Chemically Modified Fiber Technology- Benefits For Modified Asphalt Applications

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Outline

- Background
- Introduction of Surface-Treated Fiber Technology
- Coating Process
- Experimental
- Data
- Advantages
- Other Potential Uses
- Conclusions
- Acknowledgments
- Questions

Background

- ***Asphalt Roofing Mastics***
  - Thixotropic in nature
    - Sag resistant, durable, and cost effective
  - Self healing sealant
    - Joints, adhesives, and defects
- ***Mastics Before 1989***
  - Asbestos used for gelling properties
    - Health concerns led to ban on the use of asbestos fibers

Asbestos Fibers

Background

- ***Mastics of Today***
  - Attapulgite or other clays replace asbestos fibers
  - Similar gelling properties with the use of a liquid surfactant
    - Hydrophilic end-clay
    - Hydrophobic end-asphalt
- ***Typical Mastic Formula***
  - Cutback
  - Surfactant
  - Clay
  - Cutback
  - Fibers
  - Cutback or other mineral fillers
  - Cutback

Development of Technology

- ***Profit Reducing Steps***
  - Transportation and storage of corrosive liquid surfactants
  - Agglomeration during packaging and storage
    - Requiring shredders
  - High levels of dust

DOT Class 8 Material

Surface-Treated Fibers

- ***Surface-Treated Fibers***
  - Coat cellulose fibers with liquid surfactant
    - 15-20% by weight for roofing mastic applications
      - Mitigates profit reducing steps for end users
      - Improves properties and performance

Left-Uncoated Fibers *Right*-Coated Fibers

Coating Process - Developmental Stage

- ***Spray Bottle***
  - Surfactant cutback with IPA at 15-30% by weight
    - Improve atomization of surfactant
  - Cutback surfactant added incrementally to pre-weighed cellulose fibers in a mixing bowl
  - Fibers mixed by hand after each incremental addition
  - Repeated until desired coating achieved

Coating Process - *Pilot Process*

- ***Insulation Blower Used to Transport Fibers***
  - **Surfactant introduced into high velocity air stream created by the blower**
    - **Blower disperses surfactant**

$$\text{Required Mass Flow Rate} = \frac{\text{ProcessSpeed}}{1 - \text{Desired Coating Fraction}} - \text{ProcessSpeed}$$

$$\text{Required Volumetric Flow Rate} = \frac{\text{Mass Flow Rate}}{\text{Surfactant Density}}$$

Coating Process - Production Scale

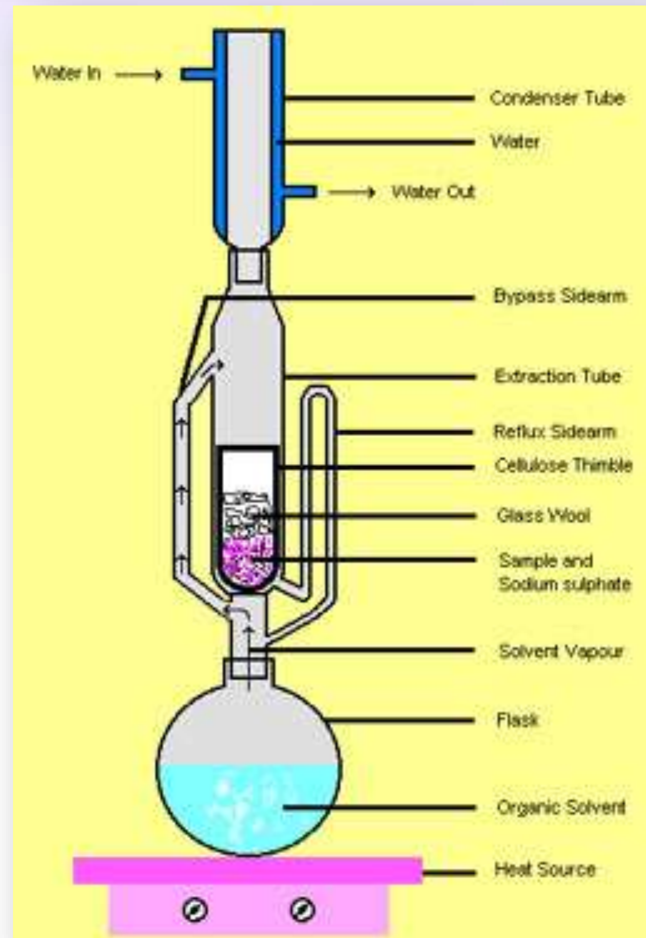
- ***Modify preexisting process by applying surfactant through water spray nozzles just prior to entering mill***
- ***Centri-Sifter® by Kason Corporation, Milburn, NJ***
  - Flexible continuous process
    - Modified by spray nozzles mounted on center rotary shaft

Centri-Sifter®

Quality Control

- ***Soxhlet Extraction***
- ***Required Equipment***
  - Boiling flask
  - Extraction Solvent
    - IPA or ethanol
  - Soxhlet Extractor
  - Cellulose Thimble
  - Condenser

$$\text{Percent Surfactant} = \frac{\text{Surfactant Extracted}}{\text{Total Inital Fiber Weight}}$$



Experimental Process

- ***Kitchen Aid Mixer Used For Mixing***
- ***Formula***
  - Cutback
  - Surfactant-treated fibers
  - Clay
  - Mineral fillers
  - Cutback

- ***Blends mixed using coarse fiber at 15-20% by weight surfactant***
  - Added at 5-7% by weight of total blend to achieve C/S of 7-10:1
- ***Tests: Initially and 1 Week***
  - ASTM D 5329
    - Cone penetration
  - ASTM D 6511-06
    - Behavior at 60 C

Data

- ***Cutbacks Used in Testing***
- ***Control Blend***
  - D 5329 - 330 dmm

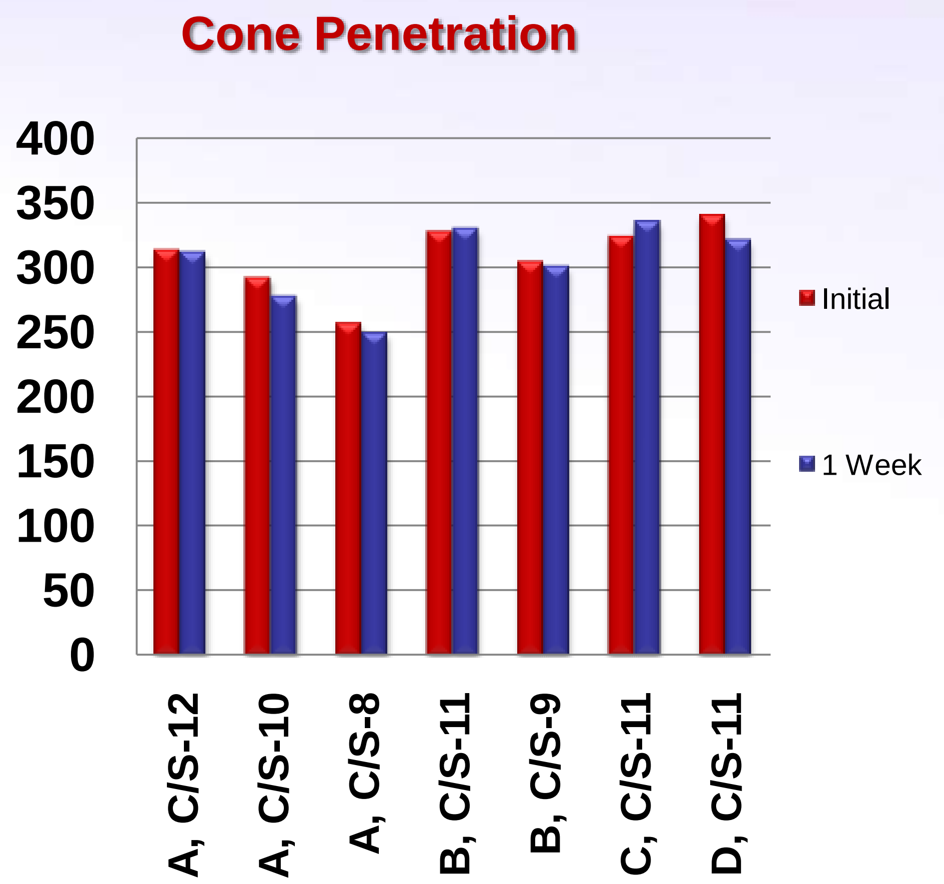
	Initial		1 Week	
	D 5329, dmm	D 6511-06	D 5329, dmm	D 6511-06
A, C/S-12	313	Pass	311	Pass
A, C/S-10	291	Pass	277	Pass
A, C/S-8	256	Pass	249	Pass
B, C/S-11	327	Pass	329	Pass
B, C/S-9	304	Pass	300	Pass
C, C/S-11	323	Pass	335	Pass
D, C/S-11	340	Pass	320	Pass

Cone Penetration and Slump Test Results

Data

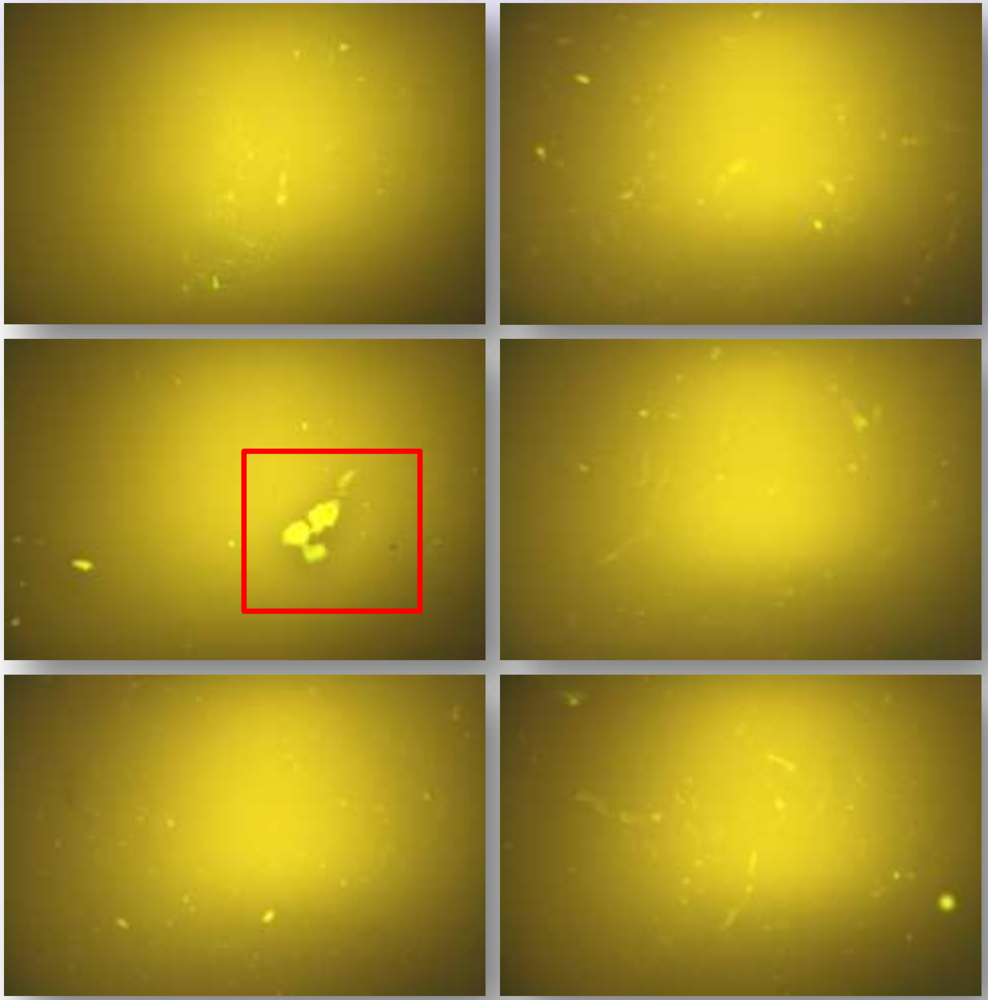
- ***5 out of the 7 batches had a decrease in cone penetration or a viscosity increase within 1 week***
  - Characteristic of good gel

- ***Samples B & C at C/S-11 cone penetration results were within error of test***
  - Could also be due to high C/S ratios used



Improved Fiber Uptake in Cutback

- ***Samples taken***
  - 18 seconds
  - 30 seconds
  - 1 minute
- ***Analyzed under UV microscopy***
- ***Surfactant-coated fibers display good dispersion***
- ***Neat fibers display some agglomeration***



Left **Neat Fibers Used** ***Right*****- Surfactant-Coated Fibers Used**

Dust Level Analysis

- ***Pictures taken after 18 seconds of mixing***
  - Neat fibers clearly produce more dust during mixing process

- ***15-20% by weight coating reduces the high dust levels commonly observed***

Neat Fibers Used

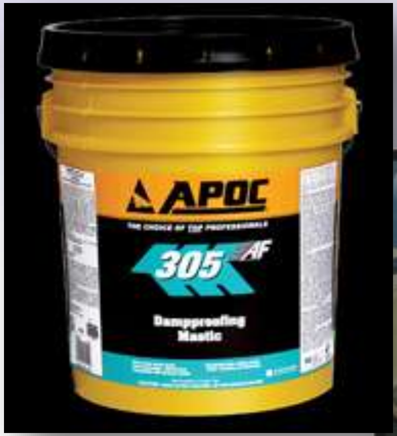
Surfactant Coated Fibers Used

Advantages

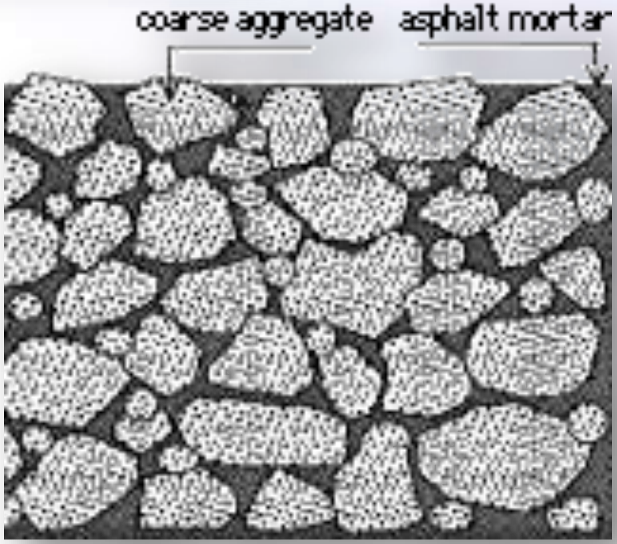
- Processing flexibility
- Fewer processing steps for end users
- Improved dispersion
- Dust reduction
- Potential anti-blocking characteristics
- Less additives required
- Lower manufacturing costs

Surface-Treated Fiber Uses

- ***Coatings***
  - Fine fibers



- ***SMA's***
  - Fibers used to prevent "draining" of the asphalt
  - Anti-stripping agents added at 0.3-0.5% by weight of asphalt to promote asphalt/aggregate adhesion



SMA Applications

- ***SMA Composition (w/w%)***
  - **93.6-93.7 percent coarse aggregate**
  - **6 percent asphalt binder**
  - **0.3-0.36 percent cellulose fibers**
  - **0.02-0.03 percent anti-strips**

- ***Fibers could act as a carrier for the anti-stripping agent if coated with 6-8 percent by weight***
  - **Improved properties observed in mastic applications makes this a promising option**

Conclusions

- ***Surface-treated fibers***
  - Offer improved properties
    - Processing flexibility
    - Improved dispersion
    - Displays gelling properties w/o clay
  - Offer cost savings for end users
    - Reduction in additives
    - Material handling of corrosive liquids
    - Fewer processing steps
- ***Improved properties seen in roofing mastics with the use of surface-treated fibers makes SMA an area of interest for expanding the use of fiber technology***

Acknowledgments

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Questions