

SCTMG 2020

International Scientific Conference «Social and Cultural Transformations in the Context of Modern Globalism»

GREEN CHEMISTRY AS ETHICS AND MORAL RESPONSIBILITY BASIS OF ENGINEER OF FUTURE

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Abstract

Progress brings good and comfort to human life, but together with new discoveries there are environmental problems, which are difficult to predict at the moment of introduction of innovative products into the world national economy. Thus, at present we are facing the negative effects of technological progress in the form of global pollution. The paper considers the appearance of plastic in the world from the point of view of the consumer, who was not aware of the potential harm of plastic products and could not assume what its uncontrolled use could lead to. The mindset, traditions and customs of people who fail to keep pace with modern discoveries play a key role in global plastic pollution. As an example, the paper presents the environmental disaster currently taking place in major cities of India. The last inventions of this kind include unmanned aerial vehicles, which served for the benefit of the mankind, but now drones are used in terrorist attacks and attempts on people's lives, and an alternative means of smoking – a vape, which was considered safer than traditional cigarettes, but now most researchers studying the consequences of using vapes are convinced otherwise. In order to forecast the negative consequences of inventions, the mankind has tools capable of processing large volumes of information, such as computer, big data, etc. In order to create such standards, it is possible to use the principles laid down within the Green Chemistry, which are based on environmentally responsible attitude towards humans and the environment.

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Keywords: Green chemistry, pollution, ethics, moral responsibility, nature, ecology.



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1. Introduction

On April 15, 2019 was a fire in the Notre-Dame de Paris leading to complete destruction of the roof of the cathedral. The incident in Paris aroused wide public interest, compassion and desire of the global community to provide as much assistance as possible in the restoration of the cathedral. More than 1 billion euros were collected within two days. According to estimates of the French authorities, the damage to the cathedral was assessed for about the same amount.

The Notre-Dame de Paris is considered a world cultural historical heritage and the fact that in the shortest possible time enormous funds were collected for its restoration proves that with clear identification of the problem the mankind quickly finds ways and methods of solving it. People demonstrated the grounds of a collective mind based on collective sympathy. The feelings that underpin the moral principles of today's civilized people play a great role in the speed of decision-making. The destruction of the famous historical monument caused compassion and desiderium among the majority of people. Thus, the feelings caused by the incident became a catalyst for instant fundraising of 1 billion euros. For comparison, this amount would be sufficient, for example, to clean up a garbage spot in the Pacific Ocean, i.e. a global environmental problem could be solved (Aryan et al., 2019).

The pollution of the world ocean is a known problem and arose long before the events in Paris. However, the Garbage Patch does not call for global public involvement in solving the problem. Why? First, this can be explained by the disengagement of the problem from humanity. It is somehow "not visible", it is not spoken of by central TV channels and is not directly broadcast from a garbage patch, and world celebrities, i.e. the opinion leaders do not call for fund-raising. The Great Pacific Garbage Patch is far away, it does not affect life and therefore does not cause hesitation of feelings in established moral principles of the mankind as much as it happened with the fire in the Notre-Dame. Second, there is the alienation of a person from the problem. That is, an individual feels no responsibility for the resulting garbage patch in the Pacific Ocean. Perhaps this is the most likely reason not just in the context of the ocean debris, but with regard to the global pollution of the planet as a whole.

2. Problem Statement

The removal of the garbage patch in the Pacific Ocean and even the treatment of all oceans from anthropogenic pollution will not be a fundamental solution to the problem since 95% of the pollution is known to come from 10 rivers, 8 of which are located in Asia. These were the rivers in Asia: Yangtze, Ind, Huang He, Hai He, Ganges, Pearl river, Amur (Heilongjiang in China), Mekong, and African Niger and Nile. The unreported flow of debris along rivers into the ocean is due to the vast majority of the world's population living in Asia. Undoubtedly, the removal of garbage from the ocean is a necessary measure, but "cleaning" solutions will not eliminate the problem of contamination of the hydrosphere. The problem lies in people and their attitude towards something "new".

3. Research Questions

Addressing historical facts, we can note that people are characterized by an instant spread of innovative solutions around the world if they are effective, convenient and profitable. The best example

of this kind is the use of oil as an energy source, which led to industrial growth and well-being in many countries. To some extent it can be argued that oil saved whales from human extermination. Whale fat was especially valued, it was used to make soap, lubricants and for jute production. Lamps and lights were filled with fat, it was used as fuel for machinery, etc., but with the advent of oil whale fat lost its relevance in chemical, fuel and lubrication industry and thus considerably reduced the interest in whales. The growth of industry and the increase in the depth of oil refining gave rise to new processes, technologies and products. Among other things, polymers and products from them – disposable tableware and bags, which quickly came into common use and gained special popularity in the modern society.

Have engineers creating plastic production processes thought about the consequences of their inventions for 10, 20 or 50 years ahead? Most likely not. Because the domination of cheap and practical products on Asian markets led to that high pollution from rivers of that continent (Wang & Jacob, 2009; Wells, 2012).

Traditionally, the population of India utilized disposable tableware made from organic materials, i.e. leaves. The tableware used as intended was not disposed of according to some approved developed technology, was not centrally collected, but was simply thrown by people under feet, and due to the features of the tropical climate was very quickly rotted through. People had no idea about garbage, treatment of waste and pollution products.

But with the advent of plastic goods, the environmental situation was dramatically deteriorated. Life has changed, while the mentality, traditions and upbringing of people have remained unchanged. As before the utilized tableware was simply thrown away, but unlike leaves plastic does not disappear, but is accumulated, gets into rivers and from there into the world ocean (Marco et al., 2019).

Some observations were made during the expedition in Nepal. It is a small densely populated state bordering India. There is the Pashupatinath temple complex in the east of the capital Kathmandu (figure 01). It is a popular place among pilgrims wandering yogis, etc. Due to high concentration of people this place is an interesting place to observe the behavior of people in relation to plastic waste. Traditional organic tableware is used during religious donations, but there is no ban on the use of plastic.



Figure 01. Consequences of religious holiday in the Pashupatinath temple complex

Figure 1 shows that together with organic waste there is the accumulation of plastic debris, which prevails in overwhelming quantities (Venkata et al., 2018).

4. Purpose of the Study

The purpose of the study is to find ways to change the mindset of engineers of the future through such scientific field as the *Green Chemistry*. Green Chemistry is characterized by a clear description of principles ensuring the creation of environmentally friendly technologies, and therefore providing for the solution of the pollution problem (Khandelwal et al., 2019).

5. Research Methods

The analysis of social activity and response to irritating events capable of causing public resonance was carried out. The analysis of historical traditions and customs of inhabitants of densely populated regions of Asia was carried out. The analysis of scientific inventive activity towards the creation of environmentally safe technologies, including bioplastic, was carried out. The behavior of people in Nepal dealing with plastic waste was observed (Jiménez-Rosado et al., 2019).

6. Findings

There are methods for producing bioplastics from plant raw materials, for example starch, which is a plant polymer. However, bioplastic technologies have higher cost compared to petroleum-based plastic materials, and consumers are not prepared to give up the use of home-friendly things, even with an eye on environmental negative effects. For example, in the spring of 2016 in the Indian state of Karnataka it was forbidden to use and sell plastic products (disposable dishes, food film, plastic bags, etc.). The citizens did not like such this innovation, they did not want to cooperate with the authorities. Four months after the ban was imposed, about 40,000 kg of plastic was confiscated in the capital of Karnataka (Laurent et al., 2012; Shaw et al., 2019).

Thus, humanity has faced the consequences of its technological breakthroughs, and the durability of plastic, which in the 20th century was seen as a positive property, has become a global problem in the 21st century. At the same time, besides purely technological problems associated with the decomposition of plastic and the development of technologies for the production of environmentally safe alternatives, there was a problem of social reluctance to abandon synthetic products of the national economy. However, if engineers together with scientists and specialists from social fields of science calculate the risks associated with environmental problems prior to releasing plastic products to the Asian market, such an approach would be an ideal model for the appearance of new products in the world economy.

7. Conclusion

In the late 1990s, Paul Anastas and John Warner formulated 12 principles for a new scientific direction *Green Chemistry*. The first one sounds like, “It is better to prevent waste than to treat or clean up waste after it has been created”. That is, returning to the case of plastic in Asia, it is the effects of

pollution that the world is now struggling with, and ideally, according to the first principle of green chemistry, it was necessary to think about reducing the “lifetime” of plastic prior to its global spread.

The remaining 11 principles of Green Chemistry have a narrower range of interpretation and represent specific requirements for chemical industry, since the majority of negative anthropogenic effects on nature comes from this industry.

To prevent such problems, both globally and locally, future engineers must understand and be able to calculate the consequences of their actions. Green Chemistry can become an excellent tool to forecast and prevent environmental consequences, and shall form the basis of ethics and moral responsibility of engineers of future.

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