Journal of Advanced Zoology

ISSN: 0253-7214

Volume ***44*** *Issue* ***S-5 Year 2023*** *Page* ***354:360***

Development of Technical Creativity of Students in Teaching Physics Using Nanotechnology Devices

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Article History

Received: 06 June 2023
Revised: 05 Sept 2023
Accepted: 14 Oct 2023

Abstract

The importance of studying modern technologies in the educational process of modern production and science today is necessary to develop technical skills not only for representatives of this field, but also for students who do not intend to connect their professional activities with modern techniques and technologies. necessary, because having such skills is important for solving problems related to modern tools used in everyday life. The development of technical creativity of students on a global scale is carried out based on modern equipment and innovative technologies. Modern knowledge is of great importance in professional activity, personal experience and formation of a person as a well-rounded person throughout his life..

Keywords: *Technical Creativity, Nanotechnology, Technology, Modern Tools, Physical Phenomena*

1. Introduction

In the development of modern technologies, the role of innovations in physics and physics lessons is important. Physical knowledge is an important component not only of the society as a whole, but also of the modern culture of each person, especially the further professional activity of a person is related to science, technology and production technology. In particular, in accordance with the decision of the President of the Republic of Uzbekistan as of March 19, 2021 No. Great attention is being paid to the selection of students, preparation of competitive specialists for the labor market, development of scientific research and innovations, and practical effectiveness. At the same time, a number of issues that have not been resolved in the field indicate the need to implement measures aimed at improving the quality of education and the effectiveness of scientific research in the field of physics.

Literature review

In the age of information technologies of the 21st century, the role of physics in the rapid development of modern technologies is considered important. It is time to move from mega-sized devices to nano-sized devices that allow us to perform experiments and obtain results with high precision in observing physical processes. At the same time, nanomaterials are displacing traditional materials from consumption day by day. High technology - nanomaterials created with the help of nanotechnology are cheaper, lighter, stronger and more efficient than the materials widely used today. In terms of their physical, chemical and mechanical properties, they are superior to ordinary materials.

In educational institutions, students' interest in technique and technology is explained through the creation of nano-sized devices and the achievements achieved with the help of these nano-devices, to educate students in the spirit of respect for the inventors of nanotechnology, and to understand the laws of operation of technical tools in the development of their technical creative abilities, there is a need to learn to solve practical problems encountered in everyday life, to have competencies in effective use of natural resources and environmental protection.

Analysis

In explaining the following topics of physics in secondary schools, academic lyceums and higher education, new inventions in this field will increase the teacher's technical creativity and students' interest in nanotechnology:

1. Interaction of particles;

2. Capillary phenomena;

3. The operation process of heat engines and their useful work coefficient (UWC).

4. Capacitors

5. Electrical conductivity

6. Innovations in the field of nanotechnologies on the topics of dispersion phenomena once again prove that students' physics is necessary in life.

In physics lessons, it is important to develop students' worldview in the field of nanotechnology, to form skills related to nano devices, to increase their interest in innovations in the field of nanotechnology, and to consciously choose professions in the field of nanotechnology that they study in science.

Improving the ways of developing students' technical creativity, teaching forms and methods, teaching methods and mechanisms on the basis of innovative technologies in physics classes is of urgent importance

3. Results and Discussion

In the teaching of physics, in the development of the technical creativity of students with the help of nanotechnology devices, attention should be paid to providing information about nanodevices based on a certain system. Explaining the topic of useful work coefficients of heat engines in physics usually gives an understanding of what heat engines are, the total work they do, and the useful work they do.

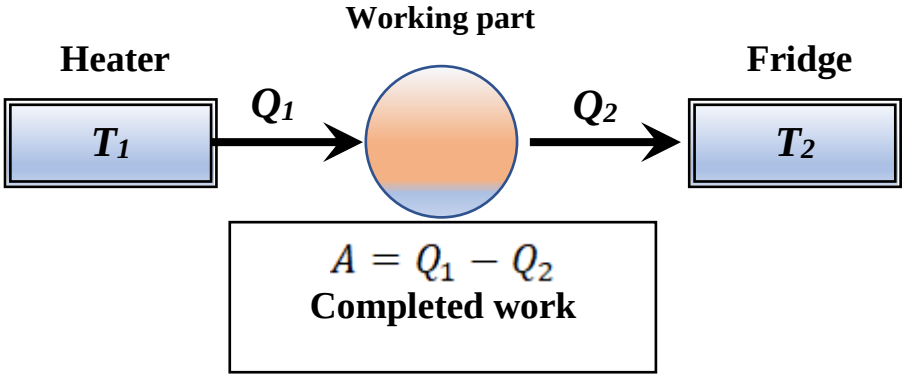
That is, heat engines are machines that convert thermal energy into mechanical energy. Because of fuel combustion in heat engines, the amount of heat given by the Q_1 heater to the energy received by the system during one cycle is calculated. The thermal energy received by heat engines is not fully converted into mechanical energy, and a certain part of it is given to the refrigerator for Q_2. Therefore, the UEC (useful efficiency coefficient) of the heat engine is always less than 1 and is determined using the following expression:

$$\eta = \frac{A_{useful}}{A_{common}} = \frac{Q_1 - Q_2}{Q_1}$$

or in percentages

$$\eta = \frac{A_{useful}}{A_{common}} \cdot 100\% = \frac{Q_1 - Q_2}{Q_1} \cdot 100\%$$

The process of heat transfer in heat engines can be explained in a simple way with the help of the following diagram:



Picture 1. The amount of heat given by Q_1-heater, the temperature of T_1-heater, the amount of heat received by Q_2-cooler, the temperature of T_2-cooler,

Through the temperatures of the heater and the cooler, the UEC of the heat engine is determined as follows:

$$\eta = \frac{T_1 - T_2}{T_1} \cdot 100\%$$

Why is the UEC of the heat engine not equal to 1?

We can safely say that the efficiency of a gasoline engine is between 20 and 25%, and there are many reasons for this. If we take the incoming fuel and recalculate it as a percentage, we get "100% energy" transferred to the engine, and then the losses:

Fuel efficiency: Not all fuel injected into an internal combustion engine is burned, a certain part of it remains with the exhaust gases and escapes into the environment, at this level we have already lost up to 25% efficiency. Of course, now fuel systems are improving, injectors and turbo engines have appeared, but this is far from ideal.

Heat loss: The engine heats itself and many other elements, such as radiators, its body, and the fluid that circulates in it. In addition, part of the heat goes with the exhaust gases. All of this results in a loss of efficiency of up to 35%.

Mechanical losses: All types of transmissions - in all places where there is friction. This includes generator load losses. Of course, lubricants have also taken a step forward, but no one has completely overcome friction - there is still a loss of up to 20%.

Thus, the efficiency on dry residue is about 20%! Of course, depending on the type of gasoline, this indicator is increased to 25%, but their number is not so large. This means that if your car consumes 10 liters of fuel per 100 km, only 2 liters will go directly to work, and the rest will be wasted!

The main goal of this article is to study the application of nanoparticles and nano-fuels in internal combustion engines. To this end, a collection of numerical and experimental studies on the use of nanoparticles in engine consumables (i.e., fuel, lubricants, and coolants) in three major areas is considered. This part of the review introduces nanofluids, whose main fuel can be diesel, biodiesel, gasoline, alcohol, or mixed fuel. A comprehensive review discusses the effects of these nano-fuels on engine performance, emissions, and finally provides a perspective on the most effective nano-fuels to reduce emissions or improve engine efficiency.

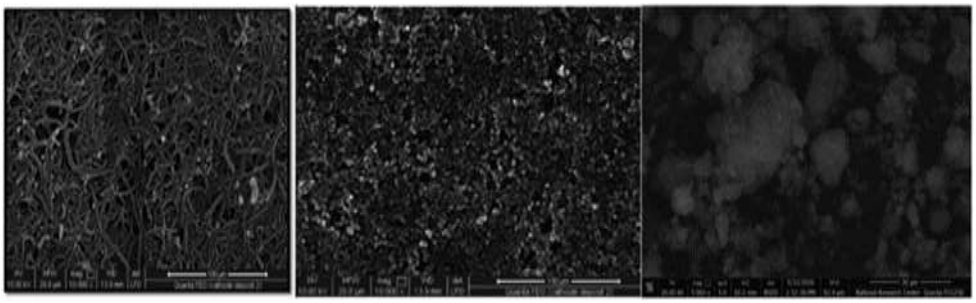
Nanotechnology is one of the main and emerging topics in internal combustion engines. Nanotechnology in internal combustion engines has a wide scope, such as nano-fluids, nano-composites, nano-rubbers, nano-materials, etc. Based on experiments on the use of nano-fluids in heat

transfer [3], they have very good properties. efficiency in heat transfer and lubrication has prompted researchers to consider them as nano-coolants and nano-lubricants in internal combustion engines. In addition, the combustion properties of some nanocavities make them suitable for use as nano-fuel additives, which serve to sufficiently increase the efficiency of internal combustion engines.

Internal combustion engines can use different primary fuels due to their advantages. For example, the experiments of Ghazikhani et al. [4] used ethanol additives in gasoline engines to reduce emissions and improve energy recovery. Experiments by Khatami et al. [5] used diesel engines for heat recovery, such as combined heating and power cycles, using different heat exchanger designs.

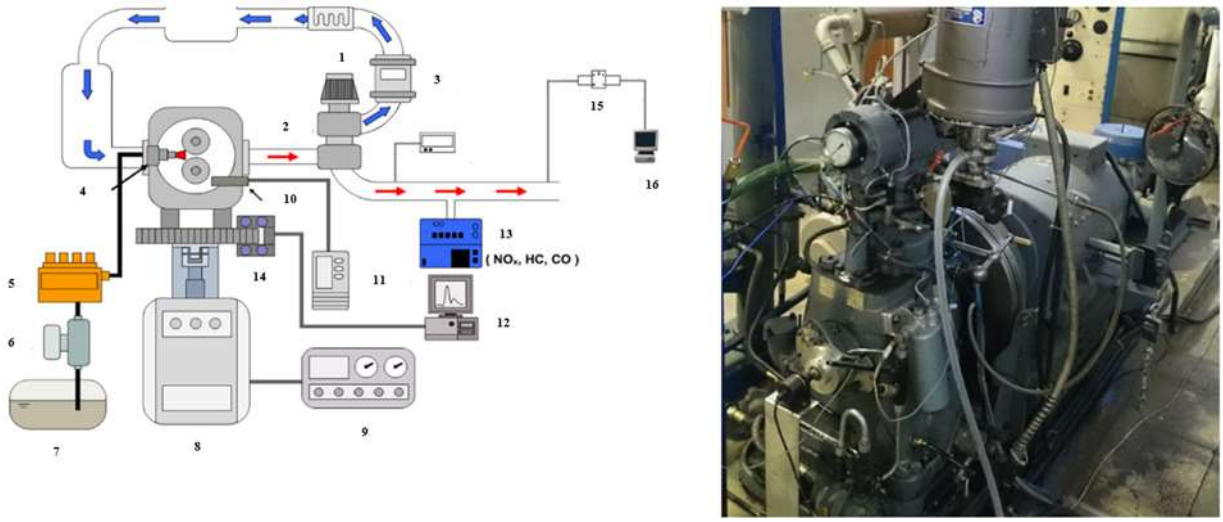
The most important field of application of nanofluids is fuel additives, which are widely discussed by researchers. According to Gad and Jayaraj [17] mixed nano additives such as carbon nanotubes, TiO_2 and Al_2O_3 into biodiesel fuel and found that biodiesel mixed with nano Al_2O_3 as J20Al100 (i.e. 20% biodiesel +100 pm Al_2O_3), all other increasing the thermal efficiency by a maximum of 6.5% compared to the tested fuels.

A blend of biodiesel with carbon nanotubes such as J20C50 (20% biodiesel+50 pm carbon nanotubes) reduced CO and NOx emissions by 35% and 52% more, respectively, than all tested fuels. Also, the blend of biodiesel with TiO_2 and J20T25 resulted in 22 and 50% greater reductions in HC and smoke emissions compared to all other fuels, respectively. Picture 2 shows images of carbon nanotubes, TiO_2, and Al_2O_3, confirming the nanoscale of the added nanoparticles.



Picture 2: Images of carbon nanotubes, TiO_2 and Al_2O_3 used for diesel engine [10]

According to the experiments of Gharehghani and Pourrahmani [8] used CeO_2 for diesel engine shown in Picture 3 and studied the engine performance such as brake specific fuel consumption and part per million emissions. According to their experimental results, if the analysis center is changed to a higher, brake thermal efficiency, the values of biodiesel and nano-particles should be about 48% and 112 pm, respectively.



Picture 3: Experimental setup for nano-additives in a diesel engine [6].

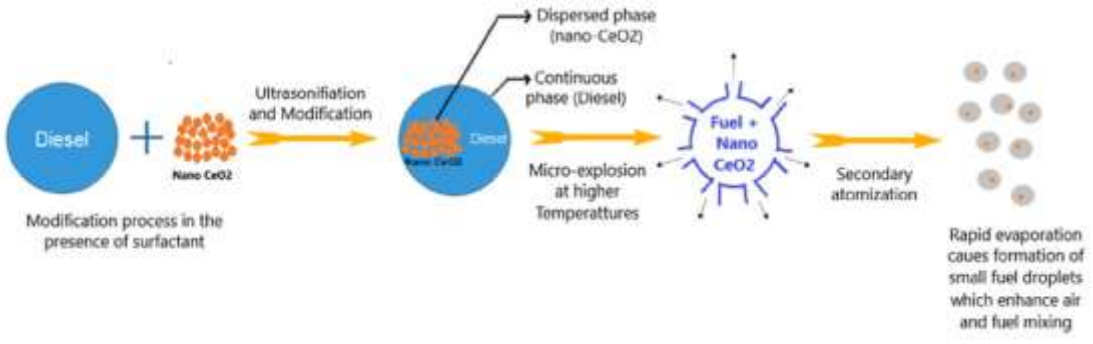
1-Air filter; 2-Recharger; 3-Air flow meter; 4-injector; 5-fuel pump; 6-flow meter; 7-Fuel tank; 8-Dynamometer; 9-Dynamometer controller; 10-Pressure gauge; 11-Charge amplifier; 12-Data collection system; 13-Exhaust gas analyzer; 14-Upper center gauge; 15-K type thermocouple; 16-data logger

Hosseini et al. [9] used graphene oxide nanoparticles additives in biodiesel-diesel blends. Their results showed that the power and exhaust gas temperature increased significantly when using graphene oxide.

In addition, a significant reduction of CO (~5%-22%) and unburnt hydrocarbons (~17%-26%) was observed with graphene oxide nanoparticles. Other nanoparticle additives such as Al_2O_3 and Fe_3O_4 have been used by Aalam in diesel engines [10]. This comprehensive process review study (in three different parts) collects all three nanofluid applications and discusses the impact on engine performance (especially for nano-fuel additives). Thus, the main achievement of this project is to find out how to improve the efficiency of engines by using nanotechnologies for the automotive industry, for example, nanofluids in fuel additives, cooling and lubrication processes. They can find the best nano-material for fuel, coolant and lubricants, which has the highest efficiency and minimum losses in engine performance and emissions. In addition, both experimental and numerical studies will be reviewed to report this project's production and educational achievements.

Nano-fuels are defined as common fuels with nanofluids added as additives to improve combustion properties. Common fuels considered as primary fuels in this study are diesel, gasoline, bio-diesel, alcohol and mixed fuels. Elahi et al. [11] reviewed studies related to nano-additives for diesel-biodiesel fuel. The results of their review generally confirmed the improvement of thermophysical properties, the improvement of the heat transfer rate and the stabilization of fuel mixtures, as well as the increase of each formation parameters of the engine and the reduction of harmful emissions depending on the dose of nanofluid additives. [11]. As the main result, they concluded that alumina, $FeCl_3$,CeO_2, MnO, CuO (metal nano additives) nanofluids significantly reduced the ignition delay in diesel engines. They also introduced secondary atomization (splitting of large fuel droplets into smaller and finer droplets as shown in Pic. 4) as one of the main mechanisms to improve the combustion of nanofluids.

They also noted that the structure of the nanofluids and the oxygen in the water (as an emulsion) cause a micro-explosion due to the very fine-sized fuel droplets that enhance the rapid vaporization and combustion properties. Among the studies reviewed, Graphene Nano-platelets had better microburst performance than Al_2O_3 and CeO_2 due to weaker Van der Waals forces. They also reported that TiO_2 additive is more effective than other applied nanofluids for increasing engine power [11]. In addition, they have improved ignition properties due to higher oxygen content and lower aromatic content, such as unburned hydrocarbons, carbon monoxide and particulate matter, and the addition of significant metal and oxygen additives. However, these additives lead to the formation of nitrogen oxides due to the excess amount of oxygen supplied to the fuel. Another main advantage of nano-fuel is the high calorific value of nanofluid, the improvement of catalytic oxidation and the reduction of specific fuel consumption of the brake due to the complete combustion of these types of mixed fuel [11]. These effects affect the type of nanofluids, which are discussed in detail in the following sections.



Picture 4: The role of nano additives in fuel combustion [13].

Ce_2O_3, copper, and Al_2O_3 have been introduced as more reasonable nanofluids due to increased viscosity index and flash point, and reduced ignition delay, as well as reduced emissions and improved combustion [16]. Dewangan et al. [12] examined the effects of metal oxide nanoparticle additives (SeO_2) on diesel engines and metal oxide nanoparticles and oxygen additives (such as Diethyl Ether derived from ethanol) at low autoignition temperatures, had a high oxygen content and excellent cetane number, thus significantly improving combustion and emissions.

Also, Nanthagopal et al [13] reviewed studies on nanoparticles and alcohol additives in diesel engines and reported that zinc oxide and carbon nanotubes were the most favorable nanoparticles compared to others due to their anti-corrosion effect and heat transfer behavior. Another study on improving engine performance, improving fuel properties and reducing emissions with nano-additives and alcohol additives is carried out by Fayyazbakhsh and Pirouzfar [14]. Khond and Kriplani [15] reviewed approved studies up to 2015 on nanoparticle additives to diesel stationary engines to reduce emissions. Based on their reviews, most researchers have concluded that adding nanoparticles to fuel improves the cetane number and calorific value of the fuel.

4. Conclusion

This article analyzed and discussed recent and new nano-fuels in internal combustion engines using nanotechnology. Emissions of various nanoparticles added to diesel, bio-diesel, gasoline, alcohol and mixed fuels were studied for the results of increasing the efficiency of engines. The following main points can be made:

1. Nanoparticles have various functions: oxygen buffer, high surface/volume ratio, micro-explosive properties, anti-wear and anti-corrosion, high thermal conductivity and catalytic activity. Additionally, the paper also notes more lubrication for nanoparticles and swirl/turbulence in the fuel.

2. The best nanoparticles for reducing specific fuel consumption in braking are: SiO_2 (-30%), TiO_2 (-23,42%), GO (-20%), carbon nanotubes (-19.85%) , Al_2O_3 (-14.66%) for diesel engines and Mn_2O_3 (-38.89%). The maximum decrease in the output temperature was recorded for Al_2O_3 (-27%), the maximum increase in the thermal efficiency of braking was recorded for multi-walled carbon nanotubes (+36.81%), Al_2O_3 (+24,7%), CeO_2 (+23%), occurred for carbon nanotubes (+18.8%), GO (+17%).

If we inculcate the innovations of nanotechnology in the minds of young students, develop the technical creativity of students with the help of nanotechnology devices in the teaching of physics, the amount of waste generated by the technologies created by our future youth will be reduced. At the same time, we are considered to have protected the environment.

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