Better Asphalt Paving Through Chemistry

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By Helen King

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Do the asphalt materials you use meet the specifications? Can they be shipped, stored and handled without separating or going out of spec? Do they consistently give the expected results in mix plants, through pavers and under compaction? Do they rut, crack and form potholes, or do they stand up to traffic, high and low temperatures and moisture? Do they pass wheeltracking tests with flying colors? Are your emulsions stable during storage shipping and application; do your chip, slurry and micro-surfacing seals set and cure when you want them to? If they do, you can thank a chemist.

It is the chemistry of the asphalt that determines its physical properties and therefore its performance. While construction quality is vital to pavement performance, it is impossible to construct quality pavements without the right materials that are easy to store, mix, place and compact.

"Asphalt chemistry is a true challenge," says Dolly Navarrete, Ph.D., chief chemist for Houston-based Martin Asphalt Company. "Most chemists deal with pure, single molecular type chemicals with consistent physical properties. Asphalt chemists deal with materials that are very different." Crude oils are composed of hundreds of different types of molecules, ranging from the very small molecules of liquid propane to the very large molecules found in asphalt. One asphalt can contain hundreds of different types of molecules. This is further complicated by the differences in asphalts from different crude sources. It is the chemistry that determines whether a crude is sweet or sour, heavy or light and if it contains waxes, sulfur, nitrogen or a myriad of other chemical species. While refiners have options of the crude sources they use, their decisions are based on availability and optimization of refinery profitability. It is usually the more profitable lighter components that drive their decisions.

While major research institutions have been studying basic theoretical asphalt chemistry for decades, the practical application of chemical principles is becoming increasingly more important. Industrial asphalt chemists have two major goals: formulating to meet specifications and improving performance both during construction and on the pavement. Chemists blend and react materials and use additives to develop formulations that most cost-effectively meet the specifications. When asphalt specifications were driven by penetration or viscosity, most of the formulation was pretty simple – either taking the cut from the refinery that met the requirements, or blending hard and soft materials to the right consistency. The Strategic Highway Research Project (SHRP) in the 1990's really complicated things.

SHRP researchers developing the PG specifications initially thought that the goal was to specify the chemistry of the asphalts. They quickly found, however, that there were many different chemistries and the chemistries were very complex. Thus the decision was made to specify performance characteristics. SHRP estimated that to meet the PG specs, 25% of the asphalt used in the U.S. would be modified. Formulators have found that to be competitive, there are a whole range of products on the market that can be used to meet the letter, if not the spirit, of the PG specs. Responsible formulators make sure that their formulations meet the specs, are stable, are constructible and perform as expected.

Measuring asphalt viscosity in the lab.

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Chemists have also been busy to determine what blends and chemical additives can be used to improve asphalts as well as construction, maintenance and rehabilitation techniques. Chemical and lime anti-strips prevent water damage to asphalt pavements, adhesion promoters strengthen the bond between rock and asphalt binder, polymers improve strength and flexibility at both high and low temperatures, and other chemicals are used

to reduce costs while improving stiffness and meeting specifications.

Dr. Navarrete further states that, "Chemically stabilized asphalt emulsions can now be used for virtually any paving application." They are particularly ideal for surface treatments, in-place recycling, base stabilization and cold and warm mixes. They reduce energy needs and emissions while improving worker safety. Asphalt emulsion chemists use surface active chemicals to formulate the emulsions to be stable during shipping and storage, but to break at the wanted time. Because of the different asphalt chemistries, the emulsions must be formulated for compatibility of the chemicals with specific base asphalts. These formulations allow micro-surfacing to be opened to traffic in an hour, warm mixes to fully coat the aggregates, and recycled mixes to have the wanted strength.

Martin Asphalt lab tests dynamic shear rheometry.

"Pavement preservation, perpetual pavements and asphalt emulsions are becoming increasingly important industry issues," says Bill O'Leary, President of the Foundation for Pavement Preservation and VP of Martin Asphalt Company. "Industrial asphalt chemists are now developing exciting new chemistries for innovative techniques, such as warm mix asphalt, maintenance mixes, preventive maintenance and pavement rehabilitation techniques. To meet these new challenges, Martin has just hired our second Ph.D. chemist." <<

Helen King has over 25 years experience as an asphalt and asphalt emulsion chemist, and has written over 50 articles and technical papers on the subject. She is currently president of GHK, Inc.

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