# Asphalt Emulsion

Emulsified asphalt, as used by TxDOT, consists of asphalt droplets suspended in water. This dispersion under normal circumstances would not take place, since everyone knows that oil and water don't mix, but if an emulsifying agent is added to the water the asphalt will remain dispersed.

Most emulsion used by TxDOT is for surface treatments. Emulsions enable much lower application temperatures to be used. Application temperatures range from 45°C to 70°C. This is much lower than the 150 to 190°C used for asphalt cements. The lower application temperatures will not damage the asphalt and are much safer for field personnel.

In the production of asphalt emulsion, water is treated with an emulsifying agent and other chemicals and is pumped to a colloid mill along with asphalt. The colloid mill breaks the asphalt up into tiny droplets. The emulsifying agent migrates to the asphaltwater interface and keeps the droplets from coalescing. The emulsion is then pumped to a storage tank.

Asphalt emulsions are very complicated and use a lot of chemistry to get the emulsion properties desired. Variables in emulsion production include the base asphalt and the type and amount of emulsifying agent. There are two basic classifications of emulsions used by TxDOT, anionic and cationic. The type (chemistry) of the emulsifying agent used determines the designation. Emulsifying agents are the chemicals used to stabilize the emulsion and keep the "billions and billions" of asphalt drops separated from one another. These compounds are large organic molecules that have two distinct parts to them. These parts are called the "head" and "tail." The "head" portion consists of a group of atoms that chemically have positive and negative charge areas. These two charged areas give rise to the head being called polar (as in poles of a magnet). Because of this polarity, and the nature of some of the atoms in this polar head, the head is soluble in water. The tail consists of a long chain organic group that is not soluble in water, but is soluble in other organic materials like oils (asphalts). Thus, an emulsifying agent is one molecule with both water-soluble and oil soluble portions. This unique characteristic gives the chemical its emulsifying ability.

**Anionic Emulsions**

The term anionic is derived from the migration of particles of asphalt under an electric field. The droplets migrate toward the anode (positive electrode), and hence the emulsion is called anionic. In an anionic emulsion, there are "billions and billions" of asphalt droplets with emulsifying agent at the water asphalt interface. The tail portion of the emulsifying agent aligns itself in the asphalt while the positive portion of the head floats around in the water leaving the rest of the head negatively charged and at the surface of the droplet. This imparts a negative charge to all the droplets. Since negatives repel each other, all the droplets repel each other and remain as distinct asphalt drops in suspension. A typical anionic emulsifying agent is shown below along with a diagram showing the orientation of the agent at the asphalt-water interface and the negative charge imparted to each drop.

*Typical Anionic Emulsifying Agent*

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  H H H H H H H H H H H H H H H H H O |
  | | | | | | | | | | | | | | | |   ‖ -
H-C-C-C-C-C-C-C-C-C-C-C-C-C-C-C-C-C-O-Na +
  | | | | | | | | | | | | | | | | |
  H H H H H H H H H H H H H H H H H
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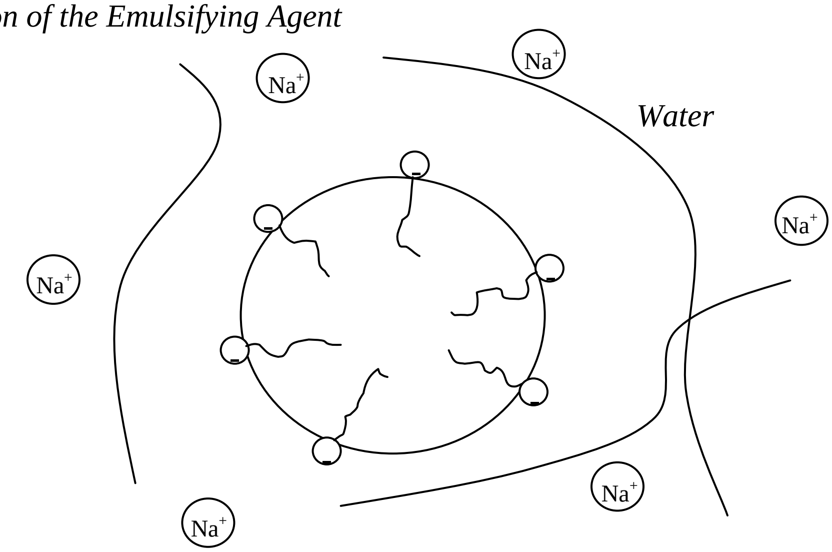
*Action of the Emulsifying Agent*

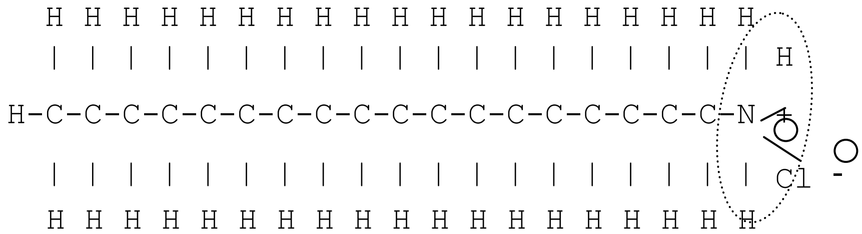



*Droplet has a Net Negative Charge.*

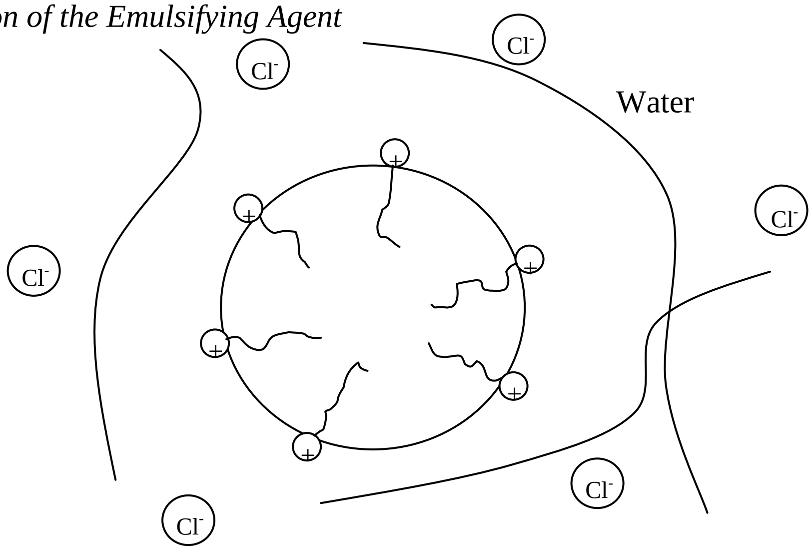
**Cationic Emulsions**

The term cationic is derived from the migration of particles of asphalt under an electric field also. The droplets migrate toward the cathode (negative electrode), and hence the emulsion is called cationic. The cationic emulsifying agent functions similarly to the anionic; the negative portion of the head floats around in the water leaving a positively charged head. This imparts a positive charge to all the droplets. Since positives repel each other, all the droplets repel each other and remain as distinct asphalt drops in suspension. A typical cationic emulsifying agent is shown below along with a diagram showing the orientation of the agent at the asphalt-water interface and the positive charge imparted to each drop.

*Typical Cationic Emulsifying Agent*



*Action of the Emulsifying Agent*



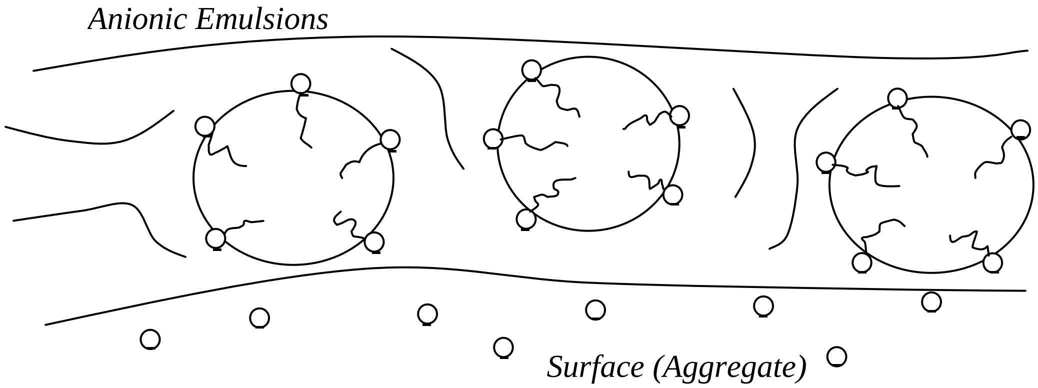

*Droplet has a Net Positive Charge.*

**Breaking Characteristics of Emulsions**

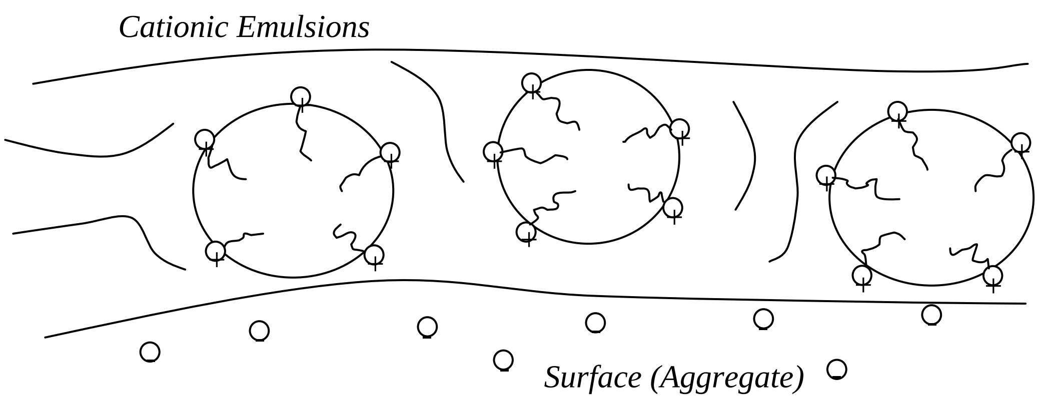
Emulsions exist for ease of application. After application we (the user) want the water to evaporate leaving the asphalt cement. In a surface treatment, after emulsion and aggregate have been applied to the road surface, we want the emulsion to “break” leaving the asphalt cement holding the aggregate. At that point we may allow traffic on the surface without loss of aggregate. The type of emulsion used has a large effect on the speed of the “break” of an emulsion.

Almost all surfaces have a net negative charge. The strength or intensity of this negative charge may be different from material to material. Because of this phenomenon, anionic and cationic emulsions break in different ways.

In an application of anionic emulsion, we are applying negatively charged drops of asphalt to a negatively charged surface. All components repel each other. The only way the emulsion can break is through the loss of water by evaporation. As more and more water is lost through evaporation, the particles are forced closer and closer together until they can no longer be separated by a film of water. At this point droplets coalesce into larger and larger drops and ultimately a sheet of asphalt on the road. A depiction of the application is shown below.




In an application of cationic emulsion, we are applying positively charged drops of asphalt to a negatively charged surface. The asphalt drops are immediately attracted to the surface and begin to break. The emulsion also losses water by evaporation. Thus the cationic emulsion has two breaking mechanisms at work and will break faster than a corresponding anionic emulsion. A depiction of the application is shown below.




The object of a surface treatment is to seal the road from moisture intrusion and provide a new skid resistant surface, but be open to traffic as soon as possible and retain aggregate. Due to the chemistry of emulsions, they may react differently in specific weather and application conditions. If you have problems in any of these areas, the problem could be because of the weather, aggregate condition or emulsion used. Below is a sampling of possible problem causes and some ideas to try and help the situation.

1) Condition: Low Humidity.
   Response: Anionic emulsions will work better than cationic emulsions. (Use HFRS-2 or HFRS-2P instead of CRS-2, CRS-2P, or CHFRS2P.) Wetting down the stockpile may help also.

2) Condition: High Humidity.
   Response: Cationic emulsions will work better than anionic emulsions.

   (Use CRS-2, CRS-2P, or CHFRS-2P instead of HFRS-2 or HFRS2P).

3) Condition: Dry dusty aggregate (possibly very absorptive).
Response: Using an anionic emulsion will be better than a cationic. (Use HFRS-2 or HFRS-2P instead of CRS-2, CRS-2P or CHFRS2P.) Wetting down the stockpile may help also.

4) Condition: Dusty Limestone.
Response: Use and anionic emulsion like HFRS-2 or HFRS-2P. The stockpile may be wet down or the rock could be precoated.

5) Condition: Hard non-absorptive rock.
Response: Either and anionic or cationic emulsion will work. Cure time will be shorter with a cationic emulsion (CRS).

6) Condition: Need a fast break to open the road to traffic quick.
Response: All things being equal, cationic emulsions cure faster than anionic emulsions. Use a CRS-2, CRS-2P or CHFRS-2P.