International Journal on
"Technical and Physical Problems of Engineering"
(IJTPE)
Published by International Organization on TPE (IOTPE)

ISSN 2077-3528
IJTPE Journal
www.iotpe.com
ijtpe@iotpe.com

December 2010 | Issue 5 | Volume 2 | Number 4 | Pages 59-62

ON THE APPLICABILITY OF OZONE TECHNOLOGY FOR NEUTRALIZATION OF TOXICITY OF PROCESSED GASES OF AUTOMOBILES

V.A. Safarov [1] **A.A. Allahverdiyev** [2] **N.A. Mamedov** [1] **Sh.Sh. Alekberov** [1] **S.B. Safarova** [1]

1 Baku State University, Baku, Azerbaijan, nematmamedov@hotmail.com, shahin8@rambler.ru
2 Azerbaijan Technical University, Baku, Azerbaijan

Abstract- In paper applying of ozone technology for neutralization of toxicity of discharge gases of the internal combustion engines has been investigated. Though today use of ozone as full decontaminating agent of the discharge gases yet is not preferable, but taking into account allowable norms of toxic structure of the discharge gases, the expediency of the complex use of the ozone technologies after preliminary neutralization of toxicity with application of one of existing thermal, catalytic or liquid methods raises.

Keywords: Ozone, Transportation, Internal-Combustion Engines, Pollution, Discharge Gases Environmental Contamination.

I. INTRODUCTION

The major problem of the big cities is environmental contamination. In this problem a special role is played with motor transport. It is connected to prompt growth of transportations of cargoes and passengers.

From the carried out analysis of an ecological condition of the big cities of the world importance of the decision of the given problem which urgency grows every day in connection with increase in a global automobile fleet and a population size.

Let's consider the given problem by the example of development of economy of our republic where the motor transport takes a special place, carrying out the basic volume of transportations of cargoes and passengers. The indices of motor transport operation for 2002 in % are given in Table 1.

Table 1. The indices of motor transport operation for 2002

Indices	Volume of transportations	
Transportation of cargoes in transport sector (mln.t. and %)	98.445	100
Including by motor transport	53.736	54.59
Transportation of passengers in transport sector (mln.t. and %)	893.226	100
Including by motor transport, mln. passengers	768.158	85.44

II. DISCUSSIONS

These parameters are not only resulting of development of the transport network, but also are caused by receipt of more perfect rolling stock allowing considerably increasing hauling ability. Now an automobile fleet of the republic has achieved 50,000 units.

The further development of automobile transportations is determined as growth of a population and increase of a level of development of various branches of a national economy, and requirements of improvement of quality of service.

Before workers of motor transport the problem is put to provide perfection of structure of the transport park more full adequate to requirements of the national economy, to a problem of fuel economy and requirements of environmental protection.

For internal-combustion engines the basic sources of emissions are the discharge gases which represent the complex aggregate including over 200 components. In Table 2 parameters of pollution of the atmosphere by motor transport in % on volume are given.

High concentration of motor transport in Baku city causes an aggravation of the environmental problem. It is obvious, that with growth of amount of the automobile fleet a tendency of increase of use of liquid fuel, and consequently to growth of volumes of toxic emissions of motor transport in the air environment arises.

In Azerbaijan the majority of the population including owners of individual cars, prefer public transport that is dictated by economic aspects. This type of transport is preferable and concerning preservation of the environment of city for required power consumption of transportations in l/100 by buses in 3-5 times is lower than passenger-kilometers for cars.

Table 2. Pollution of the atmosphere by motor transport

Components of exhaust gases, %	Petrol engines	Diesel engines
Nitrogen	74-77	76-78
Oxygen	0.3-8.0	2.18
Water vapour	3.0-5.5	0.5-4.0
Carbon dioxide	5.0-12.0	1.0-10.0
Carbon oxide	5.0-10.0	0.01-0.5
Nitrogen oxide	0.0-0.8	0.0002-0.5
Hydrocarbons	0.2-3.0	0.009-0.5
Aldehydes	0.0-0.2	0.001-0.009
Soot (in g /m3)	0.0-0.04	0.1-1.1

The discharge gases are subdivided into non-toxical and toxic substances. To non-toxical substances concern: nitrogen, oxygen, hydrogen, water pairs, carbonic gas. To toxic substances concern: carbon oxide, nitrogen oxide, the numerous group of hydrocarbons including Paraffins, Olefins, Aromatic, Aldehydes, Soot, Polycyclic Aromatic Hydrocarbons (Carcinogens) with the most harmful Benzpyrene, Sulphurous Anhydride and Hydrogen Sulphide, Lead, etc.

The structure of the discharge gases essentially depends on the operation mode of the engine. On the basis of the carried out researches it is established that in conditions of the Baku city the engine on the average idles 27% of time, with acceleration 38%, with deceleration 21%, in other conditions 14%.

The contents of toxic components in emissions depending on conditions of movement of transport are presented in Table 3.

Table 3. Dependence of the contents of toxic components in emissions from type and power setting

Components of emissions, %	Idle	Constant speed	Acceleration from 0 to 40 km/h	Deceleration from 40 to 0 km/h
Carbon oxide	0.5-8.5	0.3-3.5	2.5-5.0	1.8-4.5
Hydrocarbons	0.03-0.12	0.02-0.6	0.12-0.17	0.23-0.44
Nitrogen oxides	0.005-0.01	0.1-0.2	0.12-0.19	0.003-0.005

Action of toxic components of the fulfilled gases on a human body variously also depends on their concentration in an atmosphere, conditions of the person and his (her) specific features. It is especially important to provide cleanliness of urban-industrial environment since the person can live about 5 weeks without meal, 5 days without water and only 5 minutes without air. If to take into account that the person for a day consumes about 1 kg of food, 2/5 l waters and 12 kg of air, it is clear that clean air is the most important and main component of the consumption.

For neutralization of toxic components of the discharge gases there can be perspective application ozone technologies in different variants. We carried out calculations in view of every possible chemical reaction at ozonization:

$CO + O_3 = C\,O_2 + O_2$

$N_2O + O_3 = 2NO + O_2$

$NO + O_3 = NO_2 + O_2$

$2NO_2 + O_3 = N_2O_3 + 2O_2$

$N_2O_3 \rightarrow NO + NO_2$

$N_2O_4 \rightarrow 4\,NO + O_2$

$2N_20_5 \rightarrow 4N\,O_2 + O_2$

$C_xH_y + O_3 = C_xH_{y-1}OH + O_2$

$R - COH + O_3 = R - COOH + O_3$

$SO_2 + O3 = SO_3 + O_2$

$C + 2O_3 = CO_2 + O_2$

The received results of ozone requirement are resented in Table 4.

Table 4. Calculations of ozone requirement

Components of exhaust gases	Toxicity	Petrol engines		Need in O_3 in grams	Diesel engines		Need in O_3 in grams
		in volume %	in grams		in volume %	in grams	
Nitrogen	No	74-77	10.5-10.9		76-78	Nitrogen	
Oxygen	No	0.3-8.0	0.049-0.13		2.18	Oxygen	
Water vapour	No	3.0-5.5	0.27-0.5		0.5-4.0	Water vapour	
Carbon dioxide	No	5.0-12.0	1.1-2.7		1.0-10.0	Carbon dioxide	
Carbon oxide	Yes	5:0-10.0	0.7-1.4	1.2-2.4	0.01-0.5	Carbon	$2.4\cdot10^{-3}$-0.12
Nitrogen oxide	Yes	0.0-0.8	0.0-0.3	0.0-0.2	$2.5\cdot10^{-4}$-0.5	Nitrogen oxide	$1\cdot10^{-3}$-0.125
Hydrocarbons	Yes	0.2-3.0	0.065-1	0.1-0.15	$9\cdot10^{-3}$-0.5	Hydrocarbons	$1\cdot10^{-3}$-0.056
Aldehydes	Yes	0.0-0.2	0.0-0.1	0.0-0.06	$1\cdot10^{-3}$-$9\cdot10^{-3}$	Aldehydes	$3\cdot10^{-4}$-$3\cdot10^{-3}$
Sulfur oxide	Yes	0.0-$1.86\cdot10^{-3}$	0.0-$1.86\cdot10^{-6}$	0.0-$6\cdot10^{-7}$	0.0-$6\cdot10^{-3}$	Sulfur oxide	0.0-$2\cdot10^{-6}$
Soot (in g /m3)	Yes	0.0-0.04	0.0-$2.5\cdot10^{-3}$	0.0-0.02	0.1-1.1	Soot (in g /m3)	0.05-0.55
Total				1.3-2.83			0.54-0.85

On the basis of the carried out calculations the necessary amount of ozone for neutralization of the automobile discharge gases has been determined. At use of 1 kg gasoline required an amount of ozone will change within the limits of 1.3-2.83 kg, and for diesel fuel an amount of the necessary ozone varies within the limits of 0.54-0.83 kg.

Taking into account the tendency of toughening of allowable specifications of environmental contamination by the motor transport, becomes clear perspectives of carrying out of scientific researches in a scope of ozone technologies.

Modern ozone technology consists of large quantity of separate functional blocks which basis are ozonizers. In turn ozonizers consist of the ozone the generator (a reactor or an active part) and the power supply (the converter of frequency with the high-voltage block).

Ozone generators differ on productivity and on their assignment, some of them are intended for reception of ozone in stationary conditions from atmospheric or compressed drained and cleaned air in high voltage (barrier-free, one- or two-barrier) categories. They can be used in various continuous technological processes in different areas of the industry.

It is possible to choose ozonizers from the offered by the industry models (Table 5) with necessary parameters or to order with required characteristics.

Table 5. Key parameters of industrial ozonizers

Type of the ozonizer	P-31	P-222	P-379	P-647
Productivity on ozone, kg / hour	0.63	6.7	1.5	19.6
Concentration of the ozone-air mix, g/m^3	15	20	20	20
Power consumption, kW	8	88	151	258
Air consumption, m^3 / hour	40	435	745	1275
Water consumption, m^3 / hour	4	38.	64	97
Weight, kg	1000	3100	3700	8400

For today use of ozone as full decontaminating agent of the discharge gases yet is not preferable, but taking into account allowable norms of toxic structure of the discharge gases, the expediency of the complex use of the ozone technologies after preliminary neutralization of toxicity with application of one of existing thermal, catalytic or liquid methods raises. The principle of work of the combined method - liquid neutralizer of the processed gases of the automobile offered by us consists that from the receiver 2 exhaust gases is soaked up by the device 3, due to movement of the liquid acting from the tank 4. Movement of a liquid creates a condition exhaustion of gas and their long joint interaction.

The received mix acts in a separator 5 in which heavy making mixes are separated. The easy fraction of a mix acts in the chamber 6 where, mixing up with an oxidizer, having cleared of pollution, acts in an atmosphere 7. The scheme of the combined neutralizer of the processed gases is submitted on Figure 1.

Solutions Na_2SO_3 were applied to increase of efficiency of cleaning process instead of water, Na_2CO_3 and hydroquinone.

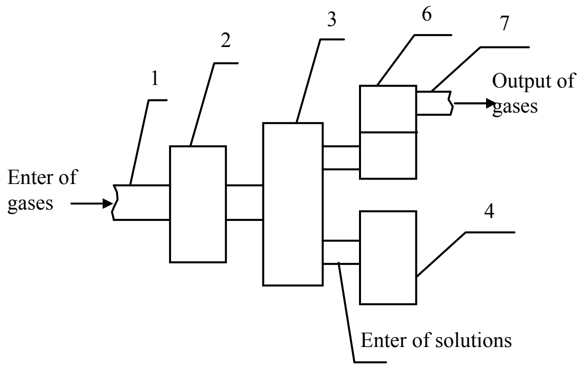

Figure 1. Principal block-scheme of clearing processed gases of automobiles
1- silencing pot, 2- receiver,
3- equipment for interacting of liquid and gas,
4- tank for solutions,
5- separator, 6- clearing chamber, 7- mouth

Work proceeds with the purpose of specification of design data and the analysis of results of clarification of the processed gases depending on a mode and operating conditions of the automobile.

III. CONCLUSIONS

Summarizing article it is possible to note, that while in service the automobile its engine works on various modes from which depends not only quantity of a combustible mix, but also speed of its combustion, hence, the structure of the processed gases changes.

The offered method takes into account these nuances and with application of modern electronics, in particular pulse technics, the opportunity without inertial to operate is represented by regulation of intensity of submission of a liquid solution.

The carried out experiments have confirmed viability of the offered method giving satisfactory results in the decision of a case in point.

REFERENCES

[1] Yu. Yakubovsky, “Automobile Transport and Environmental Protection”, Transport Publishers, Moscow, pp. 188 (in Russian), 1979.

[2] V.V. Lunin, M.P. Popovich and S.N. Tkachenko, “Physical Chemistry of Ozone”, Moscow State University Publishers, Moscow, pp. 267 (in Russian), 1988.

[3] V.G. Safarov, A.A. Allahverdiev, N.A. Mamedov and Sh.Sh. Alekberov, “Method of Clearing of the Processed Gases” 3rd International Conference on Technical and Physical Problems in Power Engineering (ICTPE-2006), Ankara, Turkey, pp.1121-1124, 29-31 May, 2006.

BIOGRAPHIES

Vaqif (Huseynqulu oglu) Safarov was born in Shamakhi, Azerbaijan, on March 5, 1941. He received the M.Sc. degree in Physics, 1963 and the Ph.D. degree in Physical Semiconductors, 1972 all from Baku State University (Baku, Azerbaijan). Currently, he is the Associate Professor in the field of Physics-Mathematics in Faculty of Physics, Baku State University (Baku, Azerbaijan). He has authored 60 scientific papers and 9 patents. His research interests are in radio-physics, electron techniques materials, solid state physics, materiality, and micro and nano-electronics effects.

Afiq (Allahverdi oglu) Allahverdiyev was born in Azerbaijan, 1937. He received the M.Sc. degree in the field of Operation Road Transport as Mechanical Engineer from Azerbaijan Polytechnic Institute (Baku, Azerbaijan) in 1960. He graduated to Ph.D. degree in automation of experimental research from Faculty Specials Retraining for New, Promising Areas of Science and Technology at the Moscow Automobile and Road Institute, Russian Academy of Sciences (Moscow, Russia) in 1985. Currently, he is the Associate Professor in the field of organization of road transport and road safety in Azerbaijan Technical University (Baku, Azerbaijan). He has authored 148 scientific papers. His research interests are in road transport of articles large-panel management, developing methods and models optimization in road transport logistics, and automation and process control and production.

Nemat (Ali oglu) Mamedov was born in Baku, Azerbaijan, on June 30, 1938. He received the M.Sc. degree in Physics, 1963 and the Ph.D. degree in Physical Plasma, 1969 from Institute of Direct Currents, Russian Academy of Sciences (St. Petersburg, Russia). Currently, he is the Associate Professor in the field of Physics-Mathematics in Faculty of Physics, Baku State University (Baku, Azerbaijan). He has authored 130 scientific papers, 2 books and 4 patents. His research interests are in radio-physics, extreme high frequency electronics, and gas discharging apparatus and devices.

Shahin (Shamshad oglu) Alekberov was born in Dashkesan, Azerbaijan, on June 8, 1980. He received the M.Sc. degree in Physics, 1997 and the Ph.D. degree in Physical Electronics, 2008 all from Baku State University (Baku, Azerbaijan). Currently, he is the research scientist in Institute for Physical Problems, Baku State University (Baku, Azerbaijan). His research interests are in plasma physics and corona discharge.

Seving (Baybala qizi) Safarova was born in Azerbaijan, 1971. She graduated from the Faculty of Physics of Baku State University (Baku, Azerbaijan) in 1993, and works at Department of Physical Electronics of Baku State University (Baku, Azerbaijan). She has 5 published scientific papers.