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

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

December 2013 | Issue 17 | Volume 5 | Number 4 | Pages 139-142

REMOVAL OF THE HARMFUL CARBONIC COMPONENTS FROM EXHAUST GASES OF TRANSPORT VEHICLES

A.T. Khudiyev [1] N.A. Mamedov [2]

1. Institute of Petrochemical Processes, Azerbaijan National Academy of Sciences, Baku, Azerbaijan, khudiev@yahoo.com
2. Baku State University, Baku, Azerbaijan, nematmamedov@hotmail.com

Abstract- The exhaust gases of transport vehicles and volatile organic components (VOC) are known as basic atmosphere contaminants. For abatement of these contaminants, we carried out studies on removal of the harmful carbonic components from air by oxidation in the presence of ozone over catalyst. We proposed a new approach for the atmospheric air cleaning the use of ozone together with the catalyst.

Keywords: Ozone, Polluted Air, Toluene, Oxidation, Volatile Organic Components (VOC).

I. INTRODUCTION

The well-known methods of air treatment from the pollutants are oxidation and catalytic oxidation, filtration and biofiltration, condensation, absorption, adsorption and finally our method of oxidation with ozone over a catalyst. It is shown [1-5] that ozone application in combination with the catalyst allows to remove the harmful carbon-containing components from the air. Therefore, in this study the effect of reactor temperature, presence of ozone and porous material (helps to increase the contact area between polluted component and ozone) on pollutant removal has been studied. High energy, obtained from the transport vehicles batteries can be used in ozone generators. The atmospheric air is possible to use as the ozone source.

II. EXPERIMENTAL

A schematic diagram of pilot plant is presented in Figure 1. In this experimental setup, the precise control of airflow rate, pollutant concentration, and reactor temperature and ozone concentration is possible. This setup can control these parameters accurately. Temperature conditions of the cleaning process were kept constant within a range of 25-400 ºC. Toluene was used as a VOC (air contaminant). These were used as the catalysts (adsorbents): quartz, silica gel, aluminum oxide, spent platinum catalyst and natural zeolite (clinoptilolite).

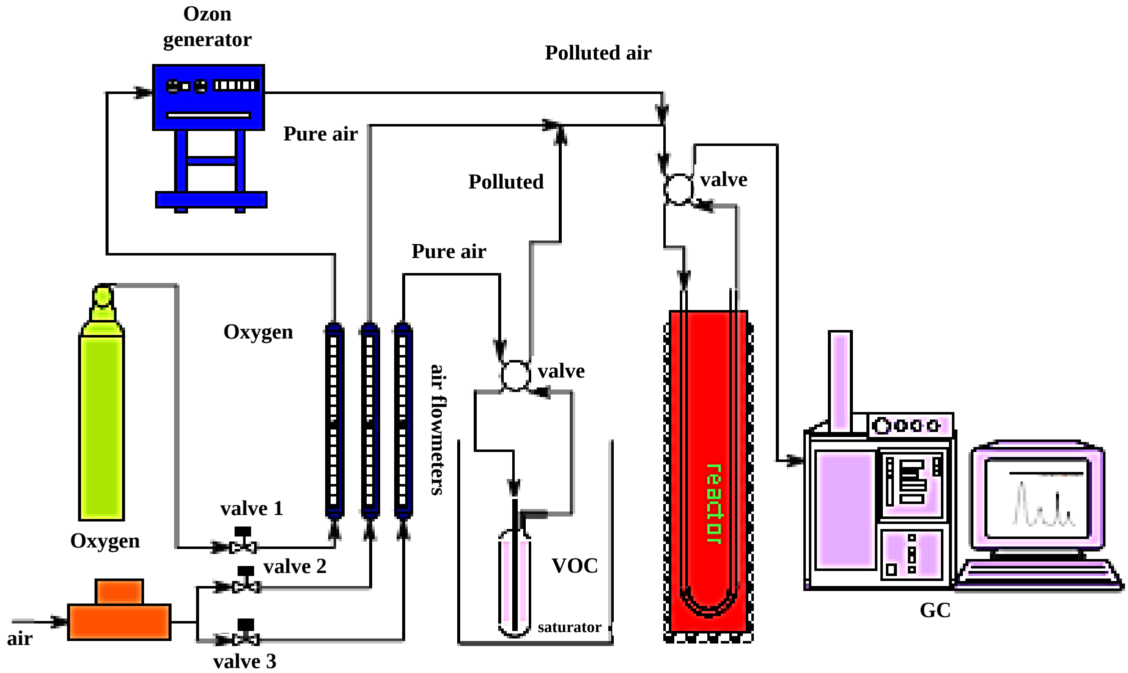

Figure 1. Schematic diagram of ozonation pilot plant

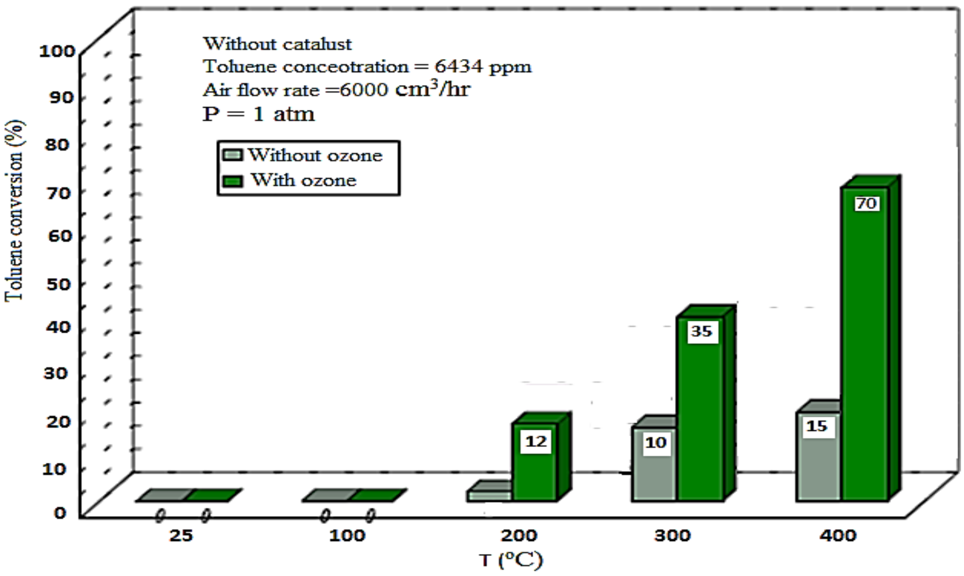

Figure 2. The polluted air cleaning without catalyst (adsorbent)

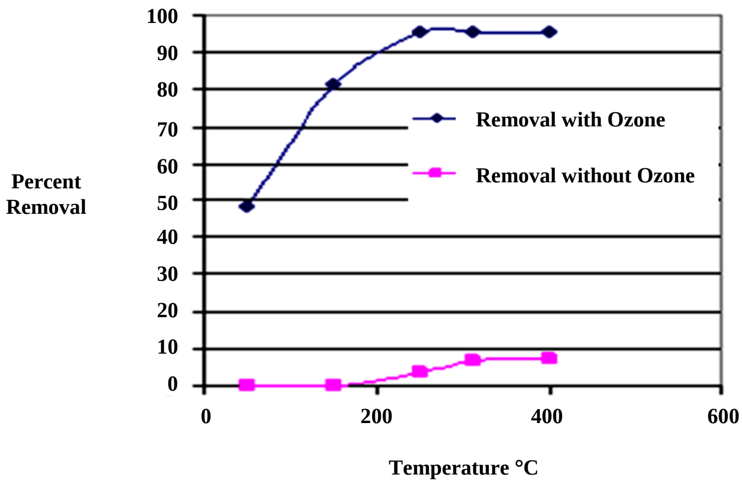

Figure 3. The polluted air cleaning over the quartz (S = 3 m^2)

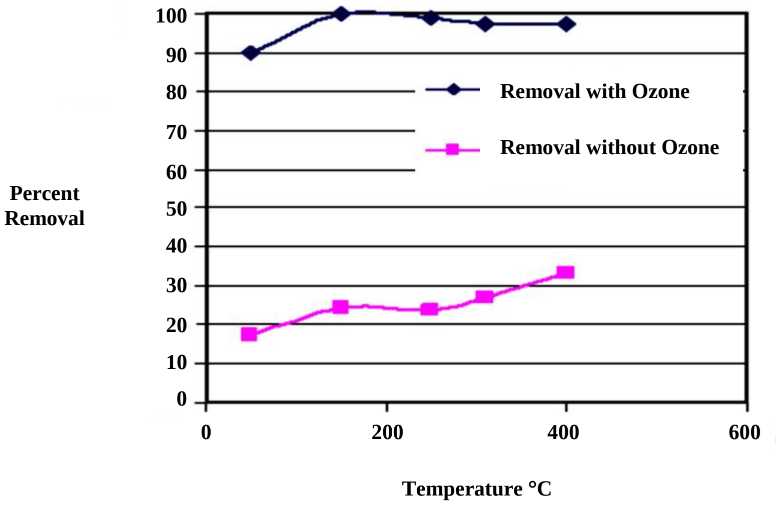

Figure 4. The polluted air cleaning over silica (S = 120 m^2)

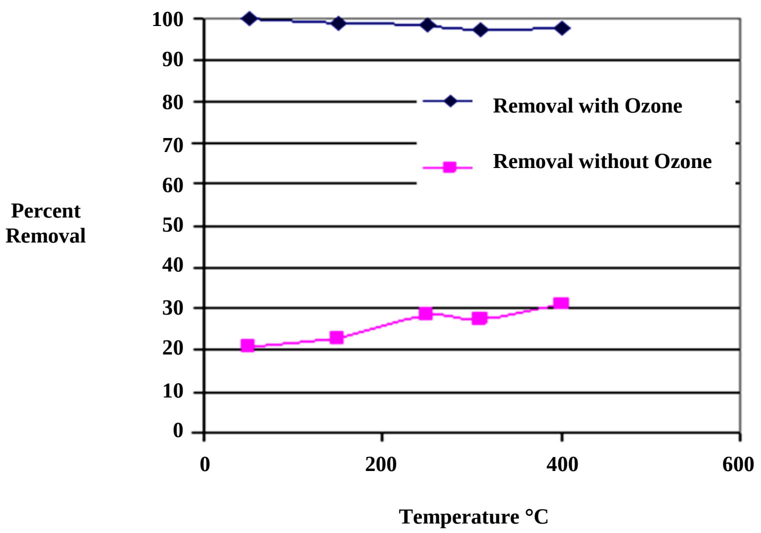

Figure 5. The polluted air cleaning over aluminum oxide (S = 120 m^2)

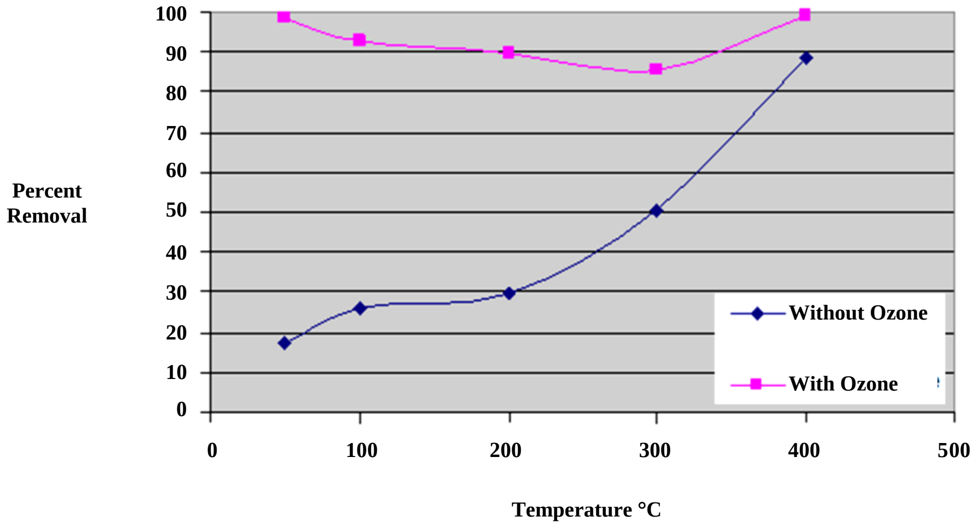

Figure 6. The polluted air cleaning over spent platinum catalyst (S = 50 m^2)

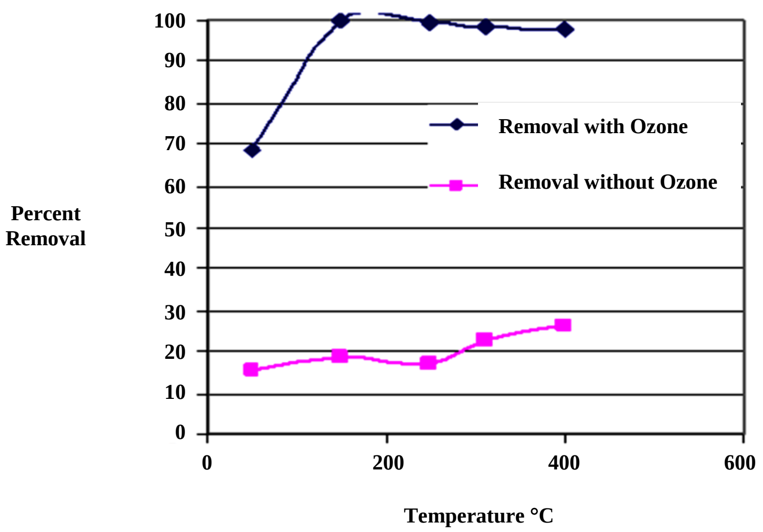

Figure 7. The polluted air cleaning over clinoptilolite (S = 30 m^2)

III. RESULTS AND DISCUSSIONS

The obtained results are given in Figures 2 to 7. As can be seen from the given data, without employing a catalyst (adsorbent) toluene has not been removed completely (~70%). Treatment of the polluted air in the presence of a catalyst (adsorbent) at temperatures up to 400 ºC also cannot remove all the VOCs completely. The maximum removal of VOCs over platinum catalyst was 88%. However, employing of catalysts (adsorbent) in the presence of ozone, the complete removal of toluene occurs at temperatures below 200 ºC. The best result of toluene removal from the air is observed in the presence of ozone over platinum catalyst and aluminum oxide.

IV. CONCLUSIONS

1. The removal of carbon-containing compounds from the air using ozone as an oxidizer gives the best results in the presence of a catalyst (adsorbent).
2. As the atmospheric air can be used as a source of ozone, for cleaning of exhaust gases of transport vehicles the ozone generator working on the vehicles batteries should be used.
3. The optimal conditions of the cleaning process are to be determined for each catalyst (adsorbent).

REFERENCES

[1] A.T. Khudiyev, M. Haghighi, J.S.S. Mohammadzadeh, "Catalytic Oxidation of Toluene in Polluted Air with Pt Catalyst", 7th National Congress of Chemical Engineering of Iran, pp. 5.256-5.261, Tehran, Iran, October 28-31, 2002.

[2] A.T. Khudiyev, S. Shafiei, M. Haghighi, S. Rajabzadeh, "Removal of VOC from Air by Ozone on Natural Zeolite", Abstracts of the VI Baku International Conference Dedicated Academician Yu.H. Mamedaliyev Centenary, p. 20, Baku, Azerbaijan, 27-30 September 2005.

[3] A.T. Khudiyev, S. Rajabzadeh, M. Nasiri, et al, "Effect of Ozone Concentration in Removal of VOC from Air on Silica", Abstracts of the 10th Iranian National Chemical Engineering Congress, p. 399, Zahedan, Iran, 15-17 November 2005.

[4] A.T. Khudiyev, S. Rajabzadeh, J.S.S. Mohammadzadeh, et al, "Removal of VOC from Air by Ozone on Alumina", 8th International Congress on "Energy, Ecology, Economy", pp. 465-469, Baku, Azerbaijan 1-3 June 2005.

[5] A.T. Khudiyev, N.A. Mamedov, R.R. Zarbaliyev, V.Q. Safarov, "Protection of the Atmosphere from the Contaminiating Industrial and Transport Withdrawals", 2nd International Conference "Ecology - Problems of Nature and Society", Dedicated of the 105th Anniversary of the Prominent Representative of Azerbaijan Science, Academician H. Aliyev, pp. 14-15 Baku, Azerbaijan, 7-8 November 2012.

BIOGRAPHIES

Anvar Teymur Khudiev was born in Fizuli, Azerbaijan on January 5, 1938. He received the M.Sc. degree from Azerbaijan State University (Baku, Azerbaijan) in 1961, the Ph.D. degree from Institute of Organic Chemistry Academy of Science (Moscow, USSR) in 1967 and Doctor of Science in the field of Chemical Engineering and Zeolites from Institute of Petrochemical Processes, Azerbaijan National Academy of Sciences (Baku, Azerbaijan) in 1989. Currently, he is the Professor in Institute of Petrochemical Processes. His reaserch interests are in physical chemistry, kinetics and catalysis, separation processes, water treatment, adsorbents, synthetic and natural, zeolites, environmental protection. He published more than 200 papers in international conferences and journals and has also 21 patents.

Nemat Ali Mamedov was born in Baku, Azerbaijan, on June 30, 1938. He received the M.Sc. degree in Physics, in 1963 and the Ph.D. degree in Physical Plasma, in 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.