# Technical Challenges

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# EMULSION TECHNOLOGY

## A world on its own

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# The world of bituminous emulsions

› Well known principles

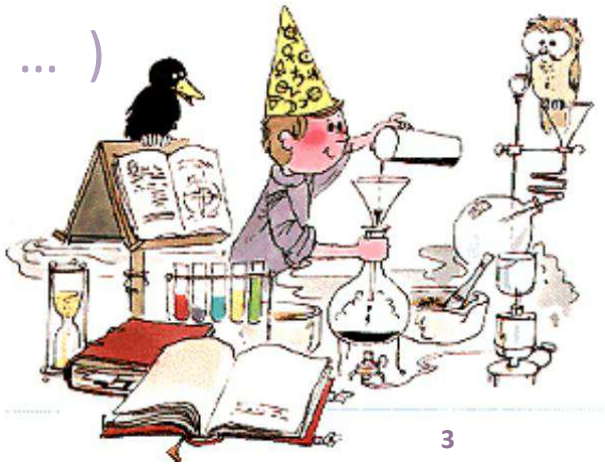
- Bitumen in water – mechanical dispersion and chemical stabilization
- Breaking in the presence of mineral aggregates

› But a wide range of applications with specific needs

- Spraying applications (tack-coats, surface dressings, …)
- Coating applications (microsurfacing, cold mixes, recycling, … )

› And a large number of impacting parameters

- Constituents (bitumen, emulsifiers, additives, …)
- Process parameters (manufacturing, mixing, laying, …)



# A creative world

› Performing solutions for pavement construction and maintenance

- Spraying applications
  - Polymer/latex modified high performance emulsions
  - « Clean » tack-coat emulsions

- Coating applications
  - Microsurfacing technology : quick reopening to traffic, resistance to water and durability
  - From gravel-emulsion mixes (reshaping of worn-out roads, base layers) to dense cold mixes for wearing courses
  - Cold recycling techniques

# Challenging products

- Quality and performance are influenced by many factors
- Much can be (and is) done through adequate QC measures
  - Emulsion manufacturing process
  - Manufacturing and placing of final products

- Variability of constituant products is however a true challenge
  - Creates unexpected problems which are difficult to solve on short notice
  - Raises doubts about the reliability of emulsion technology
  - But does also foster research and innovative thinking
- This is what we will illustrate in the case of bitumen

# Impact of bitumen on emulsion quality

- Emulsion viscosity (surface dressing)
  - « Everything else being constant », particle size distribution (hence emulsion viscosity) may change significantly depending on the origin of the bitumen
  - Concern is growing due to increasing fluctuations in bitumen supplies

- Microsurfacing
  - High performance requirements in some markets (France, UK, …)
    - Very short delay for reopening to traffic ( < ½ hour)
    - Resistance to water and heavy traffic
    - Durability
  - So far, these challenges could be met while using naphtenic bitumen
  - But availability of naphtenic bitumen is no longer guaranteed

# EMULSION VISCOSITY

## Causes and remedies

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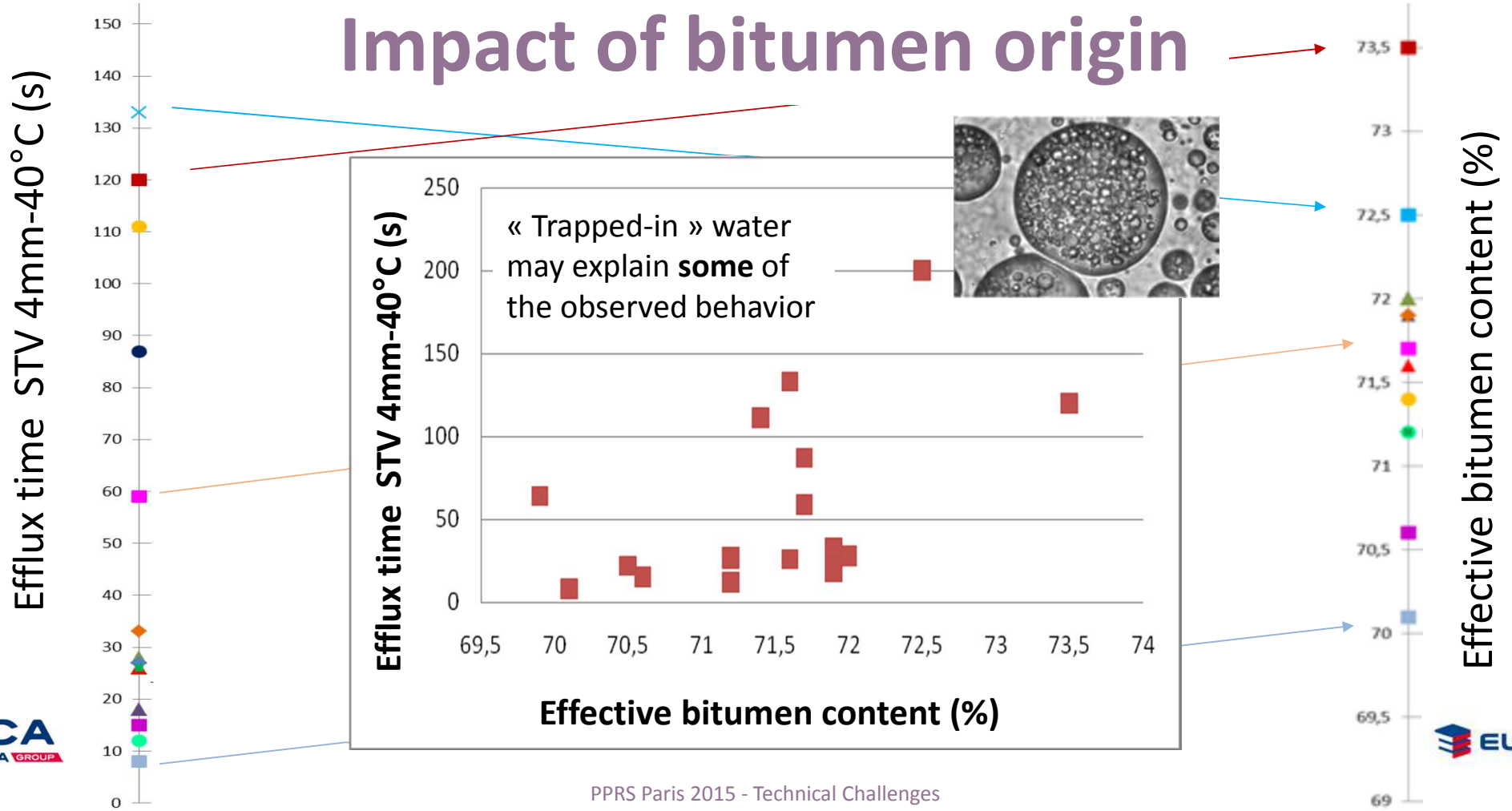
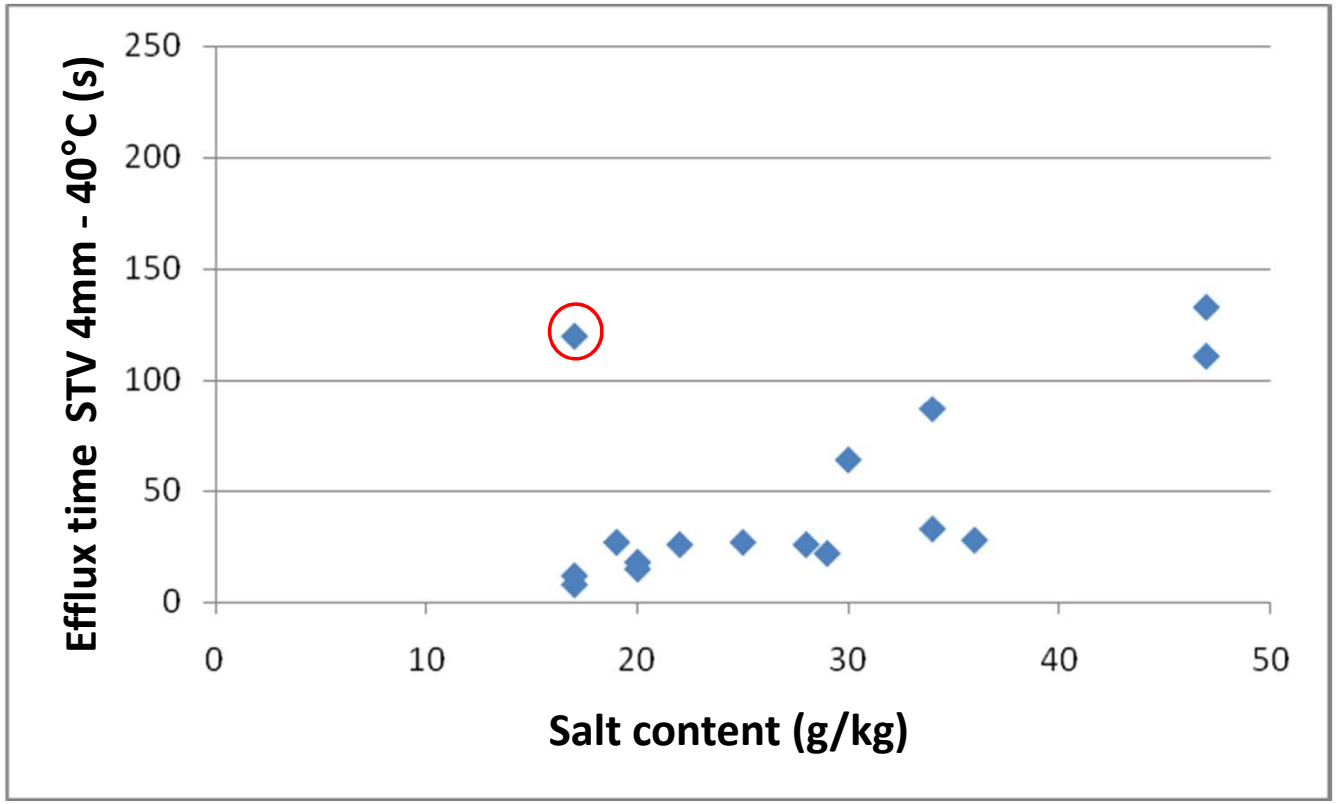
# Impact of bitumen origin



# Salt in bitumen

High salt content generally leads to high emulsion viscosity

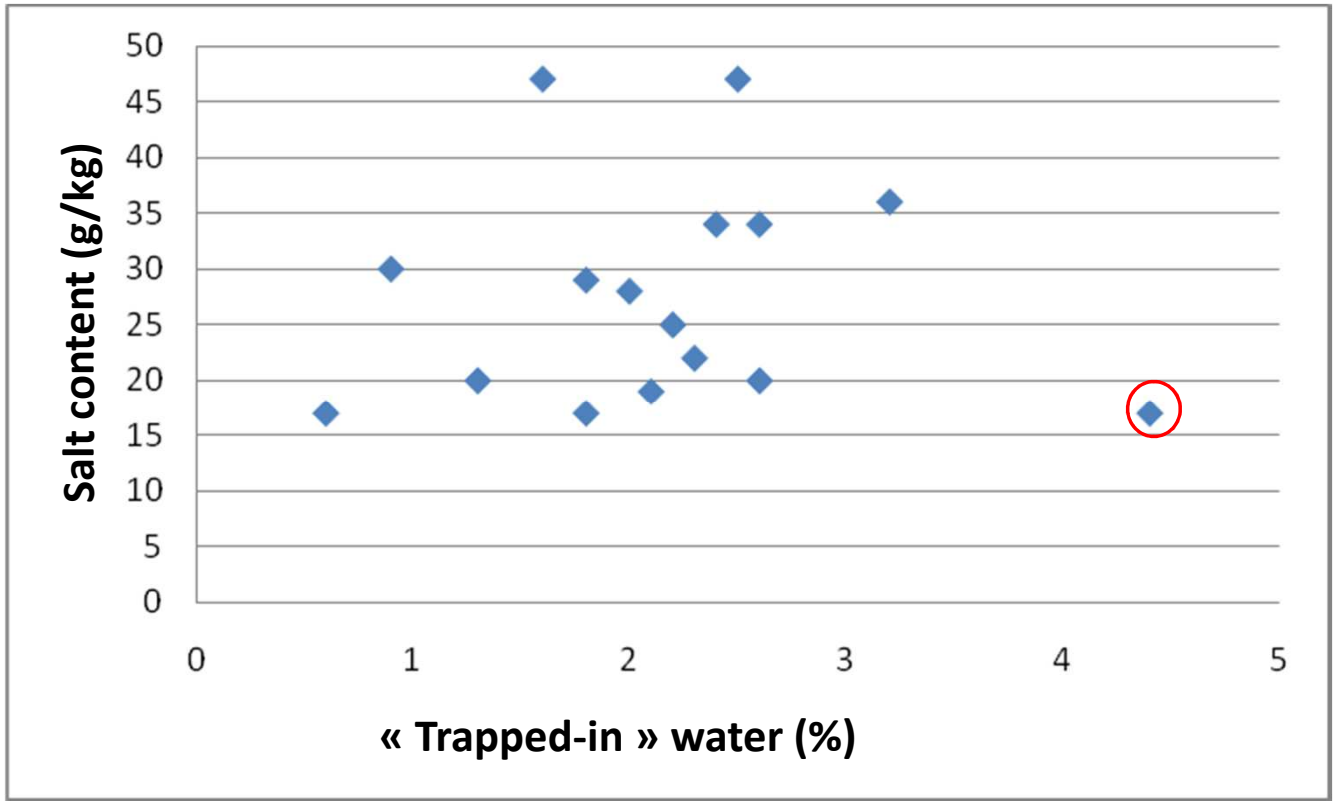



But some « low salt » bitumen may also lead to high viscosities

And vice/versa !

# Salt in bitumen

No strong correlation between salt content and « trapped-in » water



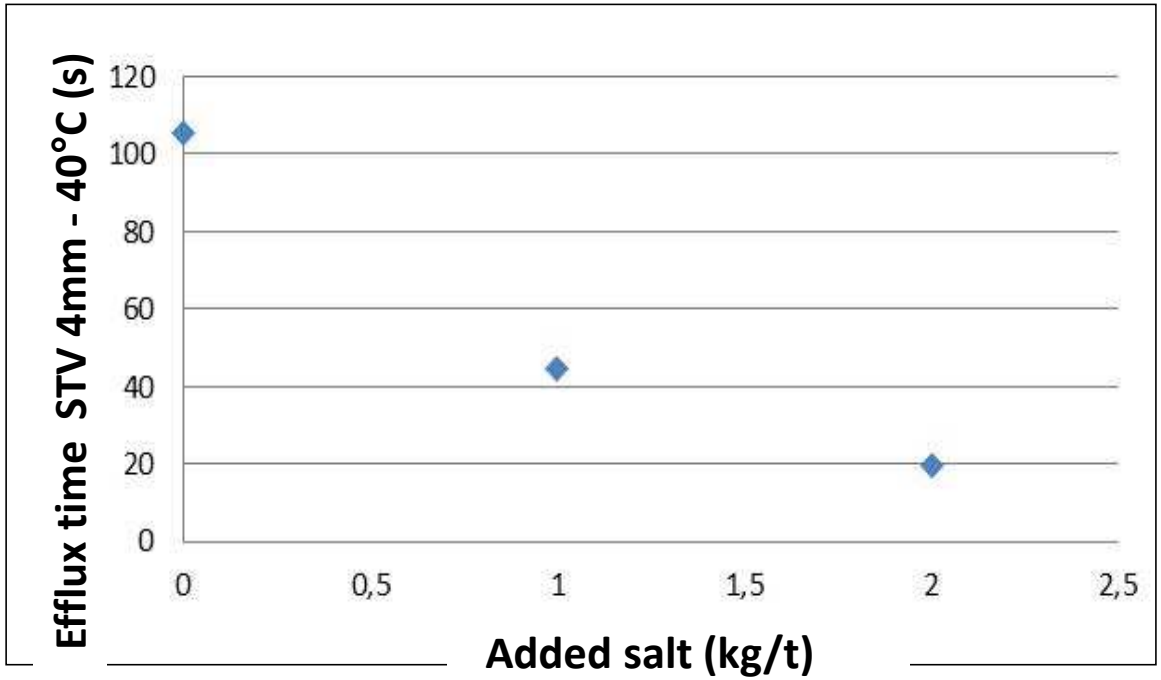

Also « low salt » bitumen may lead to high amounts of « trapped-in » water

# How to lower emulsion viscosity

› Decrease bitumen content

› Add salt into the aqueous phase

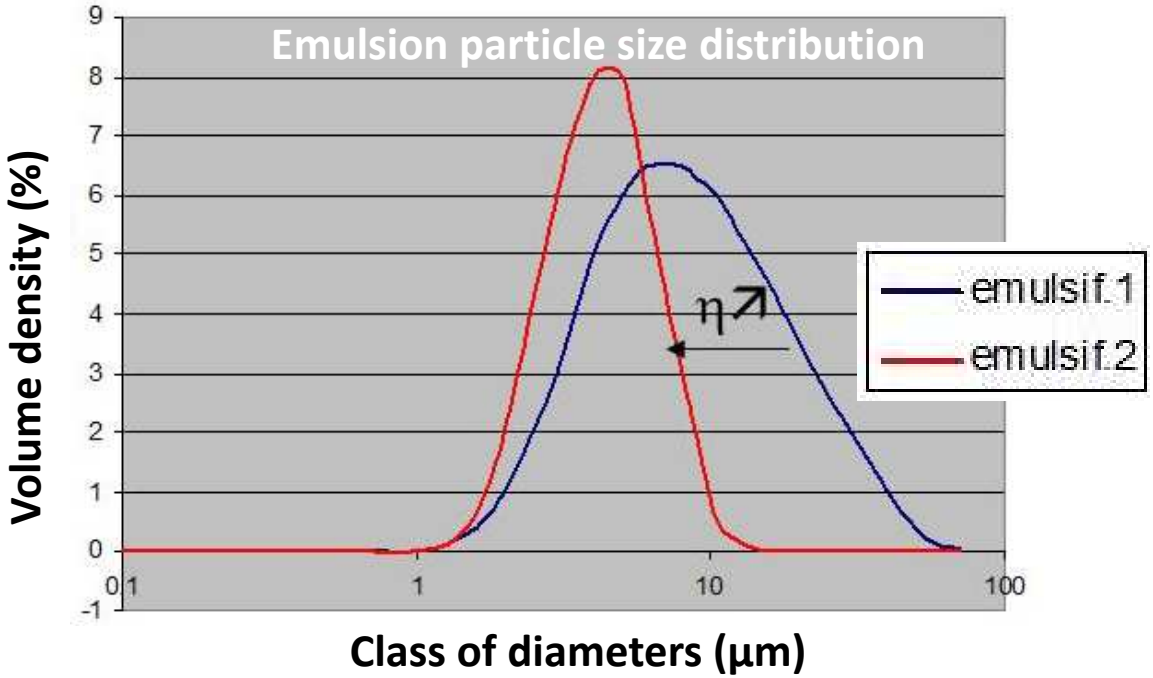
- Only works if the problem is due to water trapped into the bitumen droplets !



# How to increase emulsion viscosity

› Change particle size and particle size distribution

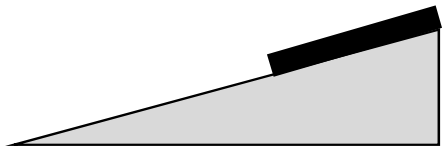
- Small particle size with narrow distribution is what is wanted
- Via process parameters (energy, flow rates, temp., ..)
- Via ad-hoc emulsifier

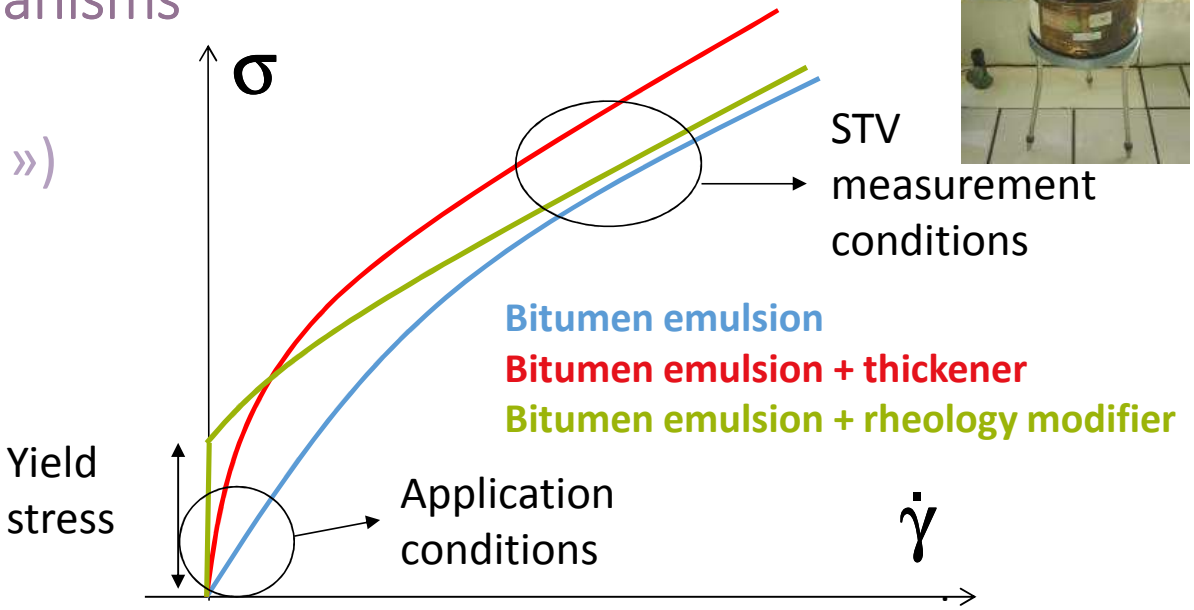



› But efficiency remains strongly dependent on bitumen quality

# How to increase emulsion viscosity

- Use of additives – 2 different mechanisms
  - Thickeners
  - Rheology modifiers (« thixotropy »)
    - Bingham liquid (yield stress)



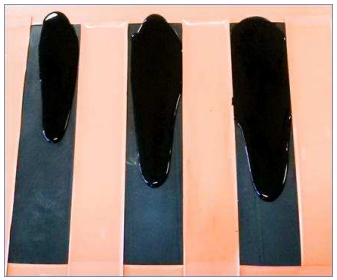



- Evidencing a new problem :

Some rheology modifiers can prevent emulsion to run off once spread on the road (shear stress < yield stress) but their effect can't be seen by STV (efflux time) viscosity.

# Emulsion viscosity - Conclusions

- Of highest concern for surface dressing emulsions
- Bitumen origin may indeed significantly impact emulsion viscosity
- Viscosity can be more easily lowered than increased
- High viscosity is essentially needed once the emulsion has hit the road
  - This is achievable through specific additives
    - Thickeners
    - Rheology modifiers
  - But raises the question on how to adequately mesure viscosity
    - Efflux time likely to be inappropriate
    - Dynamic viscosity a good alternative ?



Product and test standards will have to reflect this reality !

CECA ARKEMA GROUP

EUROVIA VINCI

# CHAPTER TITLE

# Non-naphtenic bitumen for microsurfacing

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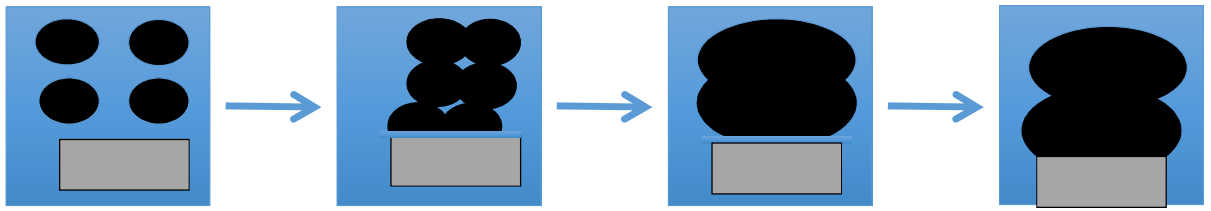
# Microsurfacing technology

- A successfull microsurfacing process will depend upon:
  - Chemistry/Behaviour of the emulsion
    - Bituminous phase / Aqueous phase
  - Chemistry/Behaviour of the aggregate
    - Surface chemistry of the larger aggregates / Reactivity of the finer fractions
  - Chemistry/Behaviour of the on-site controls
    - Cement or lime / Dope or break retarder
- Base bitumen source alone cannot guarantee the overall process performance but « chances of success » are better with naphtenic bitumen
  - But supply is getting short
- This has triggered active research

# The Bituminous Phase

› Naphtenic bitumen

- high in heterocyclic aromatic compounds, generally provides good emulsion stability, good cohesion development for slurry seal and microsurfacing emulsion production due to high acid value, (typically 2.0mg KOH/g) aiding emulsification and lowering particle size.
- Tends to reduce the interfacial tension, enhancing coalesence and adhesion
- However, this still does require a suitable aqueous phase chemistry and compatible aggregate.



› Paraffinic bitumen

- Lower aromatic content and low Acid Value (typically < 0,1 KOH/g)
- May need chemical modification for emulsion use, or a more specific aqueous phase chemistry and a more restricted number of compatible aggregates.

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# « Paraffinic » microsurfacing

- Aqueous phase
  - Many options for emulsifiers on the market
  - Hydrochloric or phosphoric acid may be used to protonate the emulsifier system
  - Many additive options to reduce interfacial tension
- It is possible to utilise a basic paraffinic type bitumen with appropriate aqueous phase chemistry to produce a reasonably functional micro- surfacing binder. However:
  - With a very limited range of aggregate sources
  - With a slower cohesion development (UK demand is stabilised within 5–10 min.)
  - Without the very black “rich” appearance provided by a good naphthenic system, or a more specific aqueous phase chemistry and a more restricted number of compatible aggregates.

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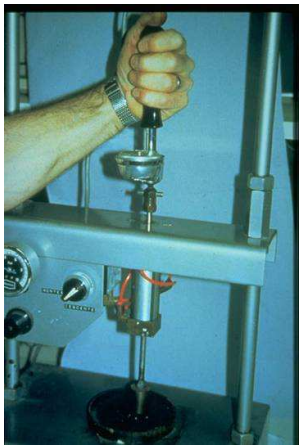
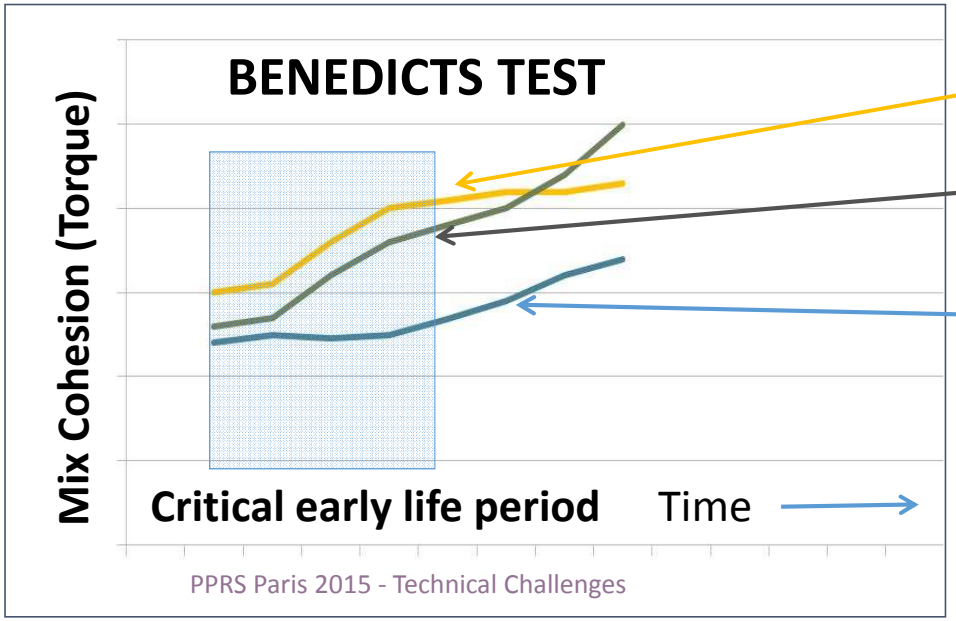
# A new binder developed in the UK

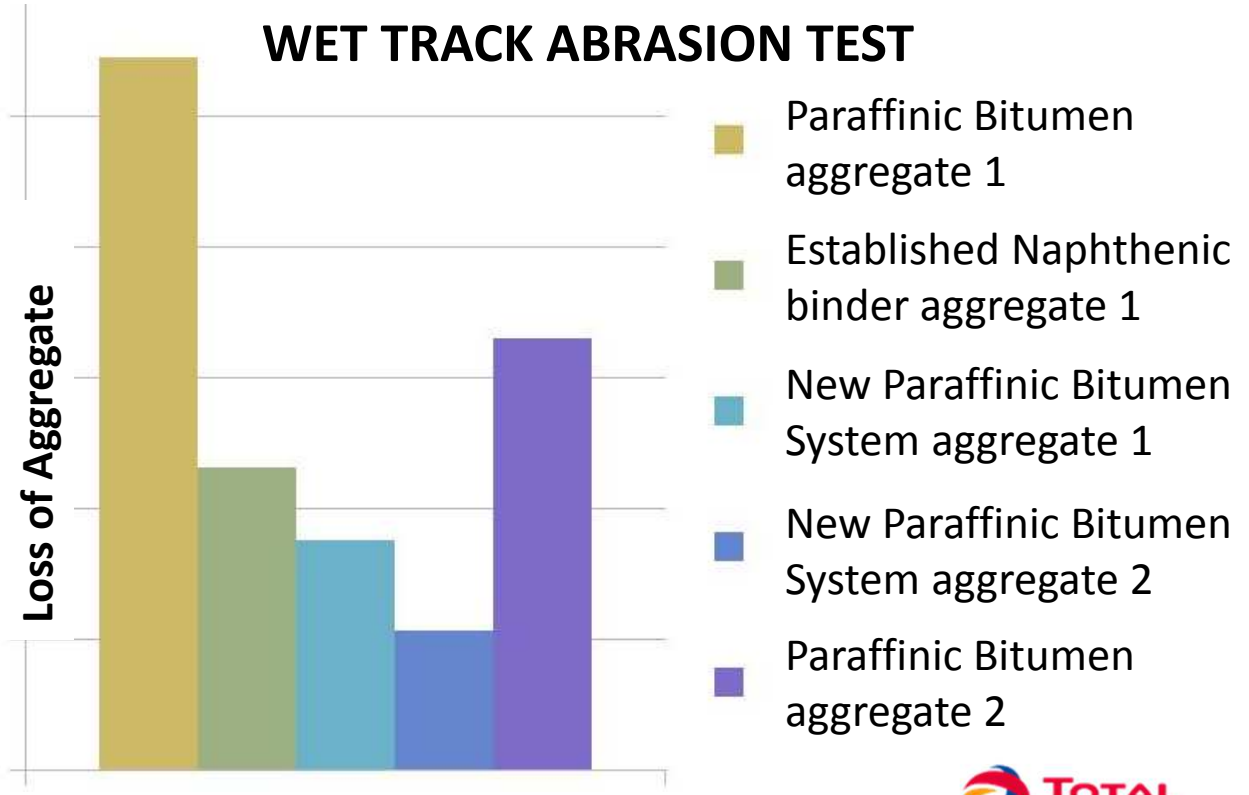
Total UK have developed a micro surfacing binder using a new paraffinic bitumen system and a very specific aqueous phase chemistry that, in lab tests, at least matches the performance of “respected naphthenic systems” in the UK; and is compatible with a wider range of aggregate sources.





# A new binder developed in the UK

- As shown by the Wet Track Abrasion test, adhesion of aggregates to the binder within the mix is also better in the additivated paraffinic system
- Although unquantified, the underlying adhesion to the substrate is also at least as good as the established naphtenic system



# A new binder developed in the UK

› Early trials with a modified paraffinic system illustrate the possible issues with compatibility of the overall system

- Photo 1 : several months after application
  - Aggregate type (a) appears very black , well coated and well adhered to the underlying surface

- Photo 2 : several months after application
  - Aggregate type (b) appears grey, inconsistent coating and poorly adhered to the underlying surface

# « Paraffinic » microsurfacing - Conclusions

- It is absolutely possible to produce a microsurfacing system based on a paraffinic bitumen that can perform at least as well as currently established naphtenic binder systems
- Issues that need to be overcome
  - Attaining adequate binder / aggregate adhesion in a sufficiently fast time (to impart mix cohesion)
  - Maintaining binder adhesion to the larger aggregate through wet conditions to reduce surface fretting
  - Achieving sufficient adhesion to the underlying layer to stop any delamination
  - Maintaining a “clean break” after adhesion to avoid pick up on feet and plant in the very early life (1st 10 minutes)
- To achieve these performance criteria we must have
  - Bitumen with suitable interfacial tension to enable “clean” coalesence and good wetting of the aggregate
  - Complimentary chemistry of the bituminous phase and the aqueous phase
  - Compatiblity between coarse aggregate fraction and finer fraction and emulsion

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# CONCLUSION

- New challenges
- Which call for
  - More creativity
  - Performance testing - Evolution of test and product standards
  - A closer relationship between suppliers and producers
- Nothing we can’t do !