WHEN WARM IS HOT

Warm asphalt offers major benefits for producers, contractors and clients.

Mike Woof reports on the application's future

The development of warm mix asphalt (WMA) technology is offering major benefits for road construction projects. This material can be produced and laid at lower temperatures than conventional hot mix asphalt, delivering several advantages for the road construction sector.

A crucial point is that lowering the asphalt production temperature by 20°-55° means that less energy is required by the plant, cutting energy consumption and running costs for the producer. According to extensive research, energy costs for the asphalt plant can be reduced by anything from 30-60% when producing a WMA, a significant saving that makes the material an attractive proposition. This lower production temperature offers another key advantage too, as the plant will emit far fewer fumes of volatile organic compounds (VOC). At a rough estimate, the quantity of fumes released can be reduced by around 50% for each 12°C reduction in temperature. This can significantly improve health and safety aspects and even result in facilities being allowed to be located in urban areas, without causing a disturbance.

The first WMA techniques were developed in the late 1990s, with suitable additives being tested in Germany and Norway. There are various systems now available to produce WMA and the technology is well proven in both Europe and the US. Several of the leading asphalt plant manufacturers such as Ammann, Astec, Benninghoven (Wirtgen) and Marini (Fayat) offer a range of WMA production solutions for the industry. A number of key contractors have also teamed up with these plant producers and with technical universities to further develop WMA technology, which can now be utilised with only a few small changes from standard practice using hot mix. One of the important areas has been improving workability at the lower temperatures of the WMA compared with hot mix.

The use of chemical additives has assisted this workability, while there has also been a great deal of development with regard to foaming the binder. Different organic additives are used to lower the viscosity of the binder at temperatures above 90°C. One of the most commonly used is a special paraffin wax produced by conversion of natural gas. Organic additives will generally allow a temperature reduction of around 20–30°C, as well as improving deformation resistance. The necessary additives for the WMA can either be pre-blended with the binder at the refinery or be inserted during the production process in the plant.

ABOVE: *A key benefit of warm asphalt is its low emissions performance*
LEFT: *Using warm asphalt allows for a high-quality surface to be delivered*

LEFT: *The warm asphalt material offers a wider window for compaction*

But the chemical additives will not change the viscosity of the bitumen. Instead these work as surfactants at the microscopic interface between the aggregates and the bitumen. The additives can help regulate as well as reduce the frictional forces at the microscopic interface. And surfactants can work across a range of temperatures from around 140°C-85°C. With the use of the additives it becomes feasible to mix the bitumen and aggregates and also compact the mixture at a lower temperature.

Meanwhile equipment has been developed specially that is fitted to an asphalt plant to carry out the foaming process. Various foaming techniques can be utilised to reduce the viscosity of bitumen with different methods used to introduce small quantities of water. This is delivered into the hot bitumen and the water turns to steam, increasing the volume by foaming and reducing its viscosity, allowing the coating of the aggregates at lower temperatures. Meanwhile any residual moisture can help later on with compaction of the mix once the mat has been laid.

However WMA can be produced and used utilising standard asphalt plants or paving and compaction machines, with only a few minor detail changes to equipment and processes needed.

Nor are the advantages restricted to the production of WMA either. In a similar fashion, the lower level of VOC fumes from WMA are of benefit on the worksite too. This can also minimise fume exposure for workers at the job site, addressing concerns over long-term health risks for construction personnel. And the lower temperature makes the material safer to work alongside, as well as being less challenging for the paver's screed controllers in hot weather.

Furthermore, the WMA material is less temperature critical when delivered onsite and is also more easily compacted. The first point means that a contractor has a wider time window in which to compact the WMA than for a conventional hot mix asphalt. The second means that the material can reach the required density with fewer roller passes, delivering an additional saving in terms of compaction need and fuel used. Both of these features can help eliminate the risk of under-compaction on a project (but in different ways), delivering a longer lasting surface as a result.

The use of WMA is well-suited to road construction applications involving stiff mixes as well as mixes utilising reclaimed asphalt pavement (RAP), although additional additives may be required for the latter.

An additional advantage of the lower temperature and longer workability too is that this allows for greater transport distances from the asphalt plant. With this, WMA can be delivered to sites at remote locations or in areas where there may be traffic delays, without concerns over a mix going 'off' while being transported.

"Contractors have successfully used WMA in base, binder and wearing course materials"

Because the WMA material is less temperature critical, it also allows a longer paving window through the year, so that surfacing work can start earlier and finish later in the season. This is another important point as it means contractors are less likely to be at the mercy of the weather or adverse climactic conditions. As a result, operations that use WMA are more likely to be delivered on time and on budget, as inclement weather will not hinder paving operations to such a degree. For construction projects being carried out in tough climates or conditions such as paving at higher altitudes (where weather and temperatures can be particularly unpredictable), WMA materials offer a good solution, without compromising on quality.

For time-critical road building operations on congested routes, a surface paved with WMA can be opened to traffic sooner due to the lower temperature of the material, lowering the impact of delays caused by construction work.

Meanwhile the lower temperatures involved in the production process reduces age hardening for the binder material, which can result in a road surface that will actually last longer.

On a wider scale, the reduced energy consumption and low level of hydrocarbon fumes helps to minimise both greenhouse gases and cuts the overall carbon profile of an operation. Contractors have successfully used WMA in base, binder and wearing course materials, with extensive trials in Europe and the US having proven the concept. Both Europe and the US have developed relevant standards for the use of WMA type asphalt and this material has been used with a great degree of success in many major highway projects as a result.

Although much of the research for WMA was carried out in Europe, take-up of the technology has been far quicker in the US. A survey carried out amongst US asphalt producers in 2012 revealed that around 25% of asphalt produced in the country was of the WMA type. The speed with which this has happened becomes apparent when it is realised that between 2009 and 2012 there was a 416% increase in the use of WMA. So far in the US, more than 40 states now have roads paved with WMA.

But WMA has also been used successfully in Europe for more than 10 years. And there is a strong move within the European asphalt industry to increase the adoption of WMA. Its lower emissions will help deliver the prime target of reducing bitumen fumes from paving operations.

If WMA is as useful as it appears, why are more operations not using it?

One of the key issues that can often dissuade specifiers from the outset is that WMA can be more expensive than conventional hot mix asphalt grades. In addition though there are technical issues regarding WMA that have to be addressed, as the lower temperatures involved meaning that there may be a risk of incomplete drying of the aggregates during the production process. But as WMA plants operate at temperatures above 100°C, the quantity of moisture remaining in the mix will be very small. And careful control of the asphalt production operation can eliminate the problem, avoiding the risk of trapped moisture in the coated aggregates. The first WMA pilot trials have been in place for some years but are still being analysed for long-term performance. ■