HRVATSKO ASFALTERSKO DRUŠTVO

CROATIAN ASPHALT ASSOCIATION

USE OF REJUVENATORS IN ASPHALT: RESEARCH INNOVATIONS AND INDUSTRIAL EXPERIENCE

KORIŠTENJE OSVJEŽIVAČA U ASFALTIMA: NOVOSTI U ISTRAŽIVANJU I ISKUSTVO INDUSTRIJE

GABRIELE TEBALDI, UNIVERSITY OF PARMA

MEĐUNARODNI SEMINAR ASFALTNI KOLNICI 2021

INTERNATIONAL SEMINAR ASPHALT PAVEMENTS 2021

OPATIJA, 30.09. – 01.10. 2021.

WHAT IS A REJUVENATOR?

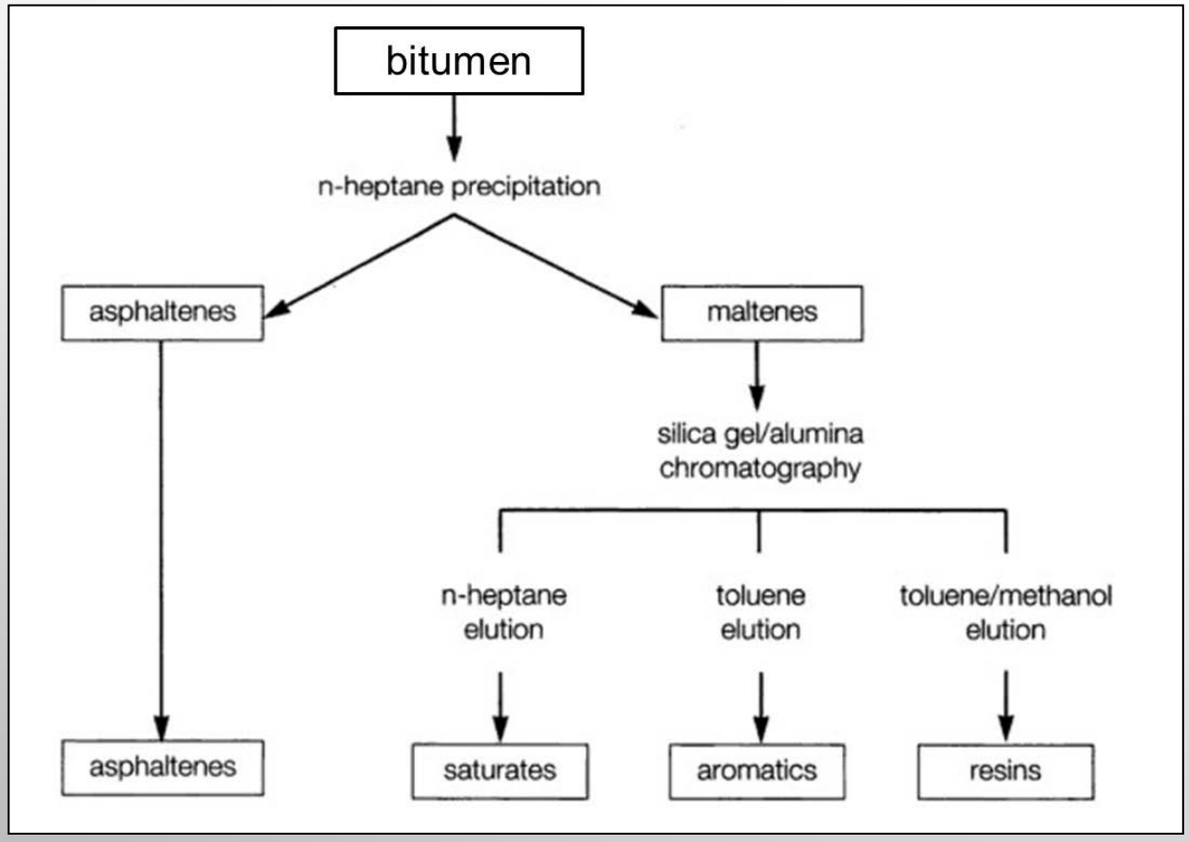
REJUVENATORS ARE SUBSTANCES THAT RESTORE SOME OF THE PROPERTIES OF THE AGED BITUMEN OF THE RECLAIMED ASPHALT (RA) AND THEY MAKE IT ABLE TO WORK AGAIN AS A BINDER

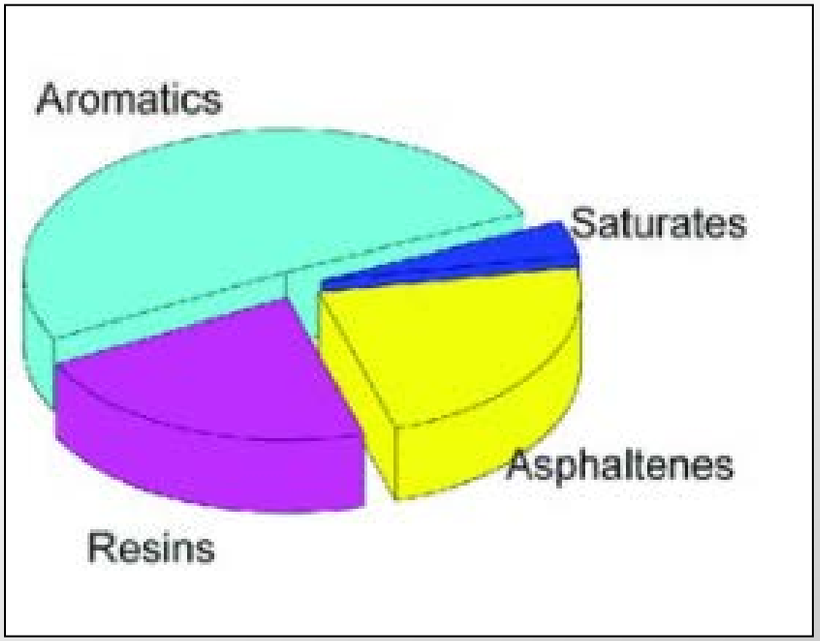
WHAT IS BITUMEN?

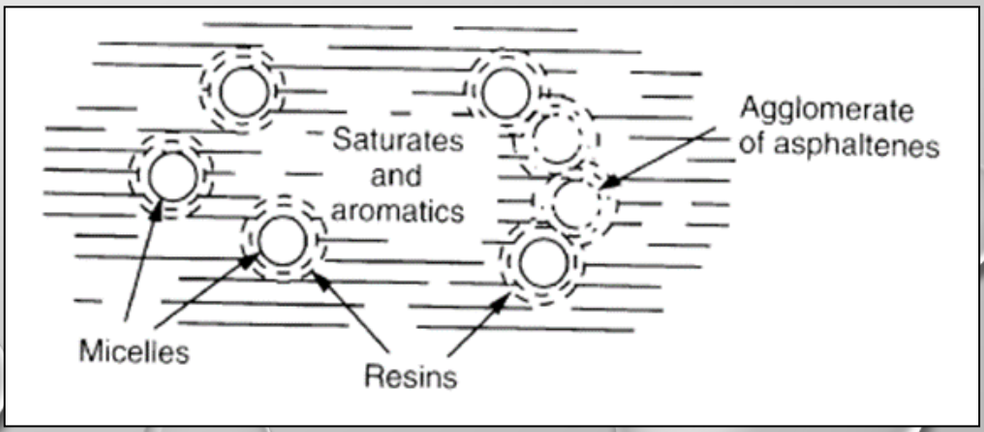
WHAT IS BITUMEN AGING?

BITUMEN

BITUMEN IS A COLLOIDAL MULTIPHASE SYSTEM



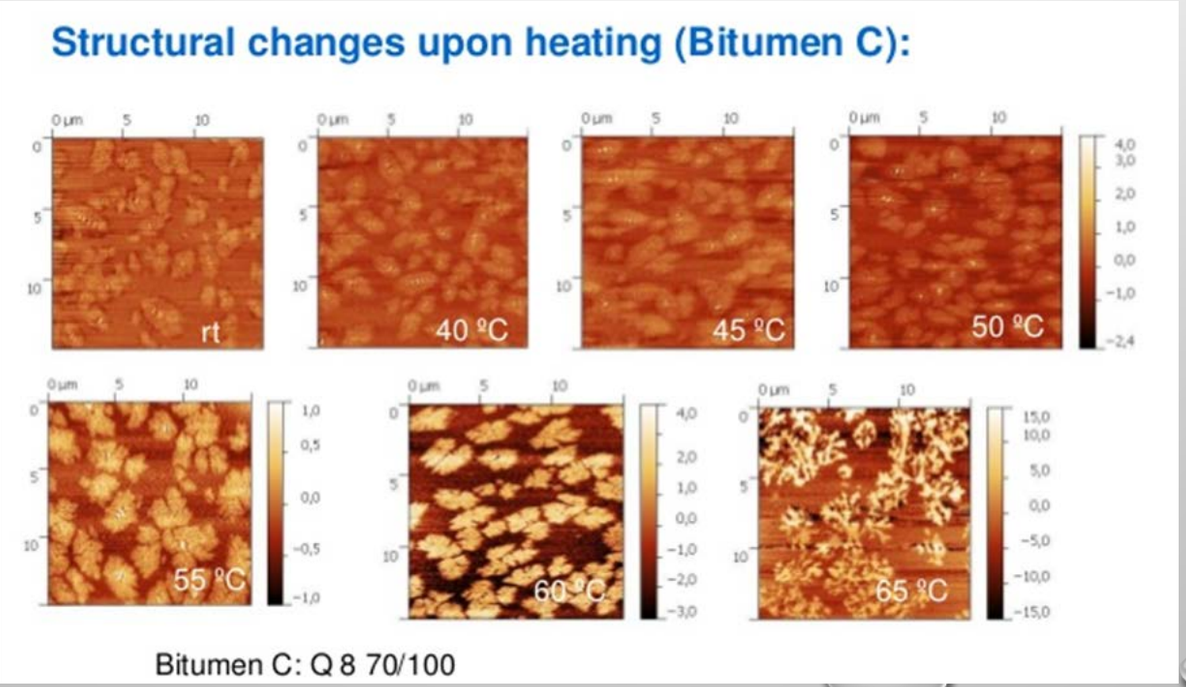




BITUMEN'S AGING

THE BITUMEN'S AGING IS THE CHEMO-PHYSICAL PHENOMENON FOR WHICH THE BITUMEN'S CHARACTERISTICS CHANGE WITH TIME

THE CHANGE OF PROPERTIES MADE BY THE AGING IT IS SHOWED MAINLY BY THE HARDENING OF THE MATERIAL



BITUMEN'S AGING

- Loss of oil components of bitumen by volatility or absorption by porous aggregates
- Change in chemical composition of bitumen molecules from reaction with atmospheric oxygen
- Molecular structuring that produce thixotropic effects (steric hardening)

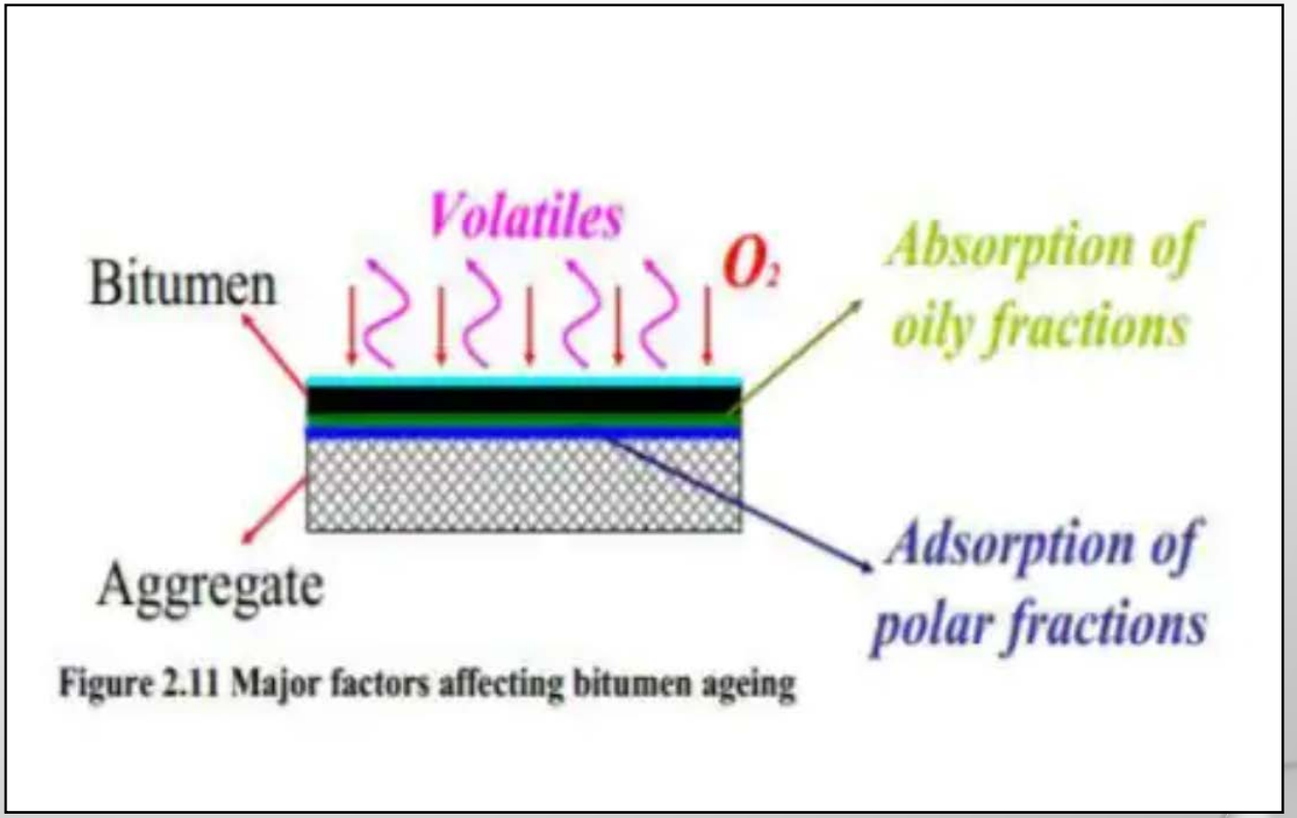


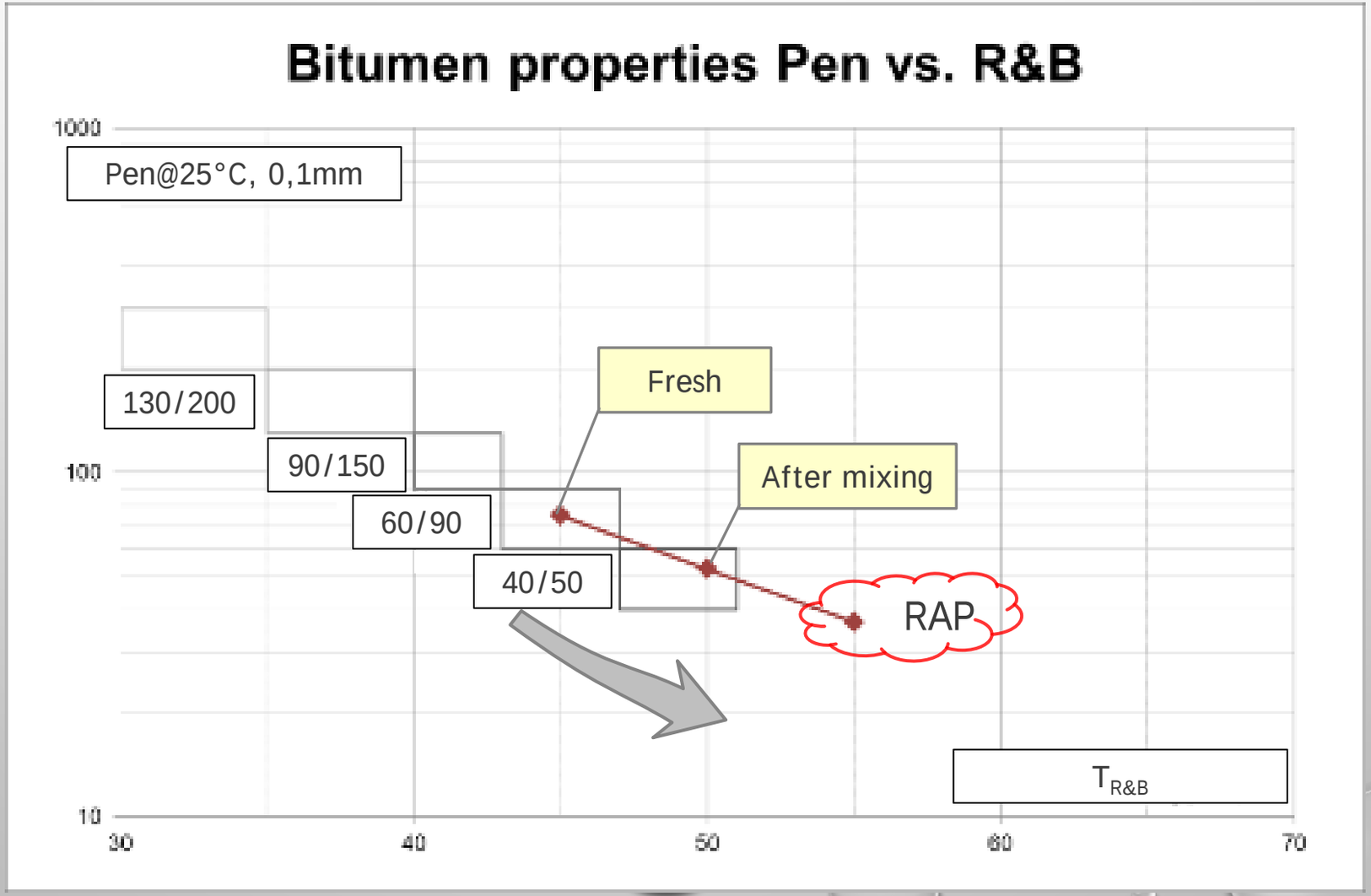
Figure 2.11 Major factors affecting bitumen ageing

BITUMEN'S AGING

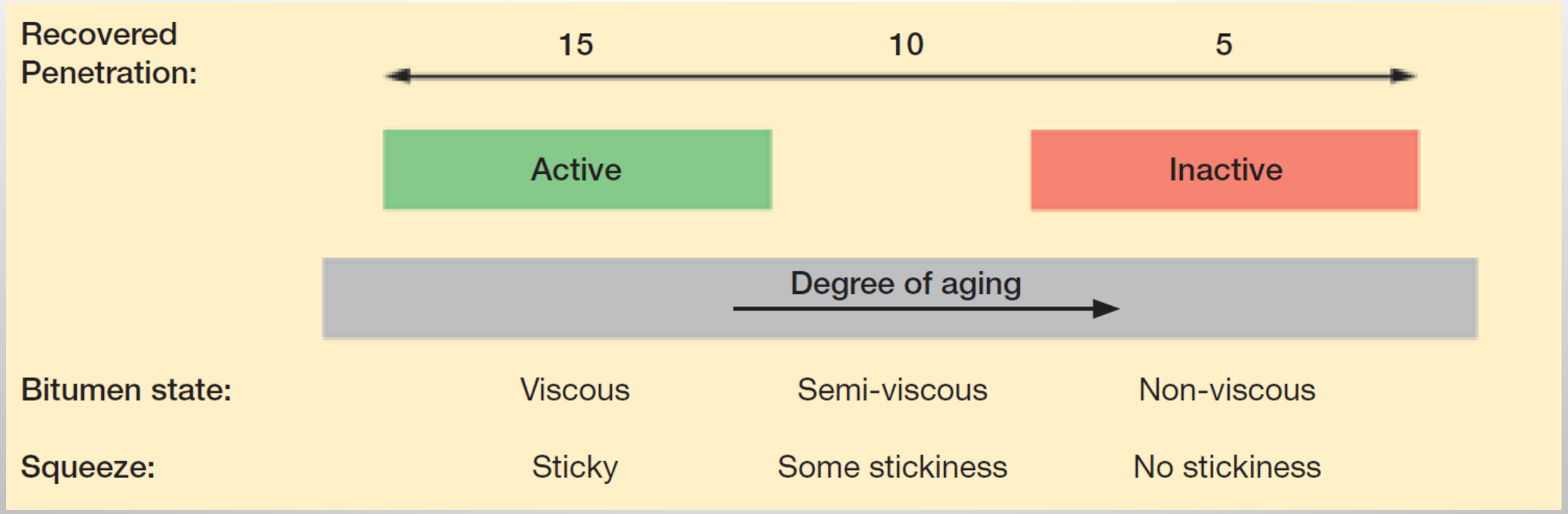
Factors	Influenced by					Occurring	
	Time	Heat	Oxygen	Sun-light	Beta & gamma rays	At the surface	In mass
Oxidation (in dark)	√	√	√			√	
Photo-oxidation (direct light)	√	√	√	√		√	
Volatilisation	√	√				√	
Photo-oxidation (reflect light)	√	√	√	√		√	
Photo-chemical (direct light)	√	√		√		√	
Photo-chemical (reflected light)	√	√		√		√	√
Polymerization	√	√				√	√
Steric or physical	√					√	√
Exudation of oils	√	√				√	
Changes by nuclear energy	√	√			√	√	√
Action by water	√	√	√	√		√	
Absorption by solid	√	√				√	√
Absorption of components at a solid surface	√	√				√	
Chemical reactions	√	√				√	√
Microbiological deterioration	√	√	√			√	√

BITUMEN'S AGING

Penetration at 25°C (Pen@25°C) ↘, softening point ($T_{R\&B}$)↗



BITUMEN'S AGING



REJUVENATOR

SOL type

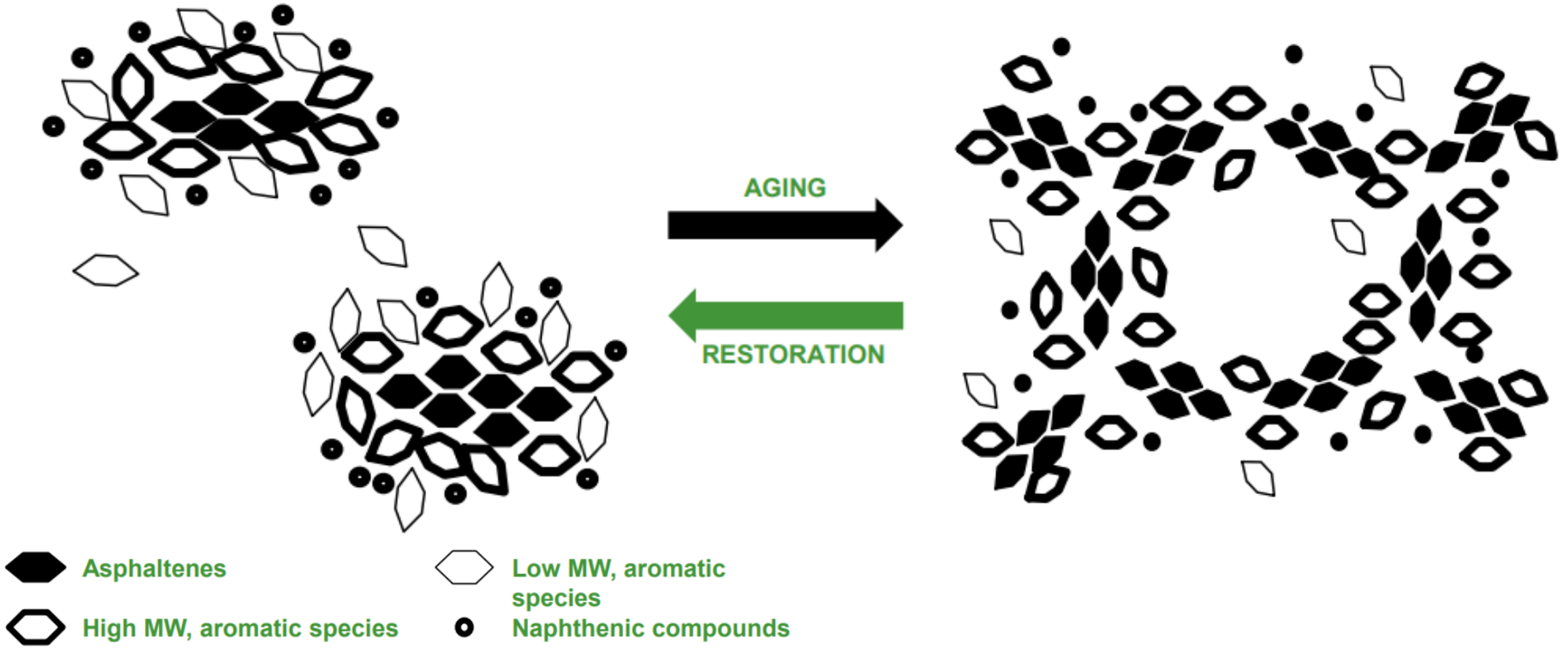
colloidal solution (sol)

Asphaltenes well disperse in the maltenic phase

GEL type

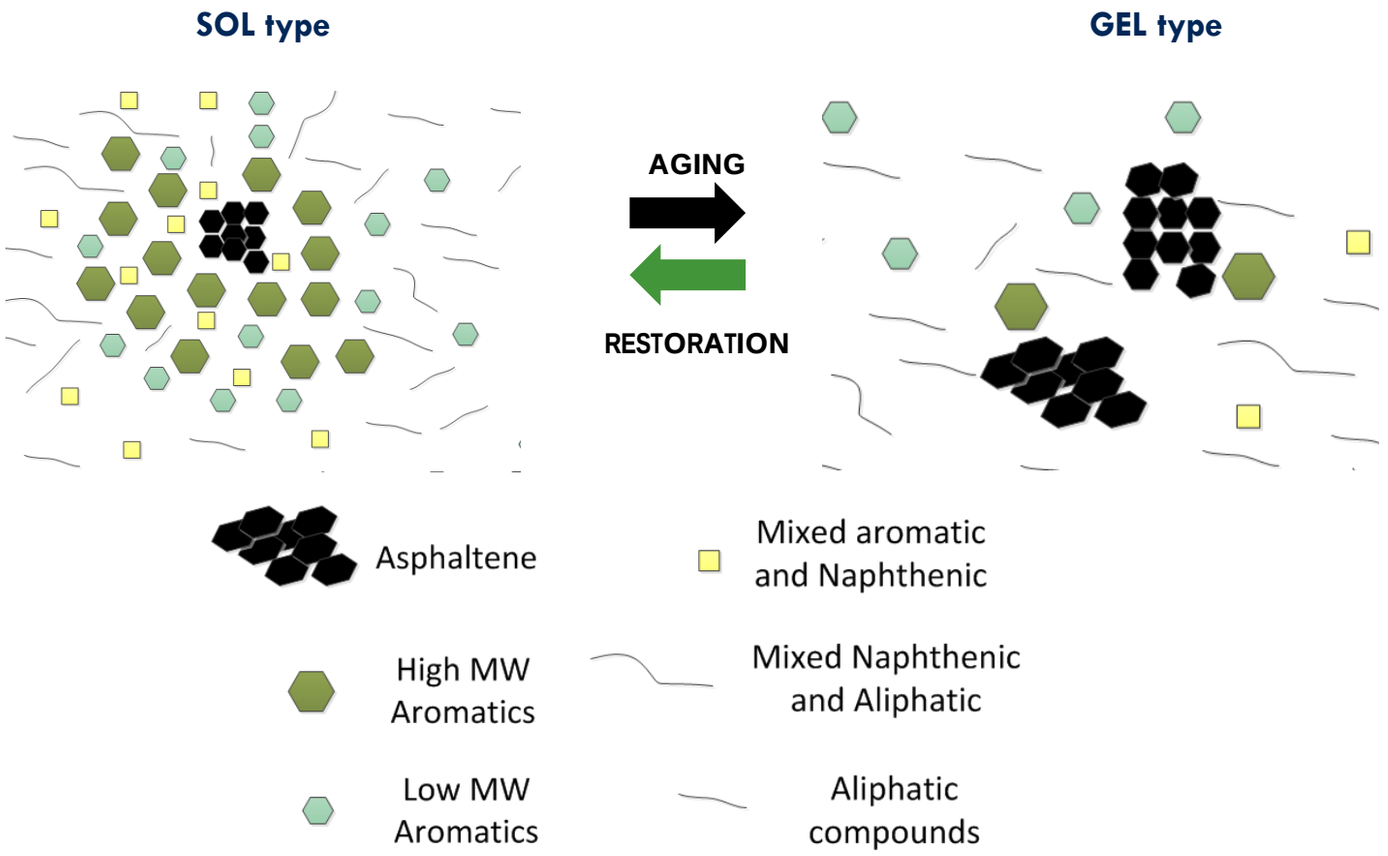
integrated network (or gel) of either discrete particles or network polymers

Asphaltenes make chains
→ Viscosity increasing



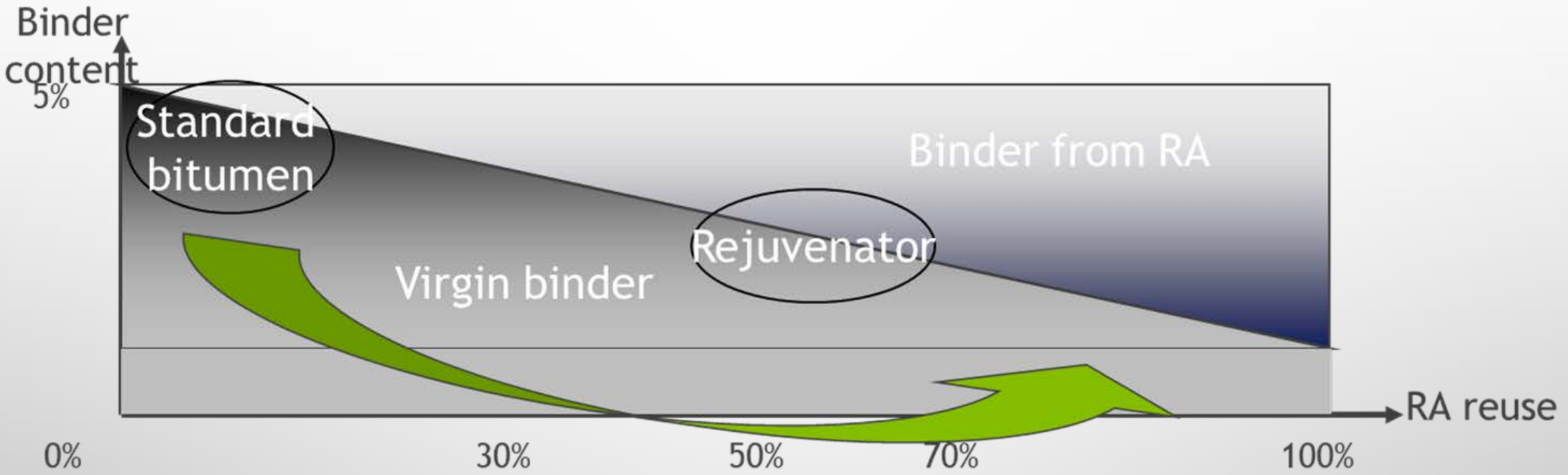
The rejuvenator breaks the asphaltenes chains

REJUVENATOR

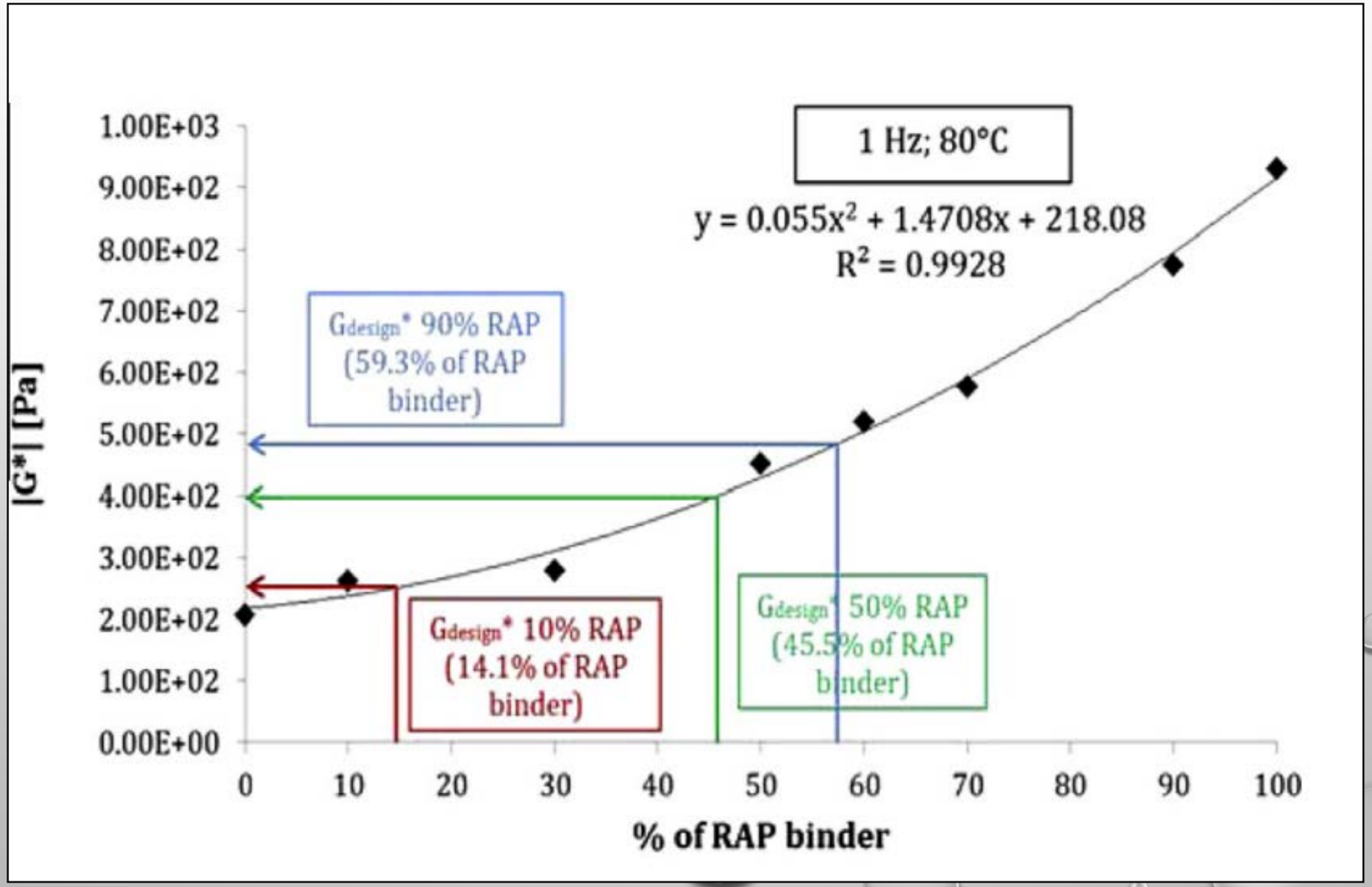


The rejuvenator reduce the bitumen viscosity reducing the size of asphaltenes

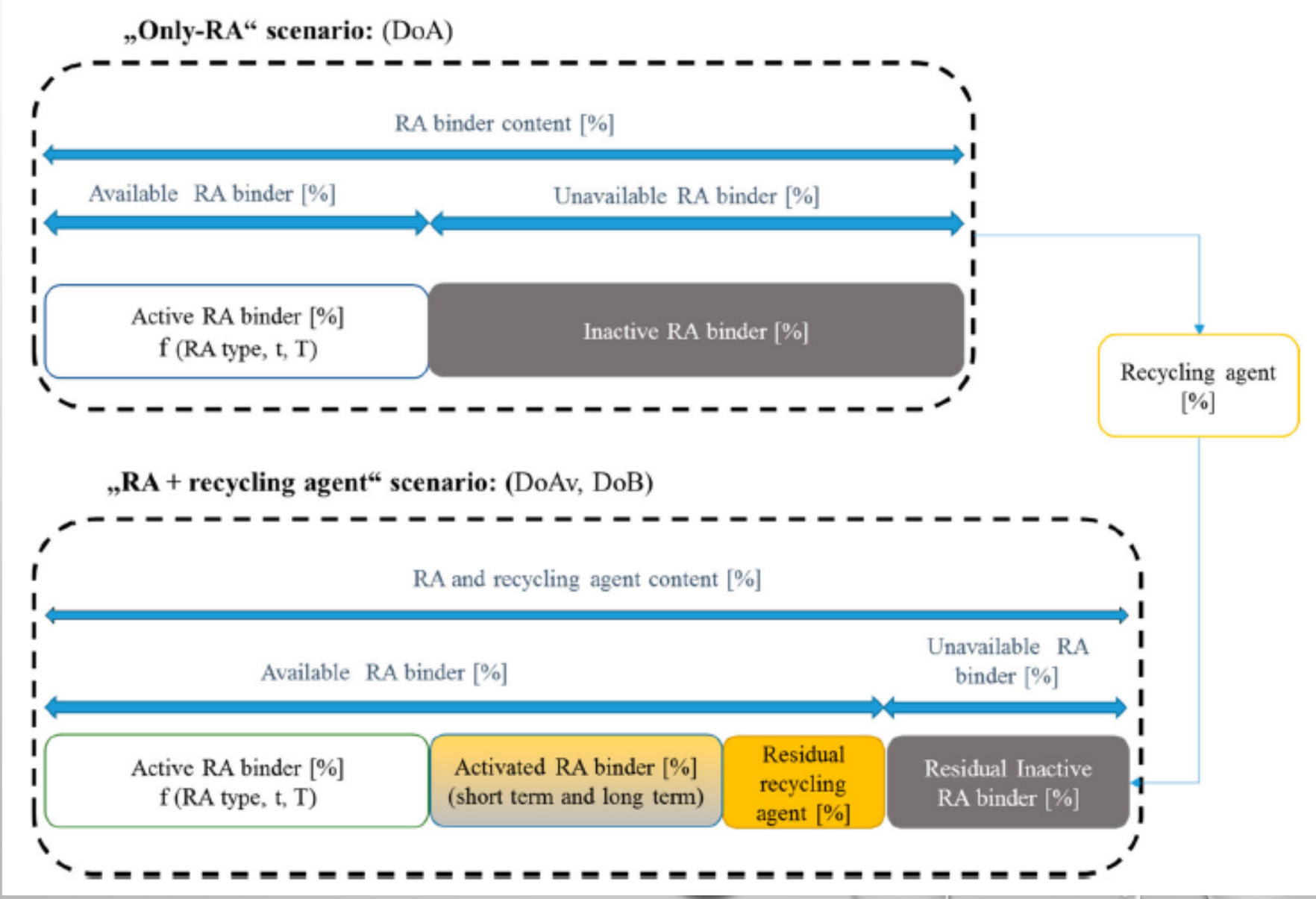
SCOPE OF REJUVENATOR USE



VIRGIN BITUMEN + RA BITUMEN



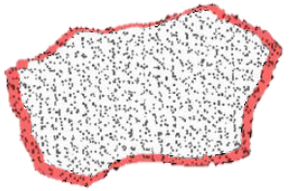
RA: ACTIVE BINDER & INACTIVE BINDER



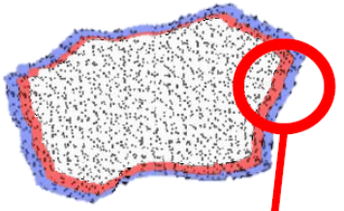
VIRGIN BITUMEN + RA BITUMEN

Hypothesis of full blending and total activation

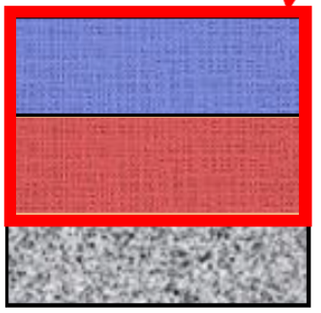
RAP grain:
aggregate + RAP binder



RAP grain in new HMA:
aggregate +
RAP binder + fresh binder



Diffusion between two different bitumens

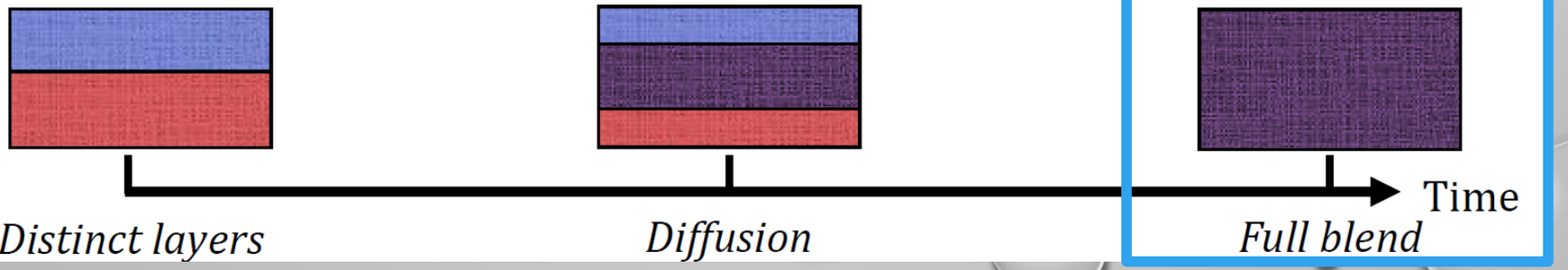


Fresh binder

RAP binder

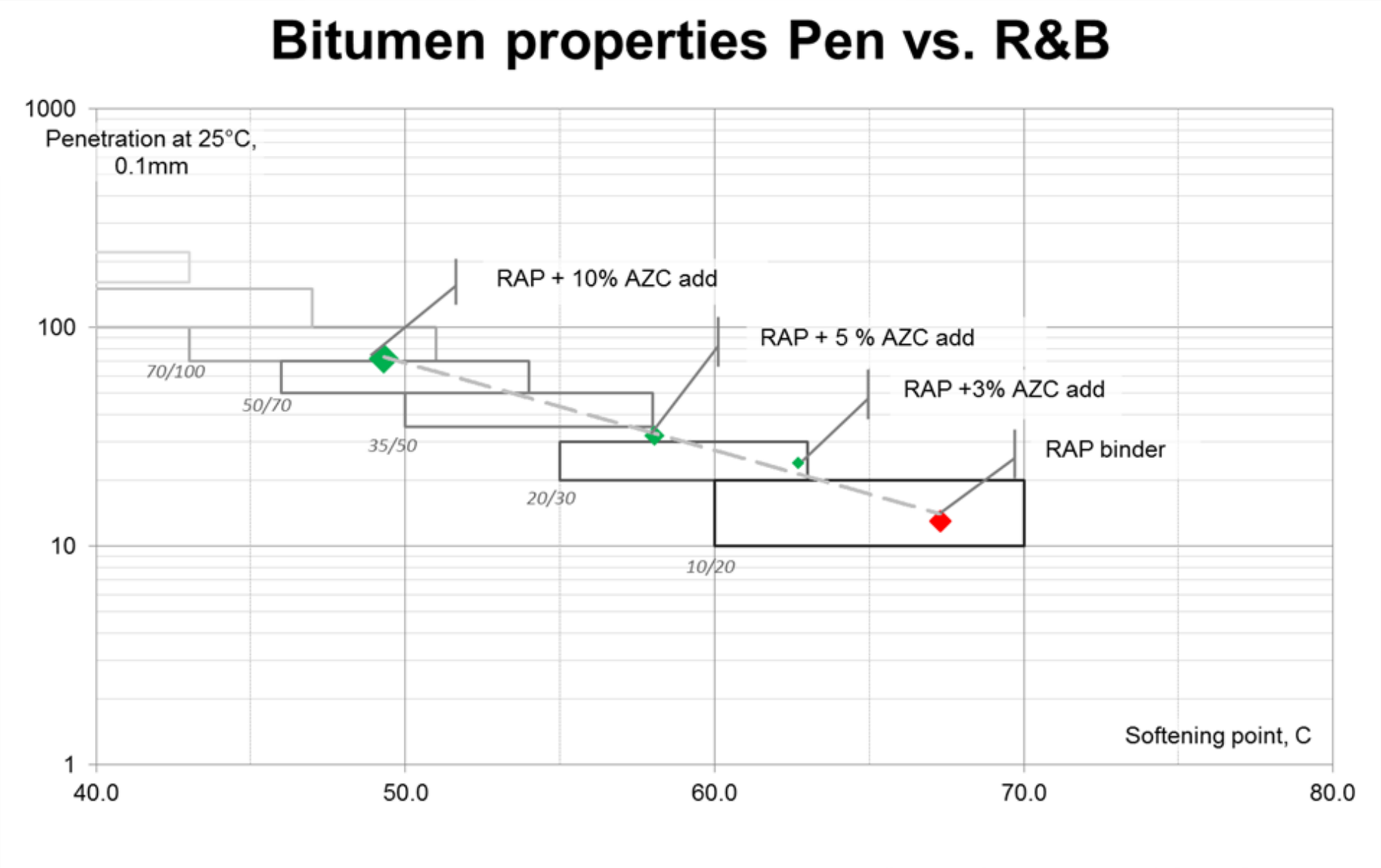
Aggregate

Bitumen

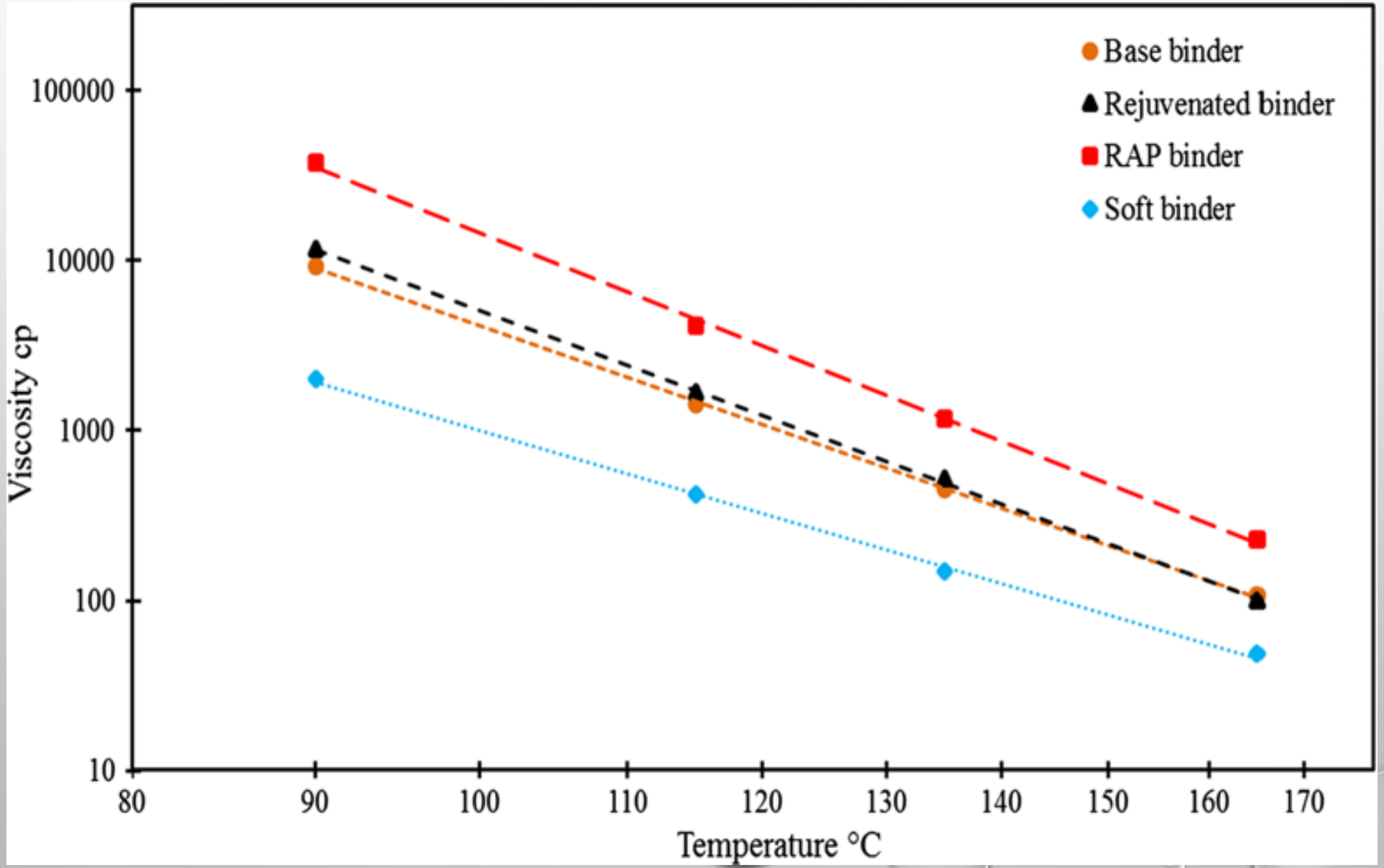


EFFECT OF REJUVENATOR

Hypothesis of full blending and total activation



EFFECT OF REJUVENATOR



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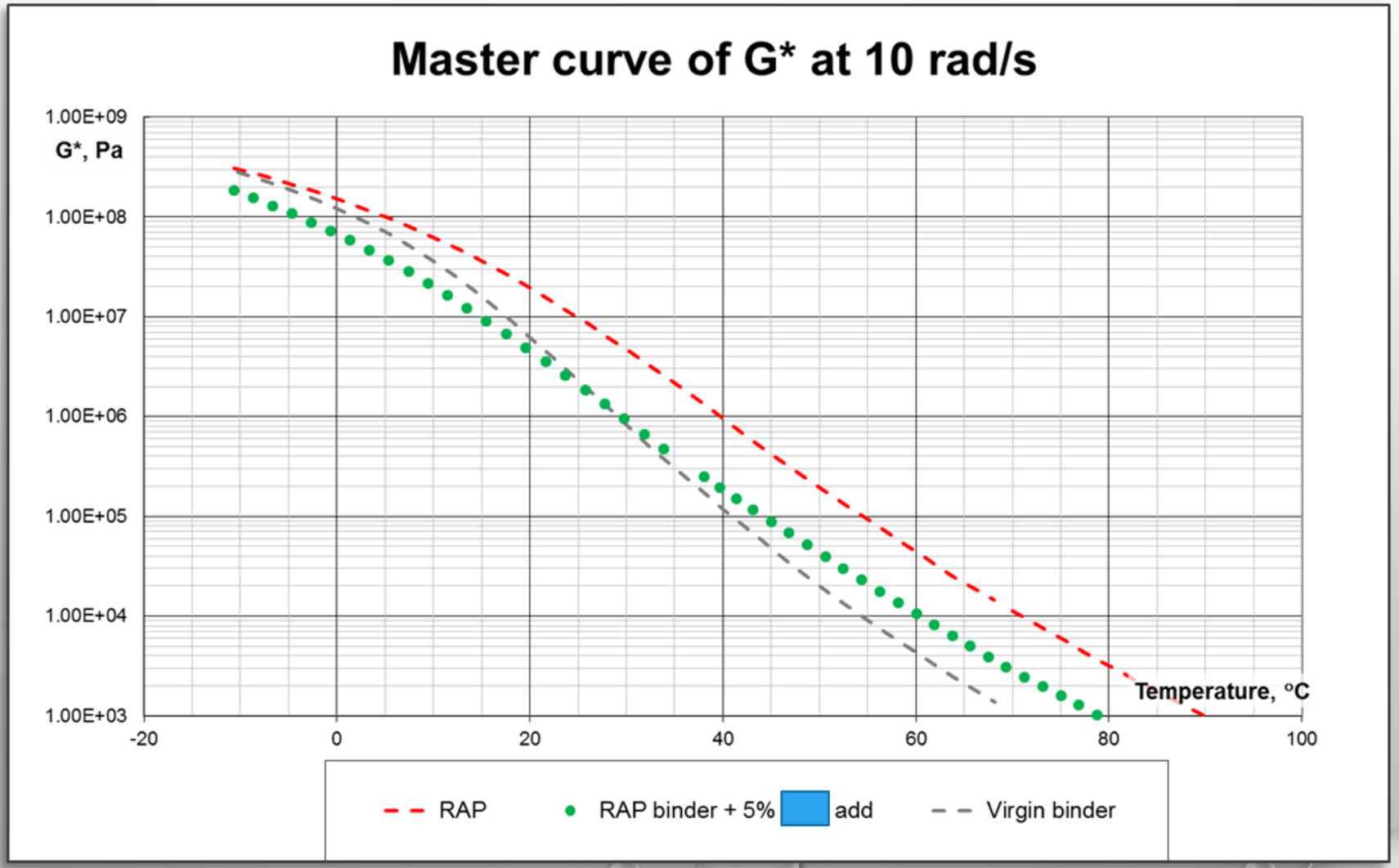
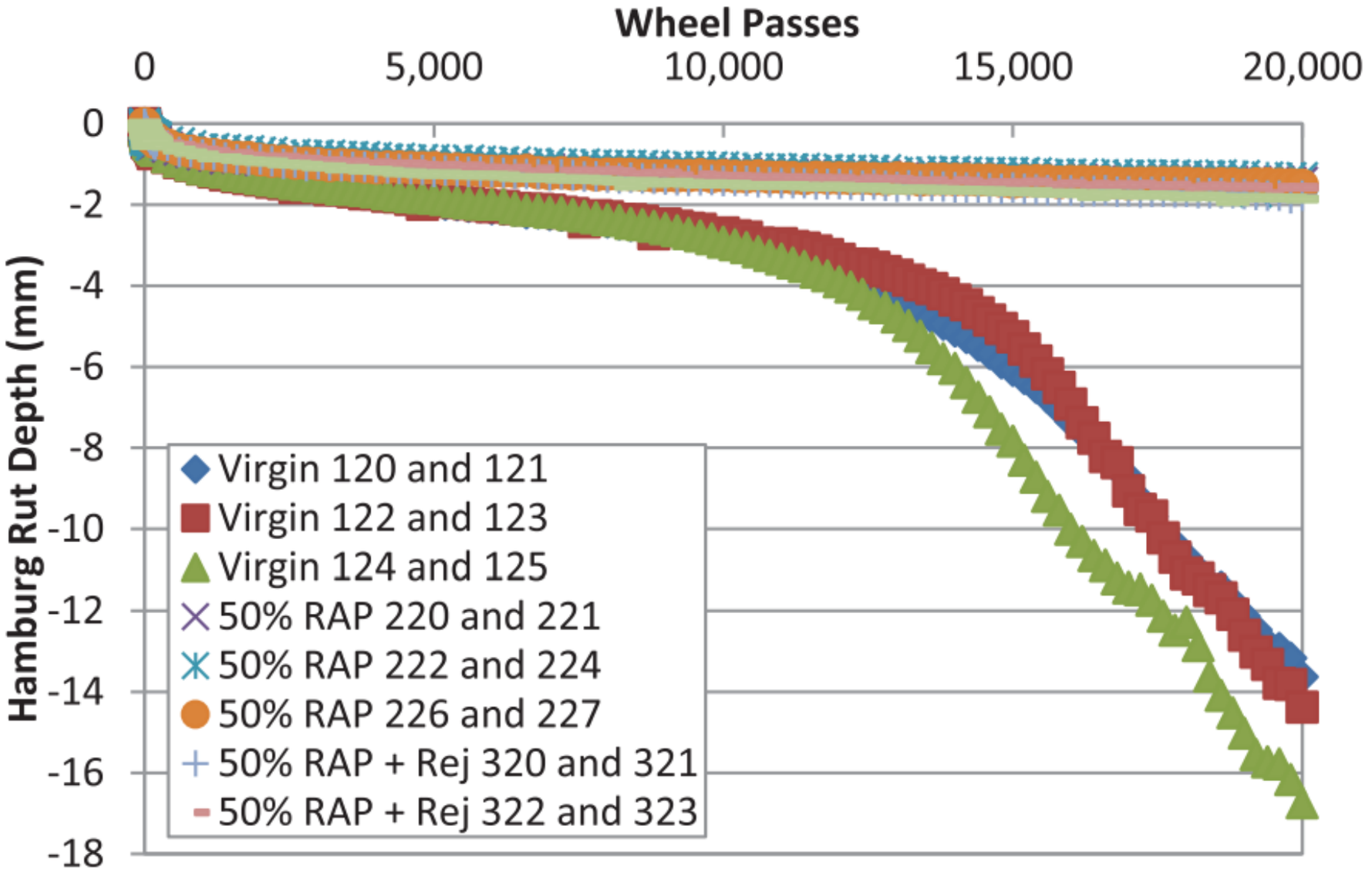
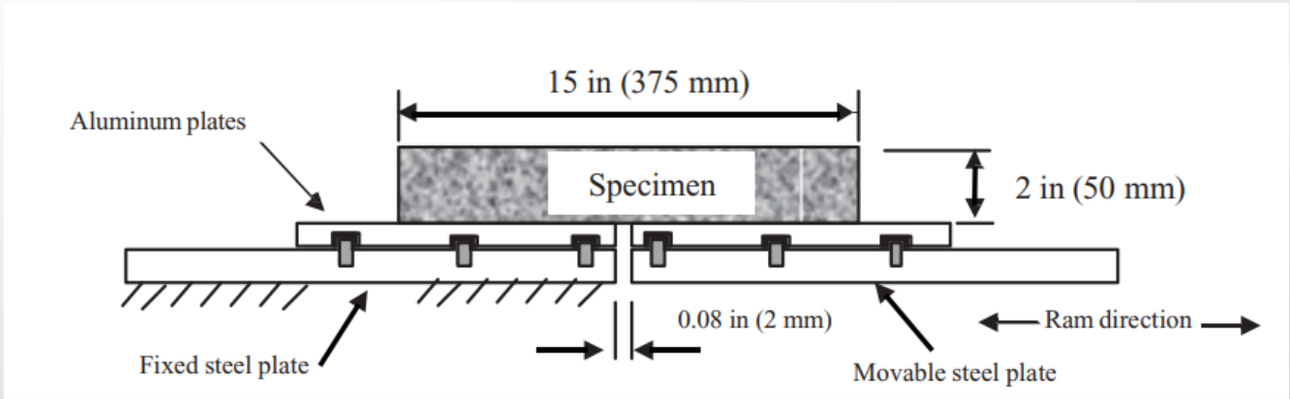


EFFECT OF REJUVENATOR

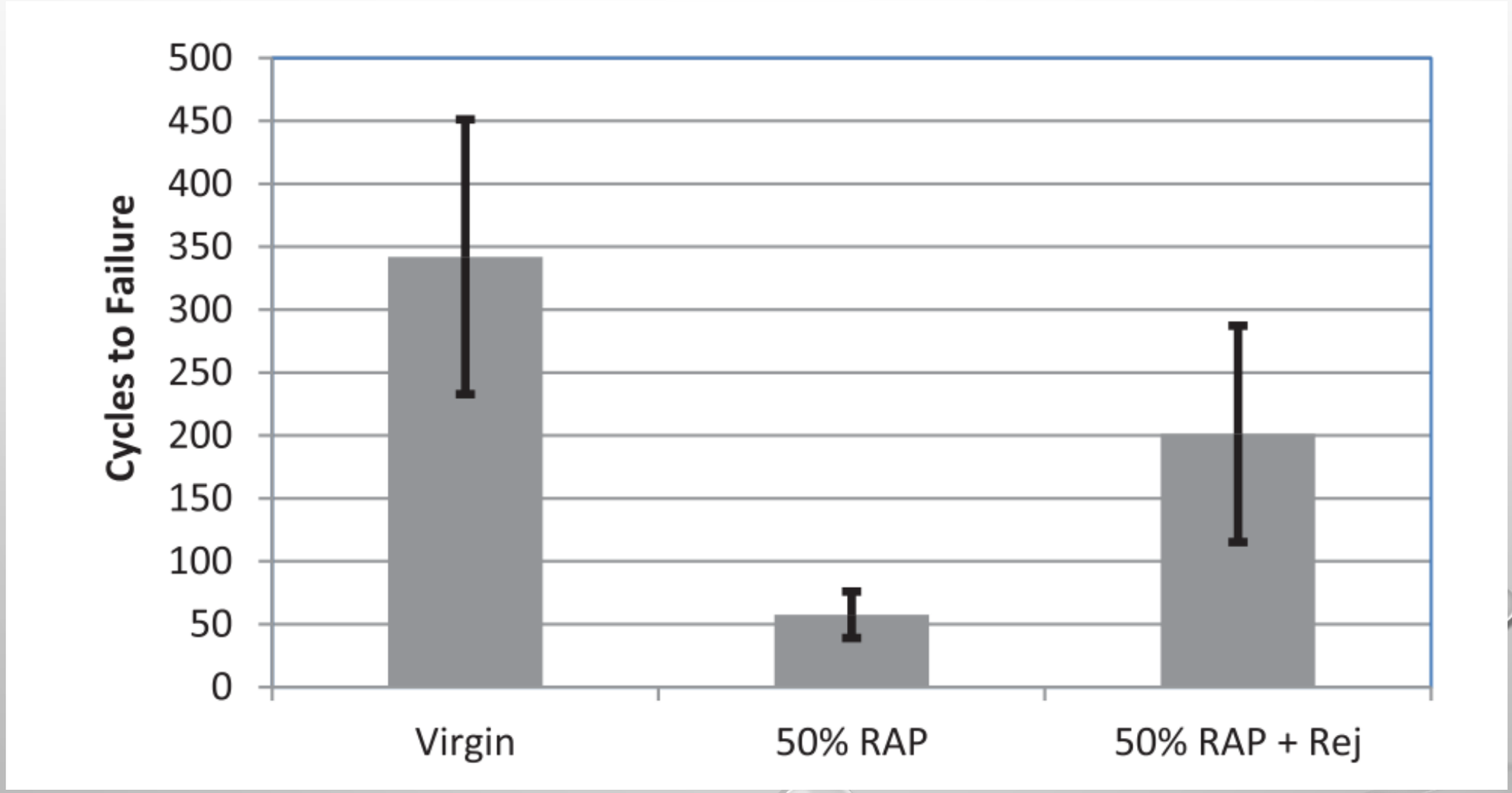


EFFECT OF REJUVENATOR

Asphalt Overlay Test

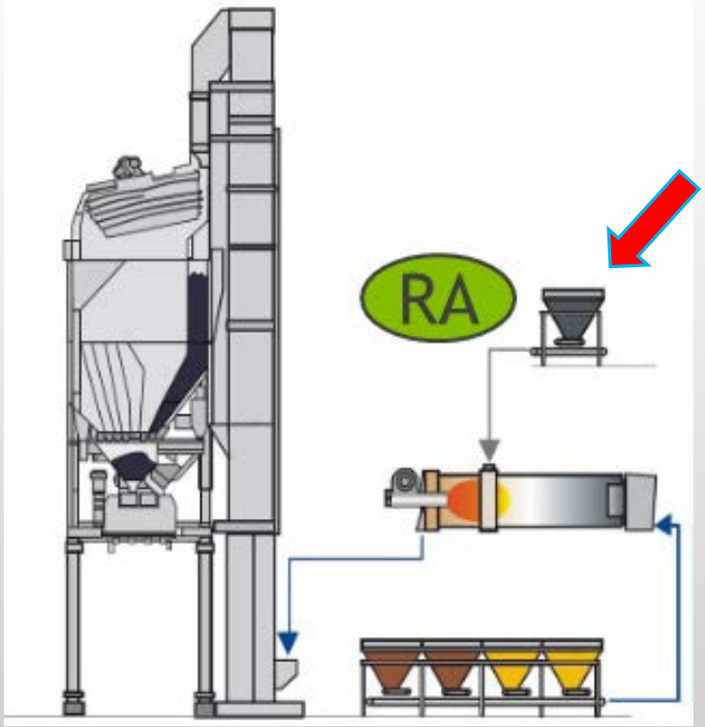


EFFECT OF REJUVENATOR



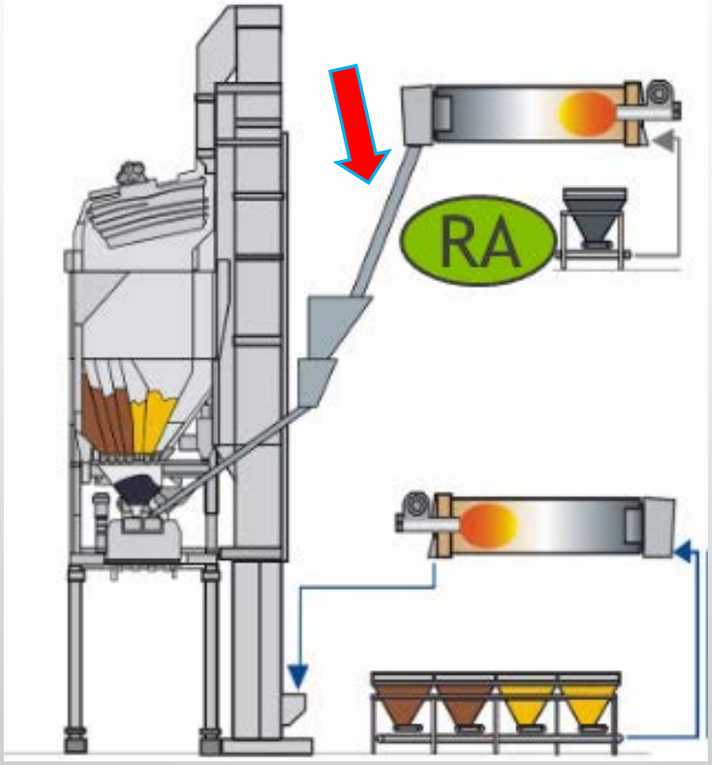
DIFFERENT OPTIONS WHERE TO INTRODUCE REJUVENATOR

On cold RA before to be heated



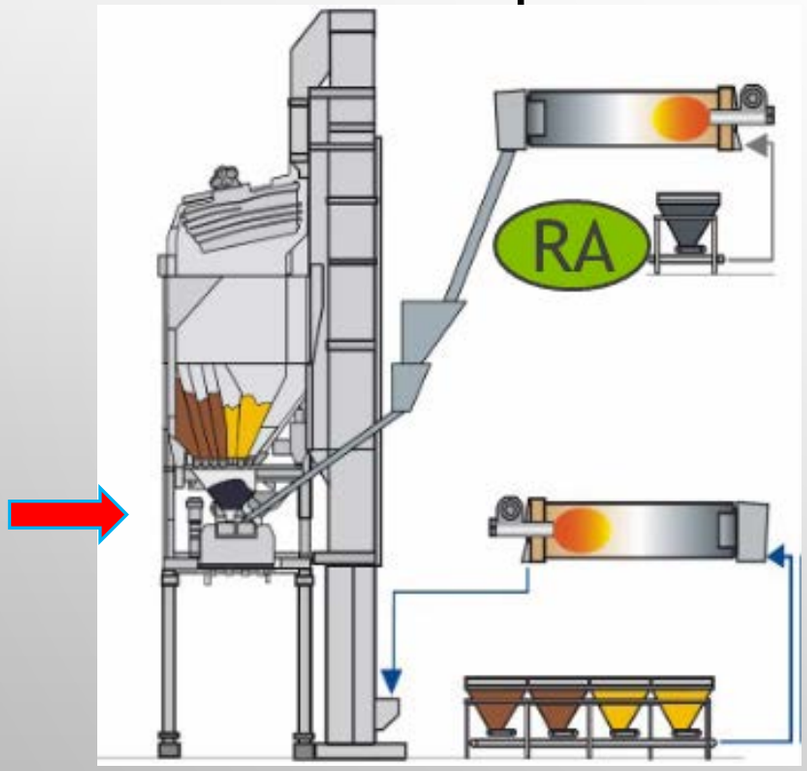
DIFFERENT OPTIONS WHERE TO INTRODUCE REJUVENATOR

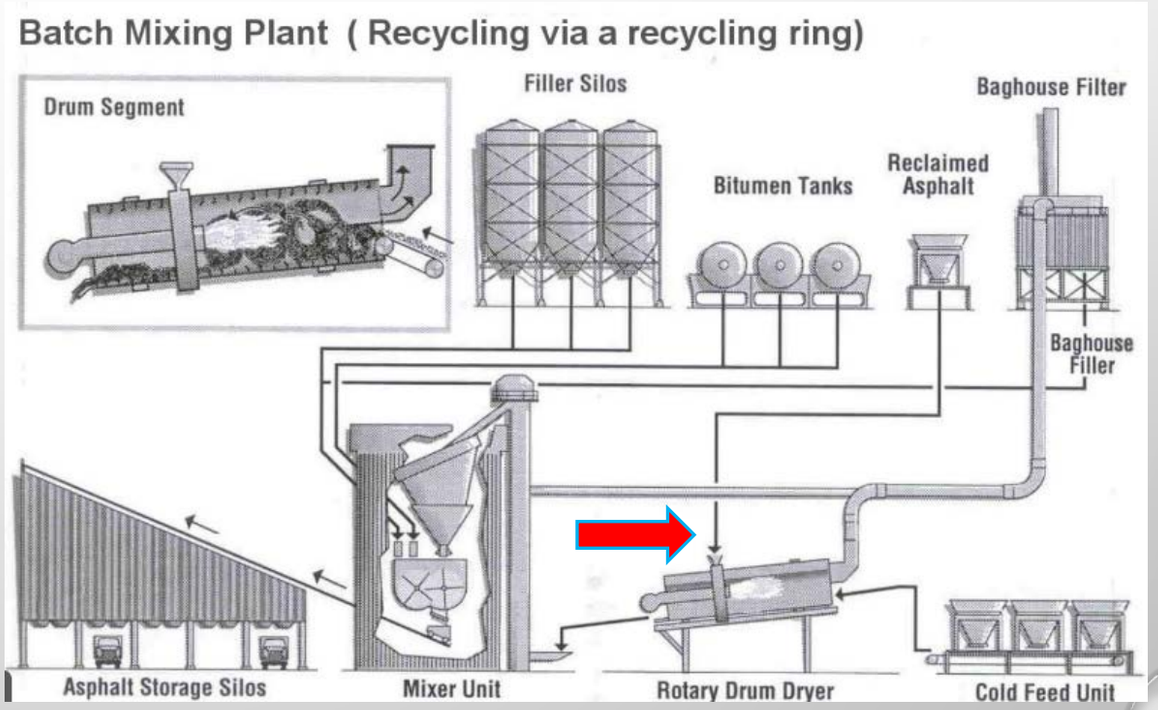
For parallel drum after heating drum and before the RA storage silo



DIFFERENT OPTIONS WHERE TO INTRODUCE REJUVENATOR

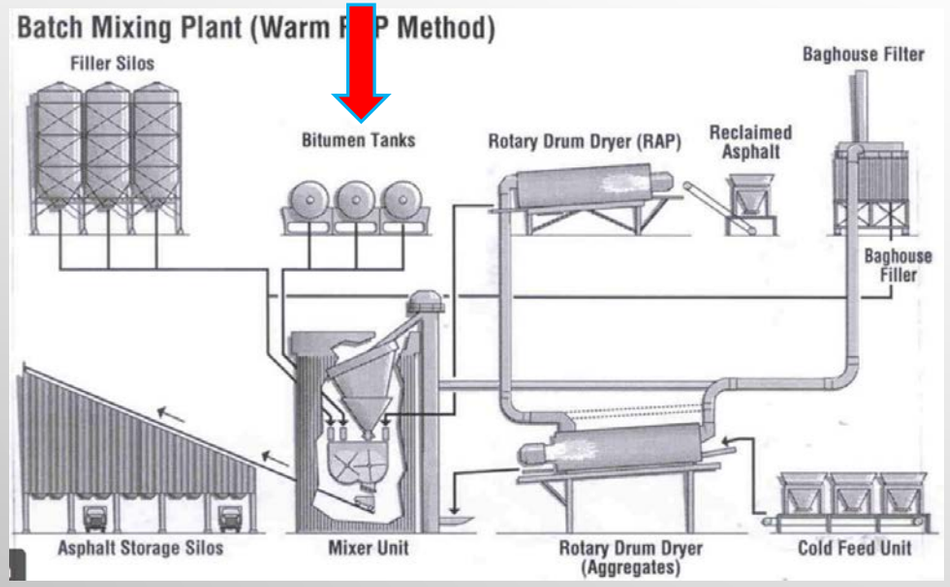
In the mixing batch / drum,
spread on RA before aggregate

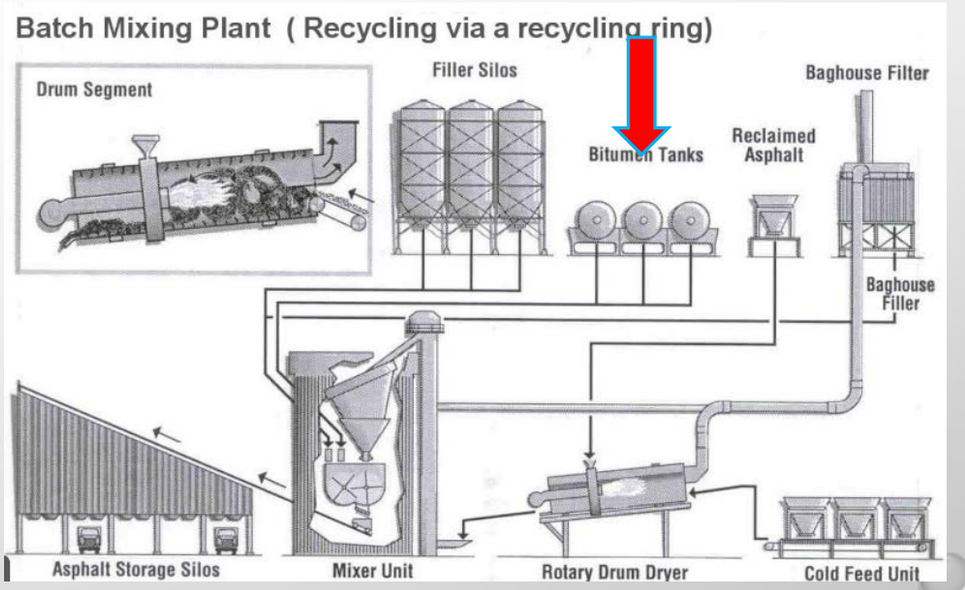




DIFFERENT OPTIONS WHERE TO INTRODUCE REJUVENATOR

On the virgin binder





CONCLUSIONS

Rejuvenators are for RA to mobilize the aged binder

- It has to treat the RA first not virgin aggregate nor binder
- It has to be dosed on RA binder content
- Maximize residence time of additive on RA alone

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