The Effectiveness of Nanotechnology in Sustainable Development

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Abstract:

Nanotechnology is one of the latest technological and scientific developments in recent years. It is the second industrial revolution that will contribute to achieving the economic, environmental and social dimensions of sustainable development by reducing industrial waste and then eliminating industrial pollution and improving the efficiency of using available economic resources and areas of application. From this standpoint, the research aimed to define nanotechnology and its nature in the industrial sector in general and the Iraqi sector in particular and to show the extent of the possibility of benefiting from it in supporting and achieving the economic, environmental and social dimensions of sustainable development. At the end of the research, the researchers reached a set of conclusions, the most prominent of which is that nanotechnology is an entry point to achieving sustainable development by reducing the resources consumed.

Keywords: Nanotechnology, Nanomaterials, Sustainable Development.

1. Introduction:

Nanotechnology is one of the latest technological and scientific developments in recent years. One of the most prominent outcomes of this technology is a significant reduction in the consumption of resources, in addition to providing alternatives to rare raw materials or those with harmful environmental impacts. It contributes to avoiding the use of hazardous materials that are highly toxic or harmful to the environment whenever possible, and raising the efficiency of products and their production methods to achieve the two previous goals. This technology also contributes to reducing emissions, discharges and waste during the production process and allows the possibility of recycling waste and investing it in its usual use as raw materials. In this context, there are two main points that developing countries must note (Köhler and Fritzsche, 2008).

The first is that many of the means and methods of industrial production in these countries have old and traditional technologies, so the process of replacing or updating them represents an opportunity to keep pace with scientific and technical developments. The second is that this update will take place at a time when tangible steps have already been taken in the practical application of nanotechnology in the most advanced countries and some developing countries. Including some Arab countries, we can benefit from their experiences and expertise and keep pace with the development taking place worldwide, represented by the widespread and accelerating application of nanotechnology in various industries, and then achieving the two goals of modernizing industry on the one hand and sustainable development on the other hand. To achieve the research objectives, it was divided

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into several axes (Al-tayyar, 2012). The first axis was devoted to reviewing the theoretical framework of nanotechnology, while the second axis dealt with the theoretical framework of sustainable development. The third axis presented the applications of green nanotechnology, while the fourth axis discussed the role of nanotechnology in achieving the dimensions of sustainable development. The fifth axis was devoted to the practical aspect of the research, followed by the sixth axis, which is concerned with conclusions and recommendations (Al-tayyar, 2012).

1.1 Research Problem

The research problem lies in the following: The failure of Iraqi establishments to keep pace with technological development in the modern manufacturing environment and its reflection on the industrial product, which led to a decline in the position of the Iraqi product in the competitive market and the control of the imported product over the market. Hence, the need to find solutions to this problem emerged through nanotechnology, which works to increase the efficiency of industrial processes, rationalize the use of resources, and reduce environmental impacts in order to achieve the basic feature of sustainable development, which is

(Meeting the requirements of the current generation while preserving the rights of future generations).

1.2 Importance of the Research

The importance of the research lies in standing on a modern topic in the industrial environment in Iraq, which is nanotechnology, which contributes to treating pollution and thermal emissions and achieving sustainable development from gaseous emissions resulting from various industrial sectors in light of the increasing global interest in the environment.

1.3 Research Objectives

The research aims to define nanotechnology and its application areas in the industrial sector, its nature in general and the Iraqi sector in particular, and the extent to which it can be used to support the economic, environmental and social dimensions to achieve sustainable development.

1.4 Research hypotheses

The research is based on the hypothesis that (the adoption of nanotechnology in the Iraqi industrial sector would contribute to achieving the dimensions of sustainable economic, environmental and social development.

2. Nanotechnology:

2.1 The concept of nanotechnology

The word Nano is a Greek word that means dwarf or small, and thus it became called the technology of very small particles or the technology of small or nanotechnology. Nanotechnology is a technology whose focus lies in studying, understanding and processing matter, as the term of this technology relates to understanding the physical, chemical and biological properties on scales with functional systems and unique capabilities, to be atomic and molecular, and controlling these properties to create new materials with dimensions ranging between 1 and 111 nanometers, which can be applied in various scientific fields such as physics, chemistry, materials science, biology, and engineering (Köhler and Fritzsche, 2008).

Köhler and Fritzsche defined nanotechnology as the process of designing, manipulating, building, and producing by controlling the shape, size, properties, responses, functions, and structures of materials at the nanometer scale. Or it is a technology that produces things by assembling them at the small level from their basic components, such as atoms and molecules. Or it is: techniques and tools concerned with the design, properties, products, and applications of the nanoscale (through the management of shape and size on the nanoscale, and the structures, systems, and devices) (Köhler and Fritzsche, 2008).

Nanotechnology, or nanotechnology, or miniaturization technology, is concerned with studying and inventing new methods and techniques whose dimensions are measured in nanometers, which is a part of a thousandth of a micrometer,

or a part of a millionth of a millimeter (Al-tayyar, 2012). Since nanotechnology is a technology that is employed to work on nanoscales, there must be a science that regulates its work. Therefore, nanoscience emerged, which can be defined as: A multidisciplinary science that includes more concepts than chemistry, physics, mathematics, biology, biochemistry, and other sciences that are multidisciplinary by nature, such as engineering materials science, which covers the concepts of chemistry and physics (Filipponi and Sutherland, 2013). Nanoscience was also defined as the study of very small things on scales ranging from one hundred to one hundred billionth of a meter, i.e. (1–111) nanometers. Nanoscience and nanotechnology all deal with very small objects and systems, from the above, the researcher defines nanotechnology or nanotechnology as the technical field that is concerned with applying nanoscience and benefiting from it in other fields by forming new materials with new and advanced nano properties (Bai and Gerstner, 2017).

2.2 Principles of Nanotechnology

One of the most important basic principles of nanotechnology

- The ability to control atoms individually, move them and rearrange them
- Changing the physical and chemical properties of matter on the NATO scale from their properties at their natural scale.
- The ability to control atoms in the manufacture of materials and machines and purify them from impurities and rid them of defects, which lead to:
  - The ability to build any material because the atom is the basic building block of all materials.
  - Discovering new properties for new materials.
  - Better properties for materials, as they are smaller in size, lighter in weight, stronger, faster, cheaper in cost and less energy consumption.

3. Sustainable Development:

3.1 The Development of the Concept of Sustainable Development

Development is considered a basic condition for the advancement of countries and societies. Development has become an international requirement for all countries and in various fields. The concept of development has gone through several stages and is interpreted according to the nature of global problems at the time and according to the interests of experts and their global orientations with human, cultural, social and economic dimensions. In the twentieth century, development was characterized by its classical concepts, which are distinguished by their "economic nature only". During the forties and fifties of the last century, development was interpreted as a term as the development of the income level of individuals, i.e., it gave an economic meaning synonymous with the concept of economic growth. In the view of some economists at the time, it was interpreted as a process in which the average income of the individual and the national income increase. Then, the specialized organizations re-clarified the concept of development in the seventies of the twentieth century to be a process of reducing poverty rates in the world and eliminating it, and eliminating the maldistribution of income and unemployment (Al- rikabi et al., 2011).

As for the mid-eighties of the last century, the international community began to realize the extent of the need to focus on solving environmental problems, when it was necessary to exert political and scientific efforts (through the formation of organizations with international parties and scientific competencies), so sustainable development took on a concept of "environmental nature". The emphasis on human development appeared through the World Human Development Report issued in 2012, which emphasized not harming future generations by preserving their right to natural resources and not polluting the environment or burdening them with public debts that are borne by previous generations, which creates difficult conditions in the future as a result of the choices of the present (Filipponi and Sutherland, 2013).

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By the twenty-first century, several conferences were held, the most important of which was the World Summit on Sustainable Development in 2016 in Stockholm and Rio de Janeiro in Johannesburg, South Africa, which reaffirmed the commitment to what was stated in the Janeiro conferences regarding environmental protection and economic and social development as a necessity for achieving sustainable development. In 1966, the United Nations Conference on Sustainable Development, known as Rio+1 or the Rio Earth Summit, was held, at which the United Nations officially adopted the Sustainable Development Plan for 2017, which is implemented for the years 2012-2017, with the participation of member states (Rabah, 2015).

The last global meeting on development was the Sustainable Development Goals Summit in 2017, where heads of state and government met on 20 and 21 September 2017 at the United Nations headquarters in New York to follow up on progress made in implementing the Sustainable Development Agenda 2017 and the 13 Sustainable Development Goals. This event is the first UN summit on the Sustainable Development Goals since the adoption of the Sustainable Development Agenda 2017 in September 2017 (Al- rikabi et al., 2011).

3.2 Dimensions of sustainable development

3.2.1 The economic dimension:

Classical economic thought explains "sustainable development" as the continuity of multiple resources in supporting economic structures to achieve the welfare of society, i.e., it ignores the right of future generations to the resources used by the current generation to achieve its welfare. As for modern economic thought, it explains sustainable development as the necessity of preserving the resources that contribute currently and, in the future, to securing the needs of the population (Rabah, 2015). This means ensuring the individual's consumption share of the resources available in nature, as well as stopping the waste of consumed resources and rationalizing them and in distributing these resources between preserving them and inventing ways to develop them as much as possible, and adopting the principle of equality of current societies and societies or future generations. The economic dimension of sustainable development also means the continuous search for methods and procedures that reduce the levels of energy consumption and natural resources, especially non-renewable resources (water and energy sources such as oil and gas) by improving the level of efficiency of production and consumption processes in various fields and lifestyles of individuals (Al- rikabi et al., 2011). Sustainable development is an important and encouraging factor for raising the level of production and achieving economic growth at all levels by focusing on environmentally friendly industries to achieve sustainable development projects. Industries that take into account the harmful side effects on the environment in the long term will lose consumer confidence.

3.2.2 Environmental dimension:

The concept of sustainable development has often been linked to the environment. For individuals who are not academically familiar with the subject of development, the term sustainable development is interpreted as a concept related to the environment and what pertains to it. The international and local community has given great importance to the environment, so that the environment is included in the sustainable development process by preserving natural resources and using them in the best and most rational ways and exploiting their benefits, in order to maintain the continuity of development, especially after the gradual increase in the problems that the environment is exposed to as a result of the production and consumption processes practiced by societies and countries that are indifferent to the resulting damage to the planet. Achieving development requires preserving the environment, whether through manufacturing or construction processes or others, and linking environmentally friendly technology with development, in order to reduce pollution in all its forms, including water and food pollution, which enhances the sustainability of resources. Therefore, it must be taken into account and respected (Zheng et al., 2004).

3.2.3 Social dimension:

This dimension is based primarily on achieving social justice, combating poverty and unemployment, and controlling human

consumer behavior. The social dimension is achieved through developing the individual's standard of living, whether in terms of health services, achieving stability in population growth and distribution, and stopping migration from rural to urban areas. The sustainable development process includes human development, which aims to improve the level of education and health care, as well as the participation of communities in making development decisions that affect equality and fairness, whether fairness to future generations or fairness to the generation living today, and ensuring equal opportunities for individuals of the current generation with others in obtaining social services and natural resources. Therefore, development aims to improve learning opportunities, provide aid to informal economic sectors, and health care for women and all segments of society. Sustainable development, such as education, means investing in natural resources or redistributing them to meet basic human needs and health, ensuring that future generations receive the same or better level of these services (Harman et al., 2010).

4. Green nanotechnology applications

4.1 What is green nanotechnology?

With regard to sustainability and the environment, the application of nanotechnology can be very useful, for example in water purification processes, in the production of more efficient photovoltaic panels than traditional ones, or in the production of automated sensors, as well as in the production of new batteries for environmentally friendly energy storage [9]. The researchers believe that the term green nanotechnology is a comprehensive term that refers to how to employ and invest in nanotechnology and nanoscience in general to support and preserve the environment, so it was also called clean technology. There are many areas in which green nanotechnology can be used, including clean energy, food security, air and water purification, and many others. Green nanotechnology has been defined as the use of nanotechnology to make current manufacturing processes for nanomaterials more environmentally friendly. For example, nanomembranes can help separate harmful chemicals from waste materials, as well as using alternative energy systems. Green nanotechnology is a means of manufacturing other processes (Hulla et al., 2015).

4.2 Applications of Green Nanotechnology:

The field of environmental protection is one of the most prominent application fields to which nanotechnology pays great attention. Nanotechnology can be used in the process of self-cleaning surfaces by using environmentally friendly nanomaterials that react with ultraviolet rays, such as: car glass, windows, and paints, as well as using nanoparticles that work to get rid of pollutants and get rid of unpleasant odors, such as using silver particles and titanium dioxide TiO2. Microscopic machines can remove toxic chemicals from wastewater discharged into rivers, and may be able to extract some radioactive isotopes from nuclear reactor discharges (Hulla et al., 2015).

4.2.1 Green nanotechnology and clean energy (green energy):

Green energy is the energy that does not leave traces or waste that harm the environment, as is the case when using fuel obtained from renewable natural sources such as (wind, tides, solar energy and geothermal energy), to be an alternative to fossil or traditional fuel sources (coal, oil and gas), which cause increased environmental pollution, global warming, ozone hole, scarcity of some natural resources and their depletion (Walker, 2013). When used in the field of generating electrical and solar energy, silicon nanoparticles are characterized by increasing the production of electrical energy in addition to extending the life of the cell and reducing the heat in it. Nanotechnology also contributes to the manufacture of energy-saving batteries and mechanical wind energy using lightweight fans, which increases the energy generated from the wind (Naji et al., 2024). It also works Nanotechnology improves the efficiency of batteries and membranes with a microstructure, which leads to accelerating the process of charging dry batteries and makes their productive life longer wind (Naji et al., 2024). Among the improvements of nanotechnology in the field of energy generation is:

- Carbon nanotubes that are characterized by lightness and increase the efficiency of electricity generated by

windmills: using tubes weight and strength, to make windmill blades.

- Nanotube slices that can be used to reduce energy loss in electricity transmission wires.
- Improving battery performance, improving efficiency and reducing the cost of fuel cells.

The researchers believe that this technology contributes to reducing the consumption of fossil fuels that result in harmful emissions, by providing alternatives to energy sources that are characterized by efficiency compared to traditional sources, and avoiding environmental pollutants. The following figure shows the energy consumed in the world in the sectors of transportation, household uses, services and industry, where the industrial sector consumes a higher rate compared to other sectors. This indicates the importance of finding ways to rationalize consumption and provide cleaner alternatives for the environment (Hussein, 2015).

4.2.2 Green Nanotechnology in Agriculture and Food Security:

Modern applications of nanotechnology have included the agriculture and food security sector, and have been reflected in changing and developing the technology used in the agriculture sector, such as improving soil fertility and increasing its ability to produce high-quality crops and the ability to resist agricultural diseases and pests. Nanotechnology can be used in the fields of food production, processing, packaging and safety, for example, nano capsules ('Nana capsules') that use chemicals and pathogens in food, in addition to enhancing the flavor of food, in the treatment of) that use nano-packages that release some chemical preservatives for food, and nano-silica granules are also used that prevent gas molecules such as oxygen from penetrating those packages and spoiling food. In addition to improving the work of Without leaving chemical pesticides for agricultural crops with health effects on other living organisms (Berger, 2009). It also works to develop active surfaces that are antimicrobial and antifungal, so zinc oxide particles are included in plastic packaging to prevent ultraviolet rays, and provide protection and antibacterial (Naji et al., 2024).

4.2.3 Nanotechnology in the field of water purification:

Nanotechnology has worked to provide solutions to the problem of water shortage for human use by finding a technology for water filtration, which is inexpensive, and can eliminate safe pollutants Water and clean it without using electricity. Nanotechnology is used for water purification, desalination and nanofiltration nano filtration and desalination, which is called carbon tube filter CNT Membranes. These membranes are specially designed for water filtration and analysis, removing dissolved salts from water, treating waste, and removing environmental pollutants such as microbes and arsenic. The idea of a relationship between silver and electricity and killing bacteria has been exploited by spreading silver nanowires on the silver material and then covering them with carbon nanotubes to gain superior effectiveness in filtering and sterilizing water and reducing the filtration stages to only two stages. This method is an ideal way to treat water, as nanofilters are not subject to clogging and therefore last a long time, in addition to the smooth passage of water through them and do not require chemicals, in addition to the ease of maintenance and do not require a large amount of energy. A small filtration device was also manufactured that works without using electricity and can filter and sterilize (1) liter of water per hour. Its price does not exceed $12 and it is capable of removing all microbes and dangerous chemicals from drinking water (Boelt, 2014).

4.2.4 Wastewater treatment:

In the current era and in light of the scarcity of water resources, wastewater treatment is considered a basic condition for achieving sustainability due to its environmental impacts that harm current and future generations. Therefore, we must benefit from the development of science and technology to develop advanced technologies for treating wastewater with high efficiency. Among the treatments for the problem of various wastewater is the use of nano materials that have the ability to provide sustainable practical and economic solutions in this field and can be summarized in four categories:

- Using some nano materials such as activated carbon and carbon nanotubes, titanium oxide, zinc oxide, magnesium oxide, and iron oxide, which are applied to remove heavy metals from wastewater.
- Using nano catalysts such as photocatalyst and chemical oxidizer to remove both organic and inorganic pollutants.
- Using nano membranes to remove dyes and heavy metals by Carbon nanotube membranes, electrical nanofibers and hybrid nano membranes.
- Integration of nanotechnology with biological processes such as the presence of a bioreactor for membranes and a microbial fuel cell to reach the latest possibilities for purifying wastewater. A team from the Nanotechnology Center for Environmental and Biological Sciences at Rice University in the United States has developed membrane filters, by manufacturing filters made of ceramic materials from iron oxide ceramic membranes (nano granules), and these membranes are known as reactive membranes for their superior ability to remove and analyze pollutants and organic waste from water and purify them for efficiency and recycle water in a sustainable way using green nanotechnology for a better environment (Hernández and Torre, 2017).

5. The role of technology in achieving the dimensions of sustainable development

5.1 The environmental dimension:

Nanotechnology contributes to achieving the environmental dimension of sustainable development by using cleaner production techniques as an entry point for applying nanotechnology, especially since it represents a strategy for the industrial facility as a whole and is not specific to the production section only. The main goal of cleaner production is to work on the sustainability of industrial production and energy and reduce environmental pollution resulting from industrial facilities, and this is what the introduction of nanotechnology in the industrial field produces, taking into account the financial cost of its application. Given the negative effects and severe damage to the environment, especially in the current century as a result of the irrationality of the manufacturing process, many countries have resorted to adopting sustainable industrial technology, including (green technology and cleaner production methods), to preserve or reduce environmental hazards on the one hand and preserve natural resources on the other hand to ensure the share of future generations in it, in addition to its positive effects on sustainable development represented in diversifying alternative energy sources, which contributes to reducing the percentage of pollution It also produces alternatives to rare and traditional materials, more effective in terms of properties and less polluting, which contributes to increasing the flexibility of production work. By reducing the volume of waste to a minimum and using nanomaterials, the energy costs required to treat pollutants will decrease, which in turn leads to reducing capital, operating and maintenance costs. By applying the cleaner production technology (CPT), reducing the volume of waste will happen automatically, and as a result, the process of using resources as a whole will improve (Al-Birmani and Abbas, 2012).

5.2 The economic dimension:

Nanotechnology is considered an industrial revolution similar to the industrial revolution that brought about economic changes and brought the world to what it is today. The economic importance of nanotechnology is due to:

1. The ability of nanotechnology to build new materials as an alternative to traditional materials with high costs.
2. The new nanomaterials have distinctive properties compared to traditional ones such as strength, hardness and electrical conductivity.
3. The possibility of using nanomaterials in various industries and areas of life.
4. The possibility of exploiting some waste and recycling it to manufacture new nanomaterials.

These features allow the production of any commodity at a lower cost by using naturally occurring materials with poor physical and chemical properties and transforming them through nanotechnology into materials with excellent properties by rearranging their atoms to transform from worthless materials into valuable materials and alternatives to most metals and raw materials that are subject to scarcity. The above will lead to the advancement of local production if nanotechnology is exploited correctly, making the local product able to compete with imported products, which allows the advancement of economic reality and the achievement of economic development by providing products capable of winning competition through quality, efficiency and low cost. Nanotechnology as a new technological revolution requires expensive financial investments in some of its applications and equipment at its beginning, which is the same as what happened during the industrial revolution that transformed the world into automated production through industrial equipment and machines, but nanotechnology can be applied inexpensively and does not require the investment of billions of dollars through some low-cost nano-biological materials (Vajtai, 2013).

5.3 Social Dimension:

It is represented in the human right to live in a clean and safe environment, while obtaining his right to resources and wealth in a fair manner that allows him to meet his needs for environmental and social services and ensures that he obtains his needs for shelter, clothing and food. The unique properties of nanomaterials at the nanoscale (1-111 nanometers) When applied in the manufacturing industry, it achieves high material and social benefits and thus achieves social welfare for the community [16]. Also, when nanotechnology reduces costs, it will allow the employment of abundant costs in other areas, which means eliminating disguised unemployment by providing real productive job opportunities and not work that represents unproductive costs and a burden on industrial companies that, with continuity, lead to the depletion of economic resources and economically erodes society. As a result, the employment of nanotechnology will support the welfare of society and improve the quality of life. The researchers believe that the above proves the research hypothesis, which is (that adopting nanotechnology in the Iraqi industrial sector would contribute to achieving the dimensions of sustainable economic, environmental and social development). The above can be summarized by the importance of nanotechnology in achieving the dimensions of development. The three main dimensions of sustainable development have a solid foundation, which is capital, which is divided into five main types: (natural, financial, productive, human, and social). Sustainable development is achieved if production is carried out using methods, techniques, and practices that work to maintain capital in its five types. Nanotechnology works to increase the efficiency of industrial processes, rationalize the use of resources, and reduce environmental impacts by reducing waste of all kinds, thus reaching a low production cost, by using low-cost nanomaterials with higher strength and durability than traditional materials (Vajtai, 2013).

6. The modern closed battery project in the General Company for the manufacture of batteries and its impact on sustainability

6.1 The establishment of the General Company for the manufacture of batteries:

The General Company for the manufacture of batteries was established in 1231 and is currently the company's specialty in manufacturing cars and equipment. The company is a factory that includes the open and closed dry liquid lead batteries from assembling semi-manufactured and imported parts and producing lead of all kinds. The factory includes:

1. Babylon 1 and Babylon 2 factories for the production of acid liquid batteries at the Al-Waziriyah site – Baghdad.
2. Al-Nour factory for the production of dry batteries at the Abu Ghraib site – Baghdad.
3. Lead foundry for the production of pure and alloyed lead at the Khan Dhari site – Anbar.

Because the company's products suffer from competition from imported batteries from (Korean, Chinese, Malaysian, Iranian

especially 7K batteries, the company resorted to the necessity of switching to the production of the battery without maintenance, and the magic eye) (closed) The company contracted to equip, install and operate a new line to produce the battery without maintenance (smf) or dry for capacities (21, 31, 011, 01) amperes, which are highly desired in local markets.

6.2 Definition of the modern closed battery project:

The company has added an integrated production line to produce batteries without maintenance (SMF), which is one of the most important achievements of the company and is considered a radical transformation in its work, as it represents the new generation of types of batteries that are highly desired in the markets and is considered one of the most common types of local lead-acid batteries at the present time, as it is used as a car battery, especially for modern models for its features as follows:

- It does not require distilled water (it does not require maintenance
- Fully enclosed (no vent plugs)

The characteristics of this battery make it an environmentally friendly product, meaning there is no leakage of battery acid that may affect the color or body of the car when used, and it is sold charged and filled with acid and ready for use, so there is no need for the consumer to perform periodic maintenance, which poses a risk to the safety of the consumer. In terms of the interference of the process of treating the battery plates with nanotechnology in the manufacturing stages of non-permanent batteries (modern), it lies in containing Crystal Lead Dioxide Nanoparticles, which have a high bonding strength that prevents the active material of the plates from falling during the charging or discharging process while using the battery in the car, which gives the battery a longer life for use and higher efficiency in performance, in addition to its superiority over open acid batteries in terms of emitting gases and acid outside the battery and causing damage to parts of the car in contact with the leak.

6.3 The impact of using open (traditional) and non-permanent (modern) batteries on sustainability:

6.3.1 The environmental aspect:

a) Conventional batteries:

- The liquid battery consists of a number of plates, and each plate contains two poles of lead and lead oxide One negative and the other positive, and all of them are immersed in a concentrated sulfuric solution known colloquially as (water of concentrated sulfuric acid in a ratio of fire) and this liquid consists of 1 to 3 distilled water, and this liquid is dangerous and it is not recommended to deal with it.
- The battery needs periodic maintenance to maintain its efficiency, such as refilling the tanks with distilled water, and recharging it when empty, and this process may involve accidents and risks to the user.
- The operation of acid batteries (liquid batteries) depends on the chemical reaction between the lead in the plates and sulfuric acid, so the operation of the battery produces sulfur fumes that cause damage to some parts of the engine compartment as well as damage to the car paint and erosion of some of its parts.

b) Modern batteries:

- This type of battery is metaphorically called "dry batteries", as it also contains sulfuric liquids (sulfuric acid), but it is tightly sealed and does not allow the solution to leak out.
- It does not require regular maintenance like a regular battery, although the life of a dry battery is about five years, which means that

it eliminates the risk of the user dealing with the dangerous solution.

- The dry battery does not cause the emission of fumes or burning sulfur exhausts because it is completely closed, unlike the traditional open battery, which means preserving the engine and car paint from damage and corrosion. In terms of the raw materials used in the two batteries, when comparing the table of materials used, it is noted that arsenic was removed when manufacturing the battery, which is not sustainable and is considered one of the toxic elements and leads to weakening the immune response when inhaling the gases emitted during manufacturing for workers and the gases emitted during use of the battery for customers. Arsenic is added to the composition of lead alloys to improve structural hardness and make lead easier to cast. It is also noted that the antimony element used was reduced from 611 grams in the open battery to only 73 grams in the non-durable battery, as antimony, or what is called antimony, is classified among the most dangerous chemicals in the European and American risk lists, and it is suspected of causing cancer when inhaling poorly soluble antimony particles, which leads to pneumonia. When added to lead-acid batteries, it improves the strength of the plate and charging properties, and it is added to the alloy, which increases its hardness and mechanical strength.

6.3.2 The economic and social aspect:

Public companies are constantly seeking to find ways that contribute to re-raising the name of the local product in the local market after imported products dominated the market and dominated it. Therefore, the public company previously worked to improve the efficiency of the old product of liquid batteries and raise its quality by developing a production line that suits the needs of the local market in order to restore consumer confidence in the local product and the good reputation it enjoyed previously, but these attempts did not succeed due to competition from imported batteries from global origins and with advanced technologies that are compatible with the development of modern cars. Therefore, the company resorted to producing the non-durable battery as a major project that contributes to supporting the national economy and reviving it, especially since the project is capable of covering the local market and exporting abroad as well. Now, the customer's desire is the focus of the company's interest, as the price of the new battery is lower than the price of the imported battery of the same capacity by a percentage ranging between (2.1-01%) and a six-month warranty from the date of purchase of the battery, which includes maintenance and compensation in the event of a battery failure without a price. The company has also suffered from losses throughout the previous years Accumulated as a result of the decline in sales and the continued bearing of fixed costs without any production, the company represents a burden on the state budget only and is not a productive company that contributes to supporting the economy and achieving revenue as planned, but the new battery project will improve the company's reality by raising sales rates and achieving high revenues capable of covering the project costs and achieving profits as well, according to the feasibility study prepared by the management of the General Company for Battery Manufacturing. The following chart shows the company's previous and expected revenues for the coming years following the operation of the new production line.

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7. Conclusion and Recommendations

7.1 Conclusion

1. Advanced nanotechnology is a new approach to implementing sustainable development, as it allows for greater and more efficient production by reducing the use of raw materials, resources and energy.
2. Investing in nanotechnology is one of the ways to achieve sustainable development, as it contributes to the conservation of resources and their optimal use and reducing pollutants resulting from industrial processes.
3. Low-cost, ultra-pure, lightweight materials can be manufactured, and due to these advantages, they lead to many changes in the economic, social and environmental aspects of society.
4. The use of nanotechnology means less waste and emissions, thus reducing the minimum environmental impacts.
5. Nanotechnology can address the problems of high costs and pollution from the source with their causes and not their symptoms by providing alternatives to traditional raw materials; it is an advanced preventive step that eliminates the need for waste management and its costs. It can also be adopted in treating waste effectively by providing solutions at the final lines of operations.

7.2 Recommendations

1. Raising awareness among production companies about the possibility of benefiting from nanotechnology in reducing the economic resources consumed and reducing the pollution released into the environment by investing in nanotechnology applications through holding educational workshops on technological development in the world of industry.
2. Encouraging work on innovation and use of nanotechnology as an entry point for sustainable development in Iraqi industry, especially industries facing high competition from imported products and marketing environmentally friendly products in the local market as a first step by transferring the results of academic research and studies to the relevant departments within industrial companies.
3. Encouraging and developing nanotechnology research centers in Iraqi universities and establishing nanotechnology centers in the Ministries of Electricity, Industry and Minerals and working to link them with the relevant regional and international organizations to achieve coordination in the transfer and absorption of nanotechnology.
4. Encouraging the private industrial sector to adopt green nanotechnology by setting incentive policies such as exemption or reduction in taxes for projects that apply advanced nanotechnology, and imposing taxes on projects that participate in environmental pollution.

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