IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 16, Issue 12 Ser. II (December 2022), PP 01-04
www.iosrjournals.org

The Study Of The Kinetics Of The Impact Of Gas Emissions On The Environment And Human Health Of The Methane-Air Mixture Under The Influence Of Photolysis Of Vacuum Ultraviolet Rays

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Abstract
Currently, protecting the environment and human health from the harmful effects of waste in the atmosphere has become one of the most pressing problems of mankind on a global scale. Among these wastes, the processing of gaseous methane is one of the main tasks of the future due to its numerous properties and wide use, since methane is a strong greenhouse gas. Most of the emissions fall on methane from the oil and gas industry, waste processing and agriculture. Although at present, much attention is paid to CO2 emissions, and the concentration of methane is much higher than that of other organic compounds [1].
Global methane emissions into the atmosphere in 2017 increased by nine percent compared to the period 2000-2006 and amounted to 596 million tons. Compared to 2000-2006, methane emissions in 2017 increased by 9% and amounted to 596 million tons. The authors of the study note that such trends could lead to an increase in air temperature by 4.3°C by 2100 compared to previous levels [2].
In this work, modeling of the kinetic regularities of photochemical processes in methane-air mixtures was studied. The experiment was carried out under the following conditions: the composition range of the mixture components $\alpha[CH_4]=0.7\div100\%$, $\alpha[air]=0\div99.8\%$, τ- irradiation time - up to 6 hours, vacuum ultraviolet (VUV) wavelength radiation $\lambda = 123$ nm.
To understand the ecological problems of atmospheric chemistry, it is important to study the processes of structural changes in methane under the action of conditional VUV radiation. In addition, they play an important role in modern hydrocarbon processing technologies. Therefore, the study of the patterns of photostimulated reactions of methane in the air is of great importance for atmospheric chemistry and the protection of the ozone layer.
Keywords: *atmospheric pollution; methane; environment; "Greenhouse effect; components of the mixture; Ozone layer protection*

Date of Submission: 06-12-2022 Date of Acceptance: 19-12-2022

I. Introduction.

At the end of the 20th century, global environmental problems made protecting human health and the environment from all these impacts one of the priorities. On November 13, 2021, the 26th Conference of the Parties (COP26) concluded with the adoption of the Glasgow Climate Pact by all parties present representing nearly 200 countries worldwide. This global agreement will accelerate action on climate change this decade. At the conference, more than 100 countries signed a global methane commitment to cut massive emissions of the gas by 30% by 2030. These included six of the world's top 10 sources of methane emissions - the US, Brazil, EU countries, Indonesia, Pakistan and Argentina [3].

As the content of methane in the atmosphere increases, chemical processes also change, which can lead to a deterioration of the ecological situation on Earth. Naturally, the question arises about the control of chemical and physical processes in which methane is involved. In this work, the kinetic patterns of the formation of products and the destruction of the initial components VUV photolysis (λ=123 nm) of gas mixtures were studied: O_2-CH_4, O_2-N_2, air -H_2O, C_2H_5OH- air, CH_3COCH_3- air, SO_2-air. The initial partial pressure of methane changed with in PO = 0.13 ÷ 22.5 kPa, air pressure containing 2 % of water vapor changed from 0.7 to 99.8 kPa. The experiments were carried out on a vacuum installation at room temperature [4].

II. Results And Discussion.

First, the kinetics of photolysis of each of the components taken in the experiment under the action of VUV radiation was considered separately. Then the complex photolysis of these components was considered. Based on the obtained results, the kinetic curves of the main components were built and the results were compared. The role of methane, as well as oxygen and water vapor in the air, as well as chemical processes involving methane in the air, are considered.

The results of studying the main regularities of the formation of H_2, CO, C_2H_4, C_2H_6, O_3, NO, NO_2 and intermediate radicals under the action of VUV radiation in a methane-air mixture by experimental and computational methods are determined.

To increase the reliability, in all cases, we studied the dependence of the change in the concentration of products in the reaction mixture on time, and the reaction rate was determined from the initial linear sections of the kinetic curves: [N] = f[t]

Figure 1 shows the kinetics of H-water accumulation during VUV- (λ= 123nm) photolysis of methane at various methane pressures.

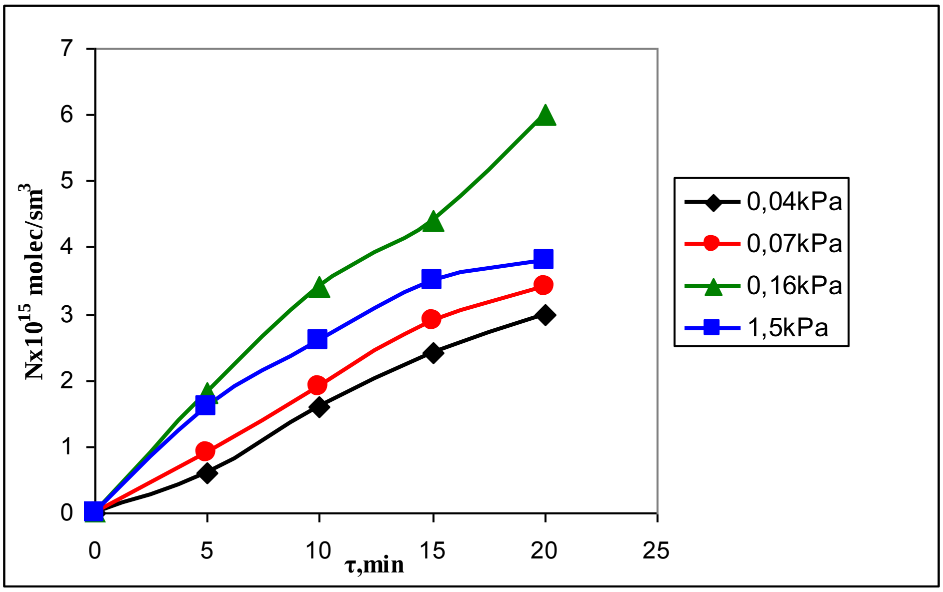

Fig.1. Hydrogen accumulation kinetics at the VUV (λ=123nm) -photolysis of methane at different methane pressure

Molecular hydrogen for methane photolysis is formed through two channels:

$$CH_4 + h\nu \rightarrow CH + H + H_2$$
$$CH_4 + h\nu \rightarrow H + CH_3$$

The dependence of the concentration of the products H_2 (◊), CO (□) and CH_4 (Δ) on the ratio of partial pressures of components with VUV(λ=123nm) -photolysis of the mixture of methane-air are shown in the figure (see fiq.2)

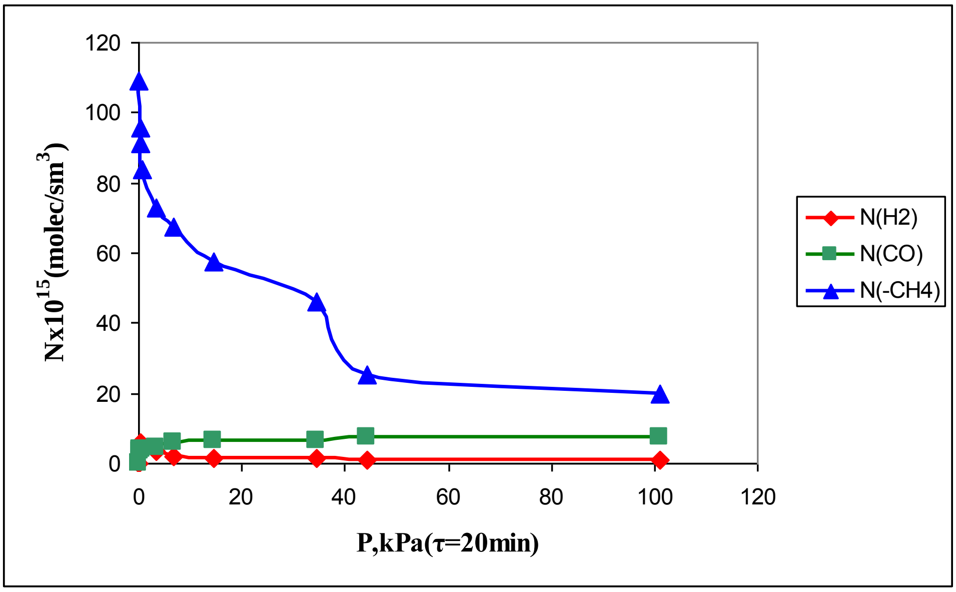

Fig. 2. Kinetics of the formation of H_2 (○), CO (□) and decompositions CH_4 (Δ) with VUV (λ=123nm) - photolysis of the mixture of methane, in the presence of 2% vapor of water.

With an increase in the concentration of O_2 to 50%, the yield of hydrogen decreases from 0.45 to 0.15 mol/quantum. A further increase in the air concentration to 90% has practically no effect on the hydrogen yield. Such a dependence $\varphi(H_2) = f([O_2])$ is associated not with the distribution of absorbed radiation between the components, but with secondary reactions of capture of H atoms and hydrocarbon radicals (CH_2, CH_3, C_2H_5) by oxygen:

$$H + O_2 \rightarrow HO_2$$
$$H + O_2 \rightarrow HO + O$$

$$CH_3 + O_2 \rightarrow CH_2O + OH$$

As a result of competition with an increase in oxygen concentration, the yield of hydrogen decreases. Since in both cases the yields of hydrogen decrease and the yields of carbon monoxide increase, the formation of OH radicals simultaneously decreases. As you know, the most reactive oxidizing agent is hydroxyl, which is responsible for the oxidation of most gases emitted into the atmosphere, and is the main absorber of methane, higher hydrocarbons (called non-methane hydrocarbons), carbon monoxide and other gases.

$$OH + CH_4 \rightarrow H_2O + CH_3$$

Therefore, methane emissions can remain in the atmosphere and react with the ozone

1. $CH_4 + O(^1D) \rightarrow CH_3 + OH$, $к=4\cdot 10^{-10} sм^3/молек\cdot s$

   $CH_4 + O(^1D) \rightarrow H_2 + CH_2$

2. $CH_4 + O(^3P) \rightarrow CH_3 + OH$, $к=9.3\cdot 10^{-12} sm^3/molek\cdot s$

It should be noted that in the presence of air impurities in methane, even at $\alpha[CH_4] \leq 1\%$, the formation of hydrocarbon gases is completely suppressed due to the rapid reaction of the interaction of methane carbon radicals with oxygen:

$$CH_3(C_2H_5) + O_2 \rightarrow product.$$

III. Conclusions.

Therefore, methane emissions affect the rate of ozone formation in the atmosphere, which may ultimately lead to a decrease in the equilibrium concentration of ozone in the atmosphere.

A kinetic scheme of reactions in a mixture and calculations according to the scheme are proposed, the results of which agree satisfactorily with the experimental data.

The results obtained are confirmed by a detailed and consistent study of the processes of photochemical conversion of methane in a CH_4-H_2O-O_2-N_2 mixture, as well as the mechanism of chemical reactions in multicomponent systems. Nevertheless, the study of the chemical mechanism of anthropogenic impact on the environment, and in particular on the stratosphere, remains the most important task today. Recent epidemic prevention and control activities showed that the COVID-19 pandemic was most severe in countries with significant ozone depletion in 2019 and 2021, where low ozone levels, high mortality were found [4].

References

[1]. 21st session of the Conference of the Parties (COP21) of the Framework Convention, (2019), Intergovernmental Panel on Climate Change (IPCC).

[2]. R B Jackson et al. (2020), Environmental Research Letters 26th Conference of the Parties (COP26), Glasgow Climate Pact November 13, 2021, Italy. Page 15

[3]. Mustafaev I.I., Mamedova S.M., Mahmudov O.M., (1995), Photochemical conversions of methane, hydrogen-sulfide and sulfhur – dioxid in air atmosphere. Proceedings of the First Trabzon International Energy and environmental Symposium, ECOS-95, Istanbul, Turkey, jule11-15,v.2, pp.531-534

[4]. Human Development Report (2020), The Next Frontier - Human Development and the Anthropogen, p.166

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