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Quality evaluation and pollution ranking of domestically produced cars

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A B S T R A C T

Today most countries, examine the problem of car pollution. They enacted laws to prevent environmental polluting cars. They also try to find out wither pollution standards are applied by car manufacturers or not. The purpose of this study is to rank domestically produced car quality based on manufacturing technology and exhaust emissions. Variables HC, CO, O2, CO2, and λ are analyzed for 10 selected car types, and results are presented with a box chart and finally, the considered cars are ranked according to the scored values. In practice, regarding the results of pollution variable, domestically produced cars can be ranked in terms of pollution quality parameters. According to the numeric range determined for each variable, a number is assigned to each car and finally, the average score is calculated for each car. In terms of pollution, car ranking help manufacturers focus more on certain cars to improve the quality of the car. The police can also use the results of this research to prevent the movement of cars that cause more pollution on polluted days.

1. Introduction

One of the major problems of large industrial cities is air pollution. Cars are one of the main resources of air pollutants. Cars also result in secondary phenomena like greenhouse effects. Today, most countries try to deal with cars pollution problem and legislate laws to prevent the environment from polluting car traffic. They also try to find out whether pollution standards are applied by car manufacturers or not [1].

Inspection and maintenance programs are important to evaluate air quality. Lack of maintenance of vehicles is an important source of air pollution. The vehicles that failed emitted up to 12 times more pollutants than those that were approved. Inspection and maintenance programs are very effective tools to reduce air pollutant levels and should be implemented and improved to get better air quality, making cities more sustainable [2].

Pollution examinations should be served as a tool for vehicle emission control. The examinations can indicate special problems and trends. The desired reduction in PM and CO emission values for appropriate vehicles. A worrisome increase in PM and CO emission values for inappropriate vehicles [3]. To control pollution, increasingly stringent regulations are being introduced worldwide to limit emissions of carbon monoxide, hydrocarbons, and nitrogen oxides. Searles etc. reviewed the techniques used and the complex relationship between control systems and engine performance [4].

Li etc. examined whether air pollution affects analyst information production by exploiting variation in air quality. Compared with other analysts, analysts exposed to air pollution are less

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likely to issue timely or accurate forecasts. Investors assigned a lower valuation to forecast revisions issued by analysts exposed to air pollution. The evidence suggested that air pollution jeopardizes analysts' ability to provide information to the capital market [5]. In other research, the causal relationship between China's fuel standards, which specify lower sulfur content, and air pollution was studied. They exploit a difference-in-differences design and regression discontinuity analyses. Evidence suggested the enforcement of high-quality gasoline standards significantly improved air quality. The results demonstrated the efficacy of precise standards in reducing air pollution in a developing country setting [6].

Technical examination has been introduced and spread as a set of rules, tests, and procedures with the use of specific equipment for each test. More than a half-century has passed since the beginning of the Technical examination plan and implementation in world developing countries.

1.2 Spark ignition engine pollutants and their reduction methods

The main pollutants result from spark-ignition engines are mostly carbon monoxide, hydrocarbons, and nitrogen oxides. In Figure 1, the contamination amount of these three major pollutants is showed as a function of dimensionless compression, for a conventional spark-ignition engine in a steady state. NO2, CO, and half of the total HC pollution is caused by engine exhaust gases. There are several ways to control these pollutions. These methods are not exclusive. Most cars use a number of these methods together. The most inexpensive and simplest method to minimize pollution is to change what happens in the combustion process [7].

1.3 Required data collection

Required data of this study has been obtained in Kerman technical examination center by random sampling of 3000 cars for 8 months.

This part includes an exhaust gas analyzer device and a computer for operator and Smoke analysis results displaying. The device used in this study was MGT5 and manufactured by MHMA from Germany, shown in Figure 2. The parameters of HC, CO, and CO2 are measured by the infrared spectroscopic method, and O2 is measured by the electrochemical method. Initially, the car is placed at a probe test location to test exhaust pollutants.

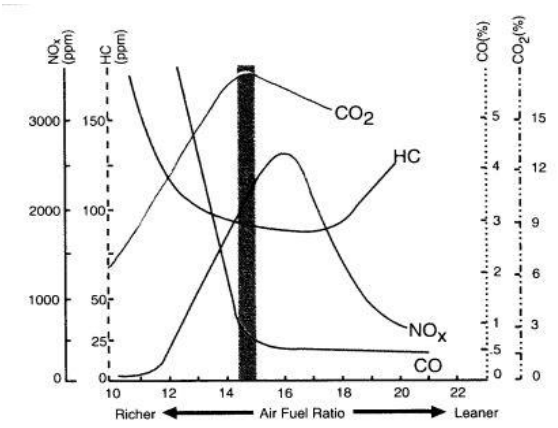

Figure 1: Concentrations of different pollutants and fuel consumption based on relative air-fuel ratio [8]

Then, the device is placed inside the exhaust. By selecting the car on a computer screen, the device starts to suck some exhaust smoke and send it to the analysis chamber. Smoke analysis results can be seen on the computer screen. Initially, the values shown are variable but will be almost constant after a few seconds.

Figure 2: The MGT5 device used in this research

2. Classification of statistical data

In this series, 10 types of domestically produced cars (Which are more produced) have been selected. Considering that carburetor car production stopped in 2003, so all selected samples are injection cars produced between 2012 and 2014. 2260 of these cars have been tested (Table 1).

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Table 1: Number of vehicles type

Vehicle	Num.	Vehicle	Num.
Peugeot 405	360	Mazda 3	80
pride	475	L90	290
Peugeot 206	312	Samand EF7	236
Mazda Pickup	118	Peugeot 207	180
Nissan pickup	112	Peykan pickup	97

In this Section, it is necessary to calculate a score for each car based on all measured parameters (HC, CO, O2, CO2, and λ). Sometimes these parameters' changes have a reverse impact on car score. For instance, cars with less HC amount obtain a higher score while the cars with a greater amount of CO2 will be rated higher. Therefore, the information in the tables needs to be re-encoded to bring together all high rating elements. To this end, each of the measured values is defined in Table 2 with new codes, based on each value importance and range of variation.

In practice, by new coding, the data will be examined more easily. Scores range between 5-22 with five very low, low, medium, high, and very high categories in Table 3, and each car is examined separately.

HC, CO, O2, CO2, and λ Variables have been analyzed for the 10 selected cars. Here is the full description of hydrocarbon variables and other variables are just discussed using box charts.

3. Results

3.1 Hydrocarbon variable description

Table 4 and Figure 3 indicate this variable description among other test cases.

In the following, the measured variables diagrams are shown in figures 4 to 7.

Table 2: parameters (λ, CO2, CO, HC, and O2) coding

parameter	Initial value(volume percentage)	score
λ	[1-1.1]	4
λ	(1.1-1.2)	3
λ	(0.9-1)	2
λ	(min-0.9)	1
λ	(1.2-max)	1
CO2	[16-max)	5
CO2	[15-16)	4
CO2	[14-15)	3
CO2	[14-13)	2
CO2	(min-13)	1
CO	(min-0.1]	5
CO	(0.1-0.3]	4
CO	(0.3-0.7]	3
CO	(0.7-21]	2
CO	(1-max)	1
HC	(min-50]	5
HC	(50-100]	4
HC	(100-150]	3
HC	(150-200)	2
HC	(200-max)	1
O2	(min-0.5]	4
O2	(0.5-1]	3
O2	(1-2]	2
O2	(2-max)	1

Table 3: Range of scores

Very low	(5-8)
Low	(9-12)
Medium	(13-16)
High	(17-30)
Very high	(21-23)

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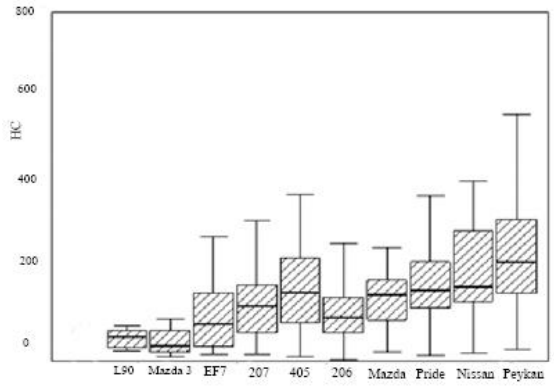

Figure 3: Hydrocarbon variable box chart

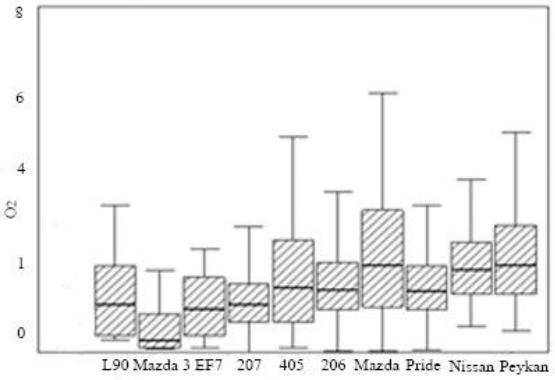

Figure 6: Oxygen variable box chart

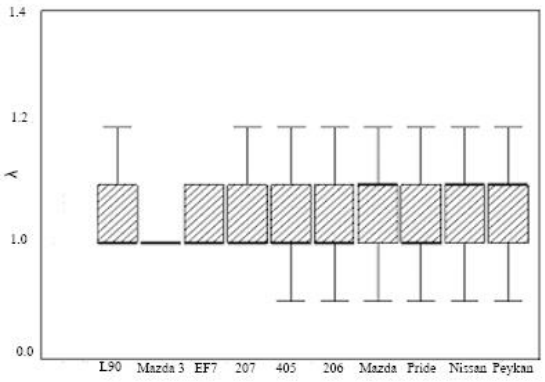

Figure 4: Box chart of concentration ratio variable

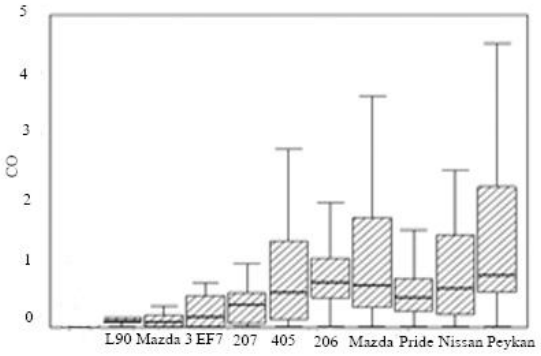

Figure 7: Carbon monoxide variable box chart

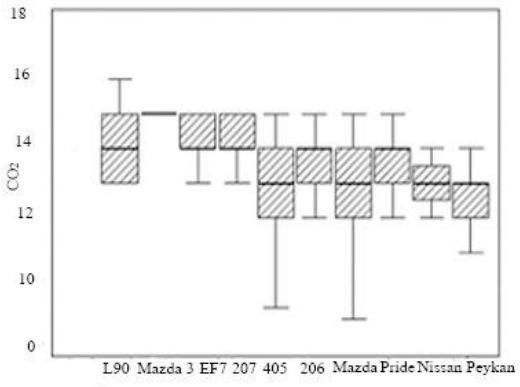

Figure 5: Carbon dioxide variable box chart

3.2 Classification of domestically produced cars

4. According to the results obtained from the previous section, domestically produced cars can be classified in terms of pollution quality parameters. According to the numeric range determined for each variable, a number is assigned to each car and finally, the average score is calculated for each car. By comparing these averages, domestically produced cars can be classified in terms of pollution quality parameters from best to worst (table 5).

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Table 4: Description of hydrocarbons variable among other test cases

vehicle	highest	Lowest	Standard deviation	mode	median	average
L90	204	18	62.64	18	56.5	75.16
Mazda 3	206	11	59.94	12	35	61.1
Samand EF7	286	16	74.25	48	85.5	100.85
Peugeot 207	410	16	107.66	33	126	144.43
Peugeot 405	615	11	118.82	112	157	171.53
Peugeot 206	1000	2.2	10.1.09	65	101	123.69
Mazda Pickup	975	20	121.4	151	151	157.51
Pride	826	14	137.89	97	162	197.48
Nissan Pickup	413	18	107.84	145	170	211.42
Peykan Pickup	1000	27	246.83	1000	229	305.59

Table 5: Classification of domestically produced cars based on pollution quality

Rank	Score	Vehicle
1	22	Mazda 3
2	20.22	L90
3	19.68	Samand EF7
4	19.36	Peugeot 207
5	17.42	Peugeot 206
6	16.87	Pride
7	16.21	Peugeot 405
8	15.92	Mazda Pickup
9	14.90	Nissan Pickup
10	12.60	Peykan Pickup

By evaluating the results, three aspects of the factors of superiority in ranking can be discussed:

1- Volumetric efficiency: It can be seen that the top 4 cars in table 5 are of the 16-valve type, which indicates the effect of volumetric efficiency on combustion quality and reduction of exhaust emissions.

2- Compression ratio: The results show that this parameter in the lower cars of table 5 starts from 7.8 and varies up to 9.8.

3- Production technology: Because the combustion process is severely affected by the fluid flow, the design of the combustion chamber and the inlet manifold play an important role in the quality of the combustion.

5. Conclusions

The purpose of this study is to rank domestically produced car quality based on manufacturing technology and exhaust emissions. Variables HC, CO, O2, CO2, and λ are analyzed for 10 selected car types. To keep themselves and others healthy, customers can pay attention to the car's pollution parameters when shopping and so manufacturers need to improve the quality of cars that are more polluting to satisfy customers. The police can also use the results of this research to prevent the movement

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of cars that cause more pollution on polluted days.

Among eleven of the examined cars that are scored based on the measured parameters. There is a total of 22 points, Mazda 3 with a score of 22 is at the top in terms of pollution quality. Peykan Pickup with a score of 12.60 is at the bottom. Results show that four cars Mazda 3, L90, Samand EF7, and Peugeot 207, that are ranked first to fourth, are all sixteen valve type. This shows the effect of volumetric efficiency on reducing exhaust pollutants.

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