Bitumen Emulsions

About Bitumen Emulsions

Bitumen emulsions are usually dispersions of minute droplets of bitumen in water and are examples of oil-in-water emulsions. The bitumen content can be varied to suit different requirements and is typically between 30% and 70%. The primary objective of emulsifying bitumen is to obtain a product that can be used without the heating normally required when using cutbacks and paving grade bitumen. In the manufacture of bitumen emulsions, hot bitumen is sheared rapidly in water containing an emulsifying chemical (emulsifier). This produces very small particles of bitumen (the dispersed phase) dispersed in water (the continuous phase). The bitumen particles are stabilised in suspension and do not readily coalesce due to the presence of the emulsifier, which is concentrated on the surface of the bitumen particles.

During application, the water in a bitumen emulsion is either lost by evaporation, or it may separate from the bitumen because of the chemical nature of the surface to which the emulsion is applied. This process is referred to as breaking. Because bitumen has a density only slightly higher than water, sedimentation of the bitumen droplets in an emulsion during storage is very slow. Emulsions can usually be regenerated after long storage times by gentle stirring to redisperse the bitumen droplets.

Cationic vs Anionic

The coating of the bitumen particles by the emulsifier gives them an electrostatic charge. Depending on the type of emulsifier, this can generally be either negative or positive. The interaction of the charged particles is the reason it is possible to make emulsions that do not rapidly revert to the separate phases.

Emulsions in which the bitumen droplets are negatively charged are called anionic emulsions. Emulsions in which the particles are positively charged are called cationic emulsions.

The emulsifiers used to make anionic emulsions are typically prepared from fatty acids by reaction with a strong base such as sodium hydroxide or potassium hydroxide. The resultant fatty acid salt imparts a negative charge to the surface of the bitumen droplets in an emulsion.

Cationic emulsifiers are usually prepared from fatty amines by reaction with a strong acid such as hydrochloric acid. Fatty amine salts impart a positive charge to the surface of the bitumen droplets in an emulsion.

To ensure that an emulsion remains either anionic or cationic, its pH (that is the balance of acids and bases) is controlled so that typically an anionic emulsion has an alkaline pH of over 7 and a cationic emulsion has an acidic pH of below 7. This fundamental property of both anionic and cationic emulsions requires that they never be mixed. Mixing of an anionic emulsion and a cationic emulsion allows the negatively charged anionic bitumen emulsion droplets and the positively charged cationic bitumen emulsion particles to come together through electrical attraction. Ultimately enough droplets will combine and the bitumen will separate out, becoming unusable and destroying the emulsion.
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Breaking and Curing

Bitumen emulsions must remain stable so they can be transported, stored and handled. Ultimately, however, they must be made to separate or “break” so that the bitumen can coat aggregate particles or pavement surfaces. Emulsions used in sprayed sealing work are required to break relatively quickly to prevent run-off of the emulsion and the possibility of rain damage. On the other hand, emulsions used in stabilisation of soil must break relatively slowly to allow adequate mixing.

In general, the following factors affect the rate of break of a bitumen emulsion:

- The type and amount of emulsifier used in the emulsion.
- The rate of water absorption by the aggregate. Porous aggregate will make an emulsion break more quickly by absorbing water from the emulsion.
- The moisture content of the aggregate prior to application. Damp aggregate will cause the emulsion to break more slowly.
- Weather conditions, such as temperature, humidity and wind, will affect the rate of break. Hot, dry and windy conditions will cause the emulsion to break more rapidly.
- Mechanical action, such as that provided by rolling and traffic, will speed up the break time.
- Aggregate particle size distribution and mineral make-up. The finer aggregate blends will tend to cause an emulsion to break quicker than a coarser type aggregate blend because of their greater surface areas. The mineral composition of an aggregate also affects the breaking time due to chemical reactions between the emulsifier and the aggregate surface. Dirty aggregate or high fines contents can speed up the emulsion breaking rate.
- The charge intensities on the aggregate surfaces, the surfaces of the bitumen particles in the emulsion and on the emulsifier molecules all have an effect on the breaking rate.

The optimum balance between stability and breaking rate is principally obtained by careful selection of emulsifier type and concentration, emulsion pH and bitumen droplet size. A mixture of bitumen emulsion and aggregate does not fully cure and attain full strength until all the water separates out.

Anionic bitumen emulsions tend to rely more on evaporation of the water for the breaking and curing processes to occur and, consequently, their breaking and curing rates are reliant on the prevailing weather conditions. Although water displacement can be fairly rapid under favourable conditions, high humidity, low temperatures, or rainfall soon after application can severely delay full curing.

Cationic bitumen emulsions tend to break through an electro-chemical process and, therefore, weather conditions play a lesser role in the breaking rate of these types. Full curing of a cationic emulsion still requires the water to be lost through evaporation, absorption or ‘pushing out’ by the action of rolling and traffic.
Types of Bitumen Emulsions

Bitumen emulsions are available in many different forms, either cationic or anionic, with varying breaking or setting rates and binder types and contents.

Seven distinct grades of bitumen emulsion are specified under Australian Standard AS1160 Bitumen emulsions for road construction and maintenance – each defined by their basic type and setting characteristics.

The two most common basic emulsion types are designated by the letter ‘C’ for cationic emulsions, as in CRS (cationic rapid setting), and by the letter ‘A’ in anionic emulsions, as in ASS (anionic slow setting).

The characteristics of an emulsion are designated by the terms rapid (R), medium (M) and slow (S).

The main grades for bitumen emulsions are classified as follows:

<table>
<thead>
<tr>
<th>Anionic</th>
<th>Cationic</th>
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<tbody>
<tr>
<td>ARS</td>
<td>CRS</td>
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<tr>
<td>AMS</td>
<td>CMS</td>
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<tr>
<td>ASS</td>
<td>CSS</td>
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</table>

Slow setting emulsions are more stable than medium setting emulsions which, in turn, are more stable than rapid setting emulsions.

The binder type used in bitumen emulsions is usually Class 170 bitumen, however specialised applications may require the use of polymer and other additives to enhance the emulsion and binder performance.

The binder content of an emulsion is designated as percent mass. Typical standard emulsion grades contain a minimum binder content of 60% mass, however binder contents of greater than 70% are available for use in sealing work and contents below 60% may be required for other specialised applications.

A special emulsion grade used in the preparation of cold mix is designated as CAM (cationic aggregate mixing). This grade contains a significant quantity of solvent to ensure that mixes prepared with CAM are workable for an extended period.

Testing of Bitumen Emulsions

Laboratory testing of bitumen emulsions is performed for several reasons:

- To measure properties related to handling, storage and use.
- To control the quality and uniformity of the product during manufacture and use.
- To determine full compliance to specifications.
- To predict or control field performance.

The standard tests used for determining the properties of bitumen emulsions are as follows:

**Particle Charge test:** identifies the charge on the bitumen particles in an emulsion. A positive and a negative electrode are left in a sample of emulsion for half an hour. If there is bitumen deposited on the negative electrode at the end of the test the emulsion is cationic; if bitumen is deposited on the positive electrode, the emulsion is anionic.

**Setting Time test:** indicates the time taken for a sample of emulsion to break under controlled conditions when mixed with a standard aggregate.

**Residue from Evaporation test:** indicates the percentage mass of binder present in an emulsion. An emulsion sample is heated so that water and other volatile components are evaporated. Residue from evaporation is calculated from the mass of the sample and residue after evaporation.

**Water Content test:** determines the percentage mass of water in an emulsion. This can be performed by Dean and Stark distillation or Karl Fischer titration. In the Dean and Stark distillation, a sample is heated with a solvent that is immiscible with water. During the distillation process, the solvent and the water are separated in a trap so that the amount of water can be measured. In the Karl Fischer water content method, the emulsion is dissolved in a solvent and titrated with a Karl Fischer reagent, which reacts with the water in the emulsion. The amount of Karl Fischer reagent consumed is used to determine the water content of the emulsion.

**Consistency:** Also known as the Engler Viscosity test, this measures the rate of flow of the bitumen emulsion at 25°C. The emulsion is heated to 25°C and poured into a standard container. The time taken by 200mL of emulsion to pass through a standard orifice at the bottom of the container is measured.
**Sieve Residue test:** shows the presence of coarse binder particles in the emulsion. These particles may be in the form of relatively large globules or strings and may indicate instability or result in poor coating performance or clogging of pumps and spray equipment. The sample is strained through a 150 µm sieve and the percentage mass of emulsion retained on the sieve is calculated and reported as sieve residue.

**Sedimentation test:** indicates the extent to which the components of an emulsion sample will separate during storage. Samples are taken from the top and bottom of a 500mL sample that has stood undisturbed for three days. The samples are tested for water content. The difference between the water content of each sample is an indication of the degree to which sedimentation has taken place.

**Stone Coating Ability and Water Resistance test:** it is essential that a bitumen emulsion stands up to the action of being mixed with aggregates, coat them as completely as possible and not be washed off by any water that may fall on it once the mixing is completed. This test shows the extent to which a sample meets these requirements. It involves coating a sample of aggregate with emulsion, spraying it with water until the water coming from it is clear. The coating on the sample is assessed.

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### TYPICAL PROPERTIES OF STANDARD BITUMEN EMULSIONS GRADES

<table>
<thead>
<tr>
<th>Recommended Grade</th>
<th>ARS</th>
<th>AMS</th>
<th>ASS</th>
<th>CRS</th>
<th>CRS</th>
<th>CMS</th>
<th>CSS</th>
<th>CAM</th>
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<tr>
<td>Minimum Binder Content (%)</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>67</td>
<td>60</td>
<td>60</td>
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<td>67</td>
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**Property**

<table>
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<tr>
<th>Property</th>
<th>Binder content, % mass minimum</th>
<th>Water content, % mass maximum</th>
<th>pH</th>
<th>Setting time, minutes</th>
<th>Density conversion, L/te at 15°C</th>
<th>Recommended storage temp, °C</th>
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<tr>
<td></td>
<td>60</td>
<td>40</td>
<td>12</td>
<td>&lt; 3</td>
<td>985</td>
<td>20 - 60</td>
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<td>12</td>
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<td>10 - 60</td>
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This table refers only to bitumen emulsion grades covered by Australian Standard AS1160.
Applications

Bitumen emulsions behave more like water than bitumen when handled. This means that they can be used at much lower temperatures than bitumen, quite often at ambient temperature, and can be readily mixed with water.

Bitumen emulsions are much less sensitive to problems caused by damp or dusty aggregate and cool conditions due to their water base.

Anionic emulsions are best used with positively charged aggregate surfaces such as basalt, dolomite and limestone, whereas cationic emulsions are preferred for use with negatively charged silicious aggregates such as quartz, granite, sandstone and river gravel.

In general, cationic emulsions can be used with a wider range of aggregates, will tolerate greater quantities of moisture, and will break at a lower ambient temperature.

<table>
<thead>
<tr>
<th>APPLICATION GUIDE</th>
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<tbody>
<tr>
<td>Recommended Grade</td>
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<tr>
<td>Min Binder Content (%)</td>
</tr>
<tr>
<td>Sprayed seal</td>
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<tr>
<td>Tack coat</td>
</tr>
<tr>
<td>Primer seal</td>
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<tr>
<td>Prime</td>
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<tr>
<td>Surface enrichment</td>
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<tr>
<td>Recycling</td>
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<tr>
<td>Maintenance work</td>
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<tr>
<td>Cold mix</td>
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<tr>
<td>Slurry surfacing</td>
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<tr>
<td>Pavement stabilisation</td>
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<td>Soil stabilisation</td>
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<tr>
<td>Batter stabilisation</td>
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<tr>
<td>Dust laying</td>
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</table>

*Table A: This table defines some typical road construction and maintenance applications for different types of bitumen emulsions.*
Bitumen Emulsions

Sprayed Sealing
Sprayed sealing is the application of a thin layer of bituminous binder sprayed onto a pavement surface followed by the application of a layer of aggregate. Some of the advantages of using bitumen emulsions over cutback and paving grade bitumen for sprayed sealing work include:

- Improved ability to coat damp aggregate.
- Less hydrocarbon emissions as the addition of cutter to lower the binder viscosity is reduced.
- Lower application temperatures leading to the need for less energy for heating.
- Less likelihood of burns due to lower application temperatures and non-flammable nature.
- Flexibility of use in cooler, damper conditions.

Application
Bitumen emulsions are suitable for sprayed sealing using methods similar to those used for bitumen sealing.

ARS and CRS grades are applied as single or multiple coat seals. The higher viscosity of the high binder content emulsions, such as CRS/170-67, allows higher application rates and, consequently, larger aggregate sizes may be used.

Application rates must be carefully controlled to ensure that unbroken emulsion does not run off the pavement surface. Typically, 60% binder content emulsions must be applied at no more than 1.3L/m² and 67% binder content emulsions at below 3.0 L/m². Better results are generally achieved with multiple coat seals.

Sprayed sealing with bitumen emulsions may be undertaken when pavement temperatures are between 15°C and 50°C. Higher pavement temperatures may cause skinning of the emulsion and consequently delay the breaking process. Pavement temperatures below 15°C may prolong cure of the emulsion seal and allow damage by traffic.

Tack Coats
Tack coating is the light application of bituminous binder to a surface to facilitate the adhesion of a subsequent layer.

ASS/170-60 and CRS/170-60 are the most commonly used emulsion grades for tack coating prior to asphalt overlaying. CRS is the preferred option due to its better performance on moist pavements and in adverse weather.

Application
Emulsion application rates range from 0.17 L/m² to 0.50 L/m². Dilution with water may allow improved spray distribution at the low application rates, however the diluted emulsion will exhibit reduced storage life and should be prepared and used the same day.

Primer Seals
A primer seal is an application of binder and aggregate cover which is intended to take traffic for a short period (up to 12 months) prior to the application of a final surface.

An application of primer seal may be undertaken, for example, to protect sections of pavement on a large construction project until all sections can be simultaneously sealed or overlaid with asphalt.

ARS and CRS grades may be used in the preparation of primer seals. The ARS grades are suitable for use in fine and warm conditions and with aggregates with good adhesion characteristics.

CRS grades are suitable for use with a wide range of aggregates and in cooler and damper conditions.

The lower binder content emulsion grades, such as ASS/170-60 and CRS/170-60, are suitable for use with the smaller aggregate sizes, typically 5 and 7mm.

The high binder content emulsions, such as CRS/170-67, are suitable for use with aggregate up to 10mm and are sprayed hot, typically at temperatures between 50°C and 80°C.

Application
Due to variations in the absorbency of the substrate surface, aggregate size and traffic count, application rates may vary widely, from as low as 1.0 L/m² to as high as 1.5 L/m² for 60% binder content emulsions (equivalent to 0.6 L/m² to 0.9 L/m² of residual binder).

As a rule of thumb, greater substrate absorbency, larger aggregate size and lower traffic counts will require higher application rates.
Surface Enrichment

Surface enrichment is the light application of bituminous binder to an existing seal to replace binder lost due to oxidation and weathering effects, or to compensate for low initial application rates. It is a preventative treatment for stone loss and cracking, which should extend the life of the existing seal by up to four years.

Compared to cutbacks (which can also be used for enrichment), bitumen emulsions will cure more quickly, thus reducing problems associated with pick-up of binder on tyres.

CMS/170-60 is preferred for surface enrichment, however, CRS or CSS grades may be used. Rapid setting grades may suffer from premature break on the surface of the aggregate particles and this will result in less binder in the voids between particles. Tyre pick-up may then occur.

Application

To assist the emulsion flow down to the voids between aggregate particles, and application at low rates, dilution with water may be necessary at rates of between 1 part water to 1 part emulsion and 1 part water to 4 parts emulsion.

Diluted emulsion will exhibit reduced storage life and should be prepared and used the same day. The water should be added to the emulsion (not vice versa) and a sample of the water should be tested for compatibility before major works commence. The most appropriate practice is to mix a small amount of the water and bitumen emulsion in a container and watch for signs of breaking or separation of the bitumen.

Application rates generally vary between 0.5 L/m² and 1.3 L/m² for 60% binder content emulsions (equivalent to 0.3 L/m² to 0.8 L/m² of residual binder).

In cool conditions, application rates are usually restricted to less than 0.8 L/m², however mixtures of 1 part water to 1 part emulsion can be applied at up to 1.3 L/m².

To increase the rate of binder application, two or more spray runs may be required. These should be undertaken in opposite directions to assist binder uniformly reaching the void spaces between aggregate particles and the first pass should be fully cured prior to application of the second pass. To provide a uniform spray pattern at very light application rates, it may be necessary to use S2 spray nozzles.

Consideration should be given to variations in existing texture depth. The depth may be less along the wheel tracks and so the application rate may be altered accordingly by turning off the appropriate spray nozzles, if this is practical.

Surface enrichment should be carried out in good weather conditions with no imminent rain. Ideally, the weather should be fine, warm and with a slight breeze to assist water evaporation from the emulsion. Work should not be performed at pavement temperatures below 15°C or greater than 45°C as tyre pick-up of binder may occur.

Recycling

Recycling is a process that uses existing pavement material in the manufacture of new mix. This is done either by plant mixing reclaimed asphalt pavement (RAP) or by an in-situ process. Cold recycling can be used to remedy pavement distress involving both surface and base courses and can be performed with damp materials. The in-situ process reduces the cost of hauling materials.

Cold asphalt recycling by either the in-situ or fixed plant processes involves mixing the old asphalt material with bituminous emulsions such as AMS/170-60, ASS/170-60, CMS/170-60, CSS/170-60 or CAM/170-60.

The medium setting grades, AMS, CMS and CAM should be used for coarse aggregate mixes, for example, with open-graded mixes.

Slow setting grades, such as ASS or CSS, should be used where there is a high content of fine material, such as in dense-graded mixes.

Asphalt recycling may require the use of emulsion grades formulated specifically for the particular job and attention should be given to the nature of the material to be recycled, especially its uniformity and the condition of the binder.

Where the existing binder is severely oxidised, it may be necessary to incorporate rejuvenating oils. These oils bring the viscosity of the existing oxidised binder back to a more suitable level and are usually incorporated in the bitumen emulsion being used in the recycling process. Careful analysis of the existing binder condition is required to determine the amount of rejuvenating oil to be added to the mix.

Maintenance Work

Various maintenance tasks may be undertaken with bitumen emulsions, for example, repair of pot holes and edge breaks, and for crack sealing.
Often an emulsion layer is sprayed onto the surface prior to an application of cold mix or other repair material. The aim is to provide a bituminous layer which will help with the adhesion of the patching material to the existing surface. A cationic emulsion will generally provide the best performance particularly in damper conditions.

Penetration patching is a technique which involves the use of bitumen emulsion and aggregate mixed on the job site. The emulsion penetrates through the layers of aggregate to create a bound material. This type of patch will provide a quick, short term solution.

“Jetpatcher” type operations are used throughout Australia because they provide a comparatively quick and clean solution to patching work.

Emulsions are often used for crack filling applications. It is important to ensure the cracks are free from dust before the emulsion is applied. Compressed air cleaning may be required. Care should be taken to ensure the bitumen emulsion penetrates into the crack. A squeegee is useful to assist with binder penetration. Improved results can be obtained by using a polymer modified product, especially where the cracks are active.

**Cold Mix**

Cold mix is a mixture of aggregate and bitumen emulsion, which is used as a temporary patching material.

CAM/170-60 and CAM/170-67 are generally used. The presence of cutter in these grades allows cold mix to be stockpiled for later use and ensures its workability for an extended period.

Slow setting grades of emulsion, such as ASS/170-60 and CSS/170-60, may be utilised where the cold mix is to be used immediately.

Cold mixes made with emulsions provide users with greater flexibility compared to the hot mix alternatives, which must be kept hot and bring additional costs when work is delayed. Because of the presence of cutters, the cold mix takes time to cure, so it is not advisable to use this technique on heavily trafficked roads. Cold mix should also be avoided where the road is to be resealed within the next few months as solvent present in the uncured mix may soften the new seal or pavement.

**Application**

Local trials are the best way to ensure cold mixes are prepared to optimal specifications. They can be prepared in a concrete mixer or similar equipment. The aggregate should ideally have a minimum proportion of fines. Typical mix proportions have 70 to 90 litres of CAM emulsion to one cubic metre of aggregate. When patching with cold mix, it is necessary to grit the surface prior to traffic to avoid stone pick-up.

**Slurry Surfacing**

Bituminous slurry surfacing incorporates well-graded fine aggregate, mineral filler, water and specially formulated bitumen emulsions.

The slow setting grades, ASS/170-60 and CSS/170-60, may be suitable for the preparation of conventional slurry seals. However, these slurry types have been superseded by quick-setting, quick-traffic, polymer-enhanced slurries, called microsurfacing, which set rapidly and exhibit high strength.

**Stabilisation**

Pavement stabilisation is undertaken to improve the properties of road base, sub-base or subgrade materials.

Bitumen emulsions are used in pavement stabilisation to improve the cohesive strength of granular, low cohesion, low plasticity materials.
Soil and batter stabilisations are also undertaken with bitumen emulsions to improve their integrity and resistance to damage by water. Slow setting grades of bitumen emulsion, such as ASS/170-60 and CSS/170-60, are recommended. In soil and pavement stabilisation, bitumen emulsion is usually required to be added at 2% to 5% by mass of residual binder to provide the required gain in strength.

Addition of emulsion is readily achieved with damp materials and results in good dispersion. However, if emulsion is added to dry soils, premature break of the emulsion may occur and result in uneven distribution throughout the mix. Excessive moisture in the soil may cause instability in the mix and prevent optimum compaction.

In-situ soil and pavement stabilisation may be undertaken with special equipment. This machinery scarifies the pavement surface and either meters the emulsion into a small pug-mill with the pavement material, or sprays it directly onto the scarified surface material. Thorough mixing of the emulsion with the scarified material is essential, regardless of which process is chosen.

Use of fixed plant mixing is common for stabilisation of materials such as crushed rock and gravel base.

Batter stabilisation is usually undertaken using either of two techniques – mulching or jute mesh. Mulching involves addition of straw or hay to the soil surface where the straw or hay has either been pre-mixed with dilute bitumen emulsion or is sprayed over by dilute emulsion.

Jute mesh is a woven material with around 20mm mesh size. It is fixed in place over the area to be stabilised by a heavy application of bitumen emulsion. The jute mesh technique is particularly applicable where high water run-off will occur during plant establishment.

Pavement and soil stabilisation may benefit from the use of specially formulated bitumen emulsions tailored to suit the particular job materials.

**Application**

For straw or hay mulching, slow setting bitumen emulsions, such as ASS and CSS grades, diluted at a ratio of 1 part water to 1 part emulsion, should be applied at the rate of 1 L/m² to 2 L/m². When the mulch is pre-mixed, the application rate may be higher, up to 6 L/m².

Jute mesh stabilisation uses slow setting bitumen emulsion diluted 1:1 with water applied at 1 to 2 L/m² prior to laying of the mesh, followed by a further 2 to 4 L/m² of dilute emulsion.

**Dust Laying**

Dust laying is the application of a low viscosity bituminous binder to a dusty road surface to reduce the generation of dust clouds and to help protect the condition of the road surface.

ASS/170-60 and CSS/170-60 grades diluted with water to about 1 part in 10 parts of water can be used to suppress dust formation.

**Application**

Application is typically by water sprayer at rates of about 1 L/m² of diluted emulsion. Further regular applications may be required. Refer to the following for details on the best practice for spraying and dilution.

**Application Considerations**

**Spraying**

Conventional bitumen spraying equipment may be used to apply bitumen emulsion sprayed seals, primer seals and surface enrichments. Other equipment, such as water sprayers, may be used for jobs such as dust laying, however the application rate will be less accurate. Note that extreme care should be taken to ensure that hot bitumen is not placed in sprayers containing traces of water.

Bitumen emulsions are generally sprayed at between ambient temperature and 50°C. A4 spray nozzles are suitable for most applications of bitumen emulsion, however S2 spray nozzles may be required for light applications.

Special emulsion grades containing very high binder contents may require the use of B6 spray nozzles.

**Dilution**

For surface enrichment, tack coating and stabilisation work, dilution of the emulsion by water may be required. If dilution is required then water should be checked for its compatibility with the emulsion. The most appropriate practice is to mix small amounts of the water and bitumen emulsion in a container and watch for breaking or separation of the bitumen.

Addition of water to the emulsion is considered the best practice rather than the addition of emulsion to water. In the latter case, emulsion may break down due to the initial over-dilution.
Handling and Storage

Bitumen emulsions must be stored and handled carefully to ensure their integrity and to minimise maintenance problems. Simple rules should be followed to achieve the maximum benefit from emulsions.

Storage

Bitumen emulsions generally suffer from settlement of the bitumen particles due to the effect of gravity, as the bitumen is denser than water. Periodic mixing of storage tank and drum contents is required to prevent settlement.

Drums of bitumen emulsion should be rolled end over end at least fortnightly to ensure any settled material is redispersed. This is particularly important immediately prior to use.

Excessive mixing may cause an emulsion to break, resulting in the formation of very large particles or lumps of coagulated bitumen. This may also result from contamination of the emulsion by rust, dirt, sand or other foreign material.

Excessive evaporation of water from the surface of an emulsion may result in the formation of a surface skin of bituminous material. This can be minimised by the use of upright cylindrical storage tanks which have a low surface area per unit volume.

Pumping

Generally, all operations with emulsions should be gentle to minimise the possibility of breaking. Pumping should be with suitable pumps, such as centrifugal pumps or positive displacement pumps with larger than normal clearances to prevent excessive shearing effects. Gravity transfer of emulsions is a cost-effective method which causes little damage to an emulsion.

Mixing or agitation should be kept to a minimum whilst ensuring settlement does not occur. Settled bituminous binder at the bottom of storage tanks will be difficult to pump and will break down more readily in a pump due to the greater shearing effect.

Transportation

Transportation of emulsion should always be in full tankers or drums as this will minimise the effects of sloshing and foaming. Tankers should be filled by directing the emulsion to the bottom of the tanker compartment to minimise foaming. Foamed emulsion will suffer from excessive evaporation of water and result in the formation of a broken skin on the surface. This broken surface layer may then become mixed into the bulk material and subsequently cause problems such as increased settlement or sprayer nozzle blockages.

Cleaning

Storage tanks should be cleaned regularly by thoroughly flushing them with water, then with solvent such as kerosene, then with water again. Road or other tankers used to transport materials other than bitumen emulsions should be checked prior to loading emulsion for the presence of possible contaminants and cleaned if necessary.

It is especially important that both transport and storage tanks be thoroughly cleaned prior to changing from cationic to anionic emulsions or vice versa. Many instances exist where failure to do this has resulted in a tank full of solid bitumen being permanently put out of service. Tanks should also be cleaned when changing emulsion suppliers.

<table>
<thead>
<tr>
<th>LAST PRODUCT LOADED</th>
<th>PRODUCT TO BE LOADED</th>
<th>Bitumen (see note)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Cutback bitumens, primers and precoats</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Anionic bitumen emulsions</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>Cationic bitumen emulsions</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

Procedure A: Drain tank and flush with kerosene.

Procedure B:

a) Drain tank.

b) Flush out surplus product with water until water is not discoloured. Drain tank and lines.

c) Flush with kerosene and drain tank.

d) Flush out surplus kerosene with water and drain tank and lines.

Procedure C: Drain tank.

Note: Loading bitumen into road or similar tankers which have previously contained bitumen emulsions or in which any water is present may result in the explosive emission of the tank contents due to the rapid expansion of water vapour.
Handling and Storage

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Emulsions is a cost effective method which causes little
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Excessive evaporation of water from the surface of an
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Excessive mixing may cause an emulsion to break,

Drums of bitumen emulsion should be rolled end over end at
drum contents is required to prevent settlement.

is denser than water. Periodic mixing of storage tank and
is maximum benefit from emulsions.

Bitumen emulsions must be stored and handled carefully
to ensure their integrity and to minimise maintenance

Note:

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<tr>
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<td>Bitumen</td>
</tr>
<tr>
<td>Primers and precoats</td>
<td>Anconic emulsion</td>
</tr>
<tr>
<td>Bitumen</td>
<td>Anionic emulsion</td>
</tr>
<tr>
<td>Cationic emulsion</td>
<td>A</td>
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<tr>
<td>A</td>
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<tr>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

Health, Safety and Environment

Do’s and Don’ts

While bitumen emulsions are easy to handle and use, there are some important rules to remember as shown in this table.

<table>
<thead>
<tr>
<th>DO</th>
<th>DON’T</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Store like water, i.e. above freezing (0°C) and below boiling (100°C), usually between 15°C and 60°C.</td>
<td>• Never heat above 85°C as water may be driven off at elevated temperatures resulting in a skin of bitumen on the surface.</td>
</tr>
<tr>
<td>• Use gentle heating systems with heating element surface temperatures below 85°C.</td>
<td>• Never allow an emulsion to freeze as this generally causes them to break.</td>
</tr>
<tr>
<td>• Store at the temperature specified for the particular grade.</td>
<td>• Never allow heating surfaces to exceed 100°C as this will cause the emulsion to break.</td>
</tr>
<tr>
<td>• Protect pumps, valves and lines from very cold temperatures to ensure optimum performance.</td>
<td>• Never bubble or blow air through an emulsion to agitate it as this will create excessive foam and may cause the emulsion to break.</td>
</tr>
<tr>
<td>• Clear lines by blowing them out with air and leave drain plugs open when out of service.</td>
<td>• Never use tight fitting pumps as they may ‘freeze’.</td>
</tr>
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<td>• Use pumps which have proper clearances for emulsion use. Tight pump clearances may cause emulsion breakdown and pump seizure.</td>
<td>• Never mix different types and grades of emulsion in storage tanks. Mixing anionic and cationic grades will result in the blend breaking and separating into water and bitumen.</td>
</tr>
<tr>
<td>• Heat trace pumps to prevent overload at start-up.</td>
<td>• Never apply severe heat to pump packing glands or casings as this may damage the pump and cause any deposited bitumen to harden.</td>
</tr>
<tr>
<td>• Check the compatibility of water being used for emulsion dilution and always add water to the emulsion, not emulsion to water.</td>
<td>• Never excessively dilute rapid setting grades of emulsion as this may cause them to break.</td>
</tr>
<tr>
<td>• Regularly mix tank contents by gentle agitation or recirculation to prevent build-up of sedimented bitumen particles.</td>
<td>• Never use excessive agitation or recirculate emulsion for too many cycles as this may cause emulsion breakdown.</td>
</tr>
<tr>
<td>• Always load emulsion into tanks using a method which prevents excessive foam formation, e.g. by top loading into road tankers using a spear extended to the bottom of the tank.</td>
<td>• Avoiding the ingress of water through open hatches and manholes.</td>
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<td>If a road or similar tanker has been used to transport bitumen emulsion, or the presence of water is suspected, then loading of hot bitumen or hot cutback bitumen should commence very slowly and with great care. It is advisable in these circumstances to only fill the tank to no more than 25% capacity and then leave it for a period of at least an hour to drive off the water as vapour.</td>
</tr>
</tbody>
</table>

For full health, safety and environmental information associated with the use of bitumen emulsions, please refer to the appropriate material safety data sheet (MSDS).

In general, eye and skin contact with bitumen emulsions should be avoided through the use of appropriate personal protective equipment (PPE). Suitable PPE is described in the MSDS.

Tank contents may froth over when loading hot bitumen if it comes into contact with water or bitumen emulsion inside the tank. Care should be taken to ensure this is avoided by:

• Removing water from pipes and other fittings before passing product through them to a tank which contains bitumen.

If a road or similar tanker has been used to transport bitumen emulsion, or the presence of water is suspected, then loading of hot bitumen or hot cutback bitumen should commence very slowly and with great care. It is advisable in these circumstances to only fill the tank to no more than 25% capacity and then leave it for a period of at least an hour to drive off the water as vapour.
For advice on which product to use to meet your specific job requirements, please contact us:

**On the web:**
roadsthatperform.com.au

**By email:**
bitumen.au@pumaenergy.com

**Technical Helpline:**
1800 24 88 66

Or contact the Puma Bitumen sales manager in your region.
Puma Bitumen Locations

Head Office
Puma Energy Australia
Level 1, North Tower, Green Square
515 St Pauls Terrace
Fortitude Valley, QLD 4006
T 1300 726 706
F 1300 723 906
PO Box 95, Fortitude Valley, QLD 4006

Queensland/Northern Territory
Puma Bitumen Townsville
1 Benwell Road
South Townsville, QLD 4810
T 07 4724 9500
PO Box 2267, Townsville, QLD 4810

New South Wales
Puma Bitumen Sydney
Suite 2.10, Aero 247 Building 247
Coward Street, Mascot, NSW 2020

Tasmania
Puma Bitumen Selfs Point
Selfs Point Road, New Town, TAS 7008
T 03 6278 1310
F 03 6278 2205
PO Box 282, Moonah, TAS 7009

Victoria / South Australia
Puma Bitumen Altona
55 Toll Drive, Altona North, VIC 3025
T 03 8368 8700
F 03 8368 8701
PO Box 495, Altona North, VIC 3025

Western Australia
Puma Bitumen Kwinana
Mason Road, Kwinana, WA 6966
T 08 9419 9712
F 08 9419 9820
PO Box 2131, Rockingham, WA 6167