An innovative method to visualize the cleaning process in real time

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Mopping the floor--Retrospective

- Details of the process
  - Uses lots of water
  - Requires Energetic Scrubbing
  - Slow Process (Minutes)
  - Surfactant Choices
    - Low Foaming
    - Nonionics
    - Short Hydrophobes (C8-C12)
    - Good Grease Cutting
  - Surfactants Supplied as Concentrates

HSC test method – Historical Approach

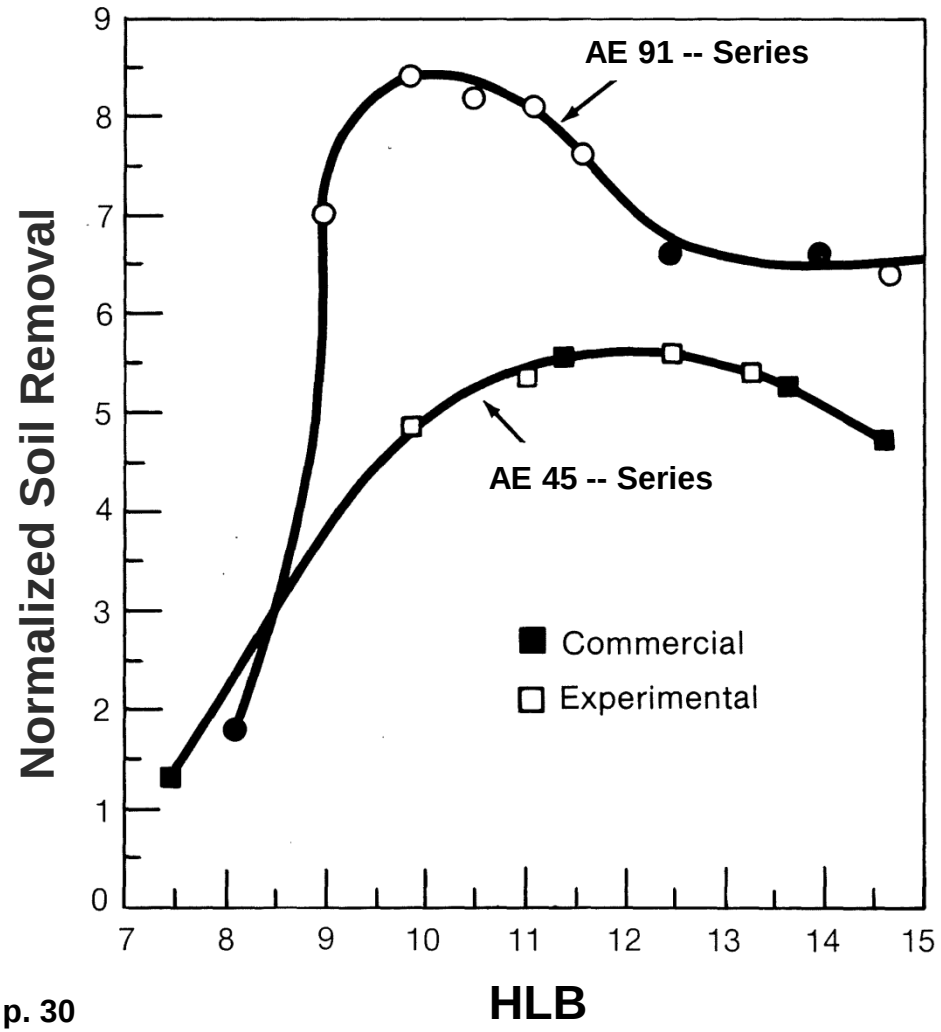
- ASTM D4488
  - Measure surface brightness of white linoleum tiles in several spots
  - Cover tile uniformly with dark soil (base of petroleum grease)
  - Stroke a weighted sponge containing test solution across tile surface
  - Predetermined number of strokes
  - Re-measure surface brightness
  - Relate % soil removal to difference in brightness (before and after)

Gardner Tester

Alderet al., *JAOCS* **6**(10), 520 (1969)

Nonionic Surfactants in Hard Surface Cleaning

Cleaning effect of ethoxylates based on short and long chain detergent alcohols



DH Scharer, et al.,
SCCS, August 1979, p. 30

Testing Formulation Effectiveness (Gardner Tester)

- Faithfully duplicates mopping process
  - Slow process
  - Uses dilute surfactant solutions
- Drawbacks
  - Tiles must dry overnight before evaluation
  - Results dependent on # of cleaning strokes used
    - One data point per tile
  - Discrimination between formulations poor unless # of strokes optimized
  - Not relevant to contemporary consumer habits

Contemporary Consumer Habit

- Direct Application of Cleaning Product
- Rapid Process (seconds)
- Minimal Scrubbing
- Cleaning dependant on chemical energy

- Formulation Testing Requires New Testing Protocol

Choice of Soil/Substrate

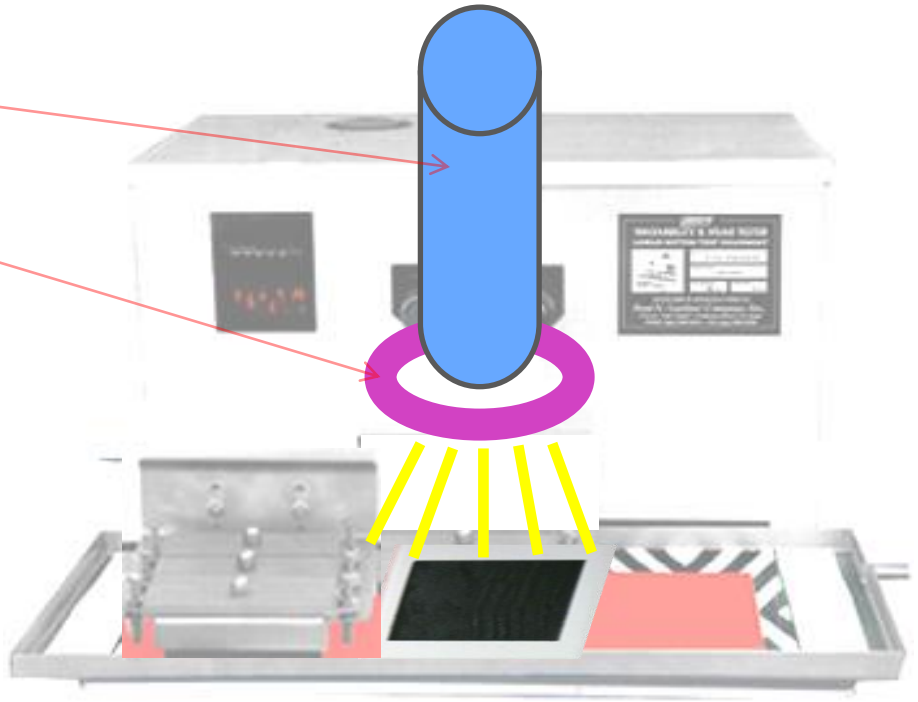
- Represent typical household dirt
  - Soil: grease, oily soil, aged triglycerides, milk
  - Substrate: granite, ceramic, stainless steel

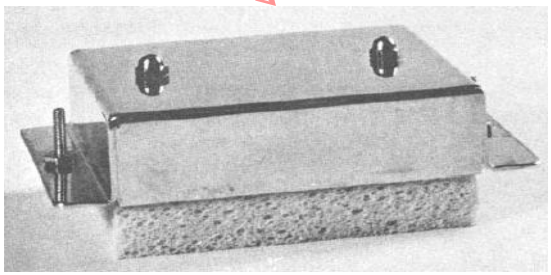
- Choice: Greasy soil on Ceramic tile (*Matte* finish)
  - Aged greasy oil splash/deposit on stove/wall
  - Tough to clean

- Cleaner formulation
  - Surfactant: AE 3wt%
  - Builder: Sodium citrate 2wt%

in-situ characterization – The setup

- Take an image after each stroke
  - Camera addition
  - Proper lighting
  - Sponge
  - Sprayer



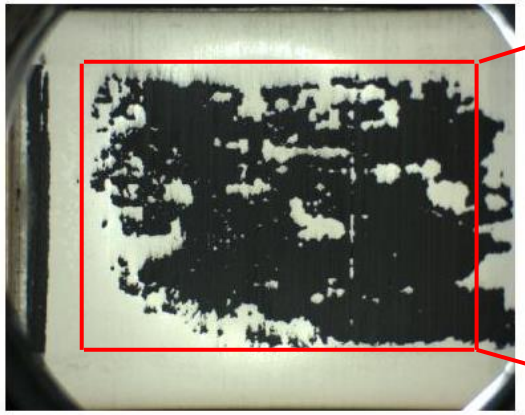


Choice of Soil and substrate (cont'd)

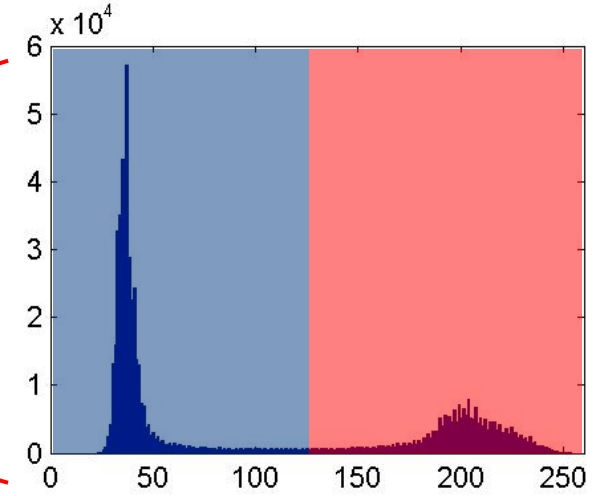
- Soil composition
  - Grease: Vegetable oil, Vegetable shortening, Lard
  - Drying oil: Linseed oil (*simulate aging*)
  - Particulate: Carbon black (pigment)
  - Solvent: Mineral spirits
- Shear blended and baked (106^{o}C) for 30min
- Cooled and aged in room temp. overnight

Cleaning process – the images

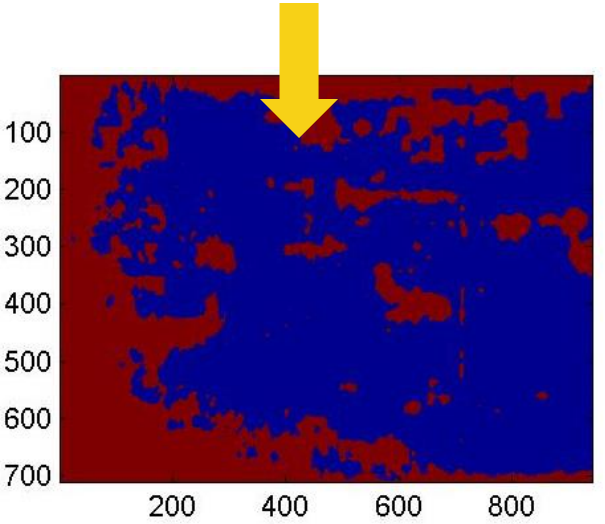
- Image processing



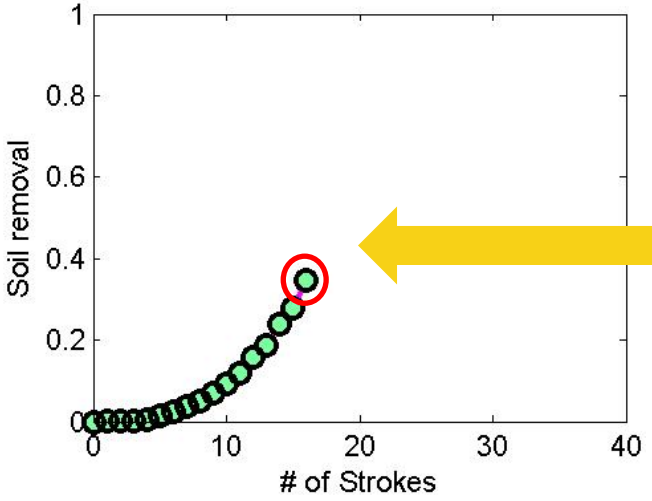
Original Image



Grey scale distribution (ROI)



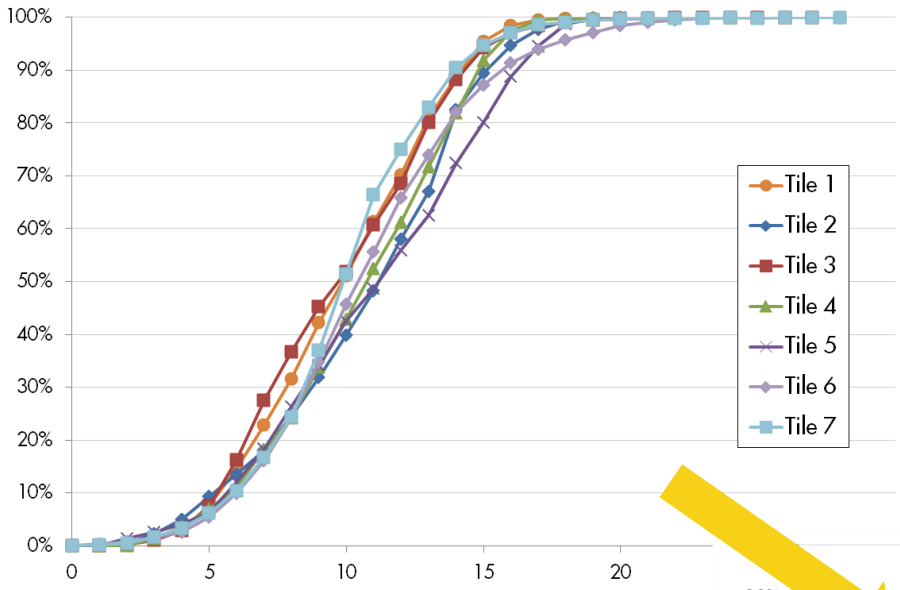
Binary ROI

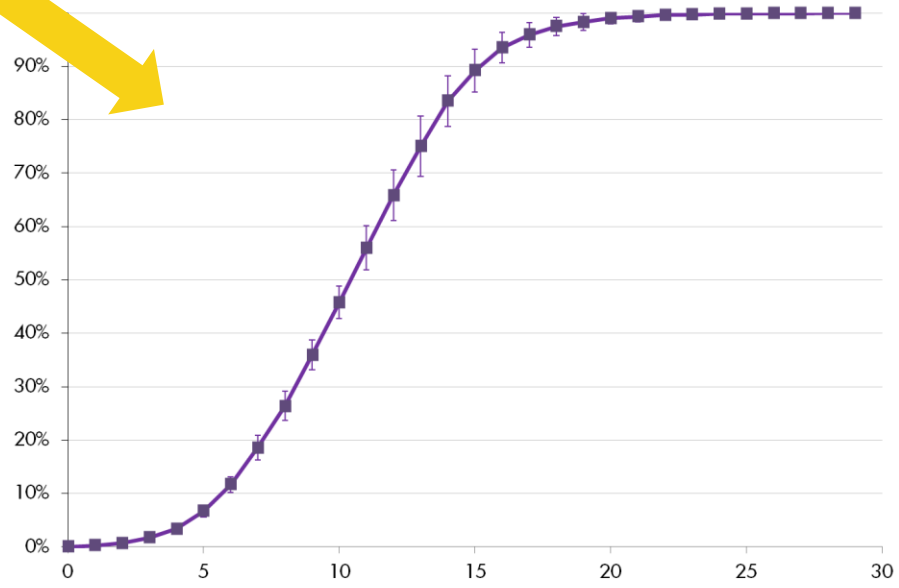


Cleaning curve

Cleaning process – the video

Consistency





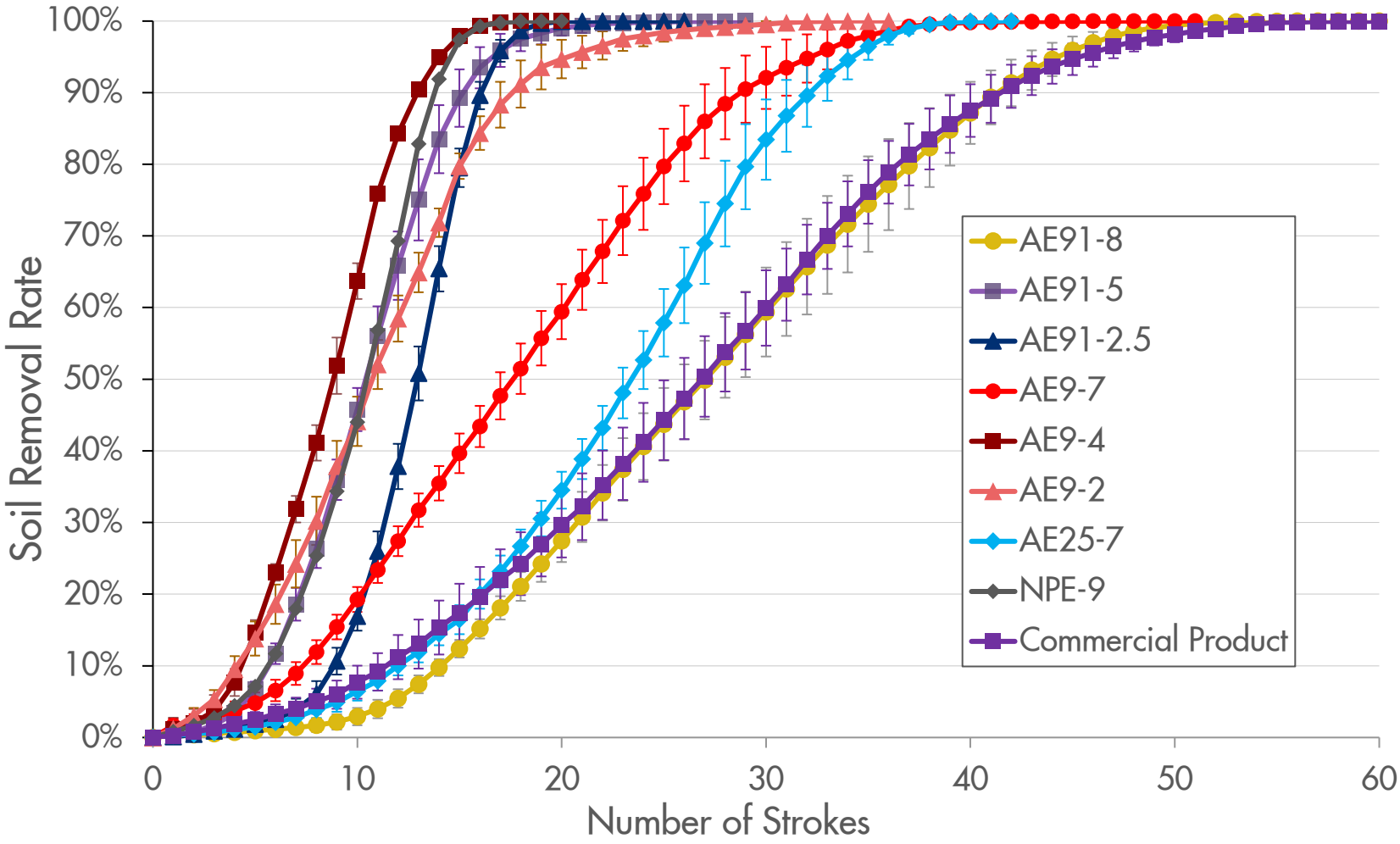
Test materials

- Alcohol Ethoxylates

Hydrophobe	Ethoxylate	HLB	Hydrophobe	Ethoxylate
C9-11	AE 91-2.5	8.1	C9	AE9-2
C9-11	AE 91-5	11.6	C9	AE 9-4
C9-11	AE 91-8	13.7	C9	AE 9-7
C12-15	AE 25-7	14.4		
Nonylphenol	NPE-9	13.0		

Cleaning curves

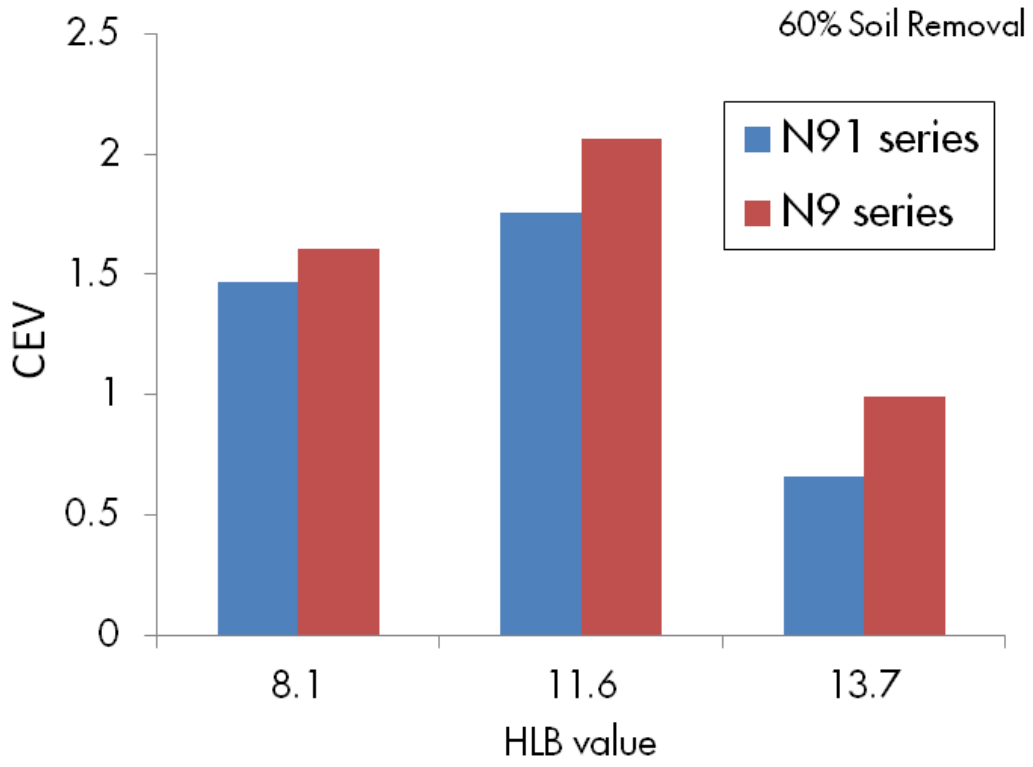
- Single surfactant formulations: 3% AE, 2% NaCitrate



Cleaning effectiveness values

- At 60% soil removal

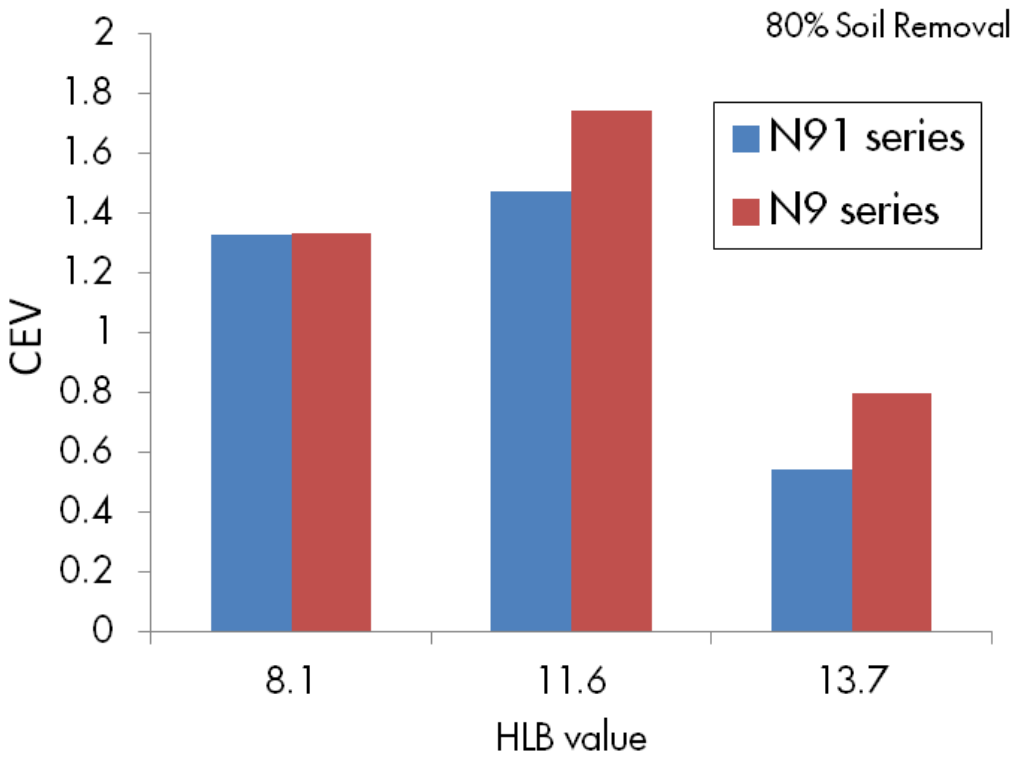
$$CEV = \frac{1}{\#\ strokes} \times constant\ (20)$$



Cleaning effectiveness values

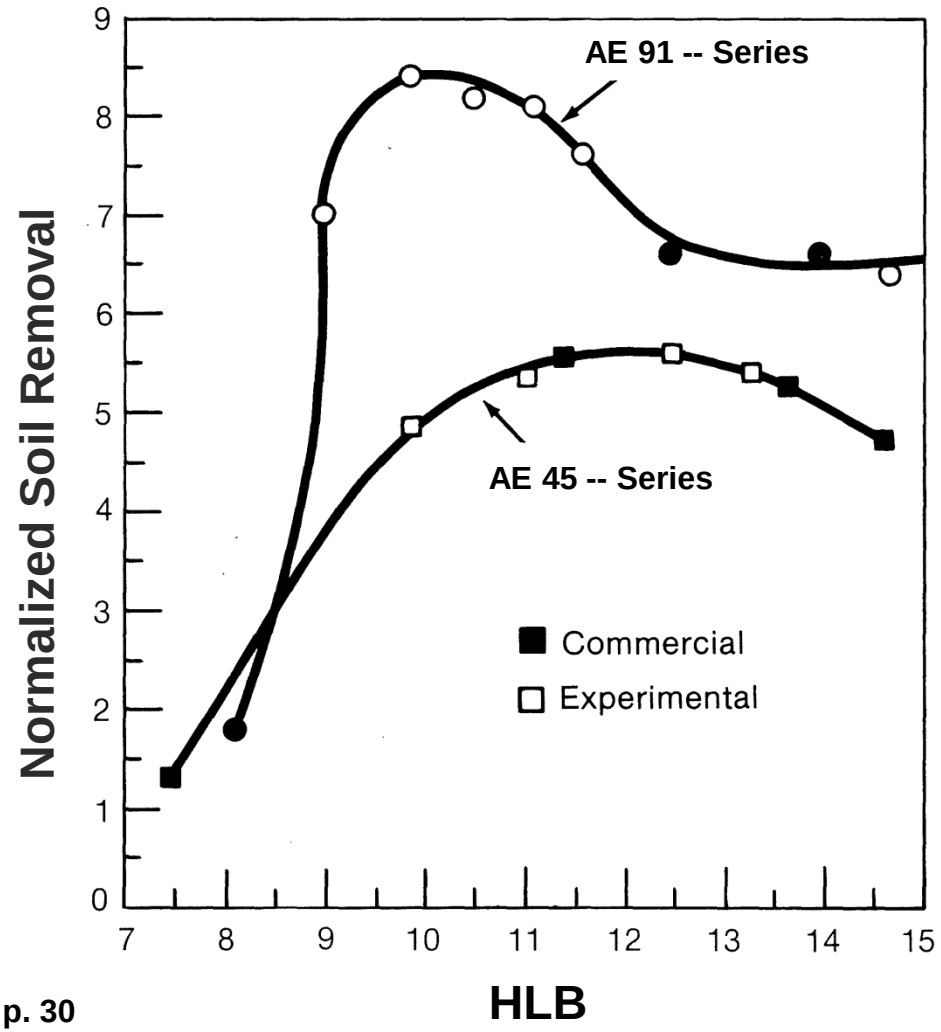
- At 80% soil removal

$$CEV = \frac{1}{\#\ strokes} \times constant\ (20)$$



Nonionic Surfactants in Hard Surface Cleaning

Cleaning effect of ethoxylates based on short and long chain detergent alcohols



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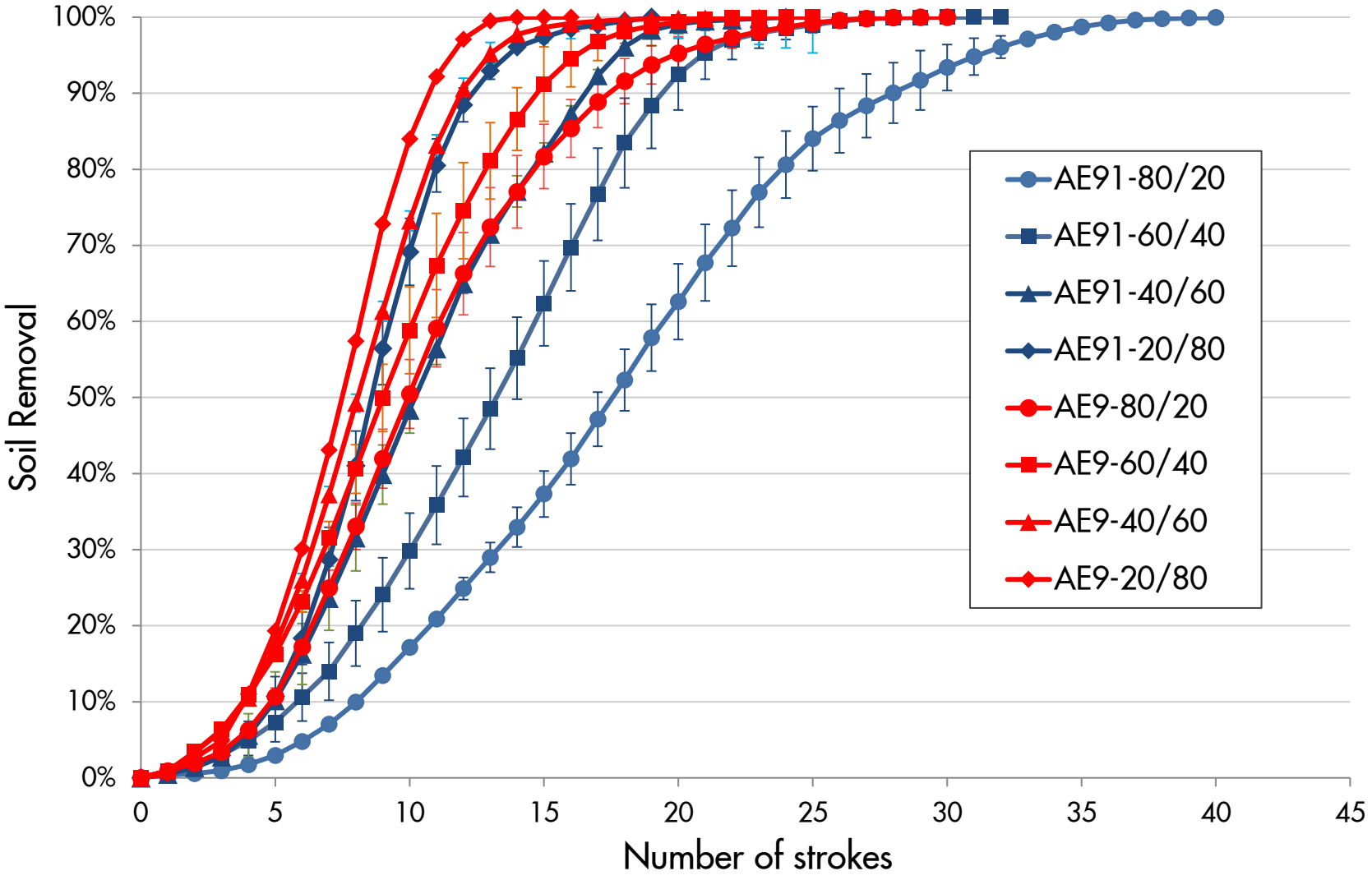
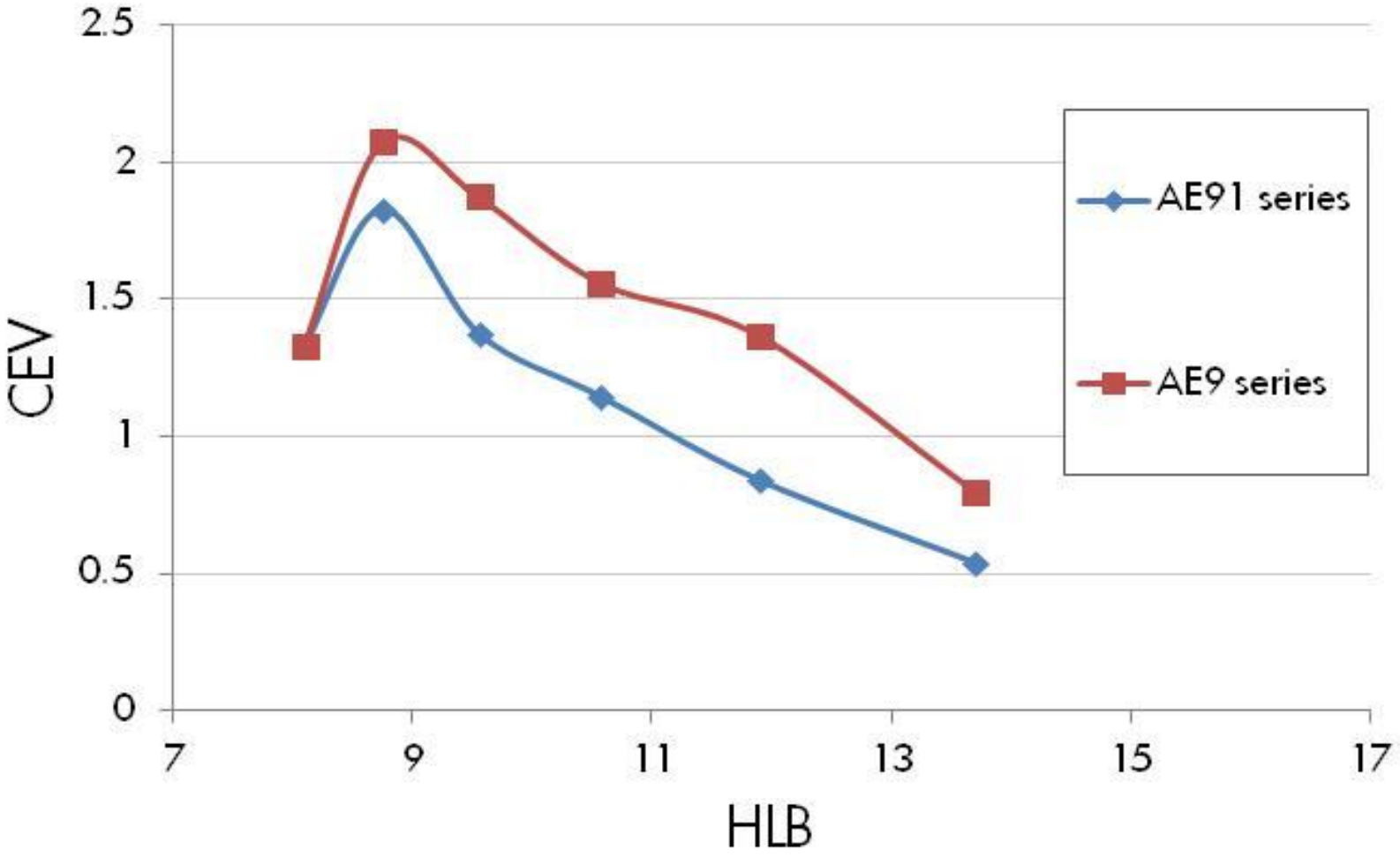
Binary formulations—High mole/Low mole Ethoxylates



Cleaning effectiveness values—Binary Mixtures

- At 80% soil removal

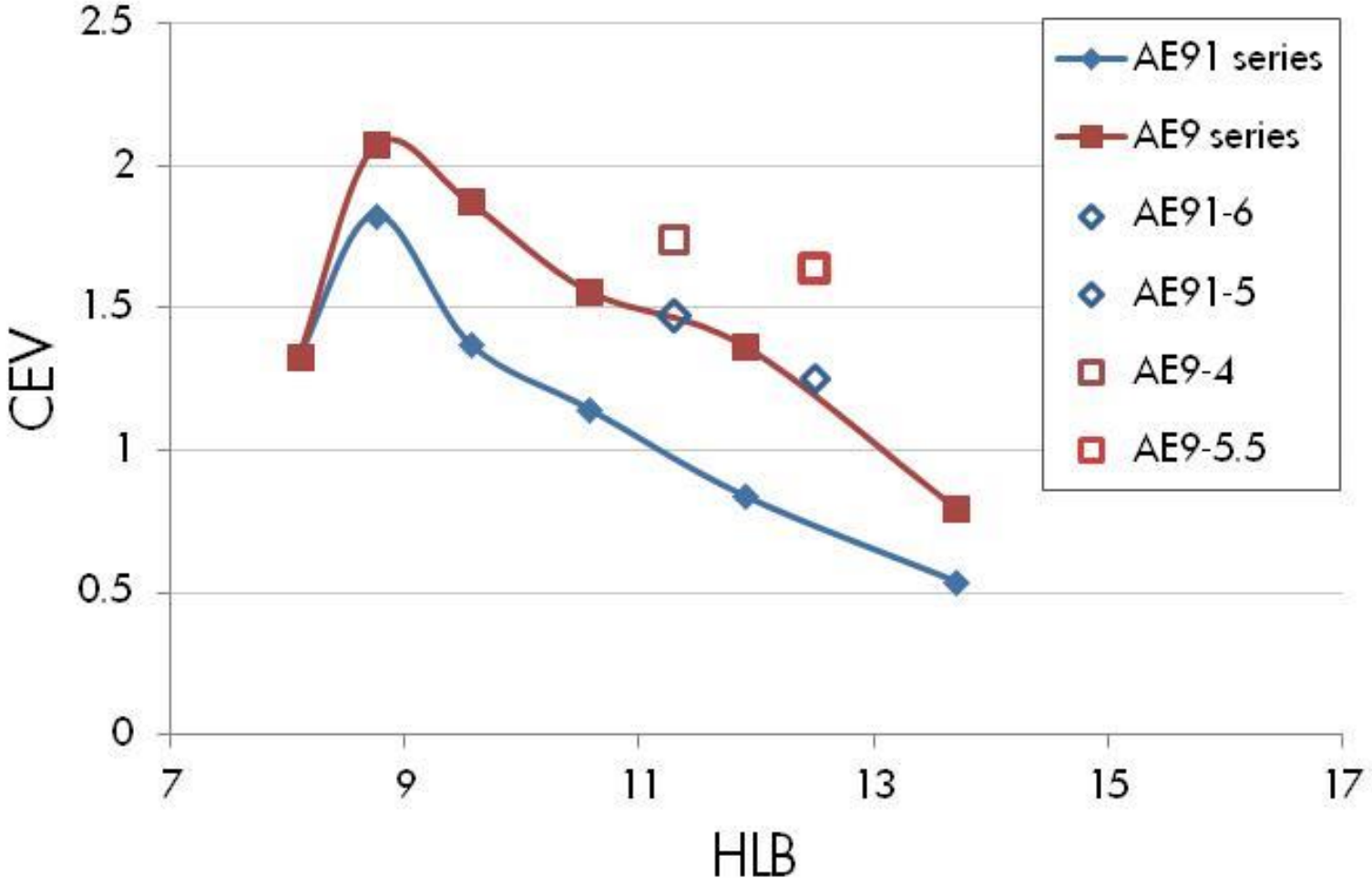
$$CEV = \frac{1}{\#\ strokes} \times constant\ (20)$$



Cleaning effectiveness values—Mixtures vs Single Cuts

- At 80% soil removal

$$CEV = \frac{1}{\#\ strokes} \times constant\ (20)$$



Conclusions--Methodology

- New HSC test device
  - Customer relevance, customer appeal
- Prototype soil/substrate
  - Tough kitchen greasy/particulate soil (drying oil simulate aging)
  - Convenient method to vary toughness (aging)
- Convenient way to compare formulations
  - Detailed soil removal rates: cleaning curves
  - Converting data to conventional charts with optimal stroke #

Conclusions--Materials

- New light alcohol ethoxylates
- C9 hydrophobe
- Comparison to C9-11 hydrophobe:
  - Lighter molecule
  - More molecules/kg
  - Cleans oily soils faster at constant HLB
  - Comparable cleaning to NPE-9