



# CRUDE PALM OIL FOR PAVING ROADS IN COLOMBIA

NEW SOURCES OF INCOME FOR THE OIL PALM AGRIBUSINESS









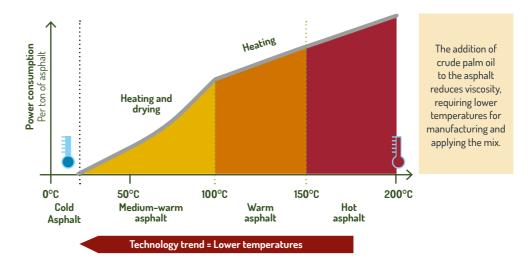


## **WARM MIX ASPHALT**

It is a material for the construction of pavement, comprised by asphalt and mineral aggregates which, in general, are a mixture of coarse, fine and mineral filler aggregates. The asphalt acts as binder, forming a cohesive mass that is ideal for building wearing courses.

Currently, the mixing and compacting processes of the asphalt mixes are made at high temperatures. The mixing temperature at the plant ranges from 150 to 200 °C, and the compacting temperature in the application of the wearing courses ranges from 130 to 150 °C, thus the name hot-mix. Asphalt and aggregates are heated to ensure a proper viscosity that is capable of covering the aggregate particles, optimizing the performance of the pavement; these procedures emit polluting gases that cause serious environmental damages.

Since the 1990's, the pavement industry around the world has been developing techniques that allow reducing asphalt mixing-and-application temperatures, resulting in a reduction in the emission of polluting gases, better labor conditions for the operators, and reducing the use of energy in both asphalt manufacturing and pavement placement operations. These are known as



**Figure 1.** Classification of asphalt concrete by temperature range. Source: The use of warm mis asphalt. European asphalt pavement association. 2014.

warm-mix asphalt technologies, which have the same performance as the hot mixes.

Different techniques have been used to reduce the viscosity of asphalt, allowing a complete cover of the aggregates and the subsequent compaction of the mix at low temperatures. The techniques to produce warm-mix asphalt may be classified according to the type of additive used to modify the viscosity of the asphalt. The most common additives include: organic additives, chemical additives, and foams. Figure 1 shows the

classification of the mixtures per temperature range.

The timeline below shows the development of warm-mix asphalt, indicating its international beginnings and the development conducted by Fedepalma based on the master's degree thesis "Diseño y producción de mezclas asfálticas tibias, a partir de la mezcla de asfalto y aceite crudo de palma" (Design and production of warm-mix asphalt from the mixture of asphalt and crude palm oil), conducted at the School of Mines of Universidad Nacional de Colombia, Medellín Campus.

## PROJECT DEVELOPMENT TIMELINE

Development of the first techniques for warm-mixed asphalt in Germany and Norway. The first test sections were constructed between 1998 and 2001. Laboratory tests of the Master's degree thesis "Diseño y producción de mezclas asfálticas tibias, a partir de la mezcla de asfalto y aceite crudo de palma" (Design and production of warm-mix asphalt from the mixture of asphalt and crude palm oil) by Conrado Lopera, thesis advisor: Jorge Eliécer Córdoba Maquilón. Universidad Nacional de Experts from the United States initiated research studies on this Colombia, Medellín Campus. technique. The first field tests were conducted in 2004. Laboratory tests show that palm oil has a great potential to reduce the viscosity of asphalt. Besides, the resulting mix shows good mechanical resistance. Fedepalma starts working with Universidad Nacional de Colombia Publication of the thesis results in Unimedios (Universidad Nacional to further develop this technique. Fedepalma contacts Luis Enrique newspaper), noting the 25% reduction in the mix manufacturing and Sabaria, Director of Corporación para la investigación y desarrollo application temperatures. de asfaltos - CORASFALTOS (Corporation for Asphalt Research and Development), who provides advice to the project, concluding that further analysis is required to characterize the asphalt mix with crude palm oil additives. Beginning of the design and characterization of the asphalt with crude palm oil at CORASFALTOS laboratories, under a contract with Fedepalma. Asphalt 60-70, with mineral aggregates and Marshall design are characterized. The rheological curve of the asphalt with crude palm oil additives showed a reduction between 5 and 9 °C in mixing and Humidity susceptibility, plastic deformation and fatigue resistance compaction temperatures. The asphalt mix with additives increased film tests for the asphalt mix with 1.0% of added crude palm oil are thickness by 0.3µm. conducted at CORASFALTOS. The mixture showed a satisfactory resistance to the damage caused by humidity; speed of plastic deformation is maintained within the limits established by INVIAS; and fatigue resistance tests show that oil palm-activated asphalt ensures a higher resistance than the conventional mix. In May, testing sections were monitored for the first time. The asphalt mix with crude palm oil additives maintains its properties and is in good conditions after 7 months of operation. CONASFALTOS applied a warm mix with oil palm additives that includes ground rubber from used tires in the municipality of San Pedro de los Milagros, Antioquia. The paving company CONASFALTOS enters the project. The joint effort between Fedepalma, CORASFALTOS, CONASFALTOS and Universidad Nacional allowed the construction of two testing sections using the asphalt mix with 1.0% of oil palm additive. This took place in October the municipality of Sabaneta, Antioquia.

# ASPHALT CONCRETE WITH CRUDE PALM OIL ADDITIVES TEST SECTION

### - MATERIALS -



Crude Palm Oil

- AGL % OR

acidity %: 2.40%

- Humidity %:

0.06%

- Impurity %:

0.022%

#### Mineral Aggregates

Aggregates were obtained from CONASFALTOS S.A. Bello quarry.

- Wear 500 rev: 23%.
- Wear 100 rev: 4%Fractured faces.96%



#### Asphalt 60/70

- Viscosity: 60 °C: 3150 P
- Penetration: 54(1/10 mm)
- Softening point: 49 °C
- The asphalt was modified with: 1% crude palm oil and 2% gilsonite

The reduction in the manufacturing temperature of the warm-mix asphalt requires less fuel for heating the mix, resulting in lower emissions at the plant.



# - MANUFACTURING OF THE ASPHALT MIX WITH 1.0% OF CRUDE PALM OIL ADDITIVE -



Addition of crude palm oil to the asphalt



Preparation of the asphalt mix at  $137 \pm 3$  °C





Production of 194 tons of this mix



Reduction of 10% of fuel usage in the production of the mix



We observed a significant reduction of steam emissions that generate volatile organic compounds







# TESTING SECTION OF THE ASPHALT MIX WITH CRUDE PALM OIL ADDITIVES

# - APPLICATION OF THE ASPHALT MIX WITH **ADDITIVES IN TWO TEST SECTIONS -**



Application of the mix at a temperature between 110-120 °C



Significant reduction in the generation of organic steams compared with a conventional mix

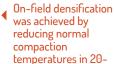




Mix compaction started at 115 °C and ended at

The mix showed good coverage and shine

Low manufacturing and placement temperatures of the warm mix minimize steam and odors emissions, creating healthier working conditions for workers. This positive aspect was noted by the application squad



30 ℃



The mix was applied in two sections of 100 and 90 meters long, 7 and 5 meters wide, and a thickness of 75 and 60 mm, respectively, in the municipality of Sabaneta, Antioquia, Medium traffic roads

# - FIRST MONITORING TO THE PAVEMENT -( ASSESSMENT 7 MONTHS AFTER THE APPLICATION )



Visual inspection





Density of the asphalt mix

The density of the samples taken is consistent with the initial compaction interval, indicating there has been no subsequent densification caused by the traffic, as a result of the good performance of the



Flatness

Planimetry assessment with a 3-meter platometer. There has been no rutting in the asphalt surface course



Surface evenness

IRI values for surface evenness range between 2.87 m/ km and 3.37 m/km. These are considered appropriate for the rehabilitation of pavement in urban roads

