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FEATURES OF CHARGING SOLUTIONS DROP LOW RESISTANCE PER UNIT VOLUME IN AN ELECTRIC FIELD

H.B Inozemtsev, p.h.d.

S.D. Vashchyshyn, graduate

The process of electrostatic printing solutions with low specific volume resistance. The peculiarities that must be considered when applying nutrients and protruyuchyh solutions for processing plants.

Electrostatic deposition method, electric charge, electric field, solutions with low specific volume resistance monodyspersnist, traffic drops, deposition on herbage plants.

Yield of crops is largely dependent on a number of factors, most of which is the protection and plant nutrition. Technologies for the protection and plant nutrition are important in agriculture because they determine the quantity and quality of the grown products.

These technologies include: root and foliar nutrient plants, which contributes to the creation of favorable conditions for their growth and development.Foliar nutrient conduct when performance is reduced nutrient uptake and root system of plants to balance the imbalance of minerals [4]. Foliar nutrient solutions and making protruyuchyh carried out by their application, preferably pneumatic, mechanical and hydraulic methods, which is inherent high polydispersity cutting (30 to 500 microns), a significant loss rozpylyuchyh solutions (75%), uneven deposition (45 to 60 %), low degree of coverage of the surface with a solution of the inverse plant leaves (5 to 15 %), etc. [3]. All this makesoverrun chemical solutions, pollution, detention and reduce the effectiveness of nutrient absorption in plants.

The elimination of these defects is possible by using an electrostatic deposition method, which can improve the quality of treatment plant efficiency of deposition and retention drops on both surfaces of leaves and so on. [3].

* Supervisor – p.h.d., professor G.B. Inozemtsev

Electrostatic method of applying the technology processing plant solutions with low specific volume resistance, now a poorly understood and need better understanding the process of charging the droplets, their dynamic movement and deposition on herbage plants.

The purpose of research - getting new ideas charging process and motion droplets of solutions with low specific volume resistance in an electric field.

Materials and methods research. Electrostatic deposition method is one of the progressive and effective methods of application, which occupies a leading position in the industry in many countries. This method is economical, provides high-quality coverage, the ability to automate the process and performance. Due to the influence of the electrostatic field at the drop of solution is reached almost their complete deposition (loss $\leq$ 10%, and the application of modern methods, losses reaching up to 60–65 %).

The process of electrostatic printing solutions, consists of the following main steps: charging solution, its spray plume formation, movement and deposition of droplets on the surface finish. Charge drops in an electric field is crucial, since the passage affects the following processes: dynamics of movement, precipitation drops to the surface treatment, determining dispersion, uniformity of deposition, coating thickness, adhesion, etc. [3, 2].

Charging efficiency strongly depends on the electrical properties of solutions (permittivity – ε, the specific volume resistance - ρ_v, the surface tension of the solution and the green mass of plants - σ_1, σ_2), which applied. Found that electric charge increases with decreasing specific volume resistance and decreases with its increase, increase ($\rho_v > 10^8$ Om cm), causes inhibition or complete termination of the charging process (fig. 1).

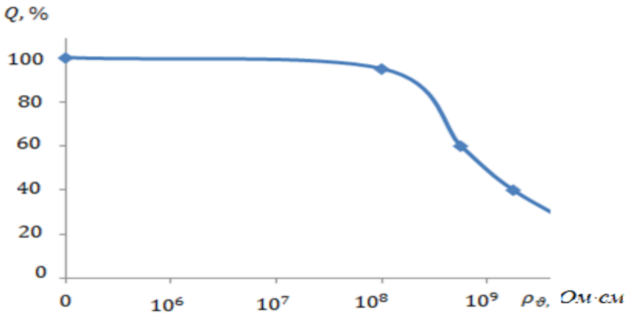

Fig. 1. The dependence of the electric charge of the solution on the magnitude of its specific volume resistance

The process of charging investigated: Vereshchagin I.P., Popkov V.I., Inozemtsev G.B, Dunskyy V.F., Borodin V.N. et al. works in which the emphasis is on materials with high specific volume resistance (10^7 ... 10^{11} Om cm). Solutions with low specific volume resistance (10^2 ... 10^3 Om cm) was given insufficient attention. Since the process of charging the droplets of solutions depends on the value of the specific volume resistance, respectively, the processes that will occur during electrostatic plottedsolutions with low and high specific volume resistance will vary.

When electrostatic application solutions are mainly used methods such charge: ionic, contact and induction.

Ion charging method is that the ions that move in a gaseous medium, such as an external corona discharge zone, faced with a drop of solution and deposited on their surface. The charge, which is obtained with this method drops charge, determined by the formula:

$$Q_{\max} = \left(1 + 2\frac{\varepsilon - 1}{\varepsilon - 2}\right) E R^2 , \qquad (1)$$

where Q_{max} – the electric charge drops, Cl; ε permittivity of the solution, E field strength at a given point, V/m; R – radius of the droplet, um.

For high value should drop the charge for a long time to be in the field of corona discharge. When charging solutions with low specific volume resistance of this feature causes significant technological and structural complexity.

Contact charging occurs through contact of the solution with corona electrode. When the contact charging method solutions in the field of corona discharge (10 – 25 times more efficient in comparison with ion method [6]), the value drops charge Q, Cl, expressed by the formula:

$$Q = R^2 \frac{U}{r \ln \frac{2H}{r}} \left[1 - A10^{-12} \frac{\varepsilon \rho_v}{H^2} (U - U_k)\right] \qquad (2)$$

where R, r radius of the droplet and radius sharp edges corona electrode microns; U, U_k the supply voltage and the initial voltage that corresponds to the formation of corona discharge at the corona electrode kV; H – distance from the corona electrode to plants m; ε – dielectric constant of the solution; ρ_v specific volume resistance of the solution, om · cm; A constant calculation [3, 5].

Studies. When electrostatic deposition and nutrient solutions protruyuchyh the charging and discharging droplets is ($t \approx 10^{-1}c$), which depends on the specific volume resistance, which increases the requirements for electrostatic application process. Addressing this issue, perhaps through the use of high-speed airflow accelerates the movement and deposition of charged droplets in an electric field.

Droplets of solutions having an electric charge moving to the surface deposition on a specific trajectory, direction and shape is determined by the action of forces on the drop [1]:

$$\sum F = F_{mg} + F_q + F_E + F_c, \tag{3}$$

where F_{mg} –force of gravity, N; F_q– force due to the electric field, N; F_E – force due to the uneven distribution of the electric field, N; F_c – resistance force protection, N.

When applying the solution with a low specific volume resistance with regard to aerodynamic forces arising from the use of high air flow, equation (3) becomes:

$$\sum F = F_{mg} + F_q + F_E + F_c + F_\alpha, \tag{4}$$

where F_α –aerodynamic force, N.

Force of gravity is determined by the formula:

$$F_{mg} = mg, \tag{5}$$

where m – mass of the droplet, kg; g – acceleration of gravity, m/s^2.

Power, the electric field acting on the charged drop, determined by the formula:

$$F_q = Eq, \tag{6}$$

where E – is the electric-field V/m; q – electric charge drops, Cl.

Force due to uneven distribution of the electric field on the charged drop, determined by the formula [1]:

$$F_E = E_1 q_2 - E_2 q_2. \tag{7}$$

Resistance force protection during movement of charged droplets, determined by the formula [1]:

$$F_c = k_c 6\pi\mu r(\upsilon - \upsilon^*), \tag{8}$$

where $k_c, \upsilon^* = \frac{(Re^* \upsilon)}{2r}$ – coefficients of the linear approximation; υ – velocity drops relative to air, m/s; r – radius of the droplet, m; μ - coefficient of dynamic viscosity of the medium, kg / (m s).

Aerodynamic force airflow acting on a charged, well, drop, determined by the formula:

$$F_\alpha = C_{F\alpha} \frac{\rho V^2}{2} S , \qquad (9)$$

where $C_{F\alpha}$-dimensional aerodynamic force coefficient; V – velocity pressure of air, m/s; ρ – density of air, kg/m^3; S – area of droplet, m^2.

Trajectory and deposition of droplets of solutions with low specific volume resistance in an electric field is shown in (fig. 2)

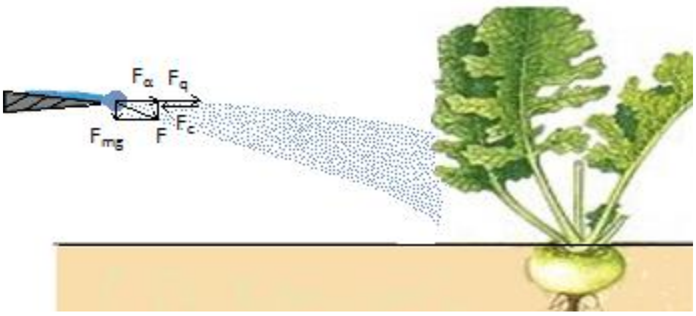

Fig.2. Trajectory and deposition of droplets of solutions with low specific volume resistance in an electric field

The final stage is the process of applying electrostatic deposition of droplets on the surface of plants, followed by spreading and flow of electric charge them.Absorption of active substances in plant tissues is only in liquid state and is determined by wettability phenomenon, ie the contact interaction on the verge of "solid (leaves) – fluid (working solution)." This correlates with retention drops wetting phenomenon, which in the process of protection and plant nutrition plays an important role.

We know that the best interaction, which determines the wettability occurs when the following conditions [3]:

$$\sigma_m \geq \sigma_{pp}, \qquad (10)$$

where σ_m, σ_{pp} –by surface tension of solids (plants) and working solution, N/m

The condition (8) must be considered in the development process because of its failure causes a negative result.

According to [1] strength retention is strongly dependent on the electric field drops to size $d_k \geq 40–60$ microns. The electric field in this case increases the maintenance force droplets on the surface of the green mass of plants.

Providing high-capacity solution causes a more developed surface drops as a result of greater contact with the surface of plant growth spreading over the surface of leaf cover, keeping it on the surface.

Conclusions

Try the new understanding of the process of charging and traffic drops solutions with low specific volume resistance ($\rho_v = 10_2 ... 10^3$ Om cm) in an electric field.

The analysis method of applying electrostatic solutions with low specific volume resistance showed that the charging and discharging droplets is ($t \approx 10^{-1}$c) and depends on the specific volume resistance, which increases the requirements for electrostatic application process.

One solution to this problem is the use of high-speed air stream to accelerate the movement and deposition of droplets on the surface of plants in the electric field.

The electric field (E = 3–3.5 V/m), causes an increase in strength retention drops, so you need to ($V_3 > V_p$, where to V_3, V_p – rate of charging and discharging droplets on the surface of the green mass of plants.)The forces of adhesion is strongly dependent on the electric field drops to size ($dk \geq 40–60$ microns).

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Рассмотрен процесс электростатического нанесения растворов с низким удельным объемным сопротивлением. Установлено, особенности, которые необходимо учитывать при нанесении питательных и защитных растворов для обработки растений.

Электростатический метод нанесения, электрический заряд, электрическое поле, растворы с низким удельным объемным сопротивлением, монодисперснисть, движение капель, осаждение на зеленую массу.

Розглянуто процес електростатичного нанесення розчинів з низьким питомим об’ємним опором. Встановлено особливості, які необхідно враховувати при нанесенні живильних та протруючих розчинів для обробки рослин.

Електростатичний метод нанесення, електричний заряд, електричне поле, розчини з низьким питомим об’ємним опором, монодисперсність, рух краплин, осадження на зелену масу рослин.