

REJUVENATOR AGENTS HIGH-RAP ASPHALT MIX

The amount of RAP in asphalt mixtures can be significantly increased with the application of good RAP management practice, readily available modern production technologies and the use of specially designed additives.



During the ageing process, the ratio of asphaltenes and maltenes change which leads to increased stiffness and viscosity of the bitumen and decreased ductility. However, the increase in the number of asphaltenes is not the only reason for the ageing. The asphaltenes interact with each other and/or with the maltenes, and therefore the increase in viscosity also highly depends on the shape of asphaltenes particles.

The life of a bitumen is characterized by two different aging phases:

- ✓ Short-term ageing.
- ✓ Long-term ageing.

The most part of the bitumen ageing occurs during mixing with aggregates, transportation and laying processes due to exposure to high temperatures. This is referred to as short-term ageing.

The amount of in-service ageing mostly depends on the void content in the pavement and layer position within the road construction (surface of the road hardens faster). This is referred to as long-term ageing.

- Reclaimed Asphalt Pavement (RAP) is the reprocessed materials containing bitumen and aggregates generated after the removal of asphalt pavements for construction, resurfacing, etc.
- RAP can be comprised of various quality and graded aggregates coated by bitumen. In general, “High RAP Asphalt Mixture” is the term given to the mixtures with higher than 15% RAP content.

The expanded use of Reclaimed Asphalt Pavement (RAP) materials in the production of asphalt mixtures is a very simple but powerful concept. Recycling or reuse of existing pavement materials to produce new pavement materials has significant economic benefits in considerable savings of material, money and energy.

- The specific benefits of recycling can be summarized as follows:
- Reduced costs of construction.
- Conservation of aggregate and binders.
- Preservation of the environment.
- Conservation of energy.

The most critical obstacle in using high content RAP asphalt mixtures is the high stiffness observed in such mixtures, which results in low workability. The inadequate workability of the asphalt mixtures prevents proper compaction in the field and can ultimately lead to premature field failure.

The use of high RAP content in mix design is mainly limited by the necessity to achieve comparative field performance to conventional asphalt pavement. Many studies on RAP mixtures have shown that the addition of RAP in asphalt mixtures changes the mechanical properties. The mechanical changes of the mixture can affect the performance either negatively. The main problem is represented by **“CRACKING RESISTANCE”**. The aged, stiff bitumen in RAP typically increases mixture stiffness and therefore can cause fatigue damage and low-temperature brittleness. The increase in RAP proportion in pavements escalates the potential of such cracking which is one of the main reasons for reluctance for administrative agencies to allow very high RAP content.

Rejuvenator Agents

“Rejuvenator Agents” improve the mechanical properties of the asphalt mixtures with high RAP content. Regarding the severe aging and different chemical composition of RAP (compared to virgin bitumen), the reconstituting of the chemical composition of RAP bitumen is essential, to balance stiffening effect. Hence, “rejuvenators” are conventionally used to moderate the stiffness of the RAP bitumen.

The ACTIVA’s “Rejuvenator Agents” affect both the physical and chemical properties of the virgin bitumen and the RAP bitumen in the mix design. They add the following benefits:

- Increase the crack resistance of the asphalt mix with high RAP content.
- Decrease the viscosity of the aged RAP bitumen.
- Reduce the production and paving temperature.
- Improve workability/compaction of the asphalt mix with high RAP content.
- Restore the asphaltenes/maltenes ratio that were lost by ageing.
- Promote bitumen/aggregate adhesion and increase the stripping resistance.

There are different types of “rejuvenators” on the market. If not well formulated these additives can create serious problems of “Rutting Resistance”. Studies have shown that these “rejuvenator” continues to penetrate in the aged binder film even after laying of the pavement. The dominant effect from the softer outer layer may lead to increased dynamics of developing permanent deformations with the consequent formation of ruts.

ACTIVA offers different types of “Rejuvenator Agents” additives all characterized by high quality and high performance.

	TRADITIONAL	REACTIVE ACF	LOWTHERM® RAP	LOWTHERM® ACF
Rejuvenate the aged RAP bitumen	■	■	■	■
Decrease the viscosity of the aged RAP bitumen.	■	■	■	■
Improve workability/compaction of the asphalt mix with high RAP content.	■	■	■	■
Promotes aggregate/bitumen adhesion		■	■	■
Protects against moisture damage		■	■	■
Allows lower mixing, laying and compaction temperatures			■	■
Not Hazardous		■	■	■
Odorless		■	■	■
Safe for workers		■	■	■
Not regulated for transport		■	■	■

REACTIVE ACF affect both the chemical and physical properties of the virgin bitumen and the aged RAP bitumen: promotes the adhesion, increase moisture damage resistance and restores viscosity, penetration, Fraass and softening points values similar to those of virgin bitumen. Therefore, REACTIVE ACF if correctly dosed, the final mixture will behave like a of conventional Hot Mix Asphalt (HMA).

Otherwise, LOWTHERM®RAP e LOWTHERM®ACF in addition to being “rejuvenating” like REACTIVE ACF, contain a special chemical substance that gives the mix asphalt great workability even at low temperatures, so much so that it can be produced ad compacted at temperatures below of a conventional Hot Mix Asphalt (HMA). LOWTHERM®RAP e LOWTHERM®ACF are additives for Warm Mix Asphalt (WMA) technology allow a significant reduction in the production, laying e compaction temperature of conventional Hot Mix Asphalt (HMA) due to the higher workability of WMA mixture. The use of WMA technology allows the incorporation of higher RAP amounts than for HMA.

REACTIVE ACF

It is a liquid and pumpable additive, decrease the viscosity and rejuvenate the aged RAP bitumen, consequently improve workability/compaction of the asphalt mix with high RAP content. It is eco-friendly, biodegradable and not classified as hazardous for human health and for the environment, easy to be handled, transported and applied. REACTIVE ACF is an additive with dual function:

- **“Rejuvenator”**
Helps regain the properties of aged bitumen to a consistency level appropriate for pavement construction and performance and restores the chemical composition to ensure durability.
- **“Adhesion Promoter”**
Promotes bitumen/aggregate adhesion, increases the “stripping” resistance, that prevents the detachment of the bitumen film and improves the aging resistance, slowing down the oxidation process of the bitumen.

LOWTHERM®RAP e LOWTHERM®ACF

This are liquid and pumpable additive, eco-friendly, biodegradable, easy to be handled, transported and applied; are based on substance made with an innovative technological process exclusively owned by ACTIVA. They decrease the viscosity and rejuvenate the aged RAP bitumen, give the mix asphalt great workability even at low temperatures and allow a significant reduction in the production, laying e compaction temperature. In addition, they have unique characteristics since they are odorless and are not classified as dangerous either for human health or for the environment.

LOWTHERM®RAP e LOWTHERM®ACF are additives with triple function:

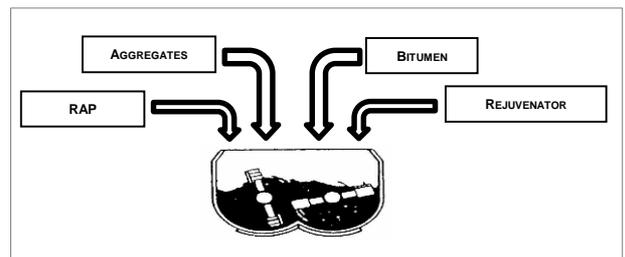
- **“Rejuvenator”**
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- **“Warm Mix Additive”**
Provides a temporary reduction in the viscosity of the bitumen, giving it extraordinary workability without raising the temperature. This extraordinary workability allows to reduce the production, laying and compaction temperatures from 30°C to 50°C, compared to those usually used.

HOW TO USE & DOSAGE

The dosage of Activa "rejuvenators" varies from 0,2% to 0,55% on the weight of the RAP added to the asphalt mix. The dosage depends on the type of RAP used but also on the operating conditions such as: RAP temperatures, RAP moisture and the required asphalt mix discharge temperature. Higher dosages may be required for asphalt produced using RAP modified with polymers, modified with tire rubber (GTR) or with the addition of bituminous used sheaths (RAS).

Activa "rejuvenators" are added directly into the mixer of to the asphalt plant during the production, using an automatic dosing system. Alternatively, they can be added directly into the bitumen storage tank while it is being loaded; if the storage tank is not equipped with a mixer, this operation must be conducted so that the additives are added at the same time as the bitumen, making sure that at the end of the transfer of bitumen, the right quantity of additives has been added to the storage tank.

RAP on Asphalt Mix	REACTIVE ACF / LOWTHERM®RAP / LOWTHERM ACF (dosage on RAP weight)
20 ÷ 30%	0,20 ÷ 0,30%
40%	0,30 ÷ 0,35%
50%	0,40 ÷ 0,45%
60%	0,45 ÷ 0,50%
≥ 70%	> 0,55%



Dosage Example	
Totla Bitumen in Asphalt Mix	: 5,0%
RAP added	: 30%
Bitumen contained in the RAP	: 4,4%
Bitumen (old) Added with the RAP	: 30% x 4,4% = 1,32%
New Bitumen Added	: 5,0% - 1,32% = 3,68%
REJUVENATOR added on RAP	: 0,3%
REJUVENATOR added on New Bitumen	: $\frac{0,30\% \times 30\%}{3,68\%} = 2,44\%$

1.000 kg of Asphalt Mix	
Total Bitumen	: 50,0 kg
New Bitumen Added	: 36,8 kg
Rap Bitumen (old)	: 13,2 kg
Medium Bitumen Italian Price	: 0,45 €/kg
Savings	: 13,2 x 0,45 = 5,94 €
REACTIVE ACF (rejuvenator)	: (36,8 x 2,44%) = 0,90 kg
REACTIVE ACF Price	: 1,80 €/kg
Incidence	: (0,90 x 1,80) = 1,60 €
Savings every 1.000 kg of Asphalt Mix	: 5,95 - 1,60 = 4,35 €



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Asphalt Applications

ACTIVA S.r.l.
Zona Industriale - Settore 1-2
87064 Corigliano-Rossano (CS) - Italy

VAT N.: IT-03496190780

Telefono	+39 0983 851070
E-mail	info@activasrl.it
Web	www.activasrl.it