Shell Chemicals

Alcohol Ethoxylates As Replacements for Alkylphenol Ethoxylates

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Outline

- Background
- Key Properties
- Comparison of Ethoxylates
  - Physical properties
  - Handling
  - Performance
  - Biodegradation
- Summary and Conclusions

Background:
Alkylphenol and Alcohol Ethoxylates

- APEs historically used for performance and cost-benefit profiles
  - Unique structure can provide benefits to the formulator
  - NPEs used in hard surface cleaning, textile applications
  - OPEs used in industrial applications

- Alcohol ethoxylates
  - Used extensively in consumer applications
  - Suitable for large-volume applications
    - Biodegradation profile
    - Performance needs to be acceptable, equivalent or improved as compared to the original surfactant in a formulation

Key Properties for Formulating with Nonionic Surfactants

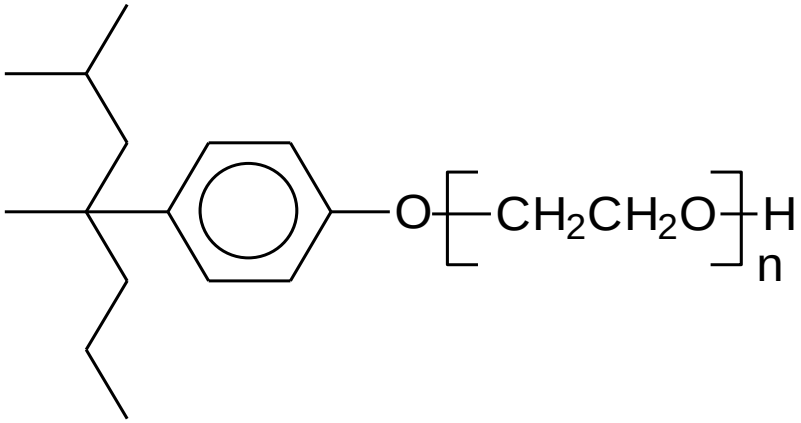
- General Properties
  - Storage and Handling
  - Emulsification
  - Wetting
  - Moderate foaming
- Hard surface cleaning
  - Fast wetting
  - Soil removal
- Textile processing
  - Fast wetting
  - Stability under a wide range of processing conditions
  - Handling

Structure and branching influence chemical and physical properties, such as…

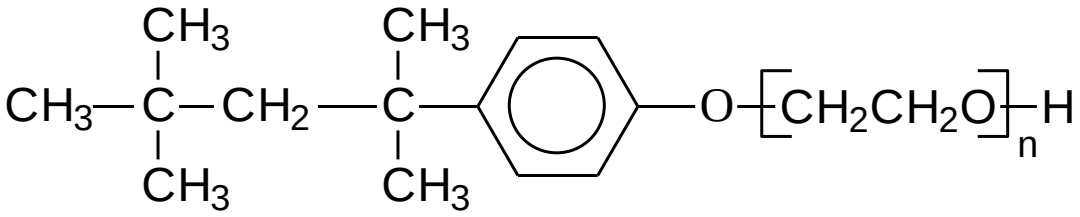
- ❑Solubility
- ❑Viscosity
- ❑Pour Point
- ❑Cloud Point
- ❑Cleaning Performance

Structure: Alkylphenol Ethoxylate Examples

Nonylphenol Ethoxylates (many isomers possible)

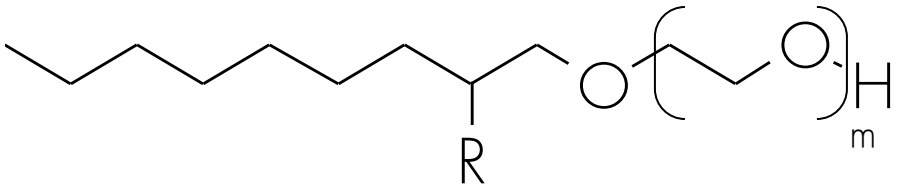


Octylphenol Ethoxylates



Structure: Alcohol Ethoxylate Examples

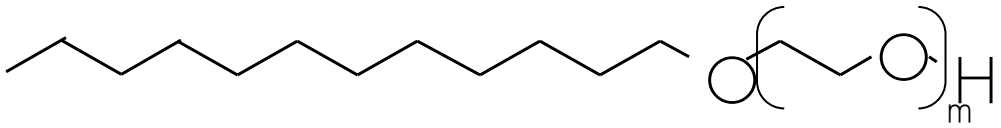
~80 % Linear
~20 % Branched at 2-alkyl position (as shown)



R = Methyl, Ethyl, Propyl, etc m = 0-9 EO units

Name	Hydrophobe	Avg EO Length
AE 91-8	C_9,C_{10},C_{11}	8
AE 1-9	C_{11}	9
AE 25-7	C_{12},C_{13},C_{14},C_{15}	7

>99 % Linear



Physical Properties of NPE and Alcohol Ethoxylates: Performance and Handling Guides

HLB

- Based on EO content
- Provides application direction

HLB	Application
4-6	W/O emulsifier
7-15	Wetting agent
8-18	O/W emulsifer
10-15	Detergent

Pour Point

Provides a good measure of ease of handling and storage (e.g. below ambient temperature)

	NPE-9	AE 91-6	AE 91-8	AE 1-9	AE 25-7	AE 25-9
HLB	13.0	12.5	13.7	13.9	12.2	13.2
Pour Point (°C)	-1	6	16	18	20	25

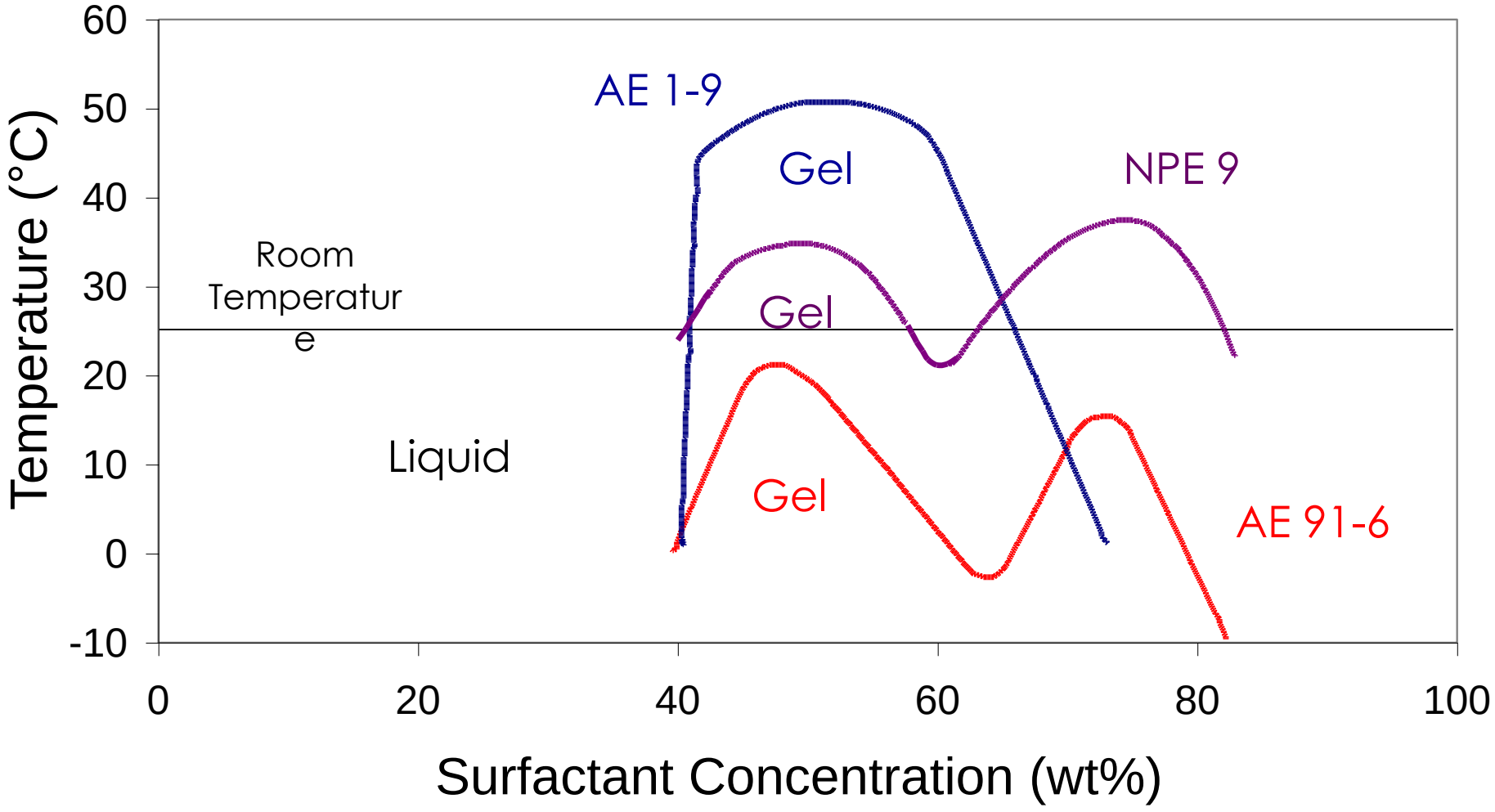
Selected Alcohol Ethoxylates are Less Viscous than NPE-9 At Concentrations Under 40%

Viscosity (cp) of Aqueous Ethoxylate Solutions at 22 °C

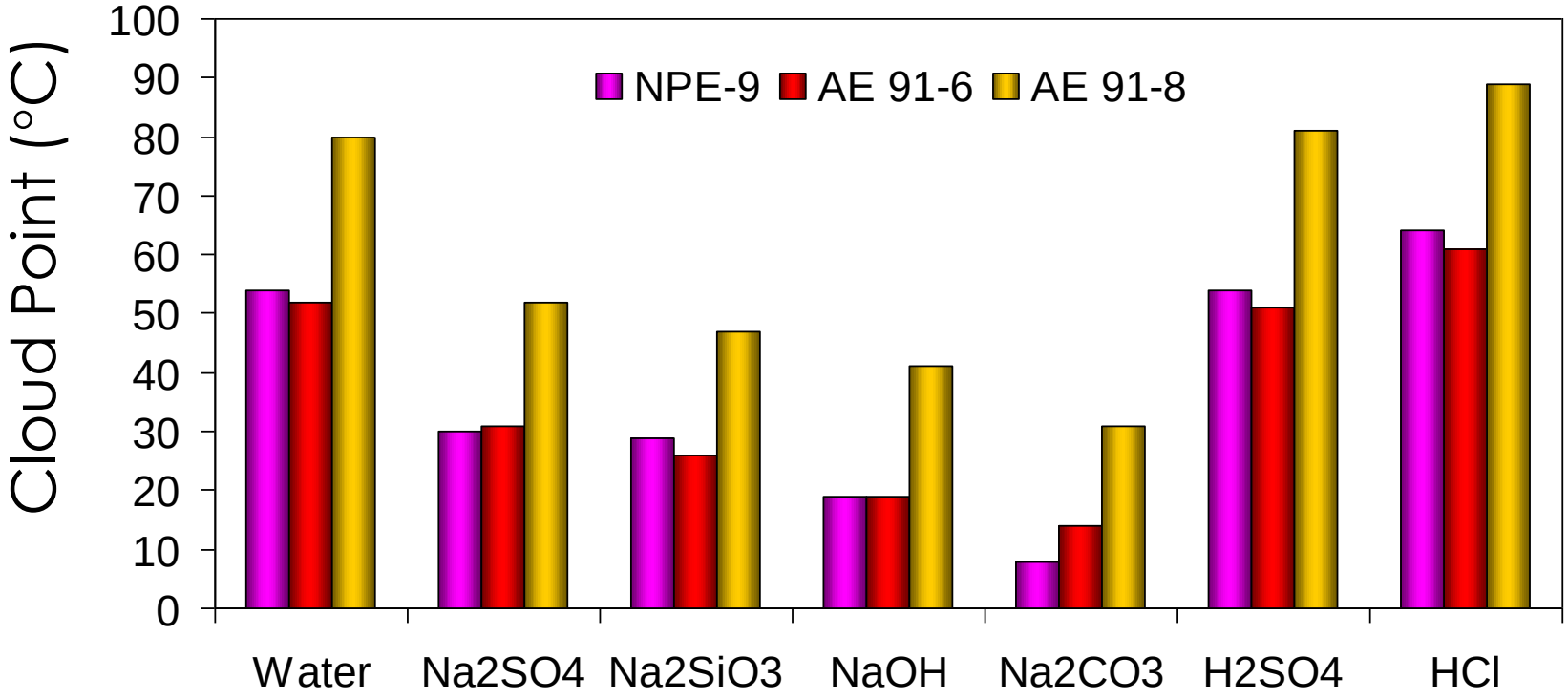
Surfactant (wt%)	10%	20%	30%	40%	50%	60%	80%
AE 91-6	3	13	63	173	187	144	80
AE 91-8	2	6	29	138	Gel	Gel	120
AE 1-9	2	6	26	245	Gel	Gel	104
NPE-9			290	Gel	Gel	3020	1080

- ✓ Alcohol ethoxylates based on light alcohols offer good formulation capability at up to 40 wt% of surfactant in solution.
- ✓ AE 91-6 is readily diluted in water over the entire concentration range (10-80 wt%).

Gel Regions Are Similar or Improved for Alcohol Ethoxylates of Light Alcohols



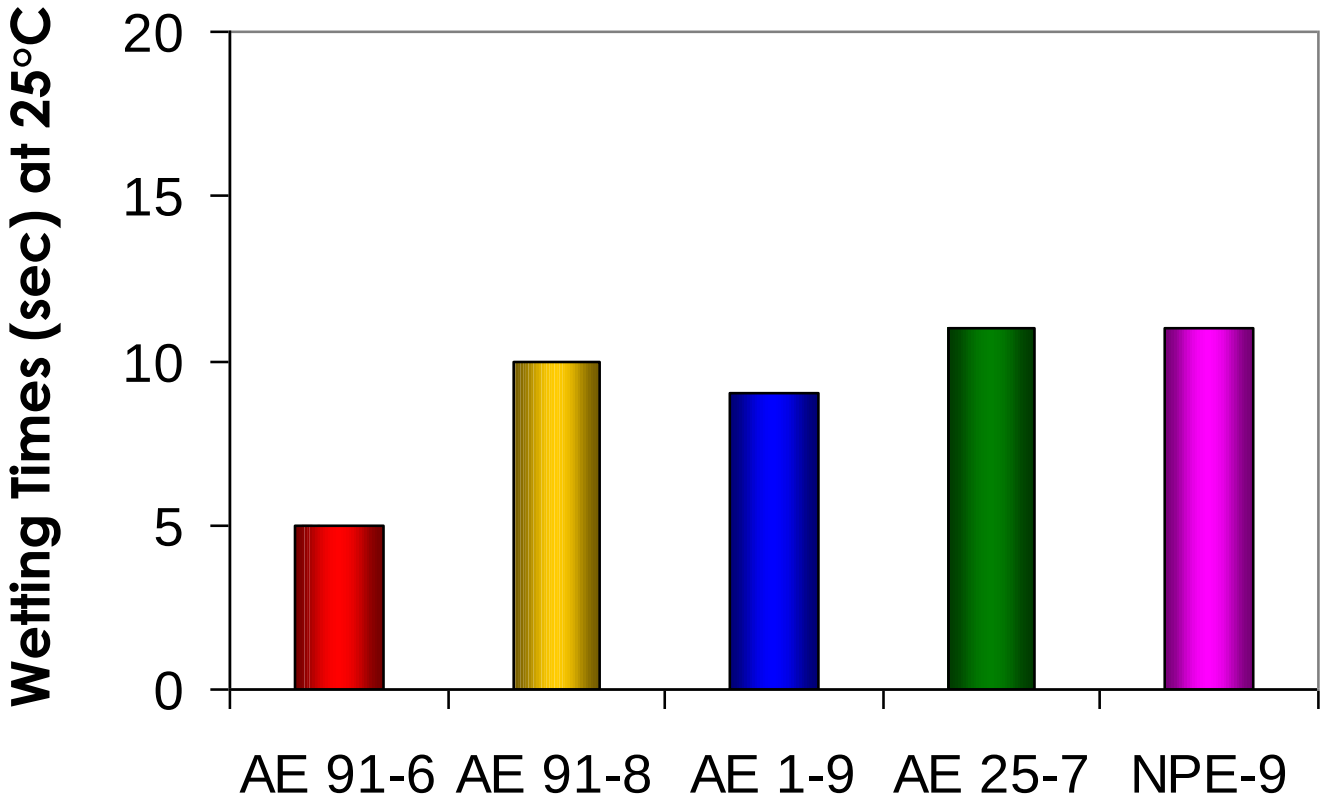
Cloud Points of Nonionic Surfactants Are Affected by Presence of Electrolytes



To maximize wetting and scouring at various temperature ranges, the effects of electrolytes should be considered when formulating with

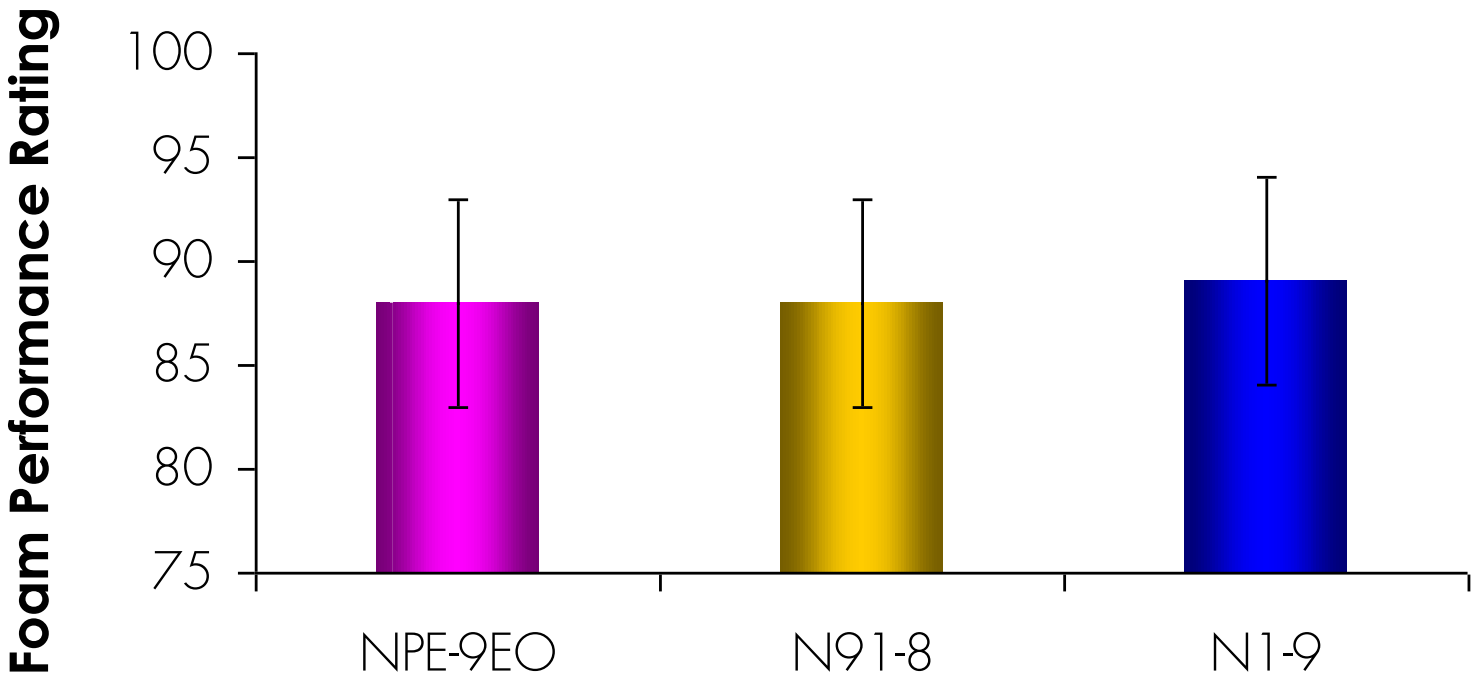
1 wt% Ethoxylate, 5 wt% Electrolyte, Distilled Water

Draves Wetting Times Are Comparable or Improved with Alcohol Ethoxylates



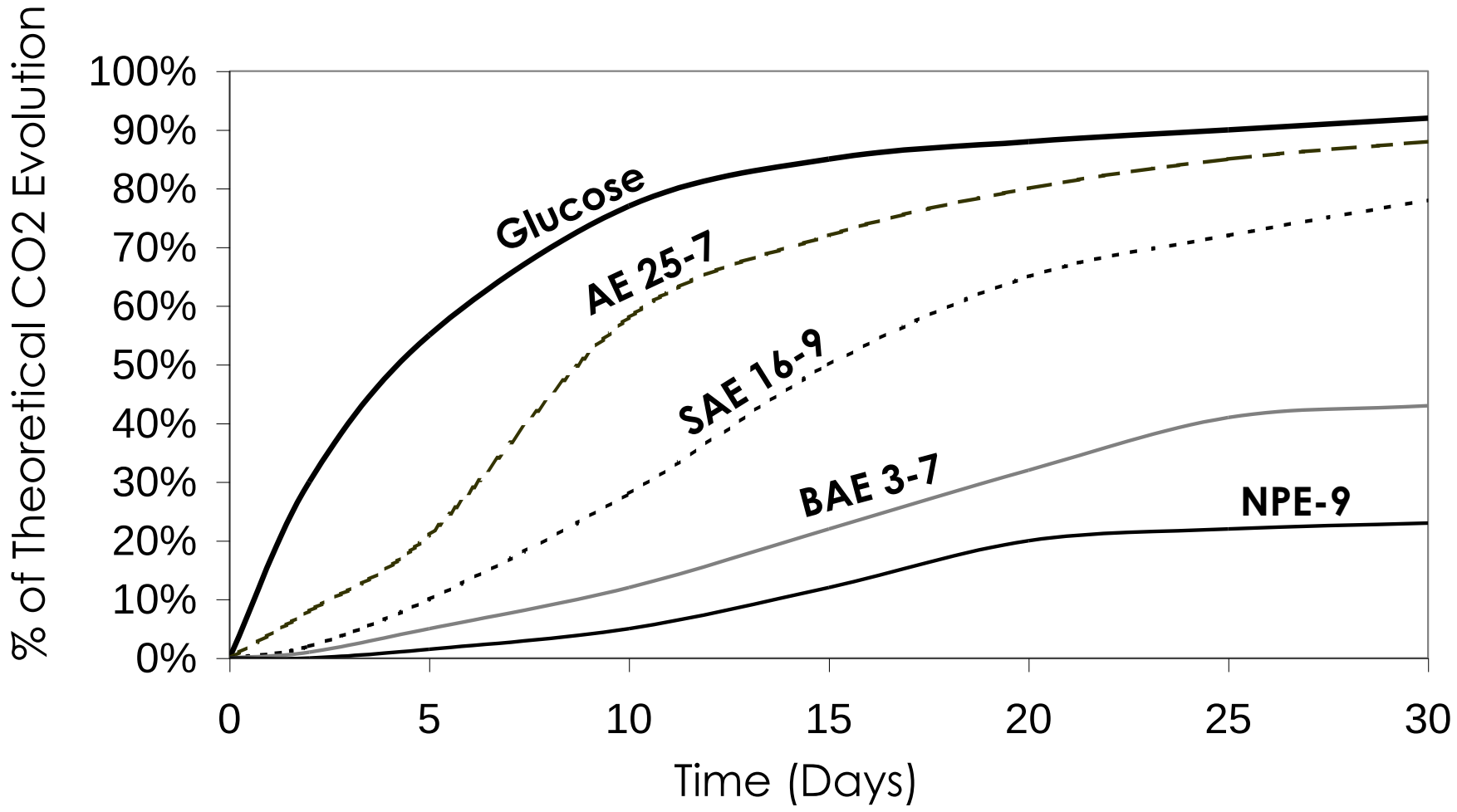
Shorter wetting times can improve cleaning efficiency and effectiveness.

Foam Stability:
Nonionic Surfactants Are Comparable



All 3 nonionic surfactants slightly reduce foam formation relative to a high-foam standard formulation

Ultimate Biodegradation Comparison of Nonionic Surfactants: Alcohol Ethoxylates Show Increased CO_2 Evolution



Summary

- ✓ APEs, in particular NPEs, have a long history of wide uses as effective cleaners and emulsifiers
- ✓ Alcohol ethoxylates can serve as excellent replacements for NPE in a variety of applications, including hard surface cleaning and textile wetting
- ✓ Replacement options are dependent upon the specific application and properties required
  - ✓ As a start, products with comparable HLB values can be selected
- ✓ Alcohol ethoxylates can offer comparable or improved formulation ease and performance compared to NPE

Acknowledgement

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Thank you!

Questions?