Research of Organic Pollutants Detection in the Roadside Soil at the Suburb of the North China

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Abstract. With the development of society and economy, more and more automobile and vehicle run in the various roads. Car tail gas can not only pollute the air, but also can still result in the pollution of soil and ground water even underground water. Soil pollution coming from car tail gas is investigated in detail by experimental detection by Geofina Hydrocarbon Meter (GHM) made in Norway in this paper. Experiment samples are collected from thruway and highway side, and the organic pollutants of the samples are analyzed by the GHM instrument. Experiment shows that various kinds of organic pollutants are found in the samples, such as 14 species normal alkanes, 25 species aromatics, 13 species hetecycle compounds and 9 species phenols and so on. The characteristics of organic pollution resulted from car tail gas in the soil are obtained by detection analysis. The soil pollution caused by car tail gas has heavy toxicity to human being and the natural environment. Consequently, organic contamination in the soil by the tail gas can’t be neglected. The relevant investigation should be made so that some precautionary and cure measures may be proposed as soon as possible.

1. Introduction

With the development of society and economy, the instant development of vehicle industry, the output of cars is increasing rapidly, all these factors make the contamination of vehicle emission more serious, it is compared to “inmaterial killer”, and become one of the fearful public nuisances which hazard the sustainable development of entire society [1-5]. The vehicle tail gas pollution due to it contains not only inorganic contaminants such as flue dust, Pb, NOx, CO and SO2, but also indispensable organic pollutants. Various vehicle discharges contain many kinds of organic compounds which have the characters of fatsoluble, particulate, persistence and may result in various diseases, for instance, cancer, malformation, and gene mutation, and their toxicity is severe [6-9]. On the other hand, the vehicle emissions may cause some environmental pollution, for instance, air, soil, surface water and even ground water [10-13]. It is to be noted that many poisonous organic pollutants may be resorted in the soils over a long period of time, and they are gathered and magnified by the form of the food chains, and then they may harm the health of animals and humanity. The vehicle discharges may even cause terrible environment disaster when the organic contaminates are accumulated to reach a certain extent [14-19]. Therefore, vehicle discharge pollution is threatening human multiply and survival, and they bring severe destroy to natural biomass and the ecological environment. The organic pollutions of the soil environments at the roadside and highway resulting from vehicle emission have been attended by relevant scholar [20-22]. The organic pollutants in the soils are detected and studied [23-24]. In this
paper, the pollution characteristics of vehicle discharges are studied by means of detecting quantitatively and qualitatively for the organic pollutants in the roadside soils at the suburb of the north China. This research may offer technological support for the methods and routes to resolve the organic contamination of vehicle tail gas, then achieves verily the sustainable development of human society and environment. Obviously human live and the development of society can not without vehicles, so we must reduce the damages to the natural environment to minimum.

2. Experiment

2.1. Samples
The research samples are collected from the roadside soil in one city of Heilongjiang in China, and then they are sent back to the laboratory in time for weighting and pretreatment. The soil samples are spread into a lamella about 10mm on a piece of clean thick paper, and the plant roof and other sundries are removed, then they are kept in the shade and out of the sunlight in order to natural air drying. After the drying, let the soil samples through stainless wire net mesh screening to obtain three kinds of samples of different particles: 65–80 mesh, 80–100 mesh, >100 mesh. The samples are put into amber glass bottles respectively, and the samples are labelled for using. The detailed sampling places of the soil samples I–VI for the research are shown in figure 1. Sample I and II are collected from the soil beside trunk roads in the city, sample III and IV are collected from the soil at the entrance and exit of highway toll station, and the sample V and VI from roadside soil in a common road from the city to another, and its condition is very bad and accidented, on the side there are some eroded pits on the road surface, thus the speed of vehicles run is low generally. The soil samples (eg. Sample I) of three different granularity, such as mesh 65–80, 80–100 and >100, are marked as I-1, I-2 and I-3 respectively.

2.2. Analysis instrument and method
The main analytical instrument used in the analytical experiment is the Geofina Hydrocarbon Meter (GHM) made in Norway Geolab [25-26]. The GHM is mainly composed of five parts: the main engine of GHM, the temperature controller of GHM, the GC separating system, the data-collecting system, and the computer managing system. The three GHM detectors are all hydrogen flame ionization detectors (FID A, FID B, FID C), the high purity helium gas is used as carrier gas in the whole detecting process. The exit pressure of high pure hydrogen was 0.26MPa, and the constant pressure of air compressor was set to 0.6MPa. The carrier gas was helium whose exit pressure was 0.4MPa and the pressure ahead of column was 0.06MPa. The pressure gauge of pre column carrier gas denotes 8.5psi (Pounds per Square Inch, 1psi= 0.007MPa). The chromatographic column is OV-1032d high springy quartz capillary column with the length of 25 meters. The velocity of helium going through

![Figure 1. Sketch map for sampling places of the soil samples.](image-url)
the chromatographic column was 0.85 ml/min. In the whole experimentation, sample injection, detector, and auxiliary parts of the instrument were set to the same temperatures (300°C). The initial temperature of quantitative analysis was set at 100°C, and then the temperature was increased to 300°C at the rate of 40°C/min and kept for two minutes. Under the condition of the organic compounds in the soils can’t be pyrolyzed in the experiment, the experimental program are controlled to make organic components in the soils may be volatilized out of the samples. The products of thermo-evaporation were carried by carrier gas to FID C and FID B respectively, then they were detected quantitatively and qualitatively. The ratio of gas distribution between FID C and FID B was 30:1. The temperature of column oven was initially set at 30°C. Then it was raised at the rate of 4°C/min to 300°C and kept for 20 minutes until the experiment was finished.

By the above experiment, the reference material such as n-enndecane, p-methyl phenol, triphenylmethane, benzopyrene are used in the qualitative analysis for test specimens, by the means of internal standard method, external standard method and retention time method. The Haicheng mudstone GB standard sample is used in the quantitative analysis for test specimens. The quantity of organic matter corresponding with per unit peak area is constant if only analytical constitutions of the instrument are invariable during the process of analysis quantitatively. So based on quantitative analytic results of standard samples, analysis quantitative constant (B) is calculated. In the above experiment standard sample is Haicheng mudstone in which the organic matter content is 6.78mg/g. When the sample is filled 8.79mg, quantification peak area is 1.73×10^8μv·s, so quantitative analysis constant B is:

\[ B = \frac{8.79 \times 6.78}{1.73 \times 10^{13}} = 34.45 \times 10^{-13} \]

Then the amount of organic matter (M) in actual unknown samples can be calculated using the following formula:

\[ M = \frac{B \times A_i}{\triangle W} = 34.45 \times \frac{A_i}{\triangle W} \]

Where, \( A_i \) is the area of quantitative peak in actual samples, 10^8μv·s; \( \triangle W \) is the real weight of experimental samples, mg.

Under general conditions, if the unit of sample quantity using mg, the unit of quantitative peak area of sample is 10^8μv·s, so the amount of organic pollutants can be calculated depending on above formula directly, mg/g.

3. Analysis results and discussion

3.1. Quantitative analysis characteristics

After three kinds of different particle samples: 65~80 mesh, 80~100 mesh, >100 mesh are analyzed by GHM, quantitative analysis results of organic pollutants in the soil samples are obtained. The detection results indicate that, the content characteristics of organic pollutants in the different particle soil samples are shown in figure 2. It shows that the amount of organic pollutants in the sample III and IV near the toll station at highway entrance are obviously higher than sample I and II which near the trunk roadside and sample V and VI nearby the common road between the city and the other one. In addition, the analysis data in the Figure 2 shows that change characteristics of organic pollutant content in the different particle samples have good regularity, along with the mesh number of the sieve increasing, the organic pollutant contents in same soil sample increase gradually, and the size of soil particles is inversely proportional to organic pollutant content. First reason is vehicles always stop at the entrance and exit of highway for charge in the toll station, vehicle tail gas was ejected too much, and may result in the phenomenon of the fuel burning incompletely, so the content of organic pollutants in the sample III and IV are higher than other samples. In addition, vehicles eject organic pollutants due to the fuel is not all combustion completely and the temperature is low. These pollutants are a high divergence, suspended solid particle, it is easily to be adsorbed to the fine soil which has large surface area, so organic pollutants are rich in fine soils.
3.2. Qualitative analysis characteristics
The qualitative analytic result for organic pollutants identified in the samples could be classified into 61 kinds and 4 types: paraffins or normal alkanes, aromatic hydrocarbons (monocycle and poly-cycle), heterocyclic compounds and phenol compounds; of which are 14 kinds of paraffins, 25 kinds of aromatic hydrocarbons, 13 kinds of heterocyclic compounds and 9 kinds of phenol compounds. The average contents of four kinds of organic pollutants in the soil samples are showed in figure 3. The results indicate that organic pollutants in the samples are mainly paraffins, aromatic hydrocarbons in the next; and the content of heterocyclic compounds and phenol pollutants are low, and that phenols is more than heterocyclic pollutants. On the other hand, the analytic results show that paraffins content in sample II is lowest in the samples, and the contents of paraffins and aromatic hydrocarbons are higher in sample III and IV than in the other soil samples.

It is especially noticed that the aromatic pollutants concentrated in the roadside soils are mostly polycyclic aromatic hydrocarbons (PAHs) and the content of monocyclic aromatics is lower by the GHM analysis of the relative distribution characteristics of organic pollutants in the samples (Figure 4). Furthermore, the PAHs have seriously effects to cause “cancer, malformation, and gene mutation”, and then their environmental and biology toxicity is extremely severity. So the damage and toxicity to the nature and human being increases greatly, which is caused by vehicle emission. It is obvious that the contamination caused by vehicle discharge is indispensable, and it should be cured and solved in time.
4. Conclusion
It is demonstrated that the different kinds of organic pollutants, such as paraffins, aromatic hydrocarbons, heterocyclic compounds and phenols are contained in the roadside soils in the city by GHM detection and analysis. The characteristics of these organic pollutants ejected by vehicles running on the roads and highway as follows:

(1) In the section of the entrance and exit of highway toll station, bad condition of the common road from the city to another, the content of organic pollutants is higher than the other sections in the roadside soils due to much more vehicles discharges.

(2) Organic pollutants are easily concentrated in the fine soils in the roadside samples.

(3) The components content of the organic pollutants in the roadside soils descend in turns: paraffins> aromatic hydrocarbons>heterocyclic compounds and phenols.

(4) The mainly component distribution in paraffins is in the range of C₁₅~C₁₈, the peak carbon is C₁₆ or C₁₇. The odd-even predominance of the paraffins isn’t obvious in the analysis figures.

(5) The vehicle emissions make the PAHs are concentrated in the roadside soils. The organic pollutants of PAHs have “three causes” and have serious toxicity to the nature environment and human health.

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