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Construction and evaluation of a hollow cone type nozzle with ceramic nanocomposites

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Introduction: In order to improve the use of pesticides and pesticide consumption and prevent environmental pollution, manufactures and scientists have considered two major trends. The first major trend is improving techniques that are practical and effective use of small quantities of chemicals to reduce the negative effect of residues of pesticides. The use of new methods usually requires investment and cost. The second major trend is changing the parts that are more important to reform the sprayer components in order to reduce pollution, mainly by including engineering controls, and design and construction of appropriate nozzles. The optimization can be done with the least expensive pesticide. Nozzle is a device for spraying the solution in the form of particles with a certain pattern. Tip of a nozzle is placed in the nozzle's body and has many different types. The main factors in choosing tips include: material, pattern of distribution, spray angle and the amount of the solution. The spray tip may be made of aluminum, brass, nylon, stainless steel, ceramic or other materials. Nanocomposites are composites that contain at least one component with dimensions in the nanometer range between 1 to 100 nm. This material is suitable as an alternative to overcome the limitations that exist with integrated microcomposites. The aim of this study was the construction and evaluation of a sprayer nozzle with ceramic nanocomposites with good shelf life and optimum performance.

Materials and methods: This research was supported by the Agricultural Engineering Research Institute and Nanotechnology Committee of the Ministry of Agriculture. The operations of this study were as follows: 1- Preparing of materials, including alumina powder and stabilized zirconia powder with yttrium. 2- Design and manufacture of molds. 3- Preparation of the samples pressing operations. 4- Zintering of samples to achieve high density. 5- Tests to determine the quality of the products. In order to prepare nanocomposite powder mixed with stabilized zirconia alumina, the ratio of 10/90 percent by volume of the powder was poured into the mill for three hours and it was stirred in the mixer. Pressing is placing the powder into a mold, and applying pressure to achieve the desired density. In this study, pressing device with 30 tons was manually used and powder sample in the amount of one gram was placed in a semi-cylindrical small hollow. After making a few samples and determining the optimal pressure and time of pressing in action, samples were manufactured under 90 kg cm^{-2} pressure at 20 seconds. A high temperature furnace model F3L-1720 was used for zintering. Samples were put into the furnace after forming by a single-axis press. Temperature the of furnace was raised up 1650°C at a rate of 10 degrees per minute and then the samples were exposed for one hour in order for the heat to be evenly applied in all the body of the nozzle. Finally, a hollow cone spray pattern fan nozzle with a major diameter of 15 mm and an inner diameter of 2 mm was built. Equipment for analyzing used in this study included: X-Ray Diffraction device (XRD), Scanning Electron Microscope (SEM). The flow rate output was measured at a pressure of 2 bar in the period of 0-50 hours at 1, 2, 3, 4, 5, 8, 10, 15, 20, 25, 30, 40 and 50 hours.

Results and Discussion: XRD analysis of nano-composite stabilizer in the presence of yttria- zirconia- alumina toughness with (Al_2O_3-ZrO_2-Y_2O_3), yttria stabilized zirconia (ZrO_2-Y_2O_3) and alumina indicates respective phases. For the samples made with better properties, it should be uniformly distributed within it. To evaluate the uniformity, SEM-Mapping test samples were made. The results showed that the distribution of Y, Zr, Al in nanocomposite (Al_2O_3-ZrO_2-$Y2O_3$) is almost uniform. The results of changes in the level of output over time showed that the rate of flow in composite (Al_2O_3-ZrO_2-Y_2O_3) nozzle versus ceramic conventional (Al_2O_3) nozzle after 50 hours of testing under static condition, flow rate was decreased to 30- 35 percent.

Conclusions: Nozzles are one of the most important terminal parts in sprayers and are used to spread the liquid evenly at a certain flow rate. Addinga nanomaterial ceramic structure as a new solution was effective. By paying attention to reduce the use of chemicals and protection of the resource bases, a correct approach to the development of agricultural mechanization equipment that are essential components should be a priorityas a low-cost solution.

Keywords: Ceramic nanocomposite, Construct and evaluation, Nozzles, Sprayer

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