Identification, Practical, Theoretical and Analytical Results of Exhaust Gases in Vehicle Internal Combustion Engines

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Abstract: In this article, the practical, theoretical and analytical basis of exhaust gas diagnostics of internal combustion engine, results and corresponding exhaust gas graphs using the protative and lightweight Kane AUTO plus exhaust gas analyzer with multilingual software are made. Carbon monoxide, carbon dioxide, hydrocarbons, oxygen, nitrogen oxides and lambdas were obtained from the exhaust gases emitted from Tracker, Nexia, Spark car engines using a gas analyzer. In the laboratory of the Department of "Energy Engineering and Professional Education" of the Tashkent State Technical University, experiments were conducted on the above-mentioned car engines.

1 INTRODUCTION

In the laboratory of the Department of "Energy Engineering and Professional Education" of the Tashkent State Technical University, experiments were conducted on the above-mentioned car engines. Car exhaust gases are a mixture of about 200 substances. They contain hydrocarbons - unburned or incompletely burned fuel components, the ratio of which increases sharply if the engine is running at low speed or when decelerating, that is, during traffic and at red traffic lights. It is at this time, when the accelerator is pressed, that the most unburned particles are released: about 10 times more than when the engine is operating in normal mode (Musabekov et al., 2023; Ergashev et al., 2022; Umerov et al., 2024; Matmurodov et al., 2024; Musabekov et al., 2023). The gas analyzer is one of the main devices in the field of modern diagnostics of the car service center. It serves to check the harmfulness of exhaust gases, to obtain information and analysis.

2 MATERIALS AND METHODS

The analysis begins with the measurement of the concentration of toxic gases in the exhaust of the car engine, thanks to this information it is possible to assess the condition of the car engine and its systems. Engine diagnostics depends on the state of the engine, the detection of defects and malfunctions, analysis data on the composition of waste (Ergashev et al., 2022; Umerov et al., 2024; Matmurodov et al., 2024; Musabekov et al., 2023; Musabekov et al., 2023; Ismatov et al., 2023).

Carbon monoxide, carbon dioxide, hydrocarbons, oxygen, NO_X and lambda readings from the Kane AUTO plus gas analyzer are obtained graphically and in real time from Kane Live software using the mini-USB port and Bluetooth connection (Figure 1).

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Figure 1: Taking exhaust gas readings from a car engine on the Kane AUTO plus gas analyzer.

This is due to the fact that the concentration of some gases in the waste is very small, and therefore it is inconvenient to use percentages to indicate their amount (Umerov et al., 2024, Matmurodov et al., 2024, Bazarov et al., 2023, Makhamadjanov et al., 2024 Alimova et al., 2024, Tursunov et al., 2023, Ismayilov et al., 2023).

Waste gases were passed through several stages:
– cleaning of exhaust gases was carried out using a filter installed at the inlet or directly. At this stage, large mechanical particles were cleaned from waste gases.
– exhaust gases are cleaned of moisture.
– the final filtration of the smallest mechanical particles was carried out using fine filtration.

Using the Kane AUTO plus gas analyzer, carbon monoxide, carbon dioxide, hydrocarbons, oxygen, NO_X and lambdas from exhaust gases emitted from Tracker, Nexia, Spark car engines are measured in the following ranges: CO 0-10%, CO_2 0-16%, NC 0-5000 rpm, O_2 0-21%, NO_X 0-5000 rpm, lambda 0.8-1.2. was obtained (Musabekov et al., 2023).

3 RESULTS AND DISCUSSION

Experiments were carried out on the following car engines and results were obtained:
1) in the engine of a trekker car with Ai-95 gasoline, propane gas, salt mode and 2000 rpm;
2) Ai-92 gasoline, methane gas, salt mode and 2500 rpm in the Nexia car engine;
3) In the Spark car engine, in Ai-80 gasoline, methane gas, in salt mode and at 2500 rpm, the parameters of the engine exhaust gas, i.e. carbon monoxide, carbon dioxide, hydrocarbons, oxygen, NO_X and lambdas were determined and their average

values were determined using formula 1 (Figures 1-24) graphs and Table 1).

$$X_{av}=(X_1+X_2+\cdots+X_n)/X_n \quad (1)$$

where $X_1+X_2+\cdots+X_n$ - the indicators obtained in the experiment, X_n - the number of indicators and values obtained.
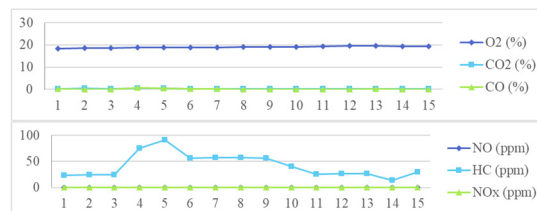

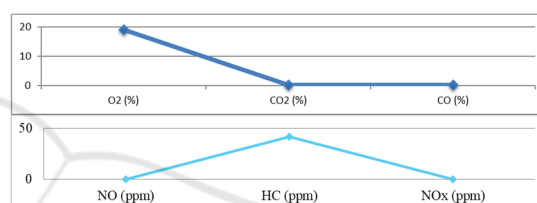Figure 1: Tracker engine Ai- 95 gasoline, indicators in Idle mode.

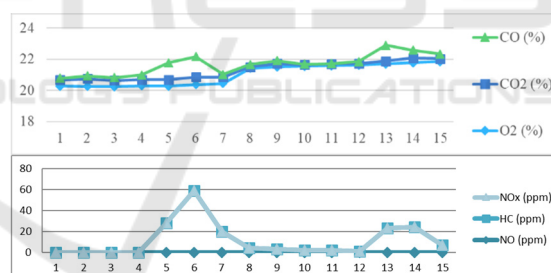Figure 2: Tracker engine Ai-95 gasoline, Idle mode, average indicators.

Figure 3: Tracker engine Ai- 95 gasoline, indicators at 2000 rpm.
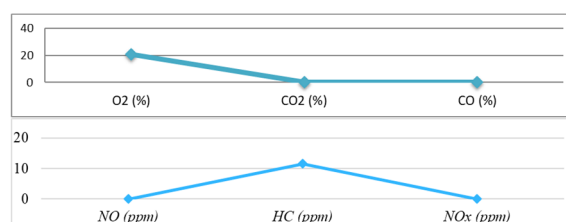

Figure 4: Average indicators of the tracker engine Ai-95 gasoline at 2000 rpm.
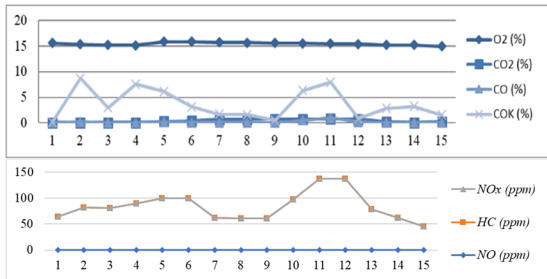
Figure 5: Tracker engine propane gas, Idle mode indicators.
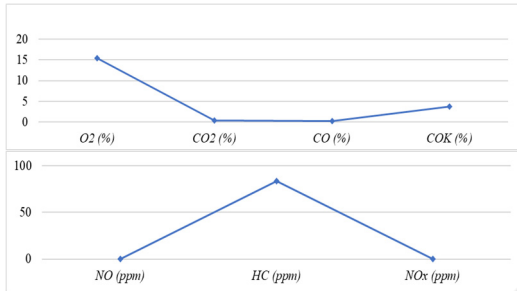

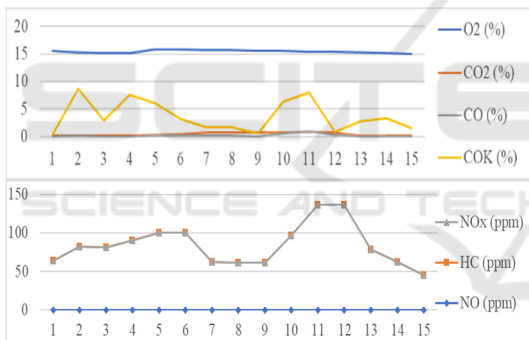Figure 6: Tracker engine propane gas, Idle mode average indicators.

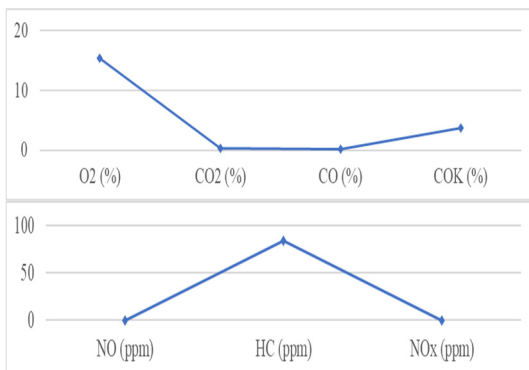Figure 7: Tracker engine propane gas, indicators at 2000 rpm.

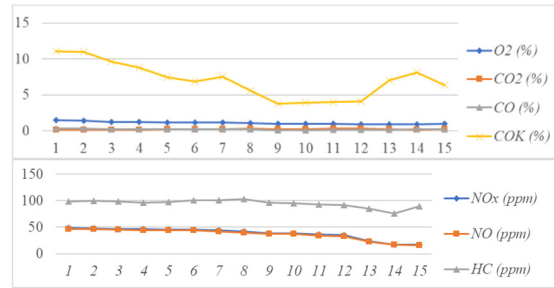Figure 8: Tracker engine propane gas, average performance at 2000 rpm.

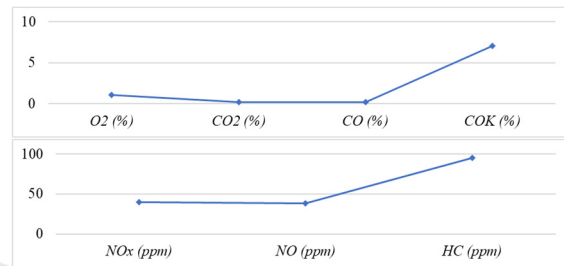Figure 9: Nexia engine in Idle mode, Ai- 92 gasoline indicators.

Figure 10: Nexia engine in Idle mode, Ai- 92 gasoline average indicators.
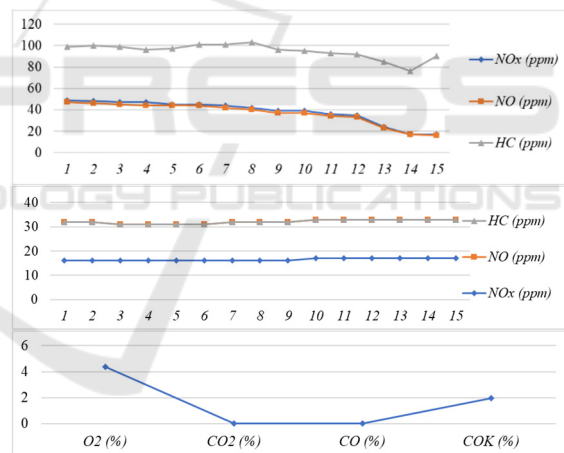

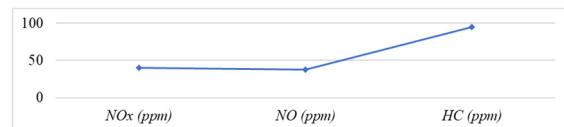Figure 11: Nexia engine at 2500 rpm, Ai- 92 gasoline, indicators.

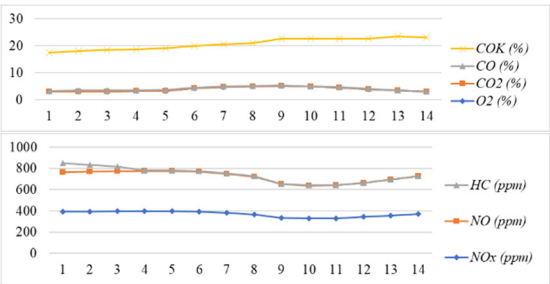Figure 12: Nexia engine at 2500 rpm, Ai- 92 gasoline, average indicators.

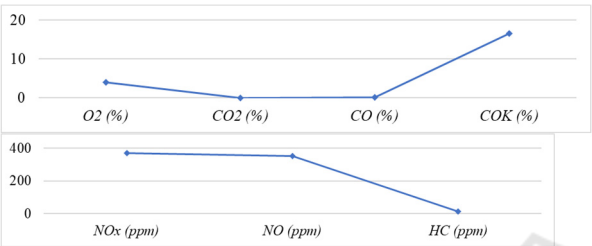Figure 13: Nexia engine in Idle mode, methane gas, indicators.

Figure 14: Average indicators of Nexia engine in Idle mode, methane gas.

Figure 15: Nexia engine at 2500 rpm, methane gas, indicators.

Figure 16: Nexia engine at 2500 rpm, methane gas, average indicators.

Figure 17: Indicators on Spark engine in Idle mode, Ai-80 gasoline.

Figure 18: Spark engine in salt mode, Ai-80 gasoline, average indicators.

Figure 19: Spark engine at 2500 rpm, indicators on Ai-80 gasoline.

Figure 20: Spark engine at 2500 rpm, Ai-80 gasoline, average indicators.

Figure 21: Indicators in the spark engine in salt mode, on methane gas.

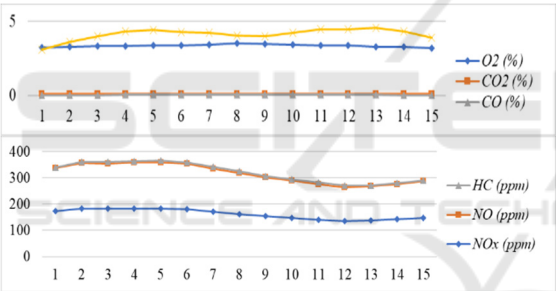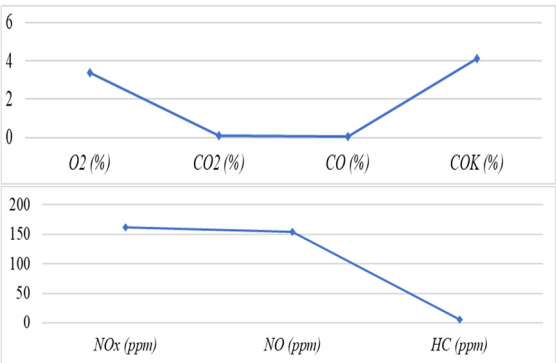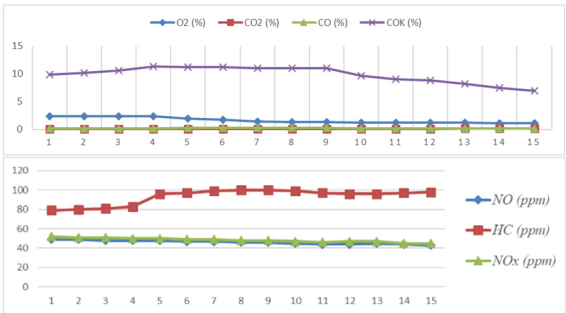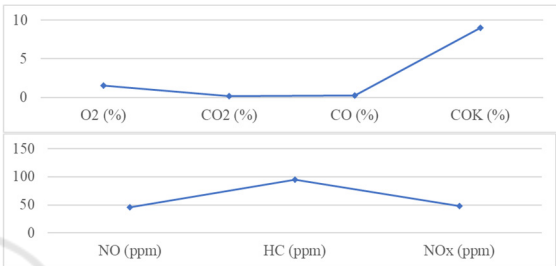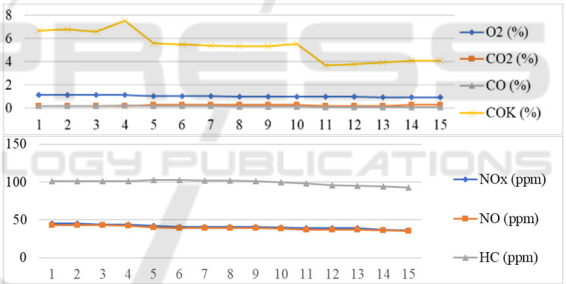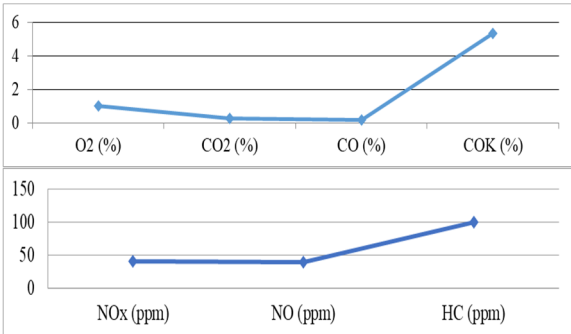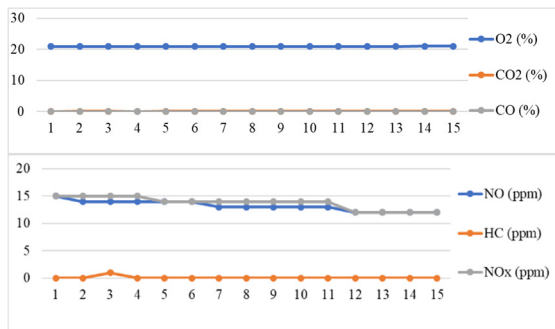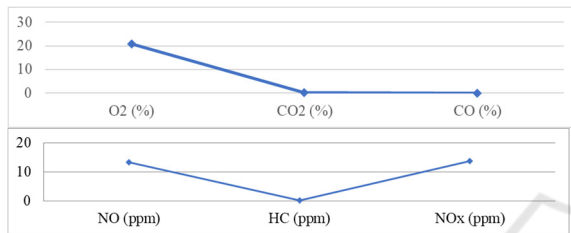Figure 22: Spark engine in salt mode, methane gas, average indicators.
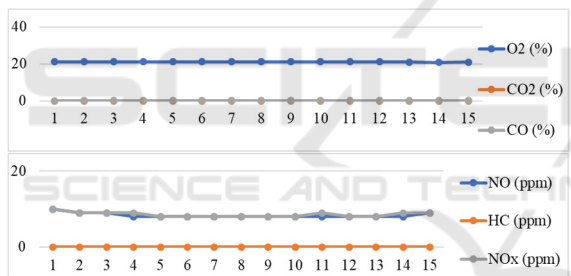

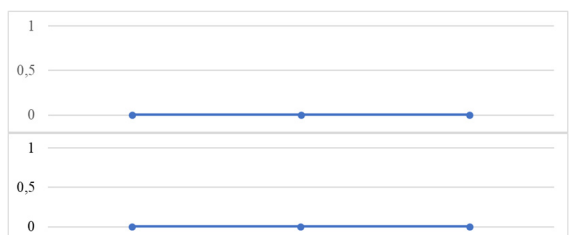Figure 23: Spark engine at 2500 rpm, methane gas, indicators.

Figure 24: Spark engine at 2500 rpm, methane gas, average indicators.

4 CONCLUSIONS

Indicators and analysis results obtained in the Kane Live program using Ai-95, Ai-92, Ai-80 gasoline, propane and methane gas in Tracker, Nexia, Spark car

engines using the Kane AUTO plus exhaust gas analyzer, i.e. CO_2, NO_x, NO - Spark, HC, COK - Nexia, O_2, CO – showed high performance in tracker engines Table 1.

Table 1: Average values obtained in the experiment

Toxic and harmful gases in the waste of ICE						
O_2	CO_2	CO	COK	NO	HC	NO_x
The amount of waste, toxic and harmful gases						
(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)
Tracker 2023 engine, Ai-95 gasoline, salt mode, X_{av}						
19.03533	0.26	0.13666	0	0	41.86667	0
Tracker 2023 engine, Ai-95 gasoline, at 2000 rpm, X_{av}						
21,008	0.28666	0.37666	0	0	11.5333	0
Tracker 2023 engine, propane gas, in salt mode, X_{av}						
15.49	0.593	0.129	3,292	0	70,73	0
Tracker 2023 engine, propane gas, 2000 rpm, X_{av}						
15,441	0.393	0.168	3,691	0	83.68	0
Nexia 2015 engine Ai- 92 gasoline, in salt mode, X_{av}						
1.09571	0.18571	0.17714	7.07357	39.785	38.0713	95.214
Nexia 2015 engine Ai- 92 gasoline, at 2500 rpm, X_{av}						
4.38	0	0	1.94066	16.4	15.7333	0
Nexia 2015 engine methane gas, salt mode, X_{av}						
3.93	0	0.173	16,644	369.92	353.21	14.64
Nexia 2015 engine methane gas, at 2500 rpm, X_{av}						
3,356	0.1	0.039	4,126	161.66	154,533	5.2
Spark engine Ai-80 gasoline, salt mode, X_{av}						
20.60	0.643	0.017	0	35,191	12.06	37.02
Spark engine Ai-80 gasoline, at 2500 rpm, X_{av}						
7.67	3,904	0.282	1,038	477.65	69,102	504.22
Spark engine methane gas, salt mode, X_{av}						
20.89	0.086	0.011	0	13.2	0.066	13.73
Spark engine methane gas, at 2500 rpm, X_{av}						
21,077	0.007	0.002	0	8,603	0	9.01

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