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Project Summary

Emission of Volatile Organic Compounds from Drum-Mix Asphalt Plants

Thomas W. Beggs

This research program was undertaken in order to develop a quantitative estimate of the emission of volatile organic compounds (VOCs) from drum-mix asphalt plants.

The study was carried out by field sampling of five drum-mix plants under a variety of operating conditions. Included in these plants was a plant that processed a mixture of recycled pavement and virgin aggregate, and a plant that employed a wet scrubber, which was tested both at the stack and also upstream of the scrubber to determine if wet scrubbing provides any significant VOC removal. The sampling method used was EPA Proposed Method 25, modified to filter out particulate emissions which would interfere with the laboratory determination of VOC concentration in the collected samples. In most cases, three simultaneous samples were taken for each set of operating conditions in order to calculate a mean and standard deviation for a statistical comparison of VOC emissions under different conditions.

Results are that VOC emission factors for drum-mix plants are on the order of 0.1 to 0.4 pounds of VOC (as carbon) per ton of asphalt concrete produced. VOC emissions appear to be independent of operating parameters, over the normal range of plant operation and within the limited scope of the statistical testing employed. It appears that a wet scrubber reduces VOC emissions somewhat but the reduction is difficult to quantify because of variation in the results.

The nationwide emission of VOCs from all drum-mix asphalt plants is estimated to be about 20,600 tons per year.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Although most existing asphalt concrete plants are still the batch type, the majority of new plants sold in the last few years have been the drum-mix type. The drum-mix process represents the state-of-the-art in the production of asphalt concrete. The process is a vast improvement over the asphalt batching process as it involves fewer items of equipment, is simpler, and more portable. Because the product mix is controlled at the feed end of the drum rather than at the discharge end, the process is more versatile than the conventional batching process, allowing rapid changes in production rate, mix type, and mix temperature.

The simplicity of the drum-mix process, as compared to the conventional process, can be seen in Figure 1. The aggregate and asphalt are mixed in the same vessel in which the aggregate is dried and heated, namely the dryer

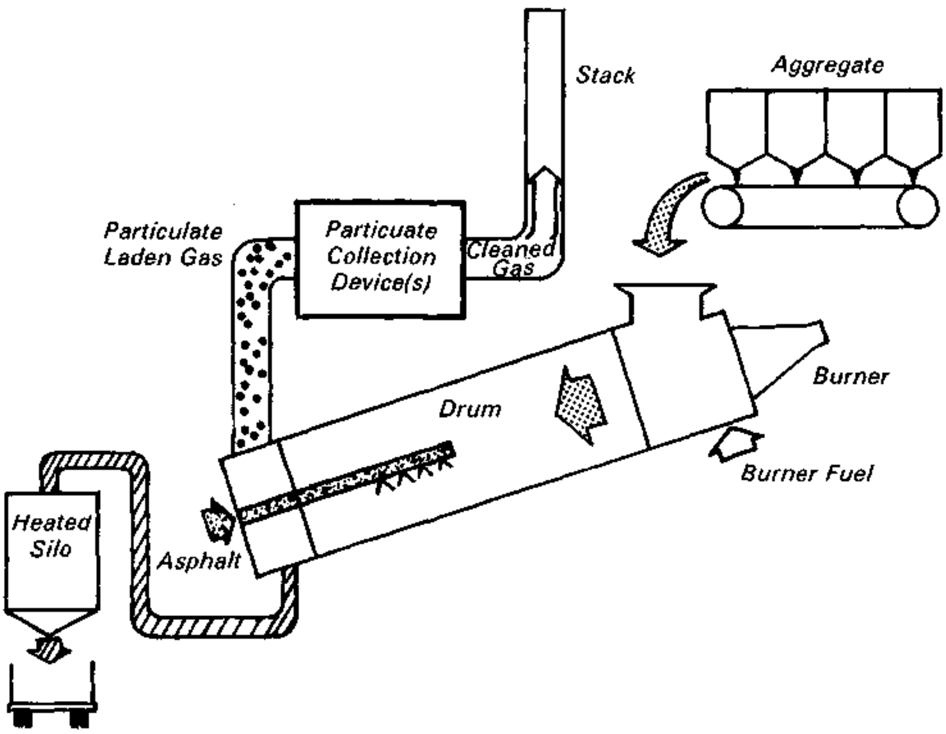

Figure 1. *Typical drum-mix process.*

drum, which obviates the need for the pugmill that is found in the conventional batch process. Also, the hot screens and weigh hoppers required in the batch process are not required in the drum-mix process due to careful control of the incoming aggregate blend by variable-speed conveyors.

In a drum-mix recycling process, salvaged asphalt pavement (or base material) that has been crushed and screened is introduced into the dryer drum at a point somewhere downstream of the virgin aggregate inlet. Current blends generally range from about 20 percent to a maximum of 50 percent recycled material.

Emissions of organic compounds from drum-mix and drum-mix recycle processes can be either liquid (blue smoke) or gaseous (VOC). The former are actually particulate emissions; in an EPA Method 5 test, the liquid aerosol particles are trapped by the filter. Therefore, these emissions must be removed from the VOC sampling train so as not to be counted as VOC emissions.

Little is known about the amount of gaseous organic (VOC) emissions generated by these processes; much less about how to control them if they are significant. (It has been suggested that a wet scrubber may reduce these emissions.) Intuitively, it can be expected that VOC emissions from the dryer in a drum-mix or the drum-mix recycle process are greater than VOC emissions from the dryer in a conventional asphalt batch process, due to the heating of a petroleum-based product (liquid asphalt) in a closed space.

This study was undertaken with the objectives of gathering data to support or refute this speculation, attempting to develop a quantitative estimate of these emissions, and determining the efficiency of a wet scrubber in VOC removal.

Sampling and Analysis Methodology

Five drum-mix plants were selected for testing, on the basis of location and the owners willingness to participate.

The test method chosen for measuring VOC emissions from the drum-mix asphalt process was EPA Proposed Method 25, "Determination of Total Gaseous Nonmethane Organic Emissions as Carbon: Manual Sampling and Analysis Procedures" (sometimes referred to as the "TGNMO" procedure). The principle of this procedure is to anisokinetically draw a sample of stack gas through a stainless steel probe and condensate trap and into an evacuated cylinder. Heavy VOCs condense in the trap, which is packed in dry ice; light VOCs remain gaseous and are collected in the tank. Both trap and tank are subsequently analyzed for total carbon by a laboratory procedure in which all nonmethane organic compounds are oxidized to carbon dioxide, reduced to methane, and then measured by a flame ionization detector (FID).

One plant was tested simultaneously for particulate and VOC emissions. For this purpose a combined train was used in which the VOC sampling train begins as a slip-stream, taken off the Method 5 train downstream of the heated filter. This combination method required isokinetic sampling at preselected traverse points representing equal areas of stack cross-section, as in sampling by Method 5 alone. The addition of the VOC train does not appreciably affect the isokinetic factor of the Method 5 test since the sampling rate of the VOC train is two orders of magnitude less than the sampling rate normally employed in Method 5.

To perform VOC sampling only, a combined train was not necessary. A modified filter assembly was used instead, consisting of a filter and holder enclosed in a box which was maintained (along with the probe) at the desired temperature by means of an electrical-resistance heater such as that used in Method 5. After solid and liquid particulates were removed by the filter, the gas passed into the VOC sampling train.

For each test run, sampling was begun after steady-state operation had been achieved at the specified conditions. Parameters varied for purposes of testing included production rate, mix temperature, fuel type, and percentage of recycled material. When sampling included particulate measurement, the VOC train was connected as a slip-stream after the particulate filter and the probe were traversed in the stack according to EPA Method 5. For straight VOC testing, the probe to the heated filter box was placed in the stack near the center, and sampling was performed anisokinetically according to EPA Method 25. When testing under conditions of high particulate loading (upstream of a scrubber in one plant), a pre-impactor was also employed along with other devices to keep particulates out of the VOC train. In most cases, three simultaneous VOC samples were obtained for each test run; each test run also included a velocity traverse and a Fyrite gas analysis for CO_2 and O_2 in the stack gas. Plant process parameters were monitored and recorded during each run. At the completion of each test run, the sample tanks were packed away and the traps were sealed and packed in dry ice until analysis. Subsequent laboratory analysis of samples was done and the results were reported in terms of total carbon for the tank, the trap, and the total.

All VOC values were converted to emission factors of pounds carbon per ton of asphalt produced by employing the measured stack gas velocity and recorded process parameters. For each test run the multiple VOC emission factors were averaged and the standard deviation was calculated. Table 1 presents these results. Statistical techniques were then used to compare results for parameter changes to determine if apparent differences were statistically significant.

Results

As a result of this study, VOC emission factors for the drum-mix asphalt process are established to be in the range of 0.1 to 0.4 pounds carbon per ton. Within the limits of the procedures used and the narrow ranges of process parameters found in most plants, no real dependence of VOC emission factors could be detected for parameters such as mix temperature, percentage of recycled material, production rate, and type of fuel. A high-energy wet scrubber (venturi) is capable of reducing VOC emissions, but the reductions achievable varied widely so that a separate emission factor range could not be established for plants with wet scrubbers.

The nationwide impact of VOC emissions from drum-mix asphalt plants is estimated to be approximately 20,600 tons per year.

The procedure of EPA Proposed Method 25, as modified to filter out particulates performed well in the field. However, additional modifications were necessary to sample under the high particulate loading experienced upstream of a particulate control device.

Table 1. Summary of VOC Test Results by Plant

				VOC Emission Factors, lb/ton*		
Plant	Production tons/hr	Burner Fuel	Control Device	No. of Samples	Mean	Standard Deviation
A	350-375	Diesel oil Natural gas	Baghouse	8	0.21	0.07
B	100-200	Propane	Baghouse	14	0.062	0.034
C	240-320	No. 4 fuel oil	Baghouse	12	0.13	0.05
D	200-275	Natural gas	Baghouse	15	0.41	0.17
E	175-200	No. 2 fuel oil	None**	7	0.36	0.22
			Venturi Scrubber	10	0.19	0.03

* As carbon.
** Upstream of venturi scrubber.

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The complete report, entitled "Emission of Volatile Organic Compounds from Drum-Mix Asphalt Plants," (Order No. PB 81-157 943; Cost: $9.50, subject to change) will be available only from:
National Technical Information Service
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