

A SYSTEM FOR ASPHALT FUME GENERATION

Sam Stone, Travis Goldsmith, Ali Afshari and Dave Frazer

Centers for Disease Control and Prevention, National Institute of Occupational Health and Safety,
Health Effects Laboratory Division, Engineering and Control Technology Branch, Morgantown,
1095 Willowdale Road, Morgantown WV, 26505

ABSTRACT

There is concern during road paving operations over the potential adverse health effects from exposure to asphalt fume. In order to study this problem a system was developed to expose small laboratory animals to a precisely controlled concentration of asphalt fumes. The fumes were generated as asphalt flowed over a heated metal plate and were entrained in heated conditioned air, which passed over the plate. After passing through the generator, the fume entered the exposure chamber through a heated pipe. The mass concentration of the fume aerosol within the chamber was estimated with a light scattering device and was used to control the amount of heated, conditioned diluent air that was added to the fume to maintain its concentration within desired limits. A second feedback system used a computer controlled needle valve to regulate the flow of asphalt across the metal plate. Additional control systems were used to sustain constant airflows and temperatures throughout the system. Specialized software was developed to continuously monitor and record temperatures, gas flows and fume concentration within the system for analysis. Laboratory generated asphalt fume was shown to be similar to field fume in terms of chemical composition.

MATERIALS AND METHODS

The asphalt fume generation system, shown in Figure 1, was designed to simulate the road paving process. The oven (Grieve HX-500) is capable of heating three five-gallon buckets of asphalt to a temperature of 170 °C in two and a half hours. Liquid asphalt flowed into a custom storage pan in the bottom of the oven as it heated. Asphalt temperature was maintained with a single on/off temperature controller and two 500 watt heaters attached to the pan. An asphalt pump (Roper 34AM01), coupled to a 1 HP motor (General Electric 5KCR48UN0102X, @1725 RPM), transferred the liquid asphalt from the pan to a specially designed bitumen kettle. This pump transferred up to 15 gallons of asphalt in under ten minutes. The plumbing between the pump and the kettle was wrapped

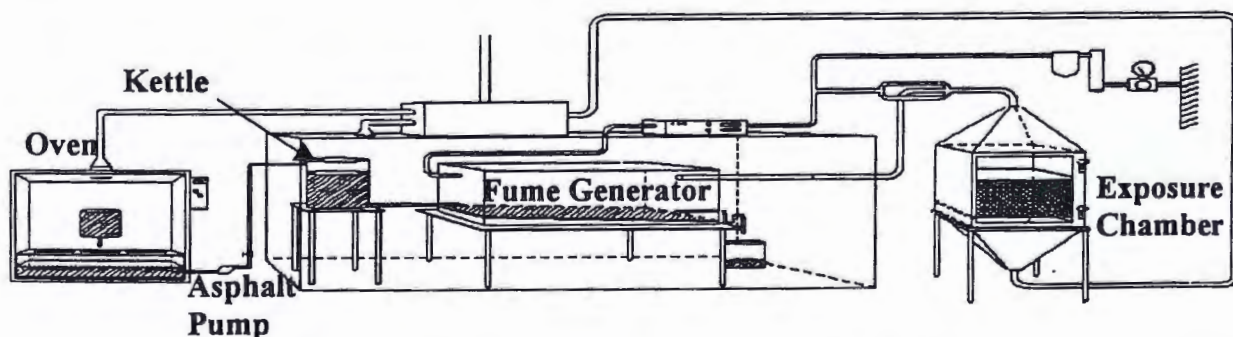


Figure 1: Block Diagram of the Asphalt Inhalation System

in 500-watt heat tape to prevent the subsequent cooling of the liquid asphalt. An ultrasonic sensor provided feedback of the asphalt level in the kettle to prevent over-filling. The purpose of the kettle was to maintain a smooth flow of asphalt across the fume generator. A much more consistent asphalt flow was obtained by pumping into the bitumen kettle, rather than directly controlling the asphalt pump. Asphalt from the bitumen kettle flowed through a needle valve which was part of a computer feedback system used to regulate asphalt flow. Next, the asphalt entered the stainless steel generator chamber where it spread over a rectangular plate (6" x 24"). It then passed through a trap and emptied into a container resting on a scale. Incremental scale readings of the container weight were used in a computer controlled feedback loop to achieve a constant mass flow of asphalt (150 mg/min) through the needle valve. A 750-watt heater and an on/off controller were used to maintain an asphalt temperature gradient of 150 °C to 125 °C across the generator bed. The asphalt was cooled as HEPA filtered air (25 °C, 50 % RH, 20 L/min) passed over the bed and entrained the asphalt fume. The inlet and outlet temperatures of the asphalt, as it passed over the plate, were measured with J-type thermocouples positioned 1" from the generator inlet and outlet, respectively. Fume produced in the generator was transported to the exposure chamber and gradually cooled to a temperature of around 25 °C. A light scattering device (DataRam PDR-1000) was used to estimate the particulate phase concentration of the fume. Fume sampling methods and analysis have been described [1]. Heated dilution air, controlled with a mass flow controller, could be added to the asphalt fume to obtain a desired concentration as needed. The system was generally operated in an open loop mode to obtain maximum asphalt aerosol concentration.

RESULTS & DISCUSSION

A typical asphalt exposure runs for 6 hours per day, 5 days a week, at maximum concentration. Figure 2 shows the average daily asphalt aerosol concentration during a recent 5-day exposure period. The dips in the graph correspond to time periods when the exposure chamber was opened to change air-sampling media. The chemical composition of this laboratory generated fume has been shown to be similar to that generated during road paving operations [1].

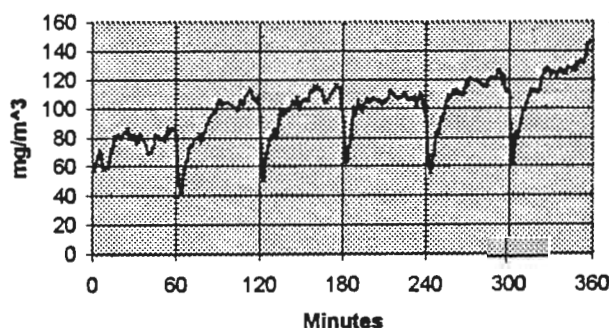


Figure 2: Average Concentration of the DataRam estimation of the particulate phase of the asphalt fume during a typical 6 hour, 5 day exposure period

ACKNOWLEDGEMENTS

The authors wish to acknowledge the work and effort of the following people: Amy Mosely, Donnie Shanahan, and Dave Edgells.

REFERENCES

1. Wang J, DM Lewis, V Castranova, et al. Characterization of asphalt fume composition under simulated road paving conditions by GC-MS and Microflow LC/Quadruple time-of-flight MS. *Anal Chem* 2001; 73:3691-3700

BIO MEDICAL
ENGINEERING
RECENT DEVELOPMENTS

JAFAR VOSSOUGH, Editor



**MEDICAL
and
ENGINEERING
PUBLISHERS, Inc, PO Box 11834, Washington, DC 20005**

BIOMEDICAL ENGINEERING RECENT DEVELOPMENTS

**Proceedings of the
Twenty First Southern Biomedical Engineering Conference
September 28 – 29, 2002
Bethesda Hyatt Regency
Bethesda, Maryland, USA**

**JAFAR VOSSOUGH
Editor**

**Biomed Research Foundation
3616 Martins Dairy Circle
OLNEY, MD 20832
Tel/Fax 301 570 9771
E-mail: Vossoughi@transinfo.com**