

# REJUVENATORS

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# WHY USE REJUVENATORS

- Restoring the properties of aged binder
- Improving mix flexibility
- Reducing consumption of virgin materials



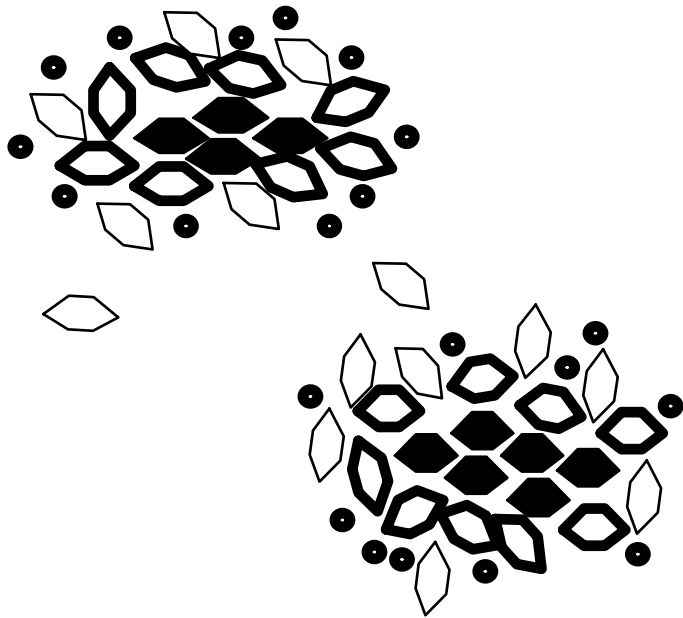
# TECHNICAL CHALLENGES OF HIGH RECYCLED CONTENT HMA



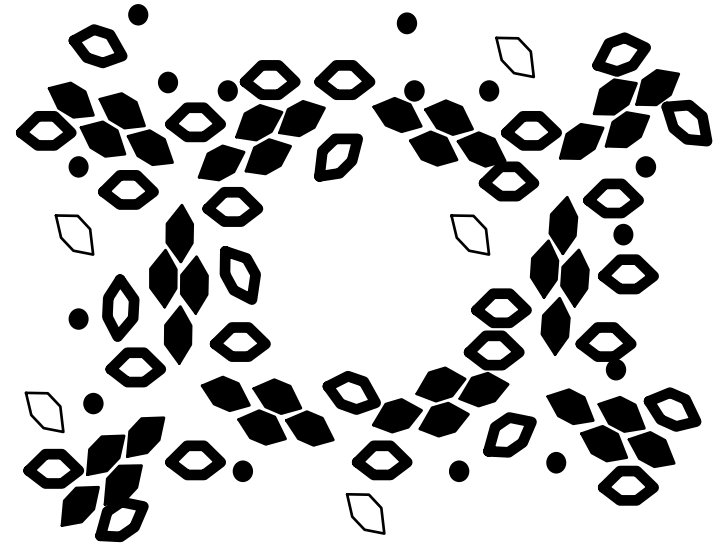
- ❧ Oxidation of bitumen causes an increase in polarity through formation of carbonyls and sulfoxides primarily in the asphaltene fraction and an increase in polarizability through conversion of aromatic resins to asphaltenes.
- ❧ As polarity and dispersion forces increase, asphaltene particles bind more tightly resulting in layering. This effect increases with increased oxidation.
- ❧ The layering of the asphaltene particles imparts rigidity which in turn leads to cracking as viscoelastic properties are lost.
- ❧ The increase in overall polarity of the bitumen increases its viscosity.

# SOL-GEL MODEL OF BITUMEN STRUCTURE

SOL type



GEL type



AGING



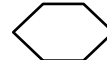
RESTORATION



Asphaltenes



High MW, aromatic species



Low MW, aromatic species

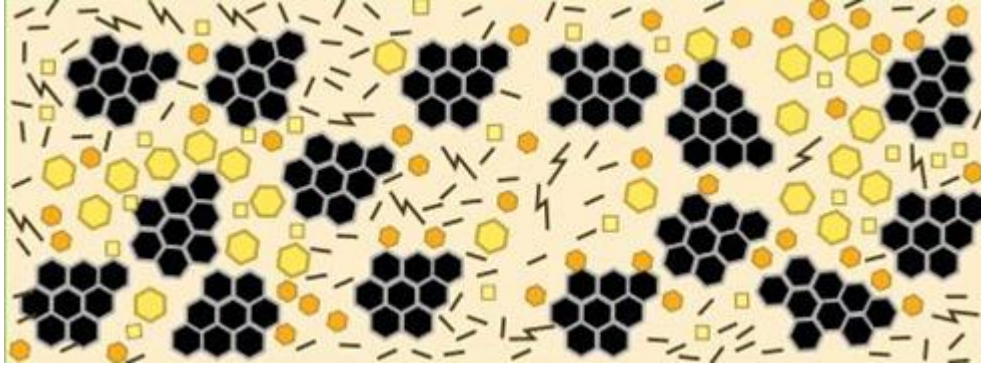


Naphthenic compounds

# REJUVENATION

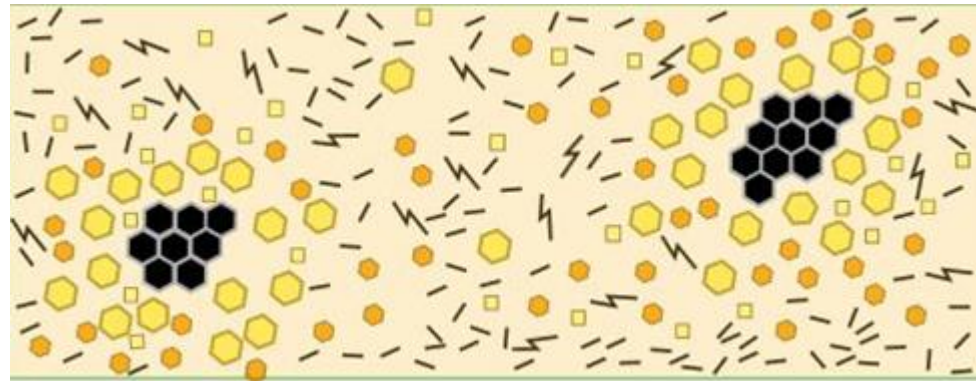
- “Rejuvenation” does not mean reversing the oxidation; rather it means a return of the viscoelastic properties of the binder.
- The layering of the asphaltene particles must be interrupted.
- A rejuvenating agent should reduce the overall viscosity through a decrease in the effective particle size of the asphaltenes by peptizing the asphaltenes.
- A plasticizer will lower the viscosity of the binder by lowering the viscosity of the continuous phase through dilution (like adding water to honey).
- A plasticizer will not interrupt the layering of the asphaltenes and will therefore not return the viscoelastic properties and prevent cracking.

# REJUVENATORS



Plasticizing additives only reduce the viscosity of the surrounding continuous phase

Rejuvenators will disrupt the layering and networking of the asphaltenes and stabilize the resulting system

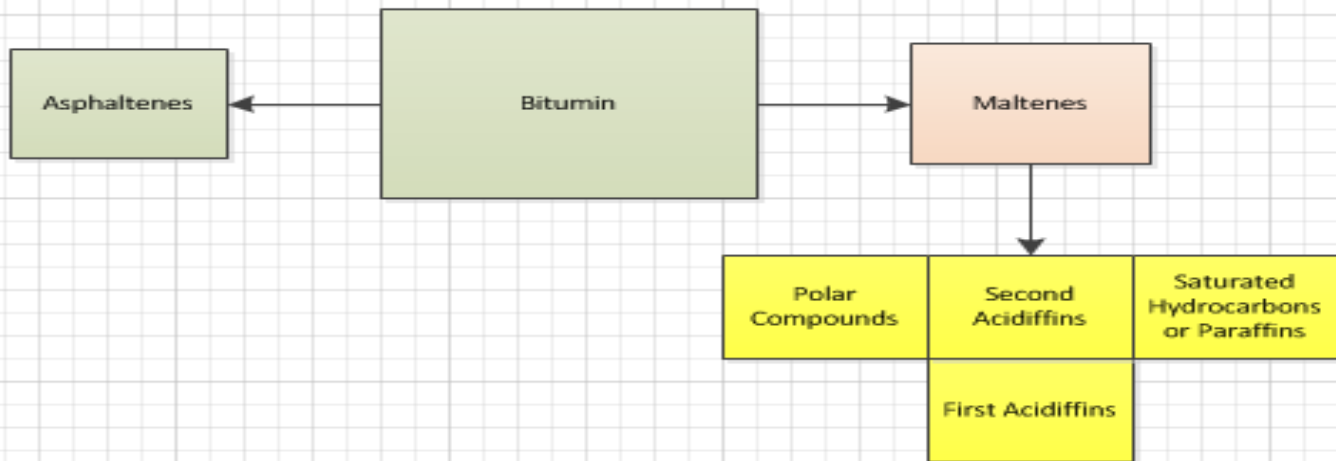




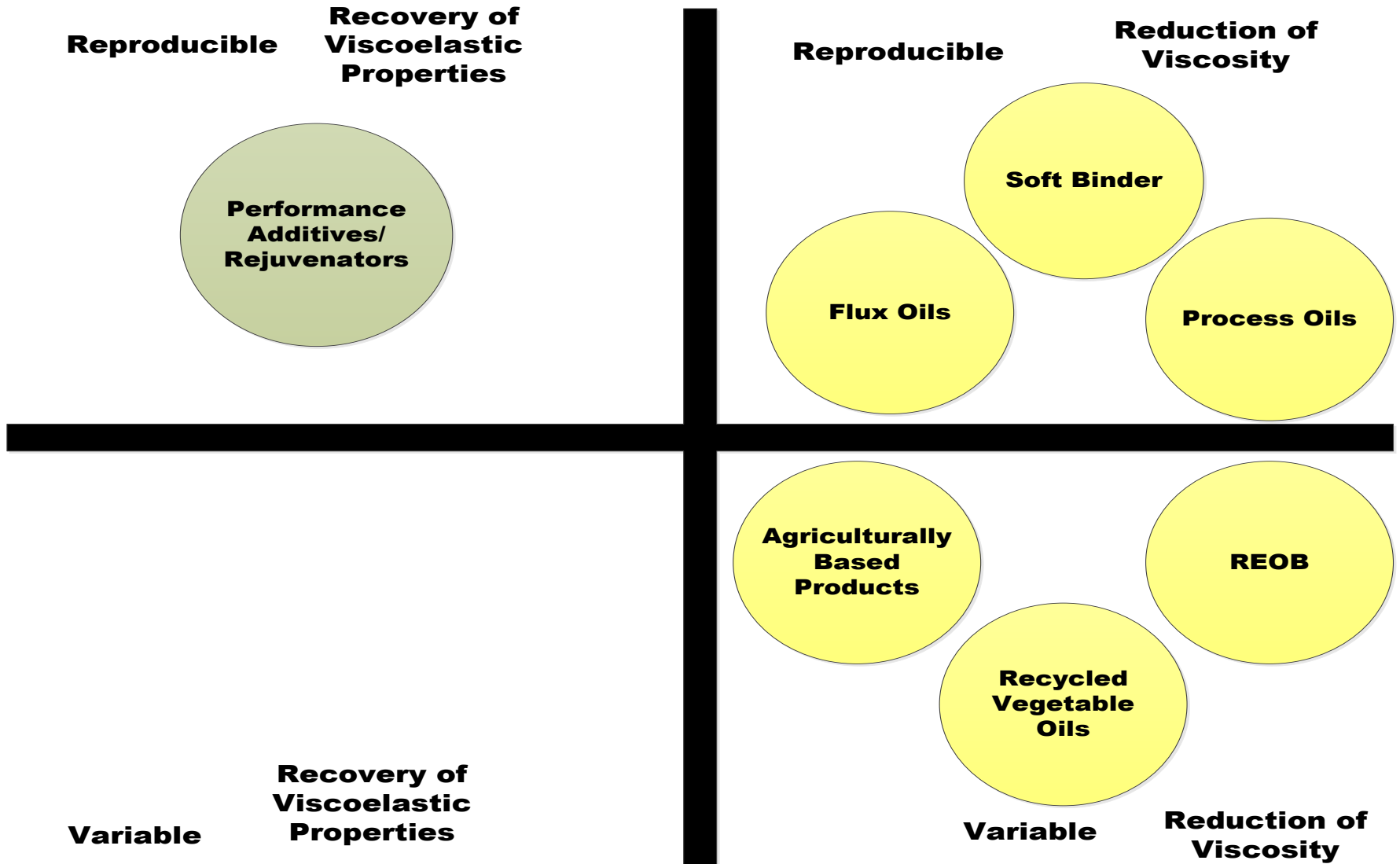
# ROLE OF A TRUE REJUVENATOR

✿ The physical and chemical characteristics to restore aged asphalt to the requirements of current asphalt specifications

- Restoration of Maltene characteristics
- Activate aged binder and not just soften or plasticize the binder
- Eliminate/reduce cracking & maintain/improve rut-resistance.
- High flash point for use in HMA plant
- Disperse readily and maintain miscibility with asphalt binder
- Must be uniform from batch to batch

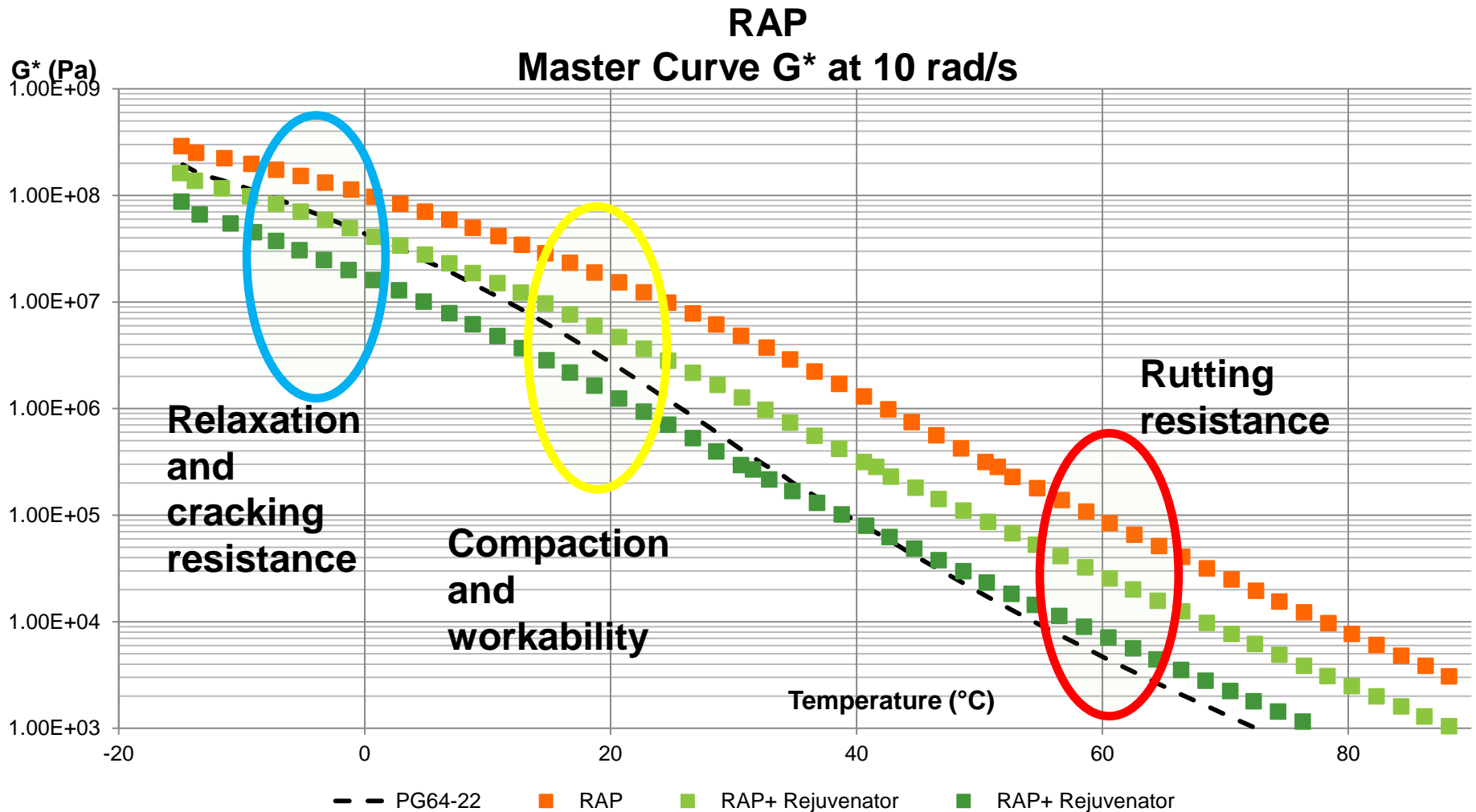


# ADDITIVE PERFORMANCE

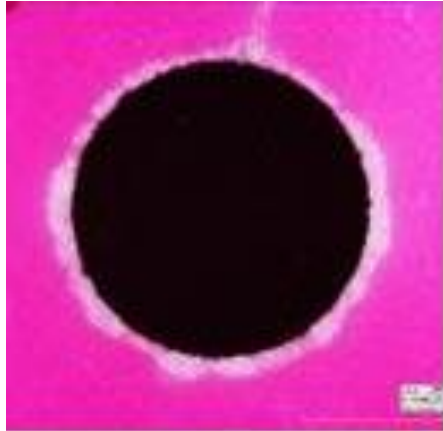




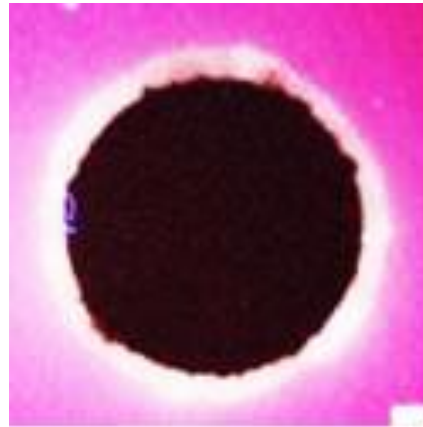
# REJUVENATORS SHOULD POSITIVELY IMPACT THE PERFORMANCE



# MISCIBILITY WITH BITUMEN



Neat binder



Rejuvenator is totally Miscible



Additive is only partially Miscible

- Exudation droplet test measures miscibility as a function of exudation as visible under UV light, after storage under 60°C for 96 h
- Droplet of binder is placed in a 10 mm by 1 mm cell on a smooth marble plate
- Performance additives blended with asphalt resulted in no additional exudation.
- Single phase system not bi-phase.

# IDEAL PERFORMANCE ADDITIVE PROPERTIES

Easy to use



Liquid at room temperature;  
easy addition to the system

Easy to use at low temperatures



Low viscosity

Cloud point – stable over  
wide temperature range

User friendly

End Performance



Improved Texas Overlay Test results

Improved Hamburg/APA Test  
results



Improved cracking  
resistance

Improved rutting resistance

Safe



No risk at elevated process  
temperatures

Safe to use, no harm to workers



High Flash Point

Non-hazardous

Stable



Product does not degrade in mix  
plant or over time on the road;  
properties are maintained

No exudation



Excellent thermal and  
oxidative stability

Fully miscible with bitumen

Sustainable



No competition with food source



Produced from bio  
renewable feedstock



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# QUESTIONS