Proposals for Reducing the Rate of Global Warming

Konstantin Ludanov

Depart. N5, Institute for Renewable Energy of NASU
G. Hotkevicha str.,20A, Kiev, Ukraine, K. Ludanov.

Abstract
The article presents a number of promising methods of combating global warming, which are rational combinations of long-known methods and optimal modifications of recently published ones. The proposals relate, first, to methods based on the powerful forces of nature, and more precisely, on the basis of solar radiation, which during photosynthesis will allow plants (on land and in the ocean) to absorb carbon dioxide from the atmosphere and water through the work of chlorophyll using carbon as a raw material for the production of biomass. In addition, the article proposes a modification of the method of sequestration of carbon dioxide from the products of combustion of fossil fuels in thermal power plants, which should soon be replaced by other types of power plants that do not give emissions of carbon dioxide into the atmosphere.

Keywords - *carbon dioxide emissions, greenhouse effect, global warming, photosynthesis of plants, solar radiation, sequestration atmospheric CO_2, chlorella, cyanobacteria, microalgae, sargassum.*

I. INTRODUCTION

Ten years ago, in the introduction to his scientific article [1] on the development of space power plants to power the planet, the author already noted the danger of global warming, I quote: "Today, humanity has realized that uncontrolled carbon dioxide emissions into the Earth's atmosphere will lead to irreversible climate change, dangerous to its very existence. An increase in the concentration of CO_2 in the atmosphere leads to the emergence of the so-called "greenhouse effect", which blocks the flow of the earth's own thermal radiation into space and thereby increases its temperature. Carbon dioxide is formed mainly by burning energy: coal, oil distillation products and natural gas. The most dangerous here is the burning of coal, since in this case there is a maximum production of CO_2 per unit of heat generated during this. If the climate warming process cannot be blocked, it will bring catastrophic consequences for humanity. In this regard, the transition to new energy sources, in particular to atomic energy, is especially relevant. However, the nuclear power plant has a low efficiency, which leads to increased heat environmental pollution due to "waste heat" of the Q_2 cycle. Promising in terms of minimum thermal "pollution" are high temperature gas cooled nuclear reactors of fuel elements and thermonuclear reactors with heat removal from blankets - at the level of 1000 ^{o}C. But this is for now perspective. At the same time in the world for many years developing solar energy, transforming concentrated solar radiation as part of thermal cycles in electricity... Solar energy eliminates CO_2 emissions into the atmosphere and does not pollute the environment waste heat. "

Since then, the Kyoto Protocol and the Paris Agreements have been signed, but the problem of global warming is becoming ever more acute. Most recently published the latest research results of Australian scientists with very disappointing conclusions. A group of experts from Melbourne published a report in which it announced the imminent death of human civilization. About it writes The Independent. According to scientists, the reason for this will be rapid climate change and the lack of necessary action by the governments of large countries. They expect that in the near future, the rate of burning of fossil fuels in the world will not be reduced. As a result, global emissions will peak at 2030. Moreover, by 2050, the average temperature on the Earth's surface will increase by three degrees, and by 2100 its growth will reach five degrees Celsius. Therefore, actions to develop measures to slow down the growth rate of carbon dioxide concentration in the atmosphere, which is responsible for the greenhouse effect, are very relevant.

To date, many different methods of dealing with global warming are already known. The main methods include the following. Firstly, it is the limitation of greenhouse gas emissions in the power industry, heavy industry and agriculture (the main thing here is the transfer of Big Power Engineering from TPPs to nuclear power plants). Secondly, this is the transfer of vehicles to fuel cells and an electric drive. Thirdly, it is an increase in the use of renewable energy sources. In addition, this can also include timely and effective extinguishing of large forest fires that emit enormous masses of carbon dioxide into the atmosphere (for example, fires in the Siberian taiga, Amazon selva and Alaska released 225 megatons of CO_2 into the atmosphere in just a month). And finally, a very important method of combating global warming is also "connecting the mighty forces of nature", i.e. the use of solar

radiation and the photosynthesis process for sequestering carbon dioxide from the atmosphere and its accumulation by plant biomass: both on land and in the oceans.

II. APPROACHES AND METHODS

The article does not consider those approaches to combating global warming and methods for reducing the concentration of carbon dioxide in the atmosphere that use measures to pollute the air and the environment, since here the situation is already critical and it is dangerous to worsen it further. On the contrary, the article considers such methods of the tasks that are now economically feasible (cost-effective), since humanity is struggling not only with global warming, but also with hunger and poverty, which also require very large investments. The author believes that when choosing new and modifying known methods to reduce the rate of climate warming, the principles of inventive activity should be used. Obviously, you should choose only those of the considered methods that allow you to solve several problems at once, namely: choose not those that allow you to achieve "either one or the other," but only those that allow you to achieve "both that and the other".

III. RESULTS

A. Carbon dioxide gas sequestration in the world ocean

It is known that the waters of the oceans contain a huge amount of carbon dioxide dissolved in them, which is almost a hundred times higher than the amount of CO_2 contained in the air of the atmosphere [2]. Therefore, it is very important to create conditions for increasing the storage capacity of the oceans and to prevent the possibility of the release of dissolved carbon dioxide back into the atmosphere. In this regard, the article primarily presents methods for increasing accumulating capacity of the oceans and the assimilation of carbon dioxide dissolved in water.

1) Use of algae photosynthesis for sequestration of CO_2 from seawater and reproduction of plankton biomass in the ocean

Problem Brief

An analysis of the law established by the author [3, 4] for the maximum flow rate of a solution of mineral substances in a separate capillary of plant xylem within the framework of the moisture transpiration mechanism showed that the efficiency of plant biomass reproduction due to photosynthesis and solar radiation, and therefore the rate of atmospheric carbon sequestration (from greenhouse gas) CO_2) is inversely proportional to the fourth power of the length of the capillaries. However, plants are known (microalgae and cyanobacteria) in which there are no capillaries at all, therefore solar radiation, as well as mineral substances, enter through their surface (this includes chlorella algae) directly to chlorophyll. In such cases, the productivity of atmospheric carbon utilization by photosynthesis in plants, for example, in chlorella, will obviously be an order of magnitude (10-12 times) higher than in plants with xylem. Thus, the production of chlorella can be a very promising area for sequestering atmospheric carbon. The article proposes to develop new, more productive strains of chlorella, which plankton consumes, and "sow" the surface of the oceans with them. In this case, carbon dissolved in sea water under the influence of the energy of solar radiation and photosynthesis in chlorophyll of microalgae will effectively turn into a "nutrient broth" for ocean plankton, which is mainly consumed by fish. Thus, it is a very effective method of binding CO_2 dissolved in water, which, by "decarbonization" of the atmosphere and ocean, will significantly increase the possibility of propagation of commercial fish species in the ocean [4, 5].

A fundamentally new type of photosynthesis was found (dailytechinfo.org., 04.27.2019).

Researchers at Imperial College London described a new type of photosynthesis process they discovered. They believe that new knowledge can certainly be used to develop specially designed crops that will be more effective than existing ones. Professor Bill Rutherford - believes that in the future it will be possible to try to "instill" the possibility of a new photosynthesis to ordinary plants.

The new process of photosynthesis uses not visible, but almost infrared (near-infrared, NIR). In the usual photosynthesis that all plants use, the green pigment *chlorophyll-a*, which has a maximum absorption coefficient in the red region of the visible spectrum, takes part. During their work, British researchers found that some types of cyanobacteria can use chlorophyll-f (*chlorophyll*-f) instead of *chlorophyll-a*, which can effectively absorb almost infrared light. This, in turn, allows cyanobacteria to live and function in places where ordinary light does not penetrate, but infrared radiation reaches. Note that scientists have long known chlorophyll-f, but recent studies have helped to associate this pigment with a new type of photosynthesis.

Our proposition

In [3], on the basis of a new type of chlorophyll (*chlorophyll*-f) found by scientists, it is proposed to create new cyanobacteria and microalgae, which, in addition to existing cyanobacteria with the traditional type of chlorophyll, will allow parallel use of photosynthesis in combination (*a* + f), which makes it possible use the much wider working width of the solar spectrum. The combination of two types of algae with both types of chlorophyll will dramatically increase the efficiency of conversion of solar radiation energy in the process

of decarbonization of the atmosphere and the ocean with the accumulation of carbon from CO_2 by the biomass of cyanobacteria (due to the reproduction of microalgae in the world ocean with the release of free oxygen as a reaction by-product).

Professor Bill Rutherford's proposals to "instill" the possibility of new photosynthesis to ordinary plants that operate on the basis of the traditional photosynthesis mechanism, that is, to create a combined mechanism, the author considers to be a much more difficult task than the creation of new cyanobacteria. In addition, the creation of such plants with their subsequent planting on land will not be able to protect them from fires, which are likely to be more frequent and large with increasing air temperature. But cyanobacteria and microalgae in the ocean are not exposed to fires at all.

2) ***"Sargassum in the ocean threatens marine life."*** *Article at "**Science**". **Florida Atlantic University's Harbor Branch Oceanographic Institute*** (UKR.NET, 07.05.2019).

Problem Brief

Sargassum or "sea grapes" - a genus of marine brown algae, common in the North Atlantic, began to bloom on the stretch of the open ocean between Africa and South America. For the first time, experts noticed this phenomenon in 2011. Since then, the flowering of sargassum has reached impressive size here. A huge amount of these algae began to be thrown onto the beaches of the Atlantic Ocean and the Caribbean, which posed a threat to the local fauna and tourism industry. In 2018, the so-called Great Atlantic Sargassum Belt reached an incredible 20 million tons, which is about ten times more than in 2010. It also stretched for almost 9 thousand km. To understand the reasons for this phenomenon, Mengqiu Wang and her colleagues at the University of South Florida analyzed satellite data from over the past two decades. It turned out that the flowering of sargassum, apparently, began when the central part of the Atlantic Ocean was enriched with nutrients. Some of them came from natural sources as a result of upwelling - the rise of nutrient-rich deep waters to the surface along the west coast of Africa. Another source of "feeding" is the water of the Amazon River, which flows into the Atlantic Ocean. Scientists were able to conclude about their concentration by examining how much chlorophyll was present in surface waters. It is a green pigment found in phytoplankton and algae. It absorbs mainly blue light from the solar spectrum and a very small amount of green. In 2009, the level of chlorophyll reproduction increased sharply in that part of the Atlantic where the Amazon flows into the ocean, and remained at this high level for most of the following years. It is the nutrients that enter the ocean with the waters of the Amazon that could stimulate the flowering of sargassum in that part of the ocean where it had never been observed before. A research article published in the journal Science.

Our proposition

In light of the very high relevance of the sequestration of carbon dioxide from seawater and the conversion of the latter during photosynthesis into carbon bound in the biomass of algae (as well as into free oxygen), it would be correct not to "fight" this phenomenon, but to contribute to it. For this, it is necessary to remove all the masses of sargassum algae formed from seawater so that they do not rot in it with the release of CO_2 into the atmosphere and with the poisoning of water by rotting products. It is advisable to use these algae as an organic fertilizer for agricultural needs. If this cannot be done directly, then it is necessary to develop a number of technologies for their processing into organic fertilizers in the corresponding bio-plants. In such bioreactors, the harvested masses of sargassum algae can certainly be processed into organic fertilizers using thermal and biochemical processes. Thus, sargassum from a "threat to life in the ocean" will turn on the one hand into raw materials for the production of organic fertilizers, and on the other hand into an important method of sequestration of carbon dioxide dissolved in sea water.

3) ***The use of bacteria on the ocean floor, assimilating CO_2 from sea water*** (this is a link in the food chain of the inhabitants of the seabed) UKR.NET

Problem Brief

Oceanologists at Heriot-Watt University in Edinburgh have analyzed sedimentary rock samples from the eastern Pacific between Hawaii and Mexico, known as the Clarion-Clipperton Fault Zone (CCFZ). This is a deep-sea ecosystem in which sunlight hardly penetrates. It turned out that bacteria live there, which have the ability to absorb and assimilate carbon dioxide dissolved in water in large quantities in biomass. Carbon biomass is probably an important food source for deep-sea animals. But until now, scientists believed that the main source of food on the seabed are the remains of dead fish and plankton. According to the author of the study, Andrew Sweetman, bacteria can process about 200 million tons of carbon dioxide per year, which is about 10% of total amount that the world's oceans absorb annually.

Our proposition

Strains of such bacteria should be isolated from sediments and their reproduction and production on a mass scale should begin in biological plants, and then to begin, "seed" with living bacteria those areas of the bottom of the seas and oceans where fishing for crabs, lobsters and other crustaceans, as well as bottom fish (e.g. flounder).

This event, in addition to assimilation of CO_2, should allow to significantly increase the scale of seafood catch. Moreover, a tax on the seafood catch in these areas may be a source of funding for the development and production of such biomaterial. Such an approach will allow bacteria to sequester and preserve carbon dioxide dissolved in water, on the one hand, and, on the other hand, will significantly increase the yield of seafood.

B. Increase of the rate of the CO_2 sequestration from the atmosphere at the account of the supply of forest resources of the planet

Problem Brief

Scientists consider trees to be powerful weapons against climate change, and also not very expensive. After all, trees not only absorb CO_2 from the atmosphere, but also prevent flooding and soil erosion.

According to replyua.net, ecologist Thomas Crowther conducted a large-scale study based on observations from the Earth and from satellites, establishing that now there are 3 trillion trees on Earth, and 1.2 trillion trees can be planted in free places. According to his forecasts, with the help of mass forest planting, global warming can be significantly slowed down. An environmental scientist conducted a large-scale study, establishing that in all regions of the planet, another 1.2 trillion trees can be grown. The study showed that if all this is done, then it will be possible to minimize the effects of carbon dioxide emissions over past 10 years.

Some countries have already begun implementing forest planting projects. In Africa, to curb the spread of the Sahara, the Great Green Wall is planted from west to east. A strip of trees 15 km wide should stretch for almost 8000 km. In addition, India plans to plant 95 million hectares of forests by 2030.

Our proposition

1. The most effective and economically feasible in this case is not so much the planting of new forest stands as the termination of deforestation of existing ones (for example, in Russia, Brazil, etc.). Moreover, timely and effective fight against forest fires is very important, because they very quickly destroy forests that have grown over many years. It should be taken into account that during forest fires, a huge amount of CO_2 is released into the atmosphere.
2. Even if new forest plantations are planted, it is necessary to start with the fastest growing species, because the problem must be solved quickly. And it's best to plant sugarcane, which, in addition to quick reproduction, will provide a return on investment in these plantings.
3. From other tree species, it is proposed to plant fast-growing fruit trees, which in addition would help to combat the problems of famine that comes with warming.
4. And only last but not least, it is proposed to plant conifers, which, when the air temperature rises in conditions of warming, are extremely fire hazard.

C. Reducing CO_2 emission in heat power stations and heavy industry

Problem Brief

Information has appeared on the UKR.NET Internet resource that the Center for Geo-engineering Projects at Cambridge University has been created in England, which is part of the Greenhouse Gas-Free Initiative.

1) One of the new approaches of the Center is a variant of the well-known concept of the fence or sequestration of carbon dioxide produced by countries. It involves the interception of carbon dioxide emissions from combustion products in coal or gas thermal power plants, steel mills and the burial of carbon-preserving materials underground.
2) Another approach of the Center is carried out by Professor Peter Stiring of the University of Sheffield. He is involved in the development of a pilot project for sequestration and utilization of CO_2 together with the metallurgical company Tata Steel in Port Talbot in south Wales. This project involves the creation of a plant for the processing of carbon dioxide emissions into fuel, and this plant should operate on associated heat. The company has a source of hydrogen, a source of carbon dioxide, a source of heat, as well as a source of renewable electricity from steel production. Professor Stiring said that he was going to use all these sources in the production of "synthetic fuel".
3) It became known (mir24.tv.), that Canadian scientists from Trent University have found a new tool in the fight against global warming. Physicists have suggested spraying magnesite crystals into the atmosphere. This material in large quantities absorbs carbon dioxide from the air and, according to researchers, will help slow down global warming. A ton of this element can "bind" 500 kg of CO_2. In nature, the formation of magnesite can take several thousand years. Scientists have come up with artificial technology using polystyrene microspheres, with which magnesite can be grown at room temperature in just 72 days. This method turned out to be fast and cheap. Now the University's specialists are going to test it on an industrial scale.

Our proposition

The author believes that sequestration of CO_2 directly from the atmosphere and the burial of carbon-preserving substances in the earth, and even more so the conversion of CO_2 to synthetic fuel, are economically very inappropriate technologies and suggests intercepting carbon dioxide emissions from fossil fuel combustion products at coal or gas thermal

power plants, TPPs, as well as in steel mills, as part of plants where magnesite crystals are sprayed directly into the products of combustion with a high CO_2 content to obtain on this basis the building materials, in particular - sand for construction, which is now already a shortage. Moreover, it is proposed in the power system to introduce a tax on carbon dioxide emissions and, due to revenues from it, to develop and implement CO_2 utilization plants at existing TPPs and CHPPs so that it would be profitable for heat power companies to operate these plants and sell sand for construction projects.

IV. CONCLUSIONS

It was in the oceans that chlorophyll once arose, which, through photosynthesis in algae, saturated the atmosphere with oxygen and lowered the concentration of carbon dioxide in it. And now, it is the oceans that are capable of using the powerful forces of nature (solar radiation with a density of about 1 kW/m^2, falling on a huge surface area) to solve the problem of decarbonization of the atmosphere due to photosynthesis in algaes and due to the dissolution of CO_2 in sea water. Our task is to help in this ocean: to develop effective strains of cyano-bacteria and microalgae and sow them on the surface of the ocean. After all, algae reproduce much faster than forests that can quickly burn out in case of fires.

Since decarbonization of the atmosphere is largely carried out due to photosynthesis in the forests of the planet, it is urgent to prohibit their deforestation and burning. Because, the forest grows for a long time, but burns out very quickly. In this regard, it is now necessary to renew forest resources due to fast-growing species, and not due to sequoia, which has been growing for a thousand years.

And finally, the main thing is that it is urgent to transfer Big Power Engineering from TPPs (on coal, fuel oil and natural gas) to nuclear power plants that do not produce CO_2 emissions at all, as well as maximize the use of renewable energy sources.

REFERENCES

[1] Ludanov K. I. Modification of Glaser project. New thermal cycle for orbital solar electric power station // Space Science and Technology, – 2009. – 15, № 1, – P. 62–67.
[2] Staschuk M.F. THERMODYNAMICS and its application in lithology. M .: "Science", 1985.
[3] Ludanov K. I. Transpiration Mechanism of Capillary Transport in the Xylem of Plants. Ukr. // J. Phys. – 2014. – Vol.59. No.8 p. 781-786.
[4] Ludanov K.I. Limit values for capillary transport of substances in xylem of plant // Materials XVII International Scientific Conference, 29-30 September 2016. Kiev, NTU "KPI", Institute for Renewable Energy NASU, – 2016. – P. 553-555.
[5] Ludanov K.I. Limit values for capillary transport of substances in xylem of plant // International Journal of Current Research in Life Sciences Vol. 08, No. 01, pp.2948-2949, January, 2019

*) The manuscript of this article was received by the Editorial Board on on September 17, 2019.