Applied research in volatile organic compounds (VOCs) emission from asphalt pavement

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Abstract. Volatile organic compounds (VOCs) volatilize in quantity during production and application of asphalt. The VOCs will not only cause environmental pollution, but also affect the properties of the pavement. Therefore, the VOCs emission from asphalt pavement is a very worthwhile concern. A brief review concerning VOCs from asphalt pavement, effect of VOCs and measures to mitigate VOCs emission is presented.

1. VOCs from Asphalt Pavement

As the main raw material of road construction, asphalt is composed of different hydrocarbon and its derivatives, which has complicated species and different chemical stability, acting as anticorrosion, water-proof and adhesion [1, 2].

Yu [3] established the VOCs generator device and studied the effects of VOCs emission on the performances under different conditions focusing in non-high temperature environment. Results shows that quality reduced at high temperature while the situations was complex at the temperature less than 70 °C. The quality loss at high temperature call represent VOCs emission capacity, while different conditions take different impacts on the different asphalts at non-high temperature environment. The component change test, DSC and FT-IR test were used to study the microscopic properties of the asphalts before or after VOCs emission, mainly focusing on non-high temperature environment conditions. The total contents of aromatics and saturates reduces after VOCs emission and there is the minimal reduction in Vacuum condition. DSC data show that the arrangement of asphalt molecules become larger and neatly, and the compositions may change in the experiment temperature range decrease. Infrared spectrum tells that there is little change in peal position in non-high temperature emission condition, but some change in peak area mainly in the decline of the alkane portion. In high temperature emission condition, alkane absorption peak significantly weakened and the components of aromatics and saturates considerably reduce. The functional group index, C=O and S=O, in non-high temperature emission condition was also studied, results show a decline slightly in Vacuum condition while increase in infrared and ultraviolet conditions, and the variation of C=O is larger.

Actually, there are not many researches on asphalt VOCs particularly on the components of VOCs, in that qualitative and quantitative analyses are quite difficult for the small quantity, various species and dynamic activity. One of the difficulties in research is that complicated components and lean density of VOCs require more accurate and extensive apparatus. The other is that the open fields on which asphalt is paved change a lot, which adds to the difficulty for gathering VOCs. Therefore, it’s crucial to seek
out rational qualitative-quantitative analysis methods and VOCs analysis instruments which can simulate construction site in the lab, in order to decrease the emission and develop effective asphalt VOCs inhibitor.

2. Effect of VOCs

Great attention has been paid to VOCs due to its environmental pollution and great harm to human health. The asphalt call produce volatile organic compounds in ambient temperature and pressure in the service process, and high temperature or infrared, ultraviolet may promote the release of VOCs, leading to the deterioration of its performances and reducing life expectancy which increased the consumption of resource and energy [4].

VOCs coagulates in the air as gas, aerosol and particulate matter, resulting in serious pollution. There are abundant research manifesting that benzo pyrene, anthracene naphthalene, acridines, pyridines and phenols in over 100 kinds of components of asphalt would create great damage to human health [5].

3. Measures to Mitigate VOCs emission

Cui et al. [6] developed the inhibitors and an innovative way in asphalt VOCs qualitative and quantitative analyses. They applied some modern analytical techniques such as TG-MS coupling technique to analyze components of asphalt VOCs and the content of specific constituent. The result not only reflects the inhibitor’s effect on asphalt VOCs, but also proves that TG-MS coupling technique is qualified to make qualitative and quantitative analyses on asphalt VOCs, estimate effects of different inhibitors and supply simple but valid criterion to develop inhibitor.

In the research of Wang [7], the compositions of the leachate of the chemical constituents in asphalt were investigated with the GC/MS analysis. The results showed that the nitrogen content of leachate is different from that of asphalt binders, but the sulphide in the asphalt constitutes and leachate chemicals has the same rule. That is because the air-oxidizing and modified asphalt is much hard and them system are complex. So they have low leaching quantity at present experiment condition.

New material with no or less VOCs have become a hot research topic, and emulsified asphalt added proper modification agent has a more superior performance [8]. Hui [9] found that there was low VOCs content in an epoxy resin emulsifying asphalt in which the epoxy resin is dispersed in the form of particles or droplet and using water as a dispersion medium. Chen [10] added waterborne epoxy resin with low VOCs content into emulsified asphalt and got a composite emulsion, which can significantly improve the cohesive force.

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