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With Asphalt Emulsions, **HIGH FLOAT = HIGH PERFORMER**



Unlike conventional asphalt emulsions, after the water evaporates, high floats leave more than just asphalt behind

By Tom Kuennen, Contributing Editor

In the potentially bewildering “alphabet soup” of asphalt emulsion nomenclature, one term stands out: *high float* asphalt emulsions.

Asphalt emulsions may be designated RS, SS, QS, MS, C or AE; can be P, M or L modified; and can carry a host of numbers that designate asphalt penetration spec, or low or high viscosity. That such a plethora of designations exists underscores the sophistication of today’s engineered asphalt emulsions for just about any pavement application.

So when the prefix “HF” appears in the

type of asphalt emulsion for road work, what does it mean? An HF in the designation indicates a high float emulsion, an engineered asphalt emulsion that adds value to classic asphalt emulsion applications, from chip seals to cold recycle mixes, to mixes used for roads.

Polymer-modified HF emulsions are made with a special family of emulsifying agents that leaves a gel structure behind in the asphalt residue, and were developed for low volume roads in areas where a graded cover aggregate is to be used, according to the Iowa Highway Research Board (IHRB).



Steve Muncy
for BASF Corp.

Forces of TxDOT District 15 place chip seal utilizing CHFRS-2P asphalt emulsion in May 2011.

About asphalt emulsions

Asphalt emulsions – mixtures of liquid asphalt and water – make liquid asphalt go farther, covering more square yardage and aggregate surface area for asphalt pavement preservation surfacings than possible with thicker lifts of hot or warm mix asphalt, all things being equal.

While they don't add structural value, these thin surfacings aren't intended to. Instead, they protect aging asphalt pavements, seal cracks, retain aggregate, waterproof pavement structure, enhance friction, and with rejuvenators, give new life to an aged, oxidized asphalt surface. Emulsions used in full depth reclamation (FDR), though, can add structural value to a pavement cross section.

After placement on a pavement, the emulsified asphalt sets or "breaks" as the asphalt droplets precipitate or fall out of the water suspension and coat the aggregates placed in the emulsion. At this time, the color of the emulsion turns from brown to black. 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.

Asphalt emulsions are essential to nearly all aspects of pavement preservation, be they in-place recycling, chip seals, fog seals, scrub seals, or slurry or micro surfacings.

An asphalt emulsion is a homogeneous mixture of two insoluble substances, oil and water. In it particles of liquid asphalt (in the dispersed phase) are surrounded by molecules of water (the continuous phase), along with the emulsifier chemistry.

An emulsion is not a solution, which is a homogeneous mixture of two substances that are soluble with each other. Instead an emulsion is much like a solution, but as the two substances won't dissolve into each other, small particles of one substance must be created that will become surrounded by the other substance.

Because asphalt generally is solid at ambient temperatures, its viscosity must be lowered in order for it to be used. Energy can be added to the material to heat and liquefy it; solvents can be added to liquefy it; or it can be emulsified.

When you emulsify asphalt, you are creating a vehicle, so to speak, that will transport asphalt without having to heat it nearly as much as hot mix asphalt, or use high mechanical energy to spread it in a thin layer, or coat the surface of a rock. The water part or side

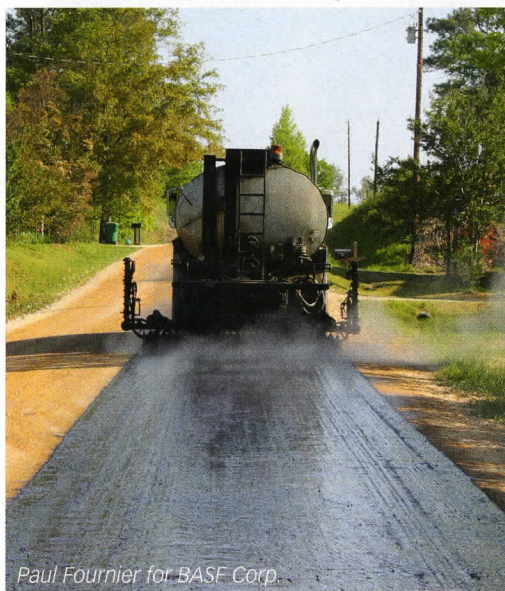
of the emulsion is a vehicle that is used to get the asphalt in place, and then it departs via evaporation. Once the water is gone, all that's left is the residual asphalt, traces of the emulsifier, and traces of other additives.

Another way of looking at it is that asphalt is emulsified to reduce its viscosity, making it liquid at ambient temperatures. Benefits include reduced energy use and costs, as not as much heat is required to

get the asphalt usable. Worker exposure is less as they are not exposed to vapors and fumes from either the asphalt itself, or from cutback asphalt solvents. And there is less opportunity for burn hazards and jobsite odor, which is important in residential areas.

Powerful blenders or colloid mills create asphalt and polymer modified asphalt emulsions. The mill consists of two parts: a stationary element called the stator, and a rotating part called the rotor. A small gap separates the two, on the order of a millimeter in diameter, up to 75/1000 of an inch across.

Hot liquid asphalt, water and an emulsifying agent are brought together in the mill, where the spinning blades of the rotor break or shear the liquid asphalt against the stator



Charles E. Watts Inc.'s E.D. Etnyre & Co. distributor sprays high-float emulsion at rate of 0.395 gal per sq. yd. on Route 29 surface following reclamation by Cherokee County, AL, forces.

into suspended micro-droplets. The asphalt globules first elongate, then break into two or three smaller particles, which themselves break up into even smaller particles. The emulsifier – commonly a surfactant or surface-active agent, think “soap” or “detergent” – maintains the microscopic asphalt droplets in a stable suspension within the water, keeping them from recombining.

Decoding asphalt emulsions

There are two main types of emulsions, cationic (positively charged) and anionic (negatively charged). Because like charges repel, bitumen droplets bearing the positive (cationic) emulsifier will repel each other, keeping them from recombining, thus providing a storage-stable asphalt emulsion product. The same is true for droplets bearing the negative (anionic) emulsifier.

Cationic emulsions begin with a “C.” If there is no C, the emulsion is usually an anionic, reports the Asphalt Institute (AI). Emulsified asphalts come in rapid-, medium-, and slow setting grades for different applications and are developed through the use of different emulsifying agents and the addition of some solvents. Still, their asphalt droplets or particles will be either anionic or cationic.

Either way, it's the emulsifier producer which applies the charge to the emulsifier molecule by making changes in its chemistry.

After the charge designation, the next set of letters describes how quickly an emulsion will set or coalesce to a continuous asphalt mass. The standard terms are RS (Rapid Set), MS (Medium Set), SS (Slow Set), and QS (Quick Set).

Rapid-setting emulsions are used mostly for chip seals, fog seals and bond (tack) coats, while the medium- and slow-setting grades are used for emulsions mixes for recycling, and also fog seals or bond coats placed in advance of asphalt lifts.

“RS emulsions break rapidly and have little or no ability to mix with an aggregate. MS emulsions are designed to mix with aggregates, and are often called mixing grade emulsions,” according to the AI. “MS emulsions are used in cold recycling, cold and warm

dense-graded aggregate mixes, patch mixes and other mixes.”

SS emulsions are designed to work with fine aggregates to allow for maximum mixing time and extended workability, AI says. “They are the most stable emulsions and can be used in dense-graded aggregate bases, soil stabilization, asphalt surface courses and some recycling. SS emulsions can be diluted with water to reduce their viscosity so they can be used for tack coats, fog seals and dust palliatives. SS emulsions are also used as driveway sealers.”

QS emulsions work well with fine aggregates but are designed to break faster than SS emulsions. QS emulsions are used in micro surfacing and slurry seal designs. The quick break allows for faster opening to traffic.

After the set designation, there is a series of numbers and letters that further describe the characteristics of the emulsions. The number 1 or 2 designates the viscosity of the emulsion, with the number 1 meaning lower viscosity and 2 meaning higher viscosity.

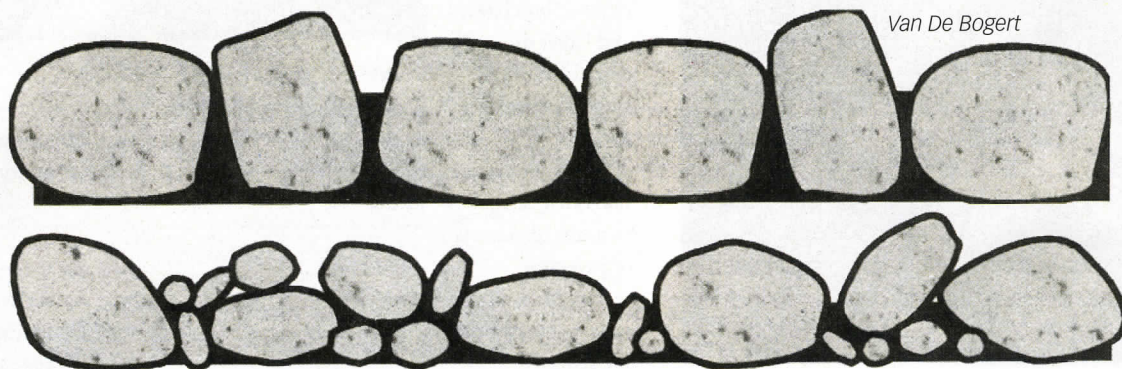
If there is an “h” at the end of the name it indicates a harder base, whereas “s” indicates a softer asphalt base. For example, SS-1h is a slow setting emulsion with a lower viscosity made from a relatively hard base asphalt. A P will be added to the set

Technology & Development Center U.S. Forest Service. “This is not so with an HF emulsion. The high float emulsifying agent creates a gel structure in the asphalt residue. The gel structure permits a thicker asphalt coating on the aggregate particles.”

This thicker film prevents raveling and is more resistant to oxidation from exposure to the atmosphere, Yamada says. “The high float residue is resistant to flow at high temperatures while not being affected as much by low temperatures. This allows a softer grade of the base asphalt to be used that will resist bleeding at high temperatures. The softer asphalt does not become as brittle at low temperatures and resists thermal cracking. HF emulsions are commonly used in hot arid environments with cold evenings.”

This gel structure prevents flowing at high temperatures and low shear rates, and allows the use of softer ACs, which aren't as brittle at low temps, according to Steve Van De Bogert, Western States Asphalt, during a presentation at the Northwest Pavement Management Association. “The gel structure doesn't flow at pavement surface temperatures,” Van De Bogert says. “That's why they tend to bleed less than other unmodified emulsions or cutbacks.”

Use of high float emulsions was mandated by the Alaska state legislature in 1983,



designation to show the presence of polymer in the emulsion. An L indicates the presence of latex polymer. Therefore CRS-2P is a cationic, rapid setting emulsion having a higher viscosity and containing some polymer.

Where high float fits in

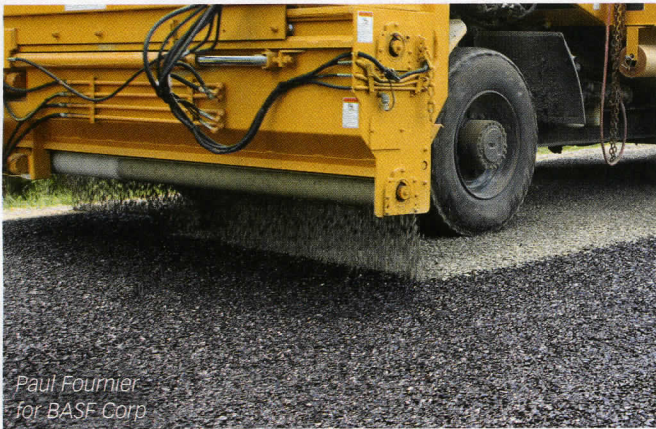
Unlike conventional asphalt emulsions, after the water evaporates, high floats leave more than just asphalt behind.

“Usually, when an emulsion breaks, the remaining emulsifying agent has little effect on the asphalt,” says Alan Yamada, San Dimas

Standard chip seal (top) is one layer thick with similar-graded aggregate, and the asphalt residue glues the chips down; in chip seal using high float emulsion (bottom), here called the Otta seal, matrix of rock interlocks for strength, while asphalt residue fills small voids and surrounds rocks as in an HMA lift.

which required the Alaska Department of Transportation & Public Facilities to investigate its use. Its first application of high float emulsion was placed in 1984, following

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Smaller, top stone, spread at 24 to 25 lbs. per sq. yd., will interlock with bottom stone when compacted by rollers.

Guide. "The high float [asphalt surface treatment] provides roughly the same service life and function as a double-layer AST,"

according to the guide. "The high float AST comprises a single, heavily applied layer of special high float emulsified asphalt, followed by a single layer of well-graded crushed cover aggregate. The cover aggregate is similar in gradation to a common base course.

"The high float cover aggregate is rolled, and after several days (usually), broomed to complete the paving," the guide continues. "The timing and amount of brooming depends on weather conditions and traffic, e.g., light

brooming may be required after no more than 24 hours. High float ASTs are placed on a smooth base course surface."

First use in a warmer climate

Although Alaska and Canada use high float emulsions because of their superior performance in cold climates, a county in Alabama has begun using them in its warm climate as well.

In 2009, an Alabama contractor introduced a rapid setting, high float asphalt emulsion for a Cherokee County, AL, pavement preservation treatment that saved time between applications, and expedited the return of traffic to the county road.

Gadsden, AL, paving specialist Charles E. Watts Inc., received permission from the county highway department to use CHFRS-2P, a cationic, high-float rapid-setting emulsion modified with latex, on its contract to double-chip seal a section of County Route 29. This was the first-time use of the product in an Alabama county.

Double-chip seal treatment consists of

Canada's first use in 1974. There, Canada found it very effective on highways where permafrost makes paving difficult, with a life expectancy between three and seven years.

There the high float technique used is an "Otta" seal, a Scandinavian innovation, which is an asphalt surface treatment constructed by placing a graded aggregate on top of a thick application of relatively soft bituminous binding agent.

The binder works its way into the aggregate with rolling and traffic. In comparison to other surface treatments, material and construction specifications are not as strict.

Local aggregates that would not meet the requirements for high quality paving aggregate are often used in Otta seals, said MnDOT's Greg Johnson and John Pantelis in their report, *Otta Seal Surfacing of Aggregate Roads*. As a binding agent, Minnesota has used HFMS-2s emulsified asphalt exclusively.

"Otta seals are constructed over an aggregate base course," says the report. "Since Otta seals do not add structural capacity to the roadway, the base/subbase must be designed to support the anticipated traffic loading. Subgrade and base materials should be compacted and graded to provide a stable working surface prior to Otta seal placement. A prime coat is usually not used above the aggregate base prior to Otta seal application."

In Alaska, dense-graded, high-float emulsion asphalt surface treatments (ASTs) have become a preferred, low-cost alternative for primary and maintenance paving in Alaska, says Alaska DOT&PF's *Asphalt Surface Treatment*

All-wheel drive E.D. Etnyre & Co. chip spreader broadcasts bottom stone at rate of 38 lbs. per sq. yd. over Cherokee County, AL, Route 29 near U.S. Route 411 intersection.



spraying a pavement surface with asphalt emulsion, covering this with a layer of stone, and repeating the process but using the same emulsion at a different application rate, and smaller stone. Compaction by rollers forces the smaller stone to interlock with the larger. Over the years this process has proven to be the best surface maintenance treatment for their roads, according to county engineer Corey Chambers.

"We get more roads done for the dollar with double chip seal than we do with 1 1/2- to 2-inch hot mix asphalt, about three times the length," says Chambers. He said the treatment adds 10 years or more of pavement life, citing as an example the pilot application of latex-modified high-float emulsion, which took place on a section of County Route 29 that was last double chip sealed in 1991.

There was no waiting between applications, or before traffic was allowed on completed sections of road. "Normally, the contractor would use a CRS-2 emulsion and then wait for it to set up," Chambers says. "But the cationic high float set up quickly, ready for the next layer of stone. It speeded up the job."

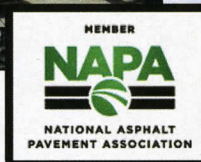
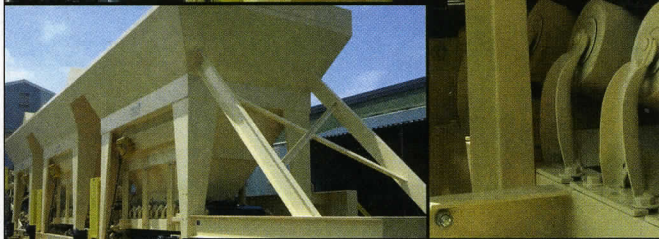
Not just for rural roads

Surface treatments using high float asphalt emulsions aren't just for rural roads. For example, use of a high-performance, high float emulsion for seal coats is providing an urban Texas county more durable chip seals, less disruption to traffic in an urban area, and significantly fewer broken windshields.

"Chip seals are economical and are one of the better treatments you can use to preserve pavements," says Tony Vasquez, public works



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operations manager, Bexar County, TX, in which the city of San Antonio is located.

"With chip seals, we get a thick coat of asphalt with a durable Grade 5 trap rock. With that combination our roads stay in great shape, which minimizes potholes, and the aggregate lasts from eight to 12 years."

While chip seals have been a long-time choice for preserving Bexar County pavements, in 2011 the county enhanced chip seal performance by adopting use of a new cationic, high-float, rapid-set emulsion.

"We used it for the first time in 2011, and it's become the only emulsion we will use," Vasquez says. "Our paving foreman, Sam Joiner, says he has seen an improvement in chip retention, that our sweepings are a lot fewer as he does not see those chips coming off, and we are able to get traffic back on the pavement a lot sooner."

Bexar County was using a CHFRS-2P asphalt emulsion from Ergon Asphalt & Emulsions Inc. That language denotes a cationic, high-float, rapid-set emulsion in the No. 2 viscosity range with polymer added. In this case the polymer is *Butonal NX 1122* from BASF Corp. Previously the county used a CRS-2P emulsion.

"Use of the new CHFRS-2P emulsion is part of our continuous effort to improve operations," Vasquez says. "We did a pilot program two years ago and tried it on one pavement. It worked so well we decided to try it extensively this year and our foreman Joiner noticed a lot better chip retention right away."

The emulsion handles in much the same way as the emulsion used previously, he says. "The CHFRS-2P handles the same as the CRS-2P," Vasquez says. "Our guys have extensive experience in handling the emulsions and I did not see any difference in handling between the two." **AC**

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