THE KINETICS OF CONVERTATION OF CARBON MONOXIDE TO CARBON DIOXIDE ON THE SURFACE OF MIXED NANO-CATALYST IN THE CLOSED SYSTEM

Hasanov S.H., Mahmudov H.M., Mustafayev I.I.
Institute of Radiation Problems, Azerbaijan National Academy of Sciences
AZ1143 Baku, Azerbaijan 9, Bakhtiyar Vahabzadeh str.
E-mail: h_sadiq@mail.ru

Abstract: In this article,the kinetics of oxidation process of carbon-monoxide on the nano-catalyst surface was investigated. The investigation conducted in the different flow conditions and the temperature range of 70-350oC depending on the kinetic convertation of carbon monoxide to carbon dioxide in the closed system. İt is determined that the speed of conversion process increases 1.30-1.32 times as temperature increases on the surface of catalyst. The conversion of carbon-monooxide to carbon-dioxide runs more rapidly at the low flow rates. Nano-catalyst introduced and tested in a process of neutralizing harmful emissions is presented in this investigation.

Keywords: air pollution, nano-catalyst, carbon monooxide, kinetic addictive, convertation,stream reactor flow rates

1. İNTRODUCTION

The rapid development of automobile transportation brings comfort, speed of movement and improved living condition to people. Unfortunately, percentage of the environmental pollution has increased considerably due to the excessive number of cars, especially, in urban areascar emissions exceed the amount of pollution causedby stationary sources in Azerbaijan, nearly 80-90% of total emission volume. According to the 2015 official statistics reports , 1,322 million vehicles were registered in Azerbaijan, while1,100 millions of them are light passenger vehicles, 31,000 are buses, 141,000 trucks. The number of vehicles has sharply increased about three times with the oil industry development if compare with the year 2000. In addition, the volume of car emissions is at the level of 1 million tons per year by the official sources. According to the evaluated numbers, impact of air pollution to human health is about 174 million USA dollar per year, which is 3% of GDP in Azerbaijan [10]. Recent outcomes make it necessary to conduct scientific researches in order to prevent soaring emissions. A lot of catalysts have been tested by the researchers. Especially, in the recent years, catalyst covered by platinum is widely used in catalytic-neytralization processes [6]. The massive use of precious materials does not meet requirments and disposing them is unacceptable.

Nano-catalyst introduced and tested in the process of neutralizing harmful emissions is presented in this article.The kinetics of decreasing emissions has been researched in various flow rates and temperature ranges of 70-350 ^{o} C at the surface of catalyst, whichis constituted by Al_2O_3 and CuO nano-paticles. Furthermore, conversion of CO to CO_2 on the mix- catalysts has been explored in the closed nano-flow reactor. Consequently, nano-particles of CuO-Al_2O_3were tested in different temperature regimes. Introduction of the study to reduce exhaust gases will lead to improve air quality [9].

2. METHODOLOGY

The research work was conducted in the quartz reactor installed in the cycle system (d=10 mm,h=1 m) where was controlled speed of air stream, the temperature of surface of catalyst and change of concentration of carbon-monooxide in air mixture. The kinetics of conversion of carbon-monooxide to carbon-dioxide in different temperature have been investigated, while air& CO mixture (various ratios) passes through the surface of catalyst in different temperature. The conversion of carbon monooxide to carbon dioxide on the stream of air mixture were analyzed at "Gasochrome 3101" and "Agilent Technologies 7890A GC " devices at J&W 113-4332,260 C, 30 m x 320 µm x 0 µm column.

Air compressor is used to circulate the mixed air in the line,while the speed of gases passing through system is controlled by gas speedometer. The parameters of scheme are H=10-15 sm and m = 8-10 gr installed in the quartz reactor, while the inlet and outlet are closed by means offiberglass. The temperature of catalyst is controlled by Al-Cr thermo-pair- installed on the surface of reactor. The reactor is covered by heat isolating material to keep the temperature stable. The ratio of $N(CO)/N(O_2)=1\div5\%$ is controlling in a proper conversion process. 5 liter flask is used to provide oxygen and $N(CO) = 10^{18}$ molec./m carbon monooxide is added to that volume.

At the end of cycle the reactor is cleaned, while the next phase is developed.

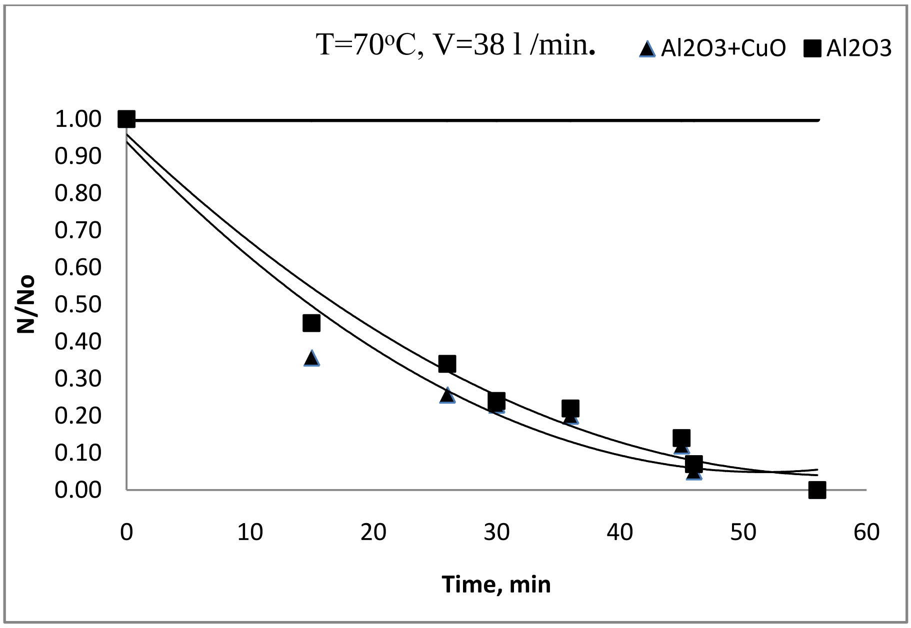
3. DISCUSSION AND RESULTS:

The main purpose of this study is analyse oxidation process of carbon monoxide at the surface of mix Al_2O_3 and CuO nano catalyst at low temperature.

$$CO + 1 / 2O_2 = CO_2$$

This type of catalysts has many superiorities and they are of more interest in the recent years. So, these types of catalysts prevails others because they are capable of cleaning carbon-monooxide CO from the mixed air better at low temperatures and the time expireis more long lasting . The surface of the catalyst is cleaned and activated after every cycle [5].

Kinetic dependance of CO conversion on the surface of catalyst is represented in the Figures 1-3. As it is shown, the speed of process increases as the temperature rises. The temperature increases from 70^{o}C to 200^{o}C, while the speed of conversion is increases W200 / W70 = 1.31 times (Figure 4).



Fiure 1. The kinetics dependence of carbon monoxide conversion on the catalysts surface at T = 70°C, (V=38 l/min. ∆- Al_2O_3+CuO, □-Al_2O_3).

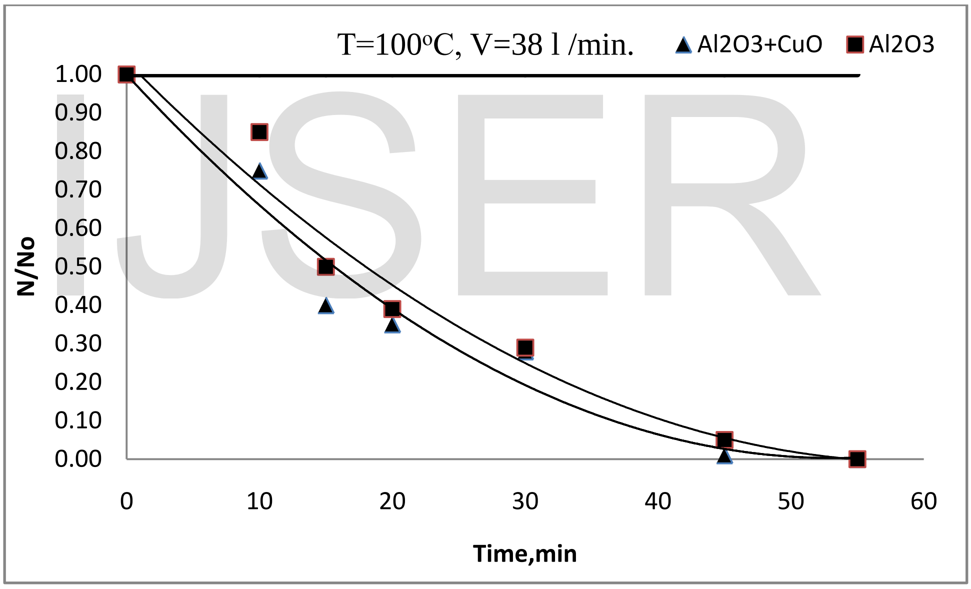


Figure 2. The kinetics dependence of carbon monoxide conversion on the surface of catalyst at T = 100°C, (V=38 l /min. ∆- Al_2O_3+CuO, □-Al_2O_3).

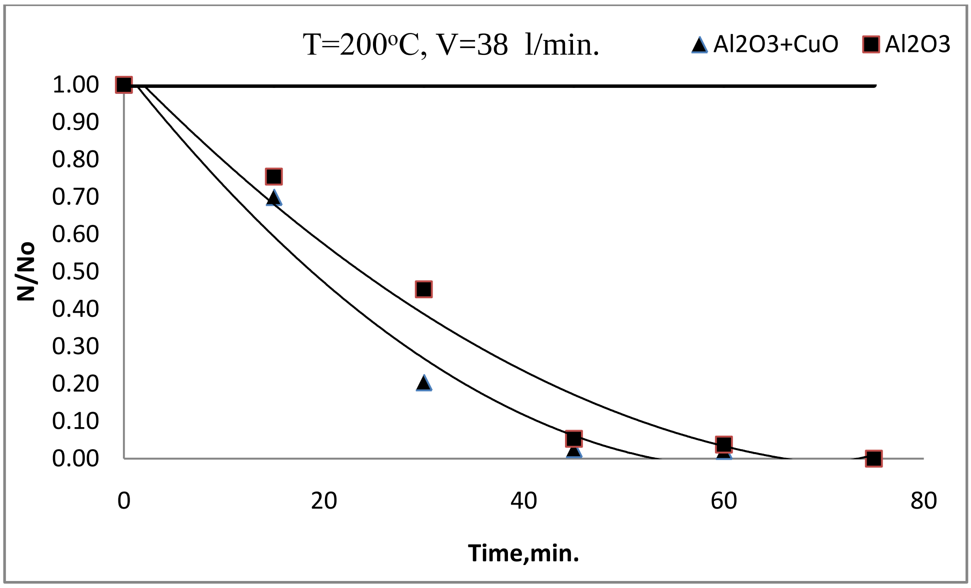


Figure 3. The kinetics dependence of carbon monoxide conversion on the surface of catalyst at T = 300^oC, (V=38 l /min. ∆- Al_2O_3+CuO, □-Al_2O_3).

Figure 4 shown the volume of CO that does not converted on it's gas mass depending on temperature(1-N/No). As it can be see, as temperature increases on catalyst surface,N/No ratio changes, whereas if it is 38% at 70º C, the conversion on the catalyst surface shows 42%. If the temperature is increased from 70^oC to 200^oC the conversion speed will increase 1.30-1.32 times, while the conversed carbon monooxide percent varies between 50 and 55%.

As it is shown in the graphs, while the temperature increases on the surface of the catalyst, the conversion process accelerates and deepens by creating the new O^- centers. As it is seen from the numerous experiments, the surface of the catalyst was repeatedly used in the oxygen environment by increasing the temperature ranges. As a result, new active centers were created on the surface of the catalyst [8,9].

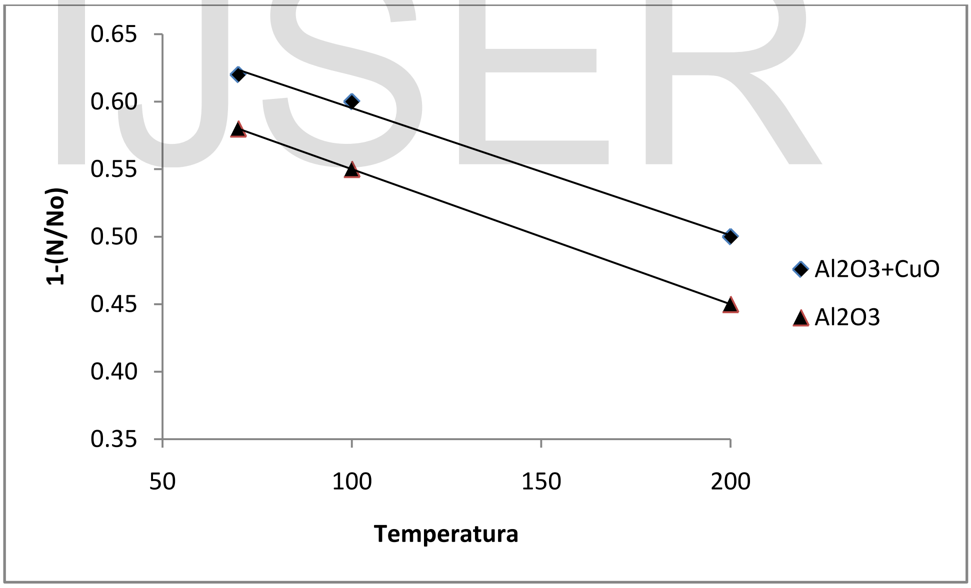
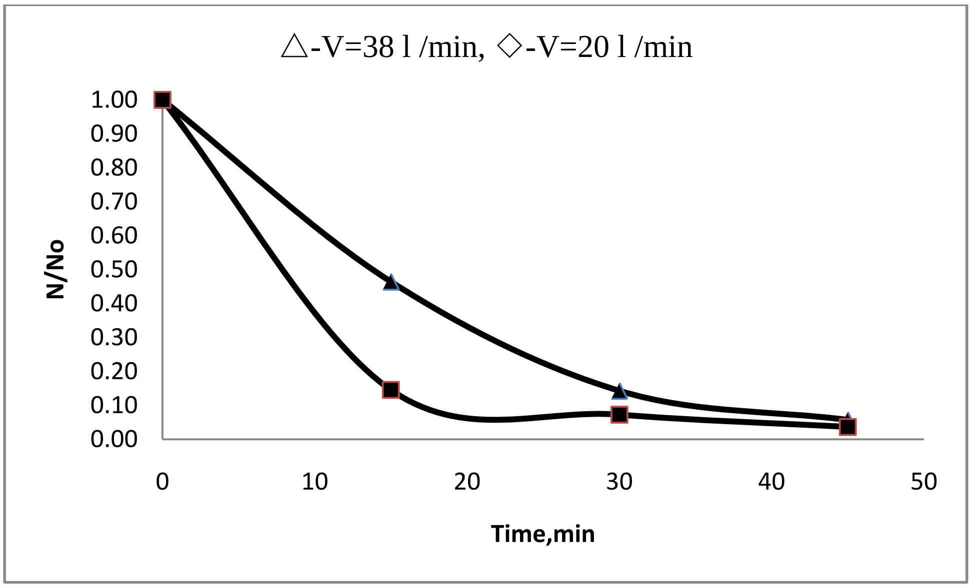


Figure 4. The temperature dependence of conversion of carbon monoxide on the catalystsurface(τ=20 min., V=38 l /min. □-Al_2O_3+CuO, ∆-Al_2O_3).

Figure 5 shows conversion of carbon monooxide on mixture nano-catalyst surface depending on the cycle speed of gas mass at 300^oC. As it is shown, the conversion processes of carbon monooxide to carbon dioxide on the surface of nano-catalyst increase at low speed which is concede by arise of active oxidation radicals in gas mass.



Fiure 5. The kinetics of carbon monoxide conversion on the catalyst surface at the different stream speed.(T=300°C, △-V=38litr/min.◇-V=20 litr/min).

Thus, in figure 5 shown that, in the flow rate of 38 l/min on the duration of 15 min, the conversion process increase by is (N/N_o)x100%= 50% , whereas, the reduction of flow speed to V=20 l/min, the conversion process increases to (N/N_o)x100%=87% during the same period of time. Consequently, the meeting time on the surface of catalyst is increases and the conversion process accelerates.

RESULTS:

- The kinetics of depending on conversion of carbon-mooxdie to carbon-dioxide of the mixture of air and carbon-mono-oxide on the surface of nano-particles of Al_2O_3+CuO catalyst in different flows and temperature range from 70 to 200°C degrees was investigated. It was determined that at all temperature ranges, conversion level reaches 90%.
- As a result of investigation, the conversion speed increased by 1.30-1.32 times, if the temperature varies between 70-200ºC in the reactor. Meanwhile, the volume of conversion of CO increases by 12-14%.
- The kinetics depending on conversion CO to CO_2.of mixture of air and gas on the surface of catalyst of nano-particles in different speed flows and under temperature on 300°C was investigated. It was determined that the conversion process of carbon-mono-oxide to carbon-dioxide is taking place more rapidly in low flow rates. Thus, at the flow rate of 38 l/ min during 15 min, the conversion process is (N/N_o)x100%= 50% ,whereas, the conversion process increases to (N/N_o)x100%=87% in the same period of time by reduction of flow speed to V=20 l/min, .

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