OWENS CORNING ROOFING AND ASPHALT, LLC
ONE OWENS CORNING PARKWAY
TOLEDO, OHIO 43659
419.248.8000

Controlling Asphalt Fumes During Built-Up Roofing Jobs

David Trumbore, Ph.D. and James Burkett.

Background

With all the questions floating around about asphalt fumes, it seems timely to review some history in order to provide a roadmap for roofing specifiers, consultants and contractors to minimize asphalt fume exposure during application of what all recognize are superior quality, low-slope asphalt roofs. This article will accomplish that by first reviewing what impacts fumes; then looking at two Trumbull® asphalt products specifically designed to reduce fumes; proprietary equipment technology that can also reduce fumes exposure during application; and, finally, reviewing recommendations that have been published by the National Institute for Occupational Safety and Health (NIOSH) that were the result of an industry, labor, and government partnership. References are provided, which enable the reader to seek out more detail than this article can provide.

Please contact the appropriate manufacturer or supplier of built-up roofing (BUR) system components for any specific questions directly related to their position or published correspondence relating to IARC (International Agency for Research on Cancer).

Source of fumes

Before describing the products and guidelines in detail it is instructive to review the sources of asphalt fumes in a hot, built-up roofing job. Built-up roofing asphalt (BURA) can be provided to a job in several ways. For large jobs it may come in the liquid form and be heated to the use temperature in the tanker truck, with limited worker exposure at the tanker. Or the asphalt can come in liquid form from a tanker at lower temperatures and be bumped up in temperature in an asphalt roofing kettle, which uses a gas flame within a firetube in the kettle to heat the asphalt. Finally, on most jobs asphalt is provided in solid form and melted in the asphalt kettles. The kettle can be located on the ground and the asphalt pumped through pipes to the roof, or it can be positioned on the roof. In either case, the asphalt from the kettle is transported, directly or through intermediate vessels, to either a mop bucket from which it is mopped onto the roof, or to a mechanical spreader from which it is spread on the roof.

The temperature of the asphalt used to make a BUR roof is determined by use of the Equiviscous Temperature (EVT) of the asphalt as described in ASTM D1079. The EVT is the temperature that provides the right asphalt viscosity (consistency) allowing the proper amount of material to be applied on the roof under normal conditions. The viscosity in question varies from the mopping process (125 cps) to mechanical spreaders (75 cps), with the mechanical spreading process requiring hotter asphalt temperatures to get to the lower viscosity. EVT is measured in the mop bucket or mechanical spreader and in order to provide that temperature at the point of application, the asphalt roofing kettle must be at a higher temperature to account for loss of heat to the environment. This difference is typically equal to or greater than 50°F. [1,2] Since any individual asphalt emits more fumes at higher temperatures, the exposure potential for workers is higher around the roofing kettles that are hotter, compared to exposures at the EVT temperature on the roof. For that reason many products have targeted the asphalt kettle as a key area for technology that reduces fume exposure.

It is easy to underestimate the impact of these temperature differences on fume production. A study of emissions from an asphalt kettle in a setting that allowed control of confounding variables showed that decreasing kettle temperature by just 50°F (from 550 to 500°F) decreased the asphalt fumes in the area by 62%, and decreased the exposure of workers in the area by 40%. [2,3] Similar reductions in temperature in paving studies have shown the same kind of reductions in relevant asphalt related exposures.[4] Therefore, temperature is a key factor impacting the amount of fumes from a given asphalt, and the difference seen from kettle to roof is an important difference. This is why NIOSH has focused so much of its research effort on methods to reduce fumes at the kettle [1,5] and why asphalt fume exposures are typically much higher at the kettle than on the roof. [2]

Low-Fuming Asphalt

As with many inventions, Owens Corning's (OC) low-fuming asphalt (currently marketed as TruLo Max®) was discovered as an unexpected benefit to a different product concept. In the mid-1990s OC was experimenting with a BURA container made from asphalt and a thermoplastic polymer. In field tests, one piece of negative feedback was that contractors could no longer use the visible fumes from the kettle to judge kettle temperature – because the fume level was so low! Thus low-fuming asphalt was born and has since been patented. [6,7,8,9] The concept is that when a small amount of polymer is added to the asphalt, some of it separates and floats to the top of the kettle, forming a stagnant surface which is cooled by exposure to ambient air temperature. This polymer layer both insulates the asphalt in the kettle and greatly reduces fuming. By adding the right amount and type of polymer, the thickness of the polymer layer on the stagnant surface can be controlled to a minimum that accomplishes the task of providing low-fuming benefits and kettle energy savings while at the same time not interfering with operation of the kettle. The effect is dramatic and does not require sophisticated measurement techniques to detect as is shown in Figure 1 – a photo of fumes being emitted from a large kettle that is transitioning to the low-fuming product and has developed the polymer layer over part of the surface. The low-fuming effect is seen in the foreground kettle surface, normal fuming in back of this. Figure 2 shows the point at which the protective layer ends with fuming much higher on the one side of that margin than the other. That said, sophisticated measurement techniques have been used to quantify the impact of the use of low-fuming asphalt on the exposure actually seen by asphalt workers at the kettle and it is not surprising that those measurements have also shown great benefit. Low-fuming asphalt was studied in the kettle setup mentioned above that controlled numerous confounding factors and was found to reduce asphalt fume in the area of the kettle by between 87% and 95% and to reduce worker exposure to fume by 79% to 88%. [2,3] NIOSH independently studied the impact of the product in the field and reported 70% to 83% reductions in fumes. [5] Because of the mode of action, the only impact at the roof top would be from intermediate vessels storing asphalt between the kettle and mop bucket – things like roofing luggers. This effect has been detected in some tests but not in others.

Figure 1: Large kettle at uniform temperature with low fuming layer in foreground and no layer in background.

Figure 2: Low fuming polymer layer development and margin beyond which asphalt fumes are still visible.

Warm-Mix Roofing

The asphalt pavement industry has, in the past decade, pioneered new asphalt products and techniques that can be used at lower temperatures in the production of asphalt roads, and they have coined the term "Warm-Mix Asphalt" to illustrate the lower application temperatures which save on energy and reduce both worker exposure to fumes and the emission of fumes to the environment. [10] It is interesting to note that the roofing industry has had its own Warm-Mix Asphalt product in place for more than 25 years, but without the snappy title! That product is PermaMop®, a proprietary [11] BURA type asphalt, formulated with an air-rectified asphalt and an additive. PermaMop® has the high softening point of a Type 4 BURA and so can be used in steep slope applications without flowing, but also has the high durability, high ductility, and low EVT of a Type 2 BURA. Normal Type 2 BURAs are limited in application to "flat" roofs while PermaMop® can be used on all roofs. The combination of a high softening point with a high durability and ductility make for a premium quality roof system. The low EVT, however, is what is of interest for fumes because it allows the entire system – from kettle to mop – to be run at a lower temperature and thus to emit less fumes than standard BURA systems. The actual EVT reduction is dependent on many factors but typical comparisons of PermaMop® to standard Type 4 BURA show that reduction to be close to 100 ^{o}F. That kind of temperature decrease for the entire system is roughly double the example of 50 ^{o}F that was reported above to give large fume reductions. One should therefore expect even greater fume reduction with PermaMop®, and that reduction would not only be at the kettle but also on the roof. In addition, PermaMop® is compatible with the low-fuming polymer technology for added fume reductions at the kettle.

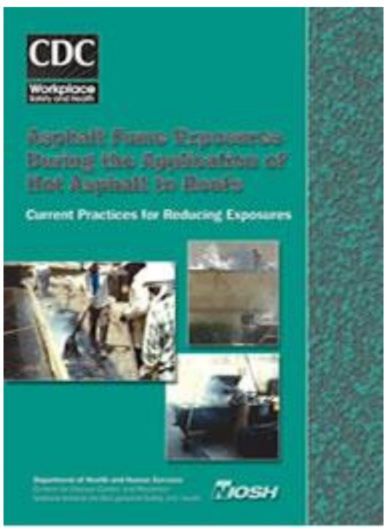
Equipment technology

In addition to the invention of different asphalt products that reduce the fumes during application, there has also been progress made in the design of equipment to capture and destroy the fumes from kettles and to limit the exposure of the workers to fumes at the kettles. [12,13,14] NIOSH reported [5] that in six field studies, the addition of afterburner systems and loader systems “may have reduced the kettle operators’ exposure to asphalt fumes, but variables such as work practices made it difficult to interpret the results.” They did report that when conditions were well controlled, the emissions were reduced by 73% to 88%.[5]

Industry, labor, and government efforts to control

A partnership between the roofing industry, roofing unions and government resulted in the 2003 publication by the NIOSH of a document entitled “Asphalt Fume Exposures During the Application of Hot Asphalt to Roofs – Current Practices for Reducing Exposures,” which summarized work done in the partnership to identify available technology for asphalt fume reduction.[1] The Industry was represented by three groups: the Asphalt Roofing Manufacturers Association (ARMA), the National Roofing Contractors Association (NRCA), and the Asphalt Institute (AI). Labor was represented by United Union of Roofers, Waterproofers, and Allied Workers (UURWAW), and government was represented by NIOSH. The publication is shown in Figure 3.

Figure 3: NIOSH Publication on Reducing Asphalt Exposure During BURA Jobs



Chapter 5 of the publication laid out the methods for reducing asphalt fume exposure. These methods for controlling exposure to asphalt fumes include the following. 1. Use low-fuming asphalt or kettles with afterburner or kettle loading systems when feasible. Note that NIOSH’s use of the term “low-fuming asphalt” in this publication and of “fume-suppressing asphalt” in a subsequent publication [5] both refer to OC’s TruLo Max® technology. 2. Use kettles of appropriate size for the job, 3. Make sure lid fits tightly, close the lid when asphalt is not being added and minimize the number of times the lid must be open. 5. Chop the kegs into easy-to-handle pieces before opening lid to reduce time it is open. 6. Place the kettle downwind from workers, and with lid facing away from building. 7. Place the kettle away from air intake vents, doors and windows. 8. Restrict access to area around kettle. 9. Calibrate kettle thermometers and thermostats at least monthly. 10. Adhere to EVTs at point of application and use insulated kettles, piping and roof equipment to minimize the kettle temperature needed to achieve the application EVT.

As mentioned above NIOSH subsequently published an update to their research on reduction of fumes at the kettle which reinforced the recommendations indicated above including their recommendation for using low-fuming or fume-suppressing asphalts, i.e. TruLo Max®.[5]

Both NIOSH publications referenced here are available free of charge at their website and contain more detail for those interested in reducing fume exposures.

Conclusions

Anyone interested in reducing asphalt fume exposure during hot asphalt roofing has a number of options available to them from new products that suppress fumes at roofing kettles, to low EVT asphalts, to equipment that reduces fumes and exposures, to a series of methods recommended by NIOSH and developed by them in conjunction with industry and labor.

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