

HEALTH, SAFETY & ENVIRONMENTAL ASPECTS OF BITUMINOUS MATERIALS

Issues of health, safety and the environment have no boundary: they are the responsibility of every one of us, irrespective of our position in the company or organisation, irrespective of whether it is our job or a competitor's, and irrespective of how urgent the work is for completion. It is a mindset we all need to nourish.

The health, safety and environmental aspects of bitumen are not any different. In order to ensure a proper understanding of these, all personnel involved in handling or use of bitumen need training as well as a continual reinforcement of work standards.

Based on practical experience over a number of years, and from specific field studies, there is no indication that bitumen presents an occupational health risk to workers who handle it regularly, nor does it present an environmental health problem to those who come into contact with bitumen during its manufacture and application.

Thus bitumen presents a low order of potential hazard provided that good handling practices are observed. These are described in detail in the Austroads "Bituminous Materials Safety Guide" 2008 and AAPA's publications "Guide to Health & Safety within the Flexible Pavements Industry" and "Guide to Good Practice in Asphalt & Bitumen Laboratories".

AAPA has also produced a Code of Practice for the manufacture, making and laying of SBS modified asphalt as well as a number of advisory notes covering topics such as storage of binders.

The following highlights some of the potential hazards associated with the handling of bitumen. However, it is not intended to be used as a substitute for health, safety and environmental information given by individual suppliers.

POTENTIAL HAZARDS DURING THE HANDLING OF BITUMEN

At ambient temperatures bitumen is solid and therefore does not pose a health hazard. But to handle bitumen it must be heated to temperatures above 100°C, which gives rise to the main hazard of heat burns.

Also, there are other possible hazards associated with inhalation of fumes and low temperature skin contact with materials mixed with bitumen which could be toxic, such as cutters, emulsifying agents, adhesion agents, etc.

Toxicity of Bitumen

Bitumens are complex hydrocarbon materials containing high molecular weight components, a low percentage of which are polycyclic aromatic hydrocarbons (PCAs). The toxicity of these components needs to be considered in view of their known carcinogenicity. In experimental animal studies polycyclic aromatics with 3 to 7 (usually 4 to 6) fused rings, with molecular weights in the range 200 to 450, have been shown to be biologically active carcinogens. In particular benzo(a)pyrene and benz(a)anthracene are considered to be powerful carcinogens. However, the concentrations of these carcinogens in bitumen are extremely low, as indicated in the table below.

The presence of carcinogens in bitumen does not necessarily constitute a risk to health in practice, but the information is vital so that appropriate precautions can be taken by personnel handling the product.

Although bitumen and coal tar are often considered to be similar materials, because of their like appearance and use in road works, they are in fact very different. Coal tar products are known to be carcinogenic and have not been used in Australia for this reason for many years.

BITUMEN HANDLING/SAFETY

The nature of bitumen, particularly its high viscosity at ambient, requires that it be maintained at a temperature sufficiently high to enable pumping to take place without line blockage and for vehicles to be completely discharged.

The main considerations therefore involved in handling bitumen are:

- The high handling temperatures, and the need to minimise these temperatures wherever practical.
- The need for purpose-designed vessels which are insulated to retain heat and prevent contact of personnel with hot surfaces.
- The need to safeguard the health of personnel by provision of suitable protective clothing. Serious burns can be caused by bitumen coming in contact with the skin.
- The training of personnel.
- The prevention of contact of water with hot bitumen.
- Flammability.

Potential Hazards via Skin Contact

(a) Skin Burns

Bitumen is handled as a hot liquid (>100°C) and therefore there is considerable potential for skin burns unless simple protective steps are taken. These generally revolve around the wearing of protective clothing designed specifically to shed splashes and spills away from the body and should include

- eye and face protection (face shield)
- heat resistant material overalls, close-fitting at the cuffs and overlapping the boots.
- heat resistant gloves with close-fitting cuffs.
- safety boots.

(b) First aid for skin burns

Accidental contact with hot bitumen to the skin or eye should be immediately dealt with by immersing the affected area in clean cool running water for at least 10 minutes or until thoroughly cooled.

For this reason, water showers and eye bath facilities should be available at fixed installations such as depots etc., at strategic locations. For other work locations, consideration must be given to where and how this safeguard would be accommodated.

Once the bitumen has cooled, no immediate attempt should be made to remove it until admission to hospital and only at the direction of a burns specialist.

All bitumen burns should receive proper medical attention without delay and burns to the eye should be referred urgently to hospital.

Bitumen encircling a limb or finger can produce a tourniquet effect as it cools. This should be relieved under medical supervision.

Bitumen burns cards are available from Austroads and are also inserted into the Austroads "Bituminous Materials Safety Guide" and good practice would have all personnel aware of the card and cards available at all work locations including in the cabin of bituminous product vehicles. A card should also accompany the injured person when they go to receive medical attention.

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(c) Skin Contamination

Bitumens have been used widely for many years and there is no direct evidence to associate them with long-term skin disorders in man. However they do contain small quantities of polycyclic aromatic compounds, some of which have been shown in animal studies to have carcinogenic properties. Therefore, it is prudent to avoid intimate and prolonged skin contact with bitumen.

Cutback bitumens and bitumen emulsions are handled at lower temperatures and therefore the likelihood of skin contact is increased. If protective clothing is not used and personal hygiene is poor regular skin contact could occur. Over many years prolonged contact could result in some risk, although slight, of skin cancer.

Solvents such as petrol, kerosene, etc. should not be used for removing bitumen from the skin as these may spread the contamination and cause skin disorders in their own right. An approved skin cleanser and warm water should be used if accidental spillage occurs.

It is only through good housekeeping and the wearing of correct protective clothing that the possibility of skin contact will be minimised.

Potential Hazard via Inhalation

When bitumen is heated either in bulk or when mixed with hot aggregate, fumes can occur. These can contain particulate bitumen, hydrocarbon vapour and very small amounts of hydrogen sulphide. When working with hot bitumen in the open air, hydrogen sulphide does not present a hazard as the concentration is too low to be a significant risk to health. However, it is possible for hydrogen sulphide to accumulate in lethal concentrations above hot bitumen in the vapour space of bulk storage tanks.

Because it is known that bitumen contains small amounts of polycyclic aromatic hydrocarbon compounds, some of which have been shown in animal studies to have carcinogenic properties, occupational exposure limits have been set. Worksafe Australia in "Exposure Standards for Atmospheric Contaminants in the Occupational Environment" provide a value for long-term exposure limit (8 hour time-weighted average) of 5 mg/m³.

In 2011 the International Agency for Research on Cancer (IARC) re-evaluated various occupations that entail exposures to bitumen's and bitumen emissions, including road paving, roofing, and application of mastic asphalt. It was concluded that:

- Occupational exposures to oxidized bitumens and their emissions during roofing are 'probably carcinogenic to humans'¹ (Group 2A);
- Occupational exposures to hard bitumens and their emissions during mastic asphalt work are 'possibly carcinogenic to humans' (Group 2B); and
- Occupational exposures to straight-run bitumens and their emissions during road paving are 'possibly carcinogenic to humans' (Group 2B).

Oxidised bitumen's are those that are heated to approximately 300°C for roofing applications. This is well in excess of the 200°C maximum that bitumen could be subject to in asphalt and surfacing applications. A group 2B agent is defined as:

Group 2B: The agent is possibly carcinogenic to humans.

This category is used for agents for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals. It may also be used when there is inadequate evidence of carcinogenicity in humans but there is sufficient evidence of carcinogenicity in experimental animals.

In all cases unnecessary exposure to bitumen fumes should be avoided.

Danger associated with water coming into contact with hot bitumen (foaming or frothing)

If water comes into contact with hot bitumen, the water undergoes a very rapid and sudden expansion, something in the order of 20 to 30 times its original volume. This foaming effect is not only highly dangerous to personnel in the vicinity but the effect could cause fire and explosion. For

Bituminous Binders

this reason care must always be taken when handling bitumen emulsions followed by bitumen. Good practice dictates that an approved switch-loading procedure is always adhered to.

Polymer Modified Binder Handling/Safety

As a general rule hot PMBs are stored and handled in the same manner as hot bitumen, however there are some additional safety and handling procedures that need to be considered.

These include:

- Hot PMBs may need to be stored and handled and applied at higher temperatures than normal bitumen;
- Storage, handling and application temperatures higher than the suppliers' recommended maximum temperatures will usually degrade the product;
- PMBs have a propensity to segregate over time and it is essential that suppliers' product storage and handling circulation advice be adhered to;
- It is important for long term performance that the suppliers' application temperatures for mixing and application be strictly followed.

POTENTIAL HAZARDS DURING THE HANDLING OF BITUMEN CUTBACKS

Cutback Bitumen Handling/Safety

As a result of application viscosity requirements, cutback bitumens may have to be applied at elevated temperatures which can be in excess of their flash point. i.e. the temperature at which the vapours will burn in the presence of air and an ignition source.

It is essential that ignition sources (naked flames, hot burner tubes etc) be excluded from the vicinity of cutback handling operations.

To minimise excessive fuming and fire risk, cutback temperatures should be kept as near as possible to the application temperature and should never exceed the maximum temperature stated in the product Material Safety Data Sheet (MSDS).

Field blending should be carried out in strict accordance with the employer's operational instructions and all sources of cutter/flux should be tested for the presence of water before addition to the hot bitumen.

Some risks associated with cutback bitumens

Cutback bitumens are usually handled above their flash points (Cutter: 38°C, High Flash Point Cutter: 61.5°C) and can evolve explosive mixtures in the tank vapour space above the cutback. Appropriate precautions must therefore be taken such as ensuring that no source of ignition is permitted in the area. To avoid unnecessary evolution of vapours, cutback bitumens should always be handled at the lowest possible temperatures consistent with easy handling whilst still meeting user requirements. Reference should be made to the supplier's literature.

Bitumen, on the other hand, is not normally handled above its flash point of >250°C and has a recommended maximum handling and storage temperature based on safety and quality considerations of 200°C maximum.

POTENTIAL HAZARDS DURING THE HANDLING OF BITUMEN EMULSIONS

Bitumen emulsions are usually handled at ambient temperature, however some new high bitumen content emulsions are handled at elevated temperatures (70–80°C) and appropriate hot liquid handling precautions must be employed.

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Bitumen emulsions can be stored over a relatively long period, provided appropriate procedures are observed:

- Never allow the bitumen emulsion to fall below 5°C as it will break in the storage tank; maintain the emulsion at a consistent temperature between 20 – 25°C
- Whenever possible choose tall vertical storage tanks to minimise the exposure of the bitumen emulsion surface to air;
- Fill / empty the storage tanks from the bottom to ensure that the bitumen skin that forms on the top of the emulsion is not broken and to minimise splash filling which can damage the emulsion ;
- Gently circulate the product if long term storage is envisaged to counter the natural settling tendency of the emulsion. The frequency and duration of circulation will depend on the type of storage being used. In bulk storage 1 to 2 hours or circulation once a day may be sufficient whereas drums should be rotated on a weekly basis. Once again do not break the skin that forms on top of the emulsion.

Bitumen emulsions can be handled and transported safely by following a few simple rules, which include:

- Never load bitumen emulsion on top of the remainder of a hot bitumen load;
- Never mix emulsion types i.e. anionic and cationic, in the same tank or pipeline as the emulsion will break into its two components;
- Ensure that the approved product tanker switch loading procedure is carried out whenever changing emulsion types or changing between loads of hot bitumen and emulsion.

Follow the suppliers Material Safety Data Sheet advice at all times.

SAFETY DATA SHEETS

Because of the number of different products on the market and new additives available, up-to-date material safety data sheets (SDS) should be sought from the supplier before use of the material, and any special handling or protective requirements explained to personnel and adhered to.

Fire Prevention and Fire Fighting

Good housekeeping and the adoption of safe handling procedures will substantially reduce the risk of fire.

Water should not be used when fighting bitumen fires as the foaming effect could spread the hot bitumen and therefore the fire.

Small bitumen fires can be put out using dry chemical powder, foam, vaporising liquid or inert gas extinguishers. These should be located strategically around handling and associated areas. All portable extinguishers should be located conveniently for access and all permanently located fire extinguishers should be made conspicuous by coloured background panels, both to assist in visual identification and to aid checking against loss. All personnel employed at the site, including drivers, should have instruction and regular drills, both in emergency procedures and in first attack fire fighting. Good practice should also see regular contact with the local fire brigade.

Recommended precautions for personnel

The main hazard from handling hot bitumen is heat burns, the risk of which can be substantially reduced if proper handling procedures and protective clothing are used.

Protective clothing soiled with bitumen should either be replaced or dry cleaned so as to avoid permeation of the product to underclothing. Soiled rags, tools, gloves, etc. should not be placed in pockets of overalls as contamination of the lining of pockets will result.

Skin barrier creams should be used to protect the skin should accidental contact occur. The barrier cream is applied prior to handling bitumen and assists in the cleaning process. Barrier creams and washing facilities should be provided and used by personnel. Skin should be thoroughly washed after any contamination and always before going to the toilet, eating or drinking.

Audits

Bituminous Binders

Regular audits of facilities and work practices should be undertaken by the appropriate group. Always seek advice if there is any uncertainty.

References

Whiteoak D (2003), The Shell Bitumen Handbook

Austrroads (2008), The Bituminous Materials Safety Guide, AP-G41/08. Austrroads

IARC (2011) Occupational Exposures to Bitumens and Their Emissions, International Agency for Research on Cancer, World Health Organisation.