ALTERNATIVE INNOVATIVE TECHNOLOGY TO REDUCING FUEL EMISSIONS IN AMBIENT AIR

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Abstract:

The study focus primarily on the technical feasibility and cost-effectiveness of new technologies aimed at minimizing the fuel emissions. The research aim is a minimization of polluting gases emitted from motor cars using cheap Georgian zeolite and respectively, introduction of the method offered by us by the state or some interested private company.

At the first stage, under conditions of zeolite use, CO, NO, NO_2 and SO_2 adsorption degree will be determined for vehicles working at gasoline and diesel (low speed) and respectively, emitted gases will be passed through different quantity of sorbents (50, 100, 200, 400g) for one and the same time unit (in order to identify the optimum quantity of sorbent). Afterwards, the similar experiments will be conducted under condition of higher vehicular load, as well.

The second stage includes a similar experiment, which will be conducted at some selected vehicle speed and fixed quantity of sorbent, but in case of different time durations (2, 4, 8 hours), in order to determine optimum research time.

Key Words: Pollution, ambient Air, sorbent, innovative technology

Introduction

Climate change is being counted as a global environmental threat caused by people. It is seen as the second most serious issue that the world faces and has brought about results that affect life adversely (European Commission 2011). The greenhouse effect is a natural process that plays a major role in shaping the earth's climate. Human activities, especially burning fossil fuels, have contributed to the enhancement of the natural greenhouse effect. This enhanced greenhouse effect stems from an increase in the atmospheric concentrations called greenhouse gases.

Transport is a main sector which causes the environmental pollution and climate change. Emissions from transport, and especially motor vehicles, add considerably to the levels of greenhouse gases in the atmosphere (OECD 2002). Transport is the second-largest sector in producing global CO2 emissions with a range of 22 % (International Energy Agency 2012). Owing to the rapid increase of motor vehicles and very limited use of emission control technologies, transport emerges as the largest source of urban air pollution, which is an important public health problem in most cities of the developing world. Air pollution in developing countries accounts for tens of thousands of excess

deaths and billions of dollars in medical costs and loses productivity every year (Faiz et al. 1996; Sivaloganathan 1998). The World Health Organization estimated that around 2.4 million people die every year due to air pollution (WHO 2007).

The research deals with the environmental pollution that is a very topical problem not only for Georgia, but for the entire world. Delvelopment of air treatment innovative technology is intended for solution of this problem [1].

There are two main sources of ambient air pollution in Georgia: emission from stationary sources (industrial and constrution facilities) and emissions generated from mobile sources (air contamination by motor transport). To date, it is worth noticing the second source, the share of which (under conditions of Georgia) in air pollution varies within a range of 70-80%. Gasoline- and diesel-powered motor transport emits into atmosphere the following pollutants: NO, NO_2, CO, CH_4, SO_2, Pb, soot and various toxic organic substances [2,3,4,5,6].

Proposal of original methods or technologies related to air quality improvement is one of the most important and top-priority problems for Georgia at both governmental level, and for private interested parties, and what is the most important, that has to be followed by their further practical application. The research topic of the offered project is an improvement (minimization) of air quality emitted from motor transport using natural Georgian sorbent – zeolite.

Study innovativeness lies in the fact that quite cheap raw material, Georgian zeolite will be used and explored for the first time in Georgia with the purpose of reduction of polluting gases (NO, NO_2, CO, SO_2, Pb) emitted from cars.

High mechanical strength, chemical stability, porosity, high sorption properties (absorption and ion-exchange abilities), as well as resistance to high temperatures (350-700˚C) predetermine its application in many spheres, as a cleaning agent for different ecosystems [7,8].

Based on integrated nature of this research, the participating scienticts differ from each other by profession (theoretical mathematics, analytical chemistry, ecology, geochemistry etc.), though they will purposefully serve solution of one and the same problem within a project framework. Proceeding from this fact, researches require the knowledge of both natural and exact sciences from participants. That's why they represent the different spheres of science, so the working group interdisciplinarity looks very interesting from this viewpoint.

It is common to find such researches in literature, which represent the different methods or approaches referred to entering of harmful gases (emitted from motor transport) into atmospheric air and to reduction of their concentrations in the environment. For these purposes specialists offer with increasing frequency different types of catalysts mainly consisting of various noble metals (platinum, rhodium, palladium etc.), mixed metal-oxide compounds etc., but these materials are very expensive. Though, over the last years different-type sorbent-like materials become more and more popular as a catchers of some polluting gases, since in addition to polluting gases, they adsorb some heavy metals at their surface, as well [9, 10].

In the researches offered by us, Georgian sorbent – zeolite will be used for the first time as an adsorbent of some gases and metals emitted from gasoline- and diesel-powered cars. It contains up to 80% of clinoptilolite and, in addition, it is a local, ecologically clean and quite cheap raw material [11-14].

Obtained results will be assessed in the context of air quality index improvement and respectively the benefitial role of the methodology offered by us in the environment protection process. It should be noted that air quality index will be calculated both taking into account the decree on technical regulation of Georgia (offered by the state) and according to methodology proposed by Europe and USA [15].

One of the important outcomes of carried-out work is the model of sorbent-zeolite as a catalyst, offered by a working group, which may be put into operation by the state or some company interested in this problem.

Study area and methods

The of the method offered by us by the state or some research aim is a minimization of polluting gases emitted from motor cars using cheap Georgian zeolite and respectively, introduction interested private company.

At the first stage, under conditions of zeolite use, CO, NO, NO_2 and SO_2 adsorption degree was determined for vehicles working at gasoline and diesel (low speed) and respectively, emitted gases was passed through different quantity of sorbents (50, 100, 200, 400g) for one and the same time unit (in order to identify the optimum quantity of sorbent). Afterwards, the similar experiments was conducted under condition of higher vehicular load, as well.

The second stage includes a similar experiment, which was conducted at some selected vehicle speed and fixed quantity of sorbent, but in case of different time durations (2, 4, 8 hours), in order to determine optimum research time.

It should be noted that the content of polluting agents (CO, NO, NO_2, SO_2) emitted from the given car was identified both without sorbent and in its presence.

In all cases, the emitted gases were analyzed by means of gas analyser „ОКСИ-5М“, which is developed and frequently used for determination of such gaseous components, as CO, NO, NO_2, SO_2, etc. Percentage

At the third stage a lead was detected in the gases emitted from the car, and its chemical analysis were conducted via atomic-absorption method using inductively coupled plasma optical emission spectrometer ICP-OES (ISO 11885:2007).

Results obtained based on comparative analysis were assessed according to Table 1, by means of which there will be established, to what extent the quality of emitted gases has been improved with the help of zeolite than without this sorbent and how positively will it impact on processes of environmental state quality improvement.

Air quality index is calculated via the following equation:

$$I = \frac{I_{high} - I_{low}}{C_{high} - C_{low}}(C - C_{low}) + I_{low}$$

where

I – index (AQI)

C – pollutant concentration

$\mathbf{C_{low}}$ – lower assessment bound

C_{high} - upper assessment bound

I_{low} – index related to C_{low}

I_{high} – index related to C_{high}

Depending on which evaluation column the AQI index obtained for each component will fall into (Table 1), it was determined to what extent can the method offered by us improve atmospheric air quality, or in general ecological state of the environment and at the same time approximate it to European standards in our conditions [15].

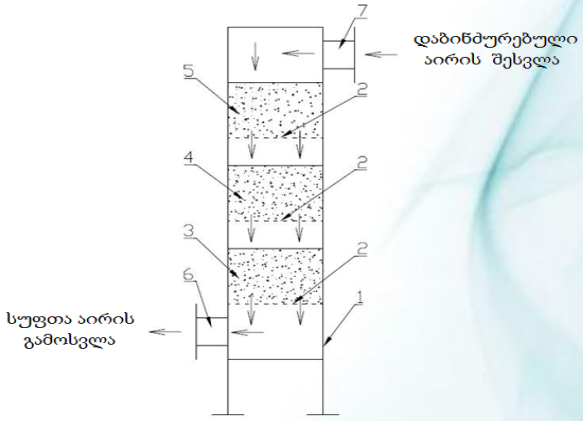
Review results

Before we went to the field research works, preliminary laboratory researches were conducted. In particular gasoline-powered car to a certain amount of emitted gases flow taken in by the mini-sorption device (Figure 1) for a certain amount of time, which consists of 2 layers of sorbent and 1 dryer. and in comparison with the gases of gas and direct gas from the machine, we have received primary results in which the sorbient used to minimize the gases used in laboratory conditions.

Some of the obtained results are presented on graphs 1-4.

Study component	Component concentration in the outflow gases (g/ m3)	Component concentration after sorbent, (g / m3)	Minimization quality,%
Nitrogen dioxide	0.45	0.31	31.1
Carbon monoxide	1.2	0.8	33.3
Sulfur dioxide	0.15	0.09	40

As we can see, according to the results obtained, the Georgian ceolit, which contains up to 80% of the clinoptilolet, showing good results in relation to the Ion Exchange-based properties (the reduction of gases from 30 to 40%) and perhaps in the future it will be a requested product in the solution of the problem.



1-building; 2-holding the grid; 3,4-modified sorbent layer; 5-gas running layer; Output of 6-pure gas; 7-contaminated gas entrance.

Conclusions

We can say that the sorbante studies on gases should be continued by the participation of the selected by us zeolite and then may be the state or private structures will be interested in to create cheaper catalysts to improve air quality to minimize gases from cars, all this will result in a significant change of atmospheric air quality, which is very important for our country.

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