MEASUREMENT OF CARBON MONOXIDE EMISSIONS FROM VEHICLES EXHAUST PIPE USING PORTABLE GAS DETECTOR

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ABSTRACT

Carbon monoxide (CO) contamination represents a major global concern. This study aimed to detect the concentration of CO, emitted from various vehicles exhausters which are important contributors in deteriorating air quality. The data was collected throughout the heavy parking period at Al- Jadyria campus in Baghdad University. The vehicles were classified into two main groups according to the type of gasoline they are filled with; including premium leaded and leaded free gasoline (PLG and LFG respectively), as well as engine size, odometer, brand and model. Seven low duty vehicles for each engine size (<1.6 to >2.0) liter were selected randomly. A portable gas detector type (Altair® 4X) was used to measure exhausted emission of CO during idle mode. The results showed that high mean levels of CO (206.111–939) ppm were observed within vehicles filled with PLG. In contrast, the vehicles filled with LFG had been detected with an observable decline (9.5714–21.5714) ppm. Also, a significant difference in gas concentration between fuel types was observed within various engine groups. This study recommended controlling these emissions and raising the concern of the government about the gasoline quality due to their adverse impact on human health and environment.

Keywords: Air quality, noxious gases, gasoline type.

قياس غاز اول اوكسيد الكاربون المنبعث من عوادم المركبات باستعمال كاشف غاز محمول

حسنين عبود حسون

مدرس

قسم علوم الحياة، كلية العلوم، جامعة بغداد، بغداد، العراق.

المستخلص

يمثل التلوث بغاز اول اوكسيد الكاربون مصدر قلق على مستوى عالمي. هدفت هذه الدراسه الى الكشف عن تركيز غاز اول اوكسيد الكابون المنبعث من عوادم المركبات المختلفه و التي باتت تشكل المساهم الاهم في تدهور نوعية الهواء. جمعت البيانات خلال فترة الذروه للساحات المخصصه للوقوف ضمن المجمع العلمي لجامعة بغداد الكائن في منطقة الجادريه. صنفت المركبات الى مجموعتين رئيسيتين طبقا لنوع الوقود (الغازولين) المعبئه به و الذي تضمن الوقود الحاوي و الخالي من الرصاص . فضلا عن حجم المحرك و عداد المسافات و الماركه و سنة الصنع. اختيرت سبعة سيارات بشكل عشوائي لكل فئة محرك و التي تراوحت بين اقل من 1.6 و الى اعلى من 2.0 لتر, تم استخدام جهاز محمول كاشف للغازات لقياس الانبعاثات من عوادم المركبات في حالتها الخامله. بينت النتائج ان اعلى مستوى لمتوسط تركيز الغاز و الذي تراوح ما بين (206.111–939) جزء بالمليون كان ضمن المركبات المعبئه بالوقود الحاوي على الرصاص, في حين اظهرت تلك المعبئه بالوقود الخالي من الرصاص انخفاضا ملحوضا في المتوسطتراوح ما بين (21.5714–9.5714) جزء بالمليون. كذلك فان فروق معنويه في تركيز الغاز قد ظهرت بين نوعي الوقود ضمن فئات المحركات المختلفه. ان هذه الدراسه تقترح السيطره على هذه الانبعاثات و زيادة الوعي الحكومي تجاه نوعية الوقود نتيجة لتأثيره السلبي على صحة الانسان و البيئه.

الكلمات المفتاحيه: نوعية الهواء, الغازات الضاره, انواع وقود الغازولين.

INTRODUCTION

The concept of air quality is becoming a common concern in the society. Environmental pollution, particularly its aerial component, is one of the top problems which should be taken more seriously. Its harmful effect on human health and require a quite understanding than those of any other pollutants (21). Controlling of these pollutants represented a valuable step to reduce the levels of noxious gases in the atmosphere (5). Vehicle exhaust emissions are considered as the main source that rising gas levels especially in large urban cities with high traffic congestion (21).Emissions from internal combustion (IC) engine are responsible for about 70% of the most undesirable gases such as carbon oxides (COx), nitrogen oxides (NOx), sulfur dioxide (SO_2) and hydrocarbons, moreover their influence exceed the heat sources by double(2). In addition to transport, industrial products and other anthropogenic activities are leading to an increase in smog and toxic odors which classified as the main contributors in global warming, combined with unfavorable weather conditions (6). Several growing countries have a negative impact of urban road traffic at noise levels and air quality (12). At present, the continuous increase in the numbers of vehicles and ambient makes the scientific community focused on how to protect environment (19). Many researchers in the 21st century try to generate new technologies which might help in improving the atmosphere (25). According to the latest reports, carbon monoxide (CO) occupied a major position among various gases deteriorating the air quality (5). Automobile emissions are responsible for more than 97% of CO in urban centers that need to justify the world concern about this affliction (5). CO is a by-product of the partial burning of organic compounds and reported as the main effluent from leaded fuel combustion (18). Approximately one-third of gas poisoning cases belong to direct exposure to carbon monoxide, due to its lack of taste, odor and color (22). In general, CO is heavier than air, thus can facilitate the rapid accumulation and atmospheric retention even in a well ventilated confined area (2). Occupational hazards assessment for taxi drivers, traffic policemen, operators at petrol filling stations and car wash employers revealed an association between high CO blood level and continuous contact with vehicle emissions (26). It becomes clear that fumes emitted from motor vehicles exhaust with their strong smelling as gas or vapor are responsible for highly percentage of accidental toxic gas poisoning (3). In addition, long period reaching to several weeks, is required to develop symptoms of CO poisoning to be noticed (17). Such side effects combined with high COHb levels that might be detected in more than 10% for these occupations (13).Hence, these facts ensure its relevance to many chronic diseases in this cohort of people. According to general traffic directorate index for year 2017 more than 2.1 million vehicles are found in Baghdad city with daily gasoline consumption reached to 7.2 million liters. All these events will exacerbate city roads, increase the congestion states and deteriorate air quality. Therefore, this study aimed to measure CO emitted from vehicle exhausters as an attempt to perform an index for this pollutant and given awareness from long-term exposure, due to future scenario proposed a current development of automobile number in Baghdad city.

MATERIALS AND METHODS

The samples were collected from parks located at Al- Jadyria campus during the year 2017. All car owners were informed about the aim of this study and their consent was obtained as study participants. The study was conducted on the first morning, the period that parking vehicle is the heaviest. The cars were classified according to engine capacity (size) which is divided into below 1.6 Liter (L) (1600 CC) (Cubic Centimeter) to up to 2.0 L (2000 CC). Seven different vehicles from each engine size were tested to cover all the possible models and origins. Both manual and automatic transmissions were represented in the samples. Samples were collected during emissions when the vehicles at an idle state (the period after starting and engine rotations (Rotation per Minute) (RPM) below 1000 (speed 0 Km/h). The models ranged from (2008-2017) and the odometer (ODO) which mean the cruising distance (Km) was also considered. The type of fuel was also included

in the criteria selection, so the vehicles were divided into two groups according to the fuel (gasoline) they filled with: including premium leaded and leaded free gasoline (PLG and LFG respectively). Portable instrument model (Altair® 4X) designated for measuring CO levels was used as the main device for vehicle exhaust emission testing. This gas detector is made by (MSA safety company), USA, with recent calibration. About 10min was a stable period for the instrument to be put proximity to exhauster without any alteration in vehicle state (4).The same period was used to keep engine warming up (11). Several automotive brands were chosen due to their high distribution in Iraqi markets, including Toyota, Nissan, KIA, Hyundai, Chery, Geely, Samand, Peugeot, and Saipa. Before commencing the study, the instrument automatically zeros itself and routinely during data collecting. The zeroing was done by the measurement of ambient air away from exhauster that is believed to be free of significant levels of CO (4). In contrast, some information was gathered by questioner related with the last time in it the spark; engine oil and air filter had been replaced. Statistical analysis, data was analyzed and displayed using Graph Pad (v6) and significance was determined using two-way ANOVA test analysis, depending on data normalcy.

RESULTS AND DISCUSSION

The transportation system in developed nations means reached a balanced position between provides and need (20). Traffic density affected by the number of vehicles due to their direct relationship, particularly when new vehicles entering the transportation system (24). This continuous entrance reduced the spaces and increased the interference among vehicles, subsequently, the traffic flow would be changed, and the roads become full (24). These conditions cause a reduction in vehicles speed that warrants the detecting of exhaust emissions at idle position. As mentioned before, data were collected during (November and December 2017) and the collection was carried out in the early morning when the sunlight at a minimum and the presence of other pollutants can be ignored (5). The concentration of CO in the ambient was recorded about 5 ppm and the air temperature was also documented which ranged between (16-26) ºC throughout the study. Daily weather condition was reported with an assistance of the national metrological service. The vehicles were classified into two groups, the first elucidated CO concentrations emitted from those filled with premium leaded fuel whereas the other for those filled with leaded free, and both are at idle state. The results showed a high CO level for PLG reached to a maximum which recorded (939 ppm) whereas the lowest is (206.111ppm) at 1.8 and 2.0 L engine groups respectively with odometer rate (13000-120000) Km. In contrast, a decline in CO levels (table 1)for vehicles filled with LFG. The maximum level reached to (21.5714 ppm) while the lowest showed an interesting level (9.5714 ppm) at 1.6 and 1.8 L respectively with odometer rate (15000-100000) Km as compared with the first group.

Table 1.Carbon monoxide concentrations (ppm)represented as (mean±SD) for vehicles filled with leaded and free leaded fuel

Engine size / Liter	CO emissions concentration (ppm)		Mean ± SD
	PLG	**LFG**	
Less than < 1.6	630.714	15.2857	mean
	132.665	3.3926	standard deviation
1.6	814.571	21.5714	mean
	252.289	7.71479	standard deviation
1.8	939	9.5714	mean
	305.075	2.64447	standard deviation
2.0	206.111	19.7143	mean
	43.6375	7.41849	standard deviation
More than >2.0	667	20.8571	mean
	235.047	3.64122	standard deviation
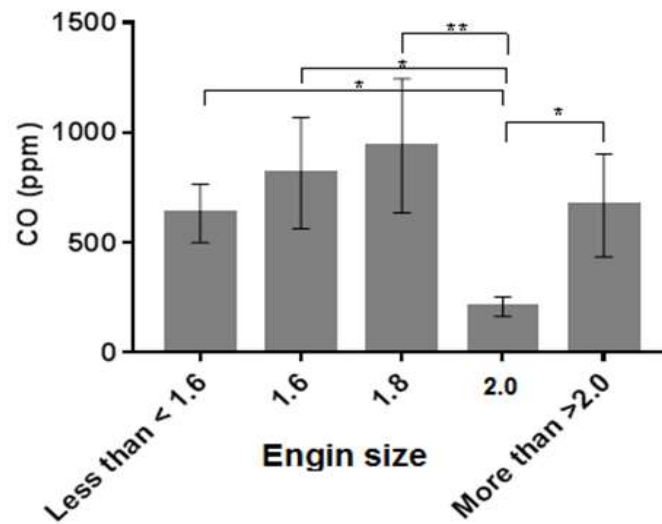
Figure 1.Mean concentration (ppm) of CO emitted from vehicles filled with PLG *(p≤0.05), * (p≤0.01)**

Significant differences (p≤0.05) are scored among engines with size <1.6, 1.6, 2.0 and >2.0 L. While, a high significance variation (p≤0.01) was found between 1.8 and 2.0 L. However, the measurement of the emissions from vehicles at idle position (zero speed and zero acceleration) may be different than those measured during the acceleration. Previous studies suggested that CO emissions during idle are lower than acceleration. The explanation of this situation related to fact that more quantity of fuel had been injected at acceleration which resulting in high fuel combustion as well as more exhaust products (11).Despite this fact, the researchers instead postulated that how those kilometers are traveled is more necessary than the period of the trip (4).Many factors affect the engine functions for example, high acceleration, driving behavior and the duration of both cold start even to high enrichment operation that reflect adversely on total emissions regardless of vehicles cruising distance, model and origin (16). The using of portable instrument represented an active and relatively low-cost method like that developed by Vojtisek- Lom, and Cobb (23), when they used equipment aimed to assess shuttle bus emissions at Pittsburgh University. Therefore it's important to develop and deploy procedure for obtaining on-road quantity through the actual users to enhance prospective management of air quality and identified the hot spots in order to improve traffic signal coordination and timing in large cities (4). Figure 2 indicated significance of variation (p<0.05) among different engines size except of group <1.6 L.
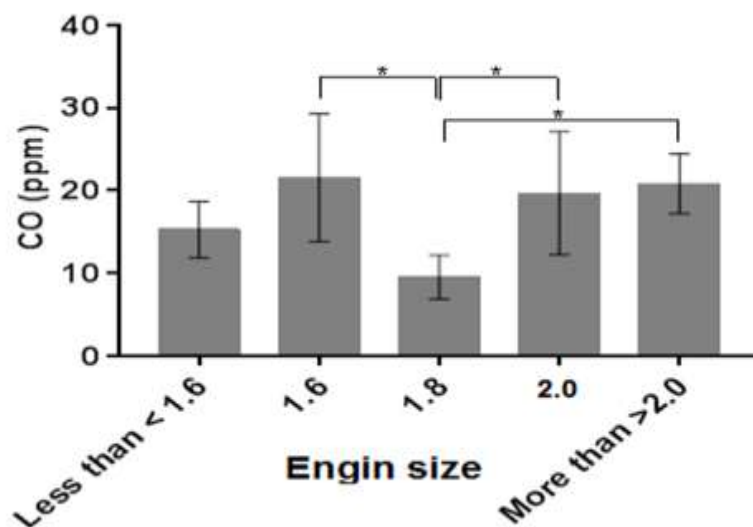
Figure 2. Mean concentration (ppm) CO emitted from vehicles filled with LFG *(p≤0.05)

A majority of modern vehicles equipped with catalyst; after only one tank of leaded gasoline a rapid decline in its performance will occur steadily. According to Michael(15) EPA performed an experiment using five vehicles provided with catalytic converter, each vehicle refueled ten times with gasoline contain 0.28 g/L of lead , the result revealed that CO emissions were nearly three times more than the original levels. Figure 3 showed no significant differences are observed among vehicles with engine size below 1.6 and 2.0 L respectively. The analysis of variance illustrated significant differences ($p \leq 0.05$) for vehicle groups (1.6 and more than 2.0) L. Similarly, statistical analysis indicated a significance of variance ($p \leq 0.01$) within group 1.8L.
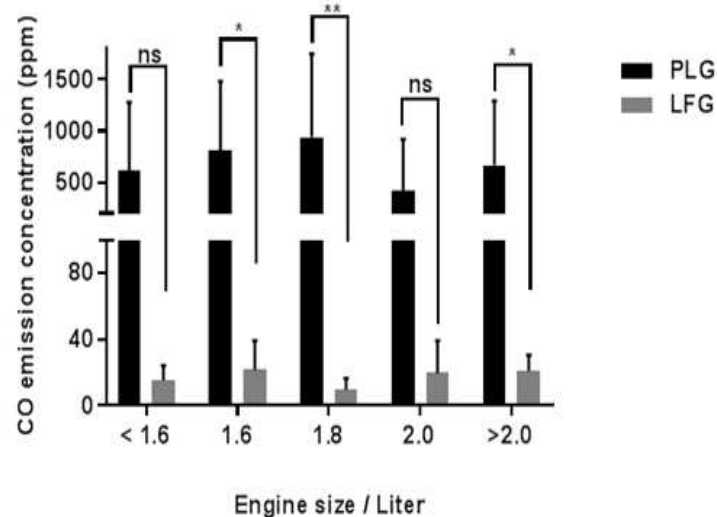
ns: no significant; *:$p \leq 0.05$; **:$p \leq 0.01$
Figure 3.Mean concentration (ppm) of CO emitted from various engine groups

Hajderi and Vyshka(7) analyzed the combustion process; they found that higher temperature is generated at loaded mode as compared with idle (no loaded); due to this variance the CO emissions at idle state would be lower. This is consistent with study of Kadhim and Adhas (11), who noticed a high gases rate at 50ºC as compare with 45 and 40ºC, this due to direct correlation between combustion temperature and gas concentration in exhauster. Continuous renewable of air filter provided the mixture air / fuel with sufficient amount of oxygen ,therefore improper rate for burning of fuel mean that oxygen is insufficient to oxidize all carbon and it will result a high value of noxious gases (8). Collectively, these informations can be used to control engine performance which is affected by many criteria such as type of fuel, spark ignition, and purity of air filter. Recently, the government efforts are focused on reducing the use of tetramethyl and tetraethyl lead as an anti-knocked. Instead one ring aromatic hydrocarbons were added to maintain this purpose in LFG (9). The results obtained from this replacement indicated a high concentration of poly aromatic hydrocarbons (PAH) which classified as probable or possible human carcinogens especially the risk of leukemia (10). Unavailable techniques necessary to examine these compounds represent an alarm against LFG to be used with caution especially it's imported from other countries, which don't adopt the same environmental protection standards. The lead industry argument is about benzene and aromatics incurred by old vehicles had not equipped with catalyst that destroy 90 to 95 percent of emissions in the exhaust stream (14). Overall, evaluation the pipe emissions from internal combustion engine with fuel injection system is a difficult task facing by contradictory legislation world around and required a sophisticated work to mange reliable measurements (1). More over the upgrading octane value by gasoline oxygenation within refining processes can produce final product with considerable reduction of harmful CO emissions (14). In general, the challenge of improving the air quality conflicted with increased number of vehicles in our country, consecutive checkpoints scattered on roads and bad behaviors of drivers are the main contributors

to total emissions. In recent years a concept developed in the world wide about how to deploy or at least control burned engine emissions. In this study portable instrument is used for measuring the emissions of gases from vehicles exhaust pipe in order to detect the amount of harmful gases. The analysis of gases at idle position it seems that vehicles filled with PLG greatly contributed in CO levels as compare with those filled with LFG. Consequently, this study represented an attempt to investigate the accurate levels in vehicles with various engine sizes at no loaded mode and given awareness to its influence on public health. Therefore, further studies are needed for exact measuring and other loaded and accelerated modes should be incorporated.

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