitudinal transverse collecting plates was 0.566mA/m^2, which was better than the conventional electrostatic precipitator that was 0.525 mA/m^2;The uniformity of current density for longitudinal transverse collecting plates was 0.367, which was larger than the conventional electrostatic precipitator that was 0.419. The average strength of electric field of plate for longitudinal transverse collecting plates was 2.73kv/cm, which was larger than the conventional electrostatic precipitator that was 2.45kv/cm.

(6) Test results showed that longitudinal groove shape matched the * type prickle of corona wire changing the distribution of electric field, eliminating the pole line borderline, eliminating the "zero" current area on the collecting plate, and forming a reasonable uniform distribution of power line.

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