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Applications of Nanotechnology for Improving Production Methods and Performance of Agricultural Equipment

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ABSTRACT: Given that the agriculture sector is one of the social, economic elements and indicators of sustainable development in any country, investigating the impact of the introduction of new technologies and how to introduce the technologies into this sector is of particular importance. Since nanotechnology, as one of these new technologies, has a growing trend in the production and manufacture of all the equipment used in everyday life, as well as nanotechnology has special features related to hard-working conditions, design and durability characteristics of agricultural equipment and one of its areas of application can be in the field of producing and manufacturing agricultural equipment with special features in different fields, this paper examines the role of this technology in improving the production methods and, ultimately, the impact of this technology on improving the performance of agricultural equipment. Nanotechnology has not abandoned any scientific field, therefore, agricultural science is not separated from this. So far several applications of nanotechnology have been proposed in agriculture, food industry and animal science. Nanotechnology is used in the production of construction materials and agricultural equipment coatings, such as the production of nano-polymer composites, metal nano composites, paints and coatings that are resistant to sunlight and wear in machinery, sensors for increased precision and performance, displays used with tractors and other equipment, propulsion of equipment, microprocessors, lubricants, smart glass, catalytic converters and filters for help to reduce global carbon emissions, protective coatings resistant to corrosion, scratches, wear and environmental factors.

Keywords: Nano, Agricultural machinery, Tractor, Nanocomposite, Nano filter, Glass, Lubricants.

INTRODUCTION

Nanotechnology is the ability to produce new materials, tools, and systems with controlling in molecular and atomic surfaces and the use of properties in which surfaces appear. It follows from this simple definition that nanotechnology is not a new discipline but a new approach in all disciplines. Nano derives from the Greek nanus, meaning "dwarf") Abedini, *et al.,* 2013). Nanotechnology is the ability to produce, control, and use nanometric materials. The particle size in nanotechnology is very important, since on a nanometric scale, the material dimensions are very effective in its properties, and the physical, chemical, and biological properties of each atom and molecule are different with the properties of the mass of the material. This size varies in different materials, but nanometric materials are commonly referred to as materials that have at least one dimension less than 100nm (Journal of Kison). Nanotechnology, as the science of working with the smallest particles, has increased the hopes for improving the productivity of agricultural systems by confronting the problems that have not been responded by using conventional methods. Evidence suggests that a high percentage of different product markets will rely on nanotechnology, which is why large and small governments and companies are looking to gain a place in these markets. The market for nanotechnology products in 2010 was estimated over $1,000 billion. The application of nanotechnology is often accompanied by lower costs, longer durability, lower energy consumption, lower maintenance costs, and better properties. One of the main topics of nanotechnology is the construction of materials with new properties. These materials will have a high added value and better efficiency in all industries, including agriculture. As nanotechnology is used in various industries, the use of this technology in the agricultural industry can also transform this industry.

Nanoscience is influential in all industries, so that all industries need to use nanotechnology in their growth and development process (Jahanshahi, 2007). Therefore, the manufacturing industry of agricultural machinery and equipment can also benefit from a new potential for its development using nanotechnology, which its fields of application are as follows:

A. The application of nanotechnology in the chassis and body of agricultural machinery

The hard-working conditions for agricultural machinery and equipment, especially tractors, combines and other machines used in fields or gardens, further specify the need for utilizing more durable parts. Using nanoparticles of clayey soil and carbon nanotubes to produce nanocomposites with improved mechanical properties compared to conventional composites can be a new approach to lightening and even replacing metal parts in agricultural machinery. Nanocomposites are a new category of materials that include old polymers reinforced with nanometric particles, and in fact nanocomposites are a group of plastics full of minerals that contain a small amount (less than 10%) of nanometric particles (often clay). Theoretically, these materials can be easily extruded or molded in the final shape, while they have the same strength of the metal and are lighter (Robert Leaversuch, May 2003). This not only affects increasing the life of this equipment, but also lightening them, reducing fuel consumption and, consequently, reducing environmental pollution. These composites also have two other advantages. First, nanoparticles significantly provide a more beauty by creating a smooth and uniform network structure, and thus nanocomposites have a more beautiful surface and more transparent colors. Furthermore, nanocomposites are lighter than common composites up to around 22% due to the need for lesser reinforcing materials, and therefore the use of nanocomposites in the production and construction of agricultural equipment and machinery is very important.

Nanocomposite features include:

- High strength and hardness to a degree equal to metals, but lesser weight
- The ability to prevent leakage of gases and fluids
- Electrical conductivity
- Anti-combustion (burning of plastics is one of the problems of using them)
- Recovery capability
- Dimensional stability
- High resistance to chemicals, heat and so on.

The first industrial use of clay-reinforced nanocomposites is to create a timing chain coating, which is done by injection molding, and these materials exhibit high rigidity and high thermal stability, and can be used in an automobile engine's body. The protective weight achieved to cover the timing chain is 25% due to the lower content of organic fibers in comparison with nylon or propylene filled with glass fibers(Vatan-dolat-xah, 2006).

B. The application of nanotechnology in agricultural equipment and machinery tires

Tire is one of the most expensive parts of a tractor or combine that can be used to increase the tire's tilt resistance and reduce the wear of tire up to 50% by adding nanoparticles to the tires of tractors and agricultural machinery. The presence of nanoparticles in the structure of tire increases wear resistance, strength (improving the mechanical properties of the fracture) and the apparent beauty of the tire. Moreover, it also brings the smoothness and elegance of the appearance of tire. All of these factors produce a high quality product that can last longer in a variety of conditions for tractors and combines. By adding these nanoparticles to the tire, the amount of butyl rubber required for the tire is reduced, and the tire becomes lighter and cheaper and remains cooler while moving. Today, nanotechnology has created a profound transformation in the industry (Razzaqi, 2010).

The properties of these types of tires include:

- Increased the resistance of tires to wear
- Increased mechanical strength of tires
-increased the thermal resistance of tires
- Reducing the flammability of tires
- Improving tire heat distortion

Goodyear is one of the largest tire manufacturing companies in Germany that uses soot nanoparticles in rubber to make its own tires (Anonymous, March 2003).

C. The application of nanotechnology in the structure of glass of agricultural equipment and machinery

Nanocrystalline materials produced by Aero-Gel method can be used as materials for intelligent glass. This glass becomes dark and opaque when exposed to intense sunlight, and when sunlight shines less, it becomes brighter. This feature causes sunlight not to annoy the tractor driver's eyes. In addition, since agricultural machinery are used in dust-free environments, this type of glass has its own self-cleaning properties, which is an important feature of the glass used in the manufacture of agricultural machinery and equipment. Another example is glass that can reflect sunlight infrared ray, in which their structure is a very thin layer of nanoparticles between two layers of the glass. This layer is responsible for reflecting sunlight infrared ray and thus preventing overheating inside the cabin (Vatan-dolat-xah, 2006).

D. The application of nanotechnology in the production of lubricants required in agricultural machinery and equipment

Nano-lubricants have billions of spherical nanoparticles that significantly improve friction and wear, as well as the compressive properties of the lubricant. The advantages of using these materials, depending on their function, can be to increase the speed and reduce the energy required, increase the life of the materials and reduce their environmental damage. In order to reduce engine erosion, copper nanoparticles are added to the engine oil, and ferromagnetic nanoparticles are used both in the structure lubricant and in the stopping leak structure. Fullerenes are also used to increase lubrication and reduce viscosity of lubricants.

A joint research team between Pishgaman-Nano-Aria Company (PNACO) and Shahid Beheshti University conducted a study on nanostructured lubricants in Iran, which produced a lubricating product based on nanotechnology that has the following properties(Anonymous,2007).

- Reducing service engine time by 2 to 5 times
- Increasing engine acceleration
- Increasing life
- Reducing the engine temperature up to 20°C
- Friction reduction between parts (1.5 to 10 times)
- Reducing fuel consumption up to 8%
- Significantly reduced engine noise
- Preventing oil leakage
- Decreasing engine sealing time up to 2 times compared to the current time

E. The application of nanotechnology in the production of mechanical parts of agricultural machinery and equipment

Most products require adequate coating to prepare for acceptable market entry. Nanotechnology can be used to increase resistance to various environmental factors, such as resistance to corrosion, the creation of new ability at the surface, such as hardening, etc. Nowadays, considering the growth of nanotechnology and its use in various fields, coating can be considered as one of the most important sectors in the use of this technology. Nanometric coating for various purposes such as increased strength, improved bending and shear properties, protective coatings resistant to corrosion, scratches, wear, and environmental factors, uniform distribution and reduced the use of chemical solvents in coating of the parts, and increased chemical and thermal stability are among the achievements of the application of nanotechnology in the production and manufacture of parts related to agricultural machinery and equipment. Moreover, the use of this technology in agricultural machinery in addition to improving equipment resistance to wear, corrosion and dust increases their useful life (Maqrebi & Shahverdi).

F. The application of nanosens or technology in agricultural machinery and equipment

Precision agriculture (PA), which has always been a long-standing wish, helps to obtain the highest output (yield) and the lowest input (fertilizers, pesticides, herbicides). The purpose of PA is to collect and process data related to the diversification of soil characteristics and the changing conditions of product production in order to increase the productivity of inputs in small units of agricultural land. One of the major roles of nanotech-based agricultural machinery and equipment is an increase in the use of automated sensors that are connected to GPS devices for real-time control. Nanosensors can be spread across the field and control and regulate the soil conditions and growth of the product. By using nano-tubes or nano-carriers, nanosensors can be constructed that are so small and can measure the size of a protein or even smaller molecules. In addition, it can be made nanoparticles or nano-surface that are able to produce electrical and chemical signals against contaminants like bacteria. It can be significantly increased the amount of product with the use of intelligent nanosensors in precision agriculture machinery and equipment.

G. The application of nanotechnology to provide agricultural machinery and equipment propulsion

Nanotechnology will not be unaffected in providing agricultural machinery and equipment propulsion, and in the future, a new generation of fuel cells will be used to generate energy and power. These fuel cells, which are used nano-crystals in their different parts, are utilized as renewable energies (Anonymous,2003). Nano-crystalline materials produced by the Sol-Gel method, due to which their aerogel structure, can save significantly more energy than common detachable plates, are used as detachable plates in the new battery generation. Nickel-metal hydride batteries (Ni-MH), made of nano-crystalline nickel and metal hydrides, require less recharging and longer life. Nanomaterials such as tungsten-titanium composites, de-boride-copper are highly susceptible materials that are used to increase combustion efficiency and thus reduce fuel consumption (Vatan-dolat-xah, 2006).

H. The application of nanotechnology in the production of paint and coatings of nanotech-based agricultural machinery and equipment

Since the use of sunlight-resistant and wear-resistant paint in the machinery is essential, nanometric coatings for various purposes such as increased strength, improved bending and sheeting properties, protective coatings resistant to corrosion, scratches, wear and nanocomposites have been used due to high strength and durability against environmental factors. One of the most important applications of this technology in the machinery industry is the production of materials such as Mica and Talc which in addition to the apparent beauty, has increased the strength and, in part, the weight loss of agricultural equipment, and finally, has caused to reduce the compaction of agricultural soils and be lacking the formation of hard layers. Furthermore, the application of nanotechnology in the production of agricultural machinery and equipment will cause reducing fuel consumption in agricultural machinery and increase the life of parts and, ultimately, increase economic efficiency. Ceramic coatings of nanoparticles contribute to thermal stability and erosion resistance in engine parts (Asadi Fard, 2004).

I. The application of nanotechnology in the production and manufacture of catalytic converters and filters used in agricultural machinery

Nanotechnology has a significant impact on environmental technologies, such as filtering, separating, absorbing and decomposing environmental pollutants before or after pollution in the wastewater treatment process through the use of filtration, nanoporous materials and catalysts in cleaning operations.

Nanotechnology will certainly have the potential to contribute to reducing global carbon emissions, and today catalytic converters play a very important role in reducing air pollution, which can be widely used in machinery used to mechanize farming. Catalytic converters counteract up to 90% of the toxic gases, so that unpolluted hydrocarbons that come out of the engine become converted into water and carbon dioxide. In addition, it converts nitrogen oxide into nitrogen gas. With the expansion of the use of catalysts, the use of inefficient fossil fuel power stations as well as inefficient power distribution networks will be significantly reduced and replaced by the production of local energy from clean and environmentally friendly sources and local power generation based on the fuel distribution network instead of the electric power distribution network. This will greatly reduce greenhouse gas emissions; therefore, catalysts are highly effective in reducing air pollution. The use of nanotechnology can be effective in the production of outlet filters to prevent the release of environmental pollutants from vehicles and other machinery powered by diesel engines. Among these filters are diesel particulate filters that eliminate particulates and soot from combustion of diesel engines. These filters can be used in the exhaust system of diesel agricultural equipment, which removes approximately 85% of the exhaust outlet particles and, under certain circumstances, sometimes reaches 100%. Some filters are disposable, and when the amount of soot and accumulated particles inside them increases, they can no longer be used and should be replaced. Today, filters are used which burn accumulated soot using a high temperature catalyst.

J. The application of nanotechnology in displays used with combines, tractors and other agricultural equipment

Displays play a major role in providing information, because they are in everyday life of all people with different uses. Consumers are looking for affordable displays with advanced features such as low thickness, good brightness, high resolution, lack of viewing angles, long life, low power consumption and light weight. Nanotechnology is an effective approach to upgrading flat panel displays to improve their performance and quality, and to address environmental issues. In today's most advanced tractor sand combines, displays are used to illustrate various factors such as advance speed, engine operating temperature and ambient temperature, engine speed, engine power and torque, wheel slip measurements, oil pressure, measured pollutants released in the atmosphere, height and various settings of various components of the equipment, wind pressure of the tire, the amount of product losses, the geographical location of the establishment in the field, the instantaneous weight of the product harvested and accumulated in the reservoir, power drops from different locations of the power transmission system, slope and the angle of deployment of the device on the surface of the earth, altitude and the atmospheric pressure, the conditions of distribution of weight on the axes, the amount of tensile strength on the machinery, the effective working width of the machinery, displaying the spacing on the rows and between the rows of planting(Sharif Nasab).Under dusty conditions and sunshine that exists in the environments in which agricultural machinery is working, the application of nanotechnology in the production and construction of displays used with combines, tractors and other agricultural equipment can effectively meet the expectations of the manufacturers of this type of machinery.

DISCUSSION AND RESULTS

Nanotechnology has potential benefits in a variety of fields. Nanotechnology is on the rise in all disciplines as well as in agriculture and increasing the productivity and performance of agricultural products. The use of nanotechnology can significantly reduce failure and damage to agricultural machinery in the industry. The applications of nanotechnology in the production of construction materials and agricultural equipment coatings such as the production of nano-polymer composites, metal nanocomposites, paints and coatings that are resistant to sunlight and wear in machinery, sensors for increased precision and performance, displays used with tractors and other equipment, propulsion of equipment, microprocessors, lubricants, smart glass, catalytic converters and filters for help to reduce global carbon emissions, protective coatings resistant to corrosion, scratches, wear and environmental factors. Users of agricultural machinery inside the country may not feel the need to use nanotechnology in machinery and equipment, but manufacturing companies must pay attention to the issue that the use of this technology will enhance their products and satisfy customers, and in the long run, it has a tremendous effect on the sale of their products. Particularly, considering the globalization of trade and the need to pay attention to the roots of competition in this field, attention to such technologies is important.

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