A Hard-surface Cleaning Performance Test Method with *in-situ* Photometric Characterization

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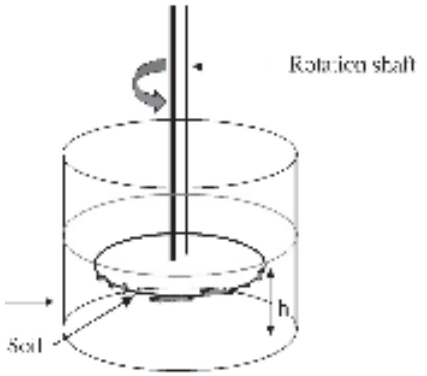
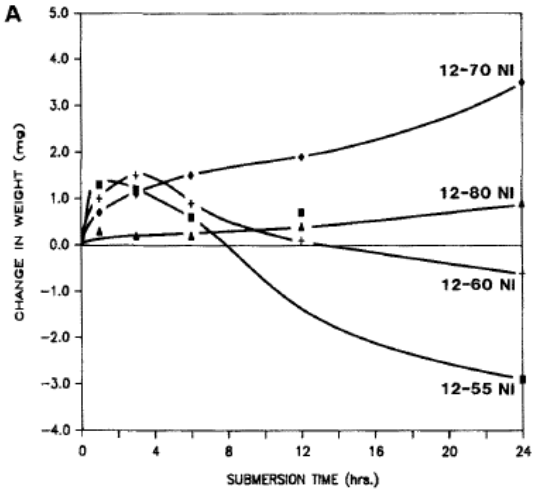
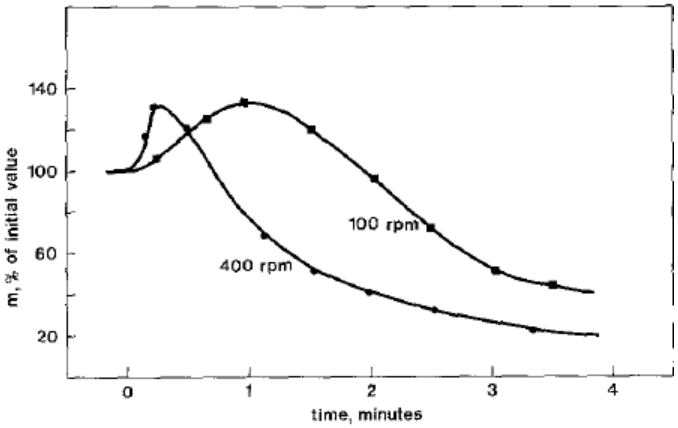
HSC test method – the scientific way

- Soiled disk soaked in surfactant solution
  - Undisturbed
  - Controlled shear



- Curves measured for remaining soil
  - Gravimetric
  - Ellipsometry
  - QCM



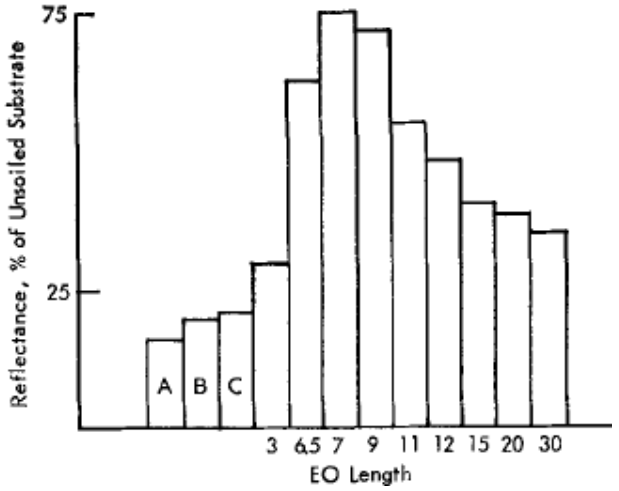


Chateau et al., *JSD*, VOL. 7, NO. 4 (2004)
MF Cox, *JAOCS*, Vol, 63, no, 4 (1986)
Backstrom et al., Journal of Colloid and Interface Science, Vol. 99, No. 2 (1984)

HSC test method – the industrial way

- Abrasion-based cleaning
  - Non-equilibrium
  - Measure after # strokes

- Soil removal measured colormetrically after drying
  - Simple results
  - Consumer relevant
  - Missing details in between
  - Hard to optimize the "#" to differentiate



Alderet al., *JAOCS,* Vol. 46, No. 10 (1969)

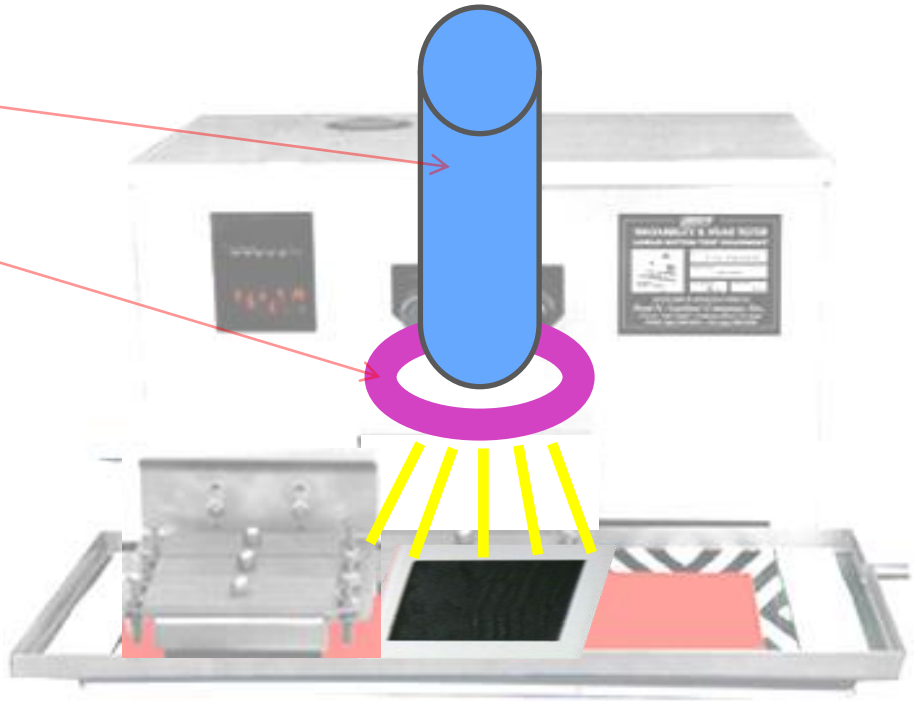
New direction HSC test method – Motivation & Approach

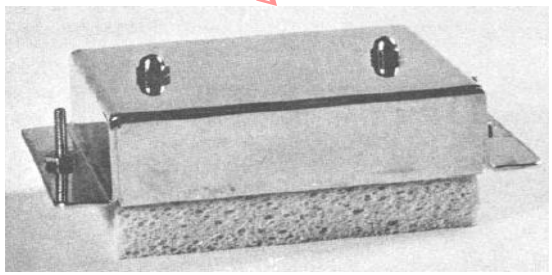
- New trend in efficient hard surface cleaning
  - Consumer relevant
  - Better customer appeal
  - Real-time measurement

- Detailed mechanism
  - Cleaning effeiciency
  - Cleaning mechanism discovery

in-situ characterization – The setup

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





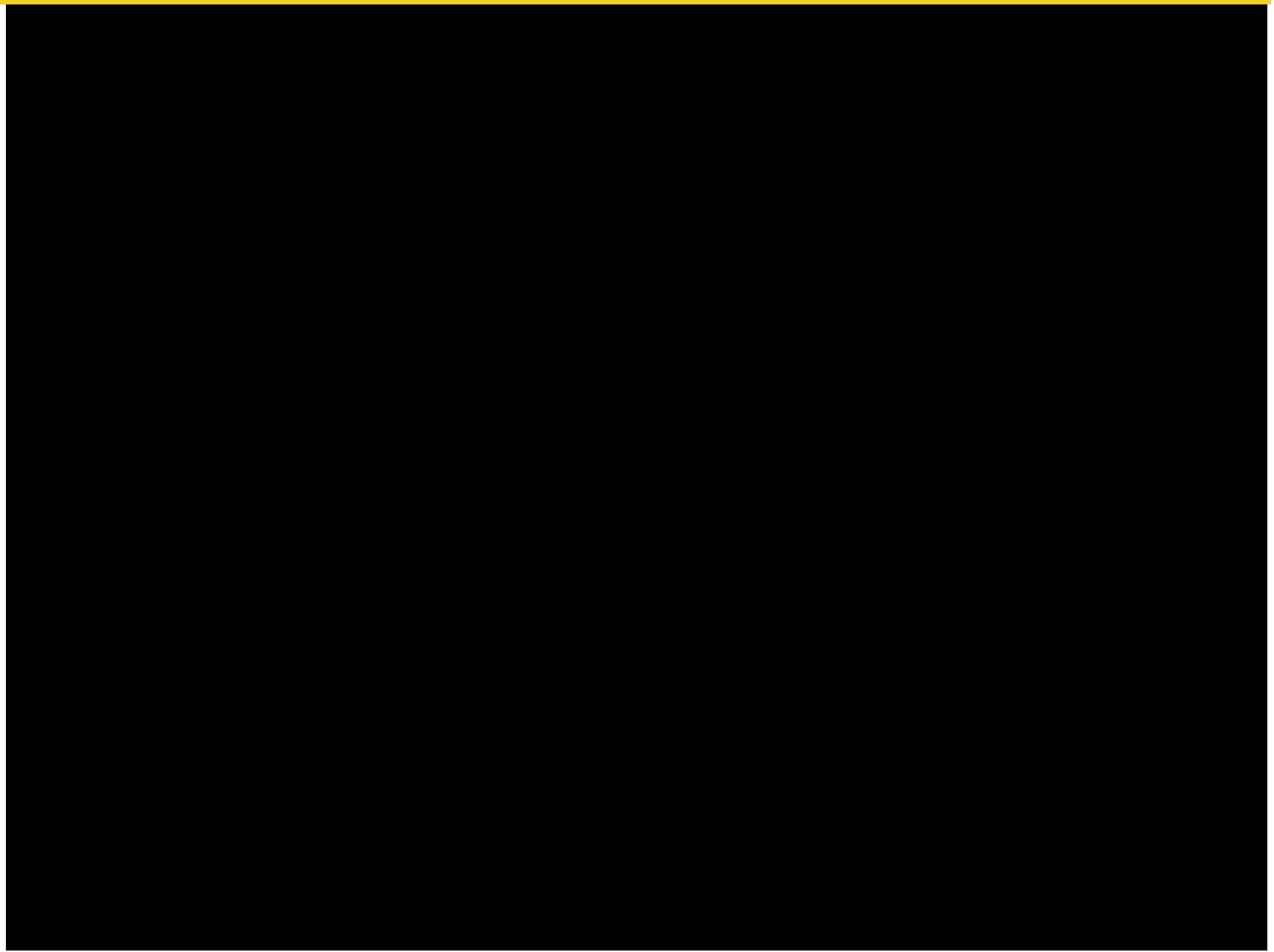
Choice of Soil and substrate

- Represent typical household dirt
  - Kitchen: grease, oily soil, aged triglycerides, milk
  - Bathroom: soap scum
- Represent typical household surface
  - Kitchen: granite, ceramic, stainless steal
  - Bathroom: ceramic wall, acrylic tub
- Choice: Greasy/particulate soil on Ceramic tile
  - Aged greasy oil splash/deposit on stove/wall
  - Tough to clean – surfactant degreaser intense

Choice of Soil and substrate (cont'd)

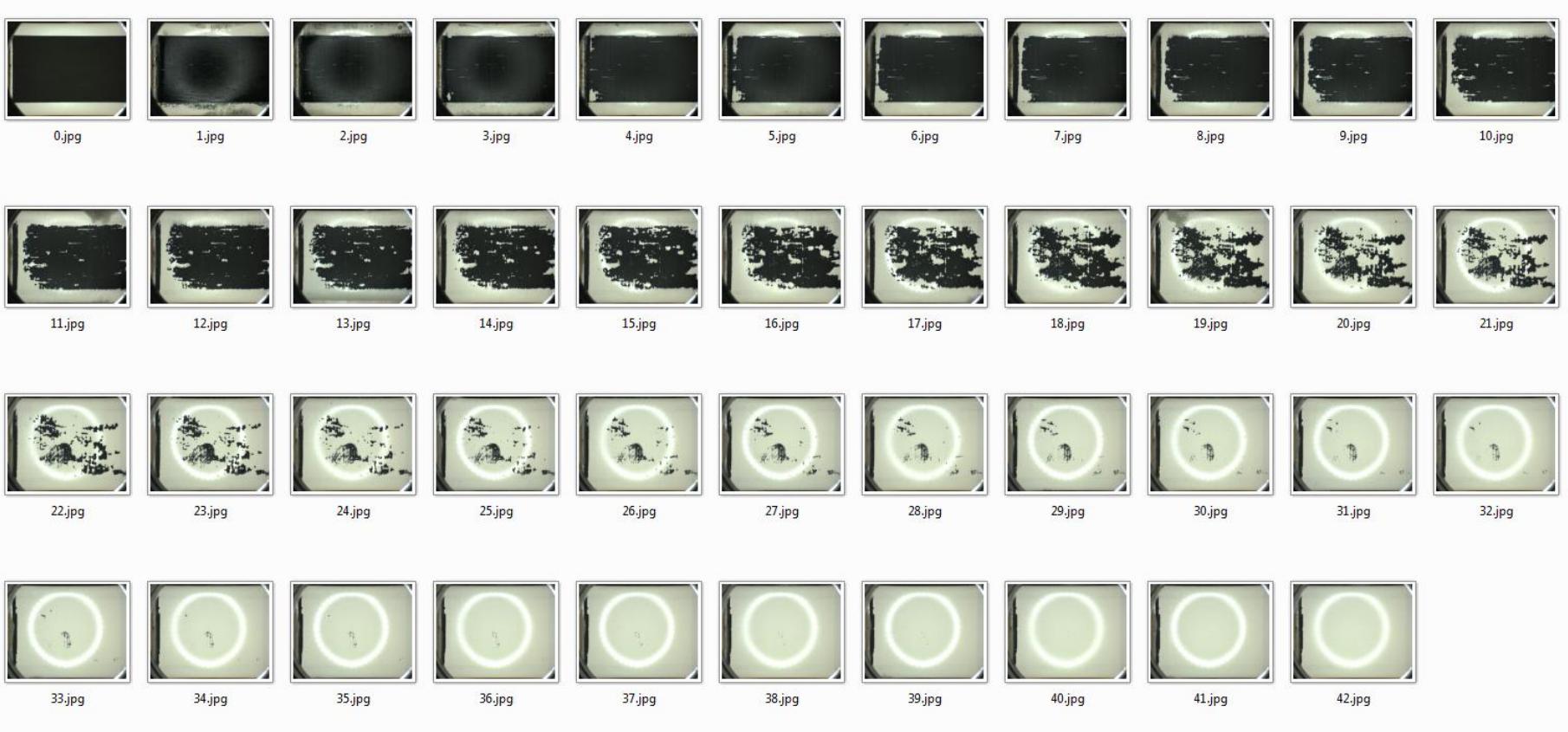
- Soil composition
  - Grease: Vegetable oil, Vegetable shortening, Lard
  - Drying oil: Linseed oil (*simulate aging*)
  - Particulate: Carbon black (pigment)
  - Solvent: Mineral spirits
- Shear blended and baked (106℃) for 30min
- Cooled and aged in room temp. overnight

Cleaning process – the video



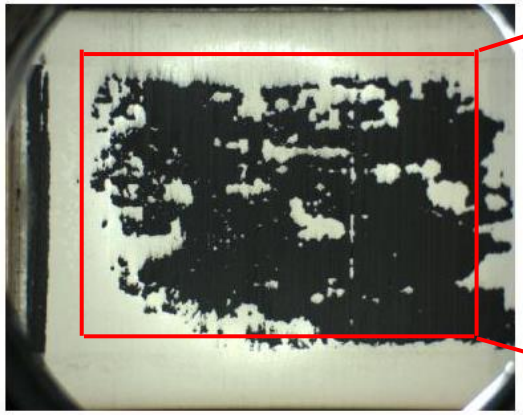
Cleaning process – the images

- The raw images

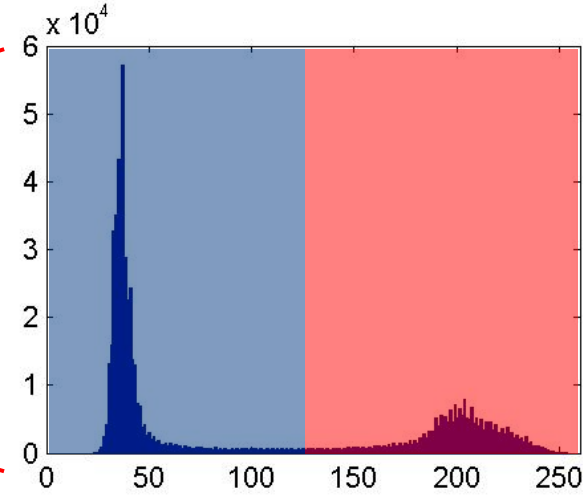


Cleaning process – the images (cont'd)

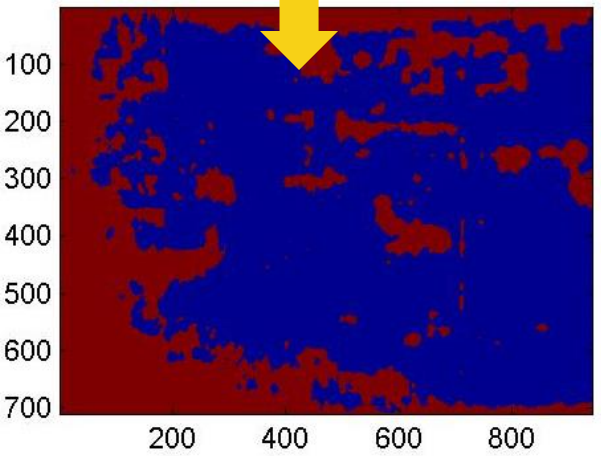
- Image processing



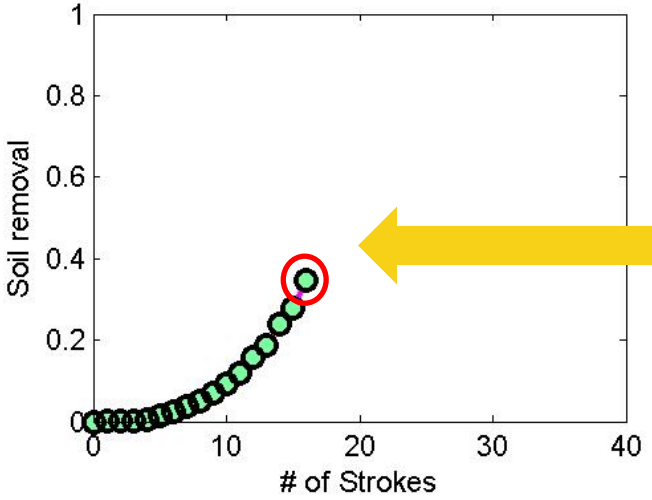
Original Image



Grey scale distribution (ROI)



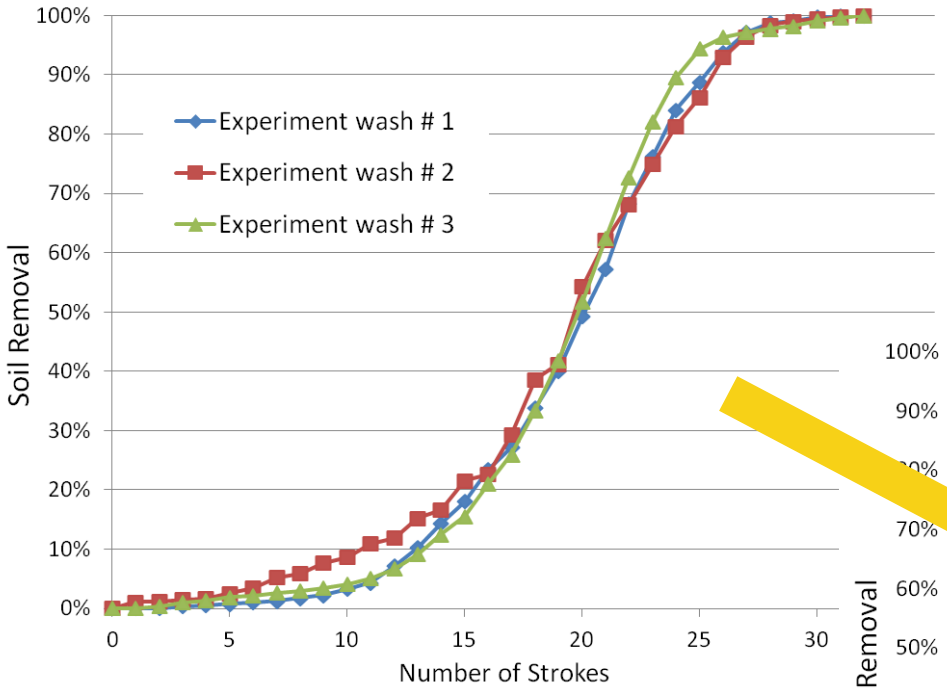
Binary ROI

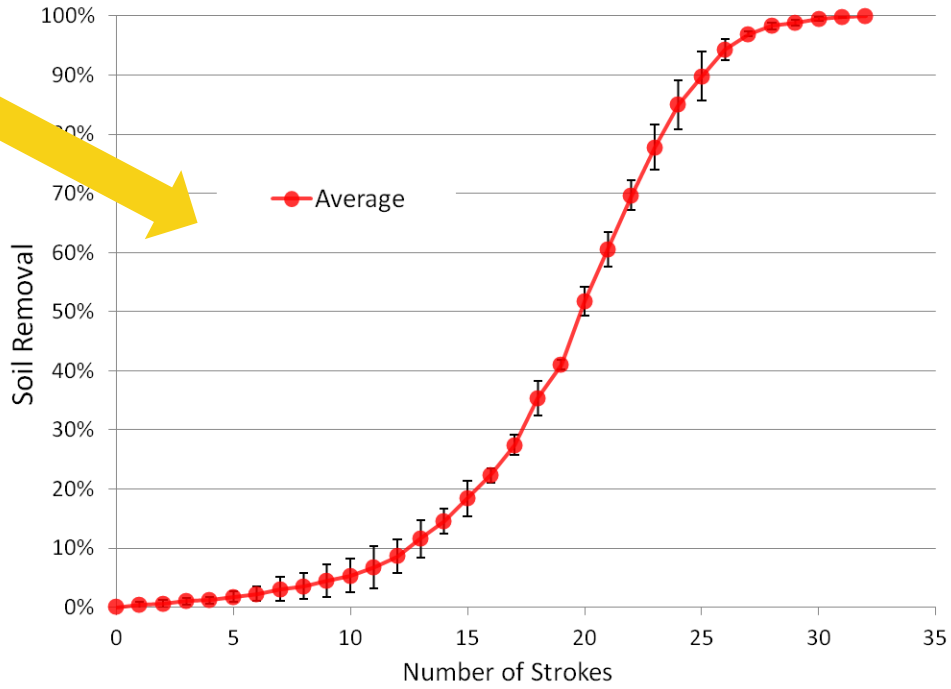


Cleaning curve

Cleaning curves

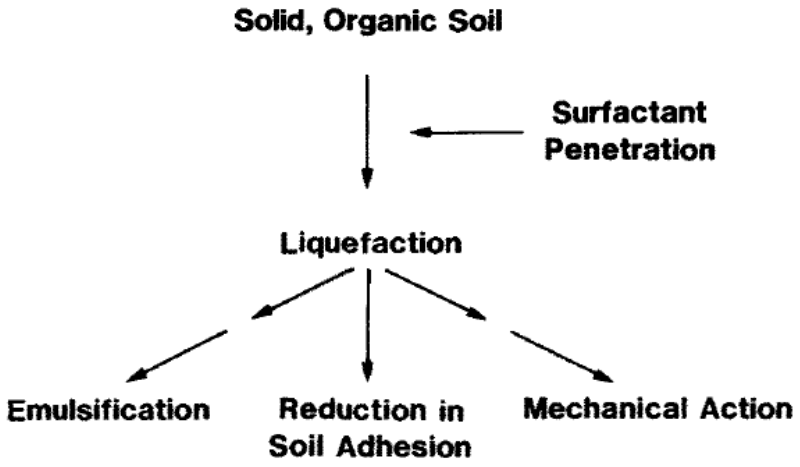
- Checking for consistency





An example – Emulsification vs. Wetting

- Organic solid soil remove mechanism
  - Which on dominates?
  - Static soil: Emulsification
  - Abrasion: Wetting (penetration)



The mechanism described above also suggests several ground rules for developing hard-surface cleaners to remove solid, organic soils.

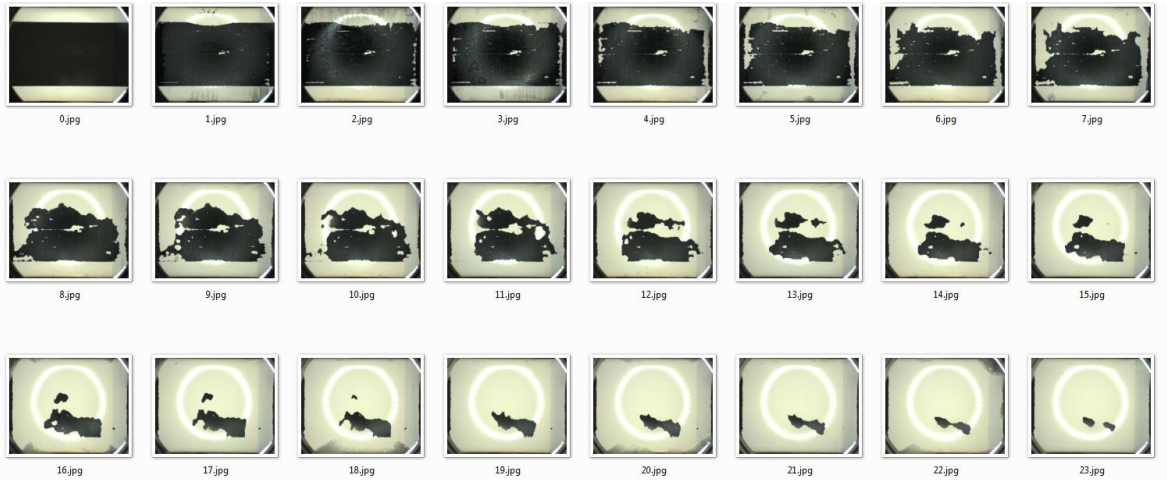
(i) Products used in applications involving some degree of mechanical action should use a surfactant which maximizes penetration (soil-softening). This can be accomplished by minimizing both surfactant hydrophobe size and water-solubility. Both nonionic (e.g., 8-60 NI) and anionic (e.g., $Mg[LAS]_2$) surfactants are effective, although their relative performance appears to depend upon soil composition.

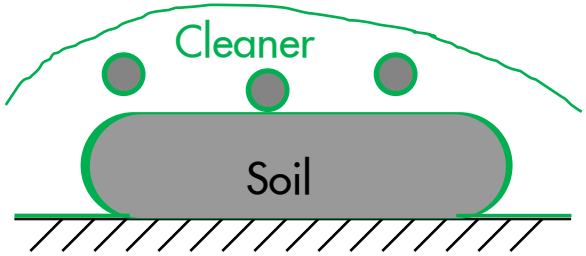
(ii) In applications involving static soil removal, the ability of the surfactant to emulsify the soil should be maximized. This is best accomplished by matching the HLB of the surfactant to that of the soil.

MF Cox, *JAOCS*, Vol, 63, no, 4 (1986)

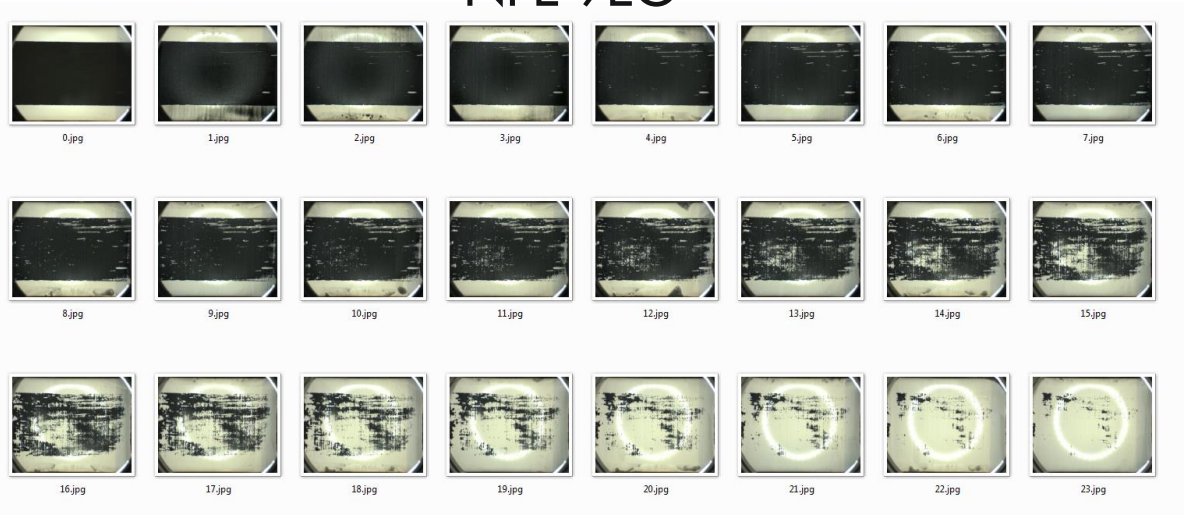
An example – Emulsification vs. Wetting (cont'd)

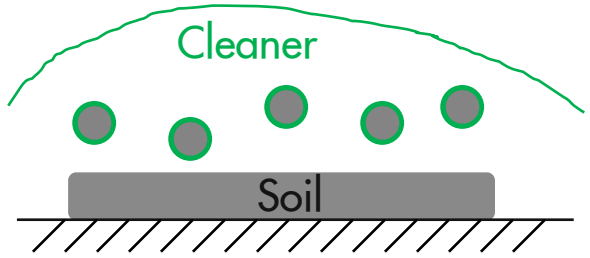
AE9-4EO





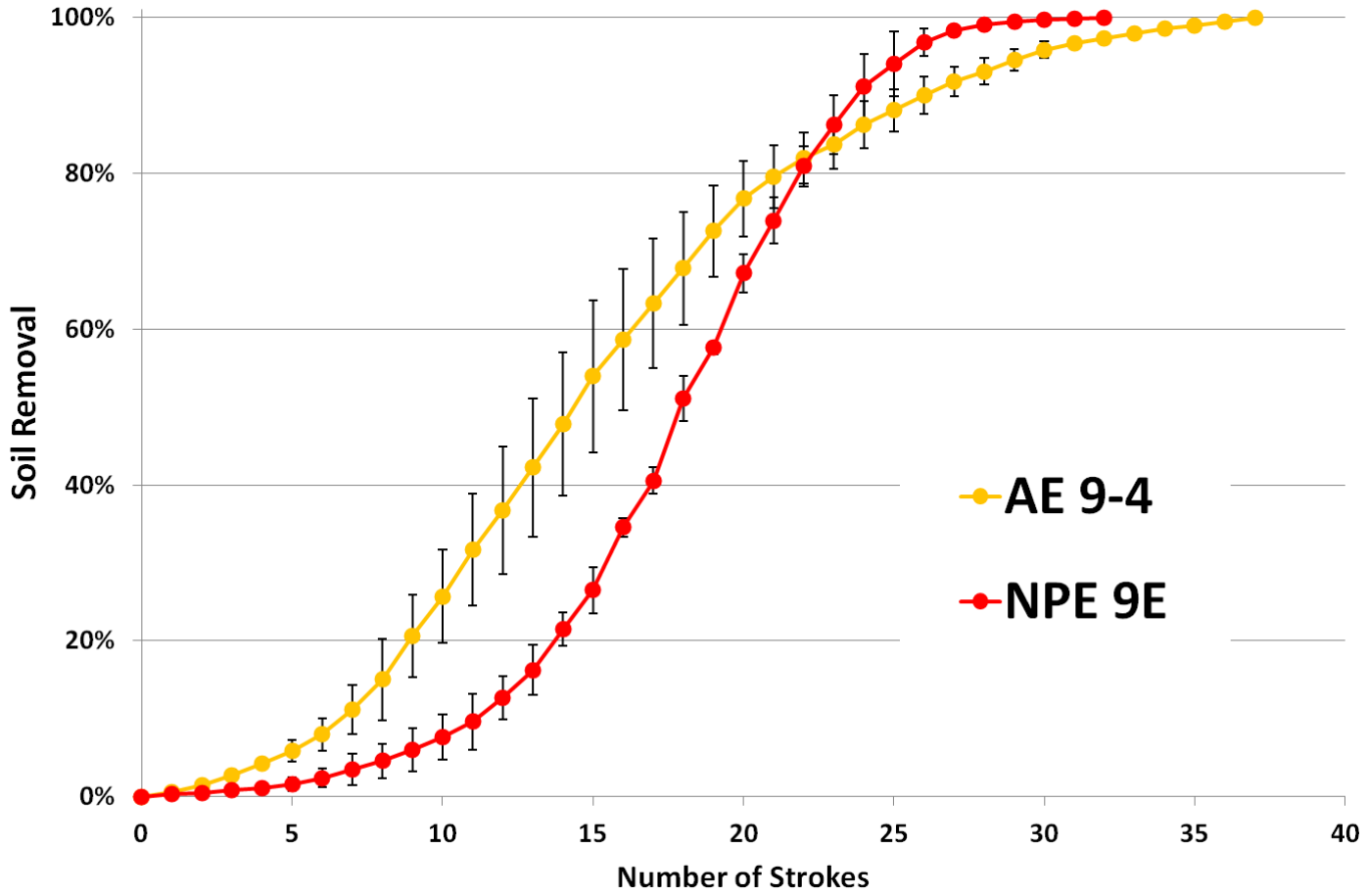
NPE 9EO





An example – Emulsification vs. Wetting (cont'd)

- The cleaning curves



Conclusions

- New HSC test device
  - Detailed soil removal: cleaning curve
  - Customer relevance, customer appeal
- Prototype soil/substrate
  - Tough kitchen greasy/particulate soil (drying oil simulate aging)
  - Convenient method to vary toughness (aging)
  - Consistency in cleaning performance
- Soil removal mechanism
  - Cleaning patterns
  - Cleaning curves

Acknowledgements

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Thank you for your attention!