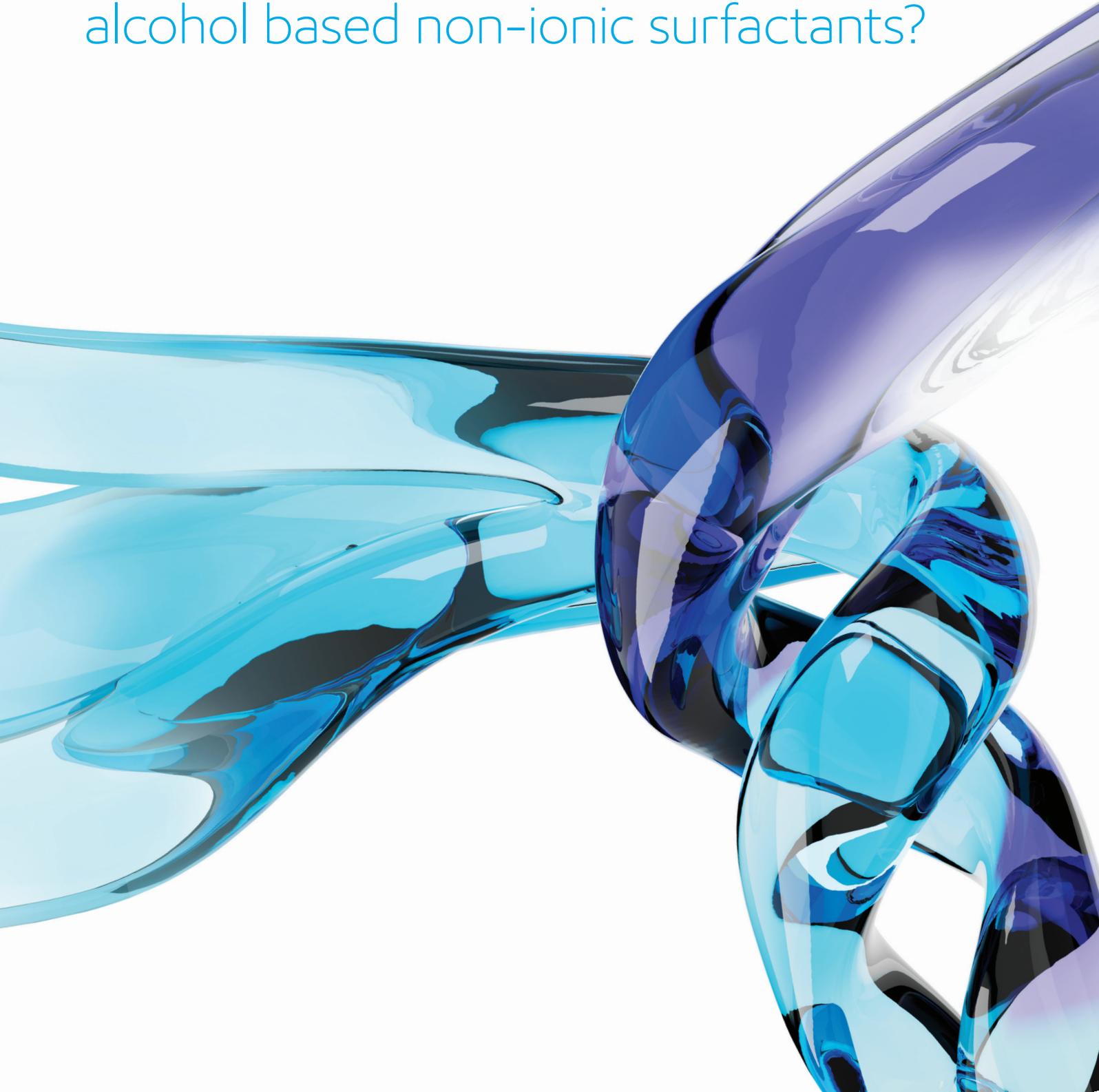
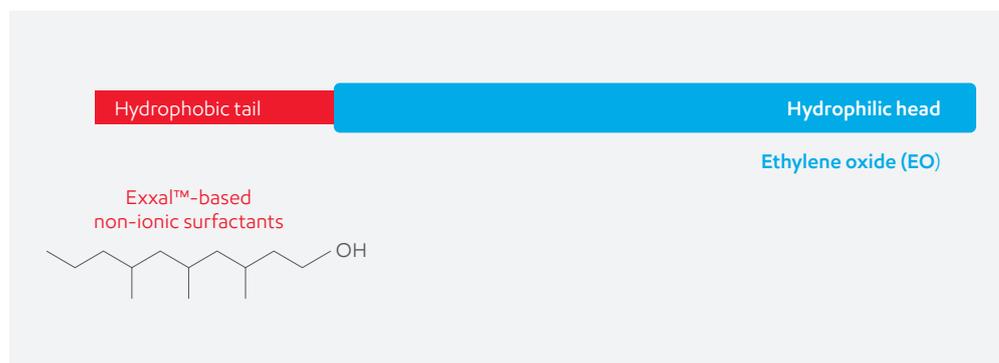
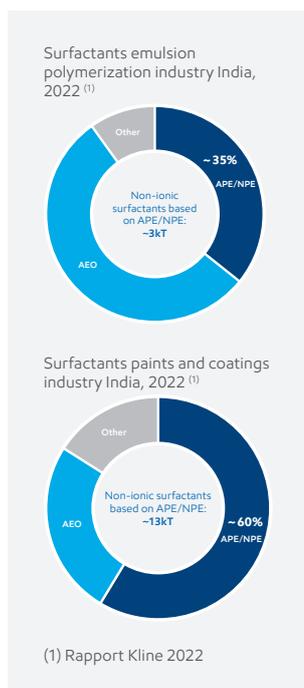


How to achieve high performance  
and **APE-free emulsion polymerization**  
and paint formulation with Exxal™  
alcohol based non-ionic surfactants?

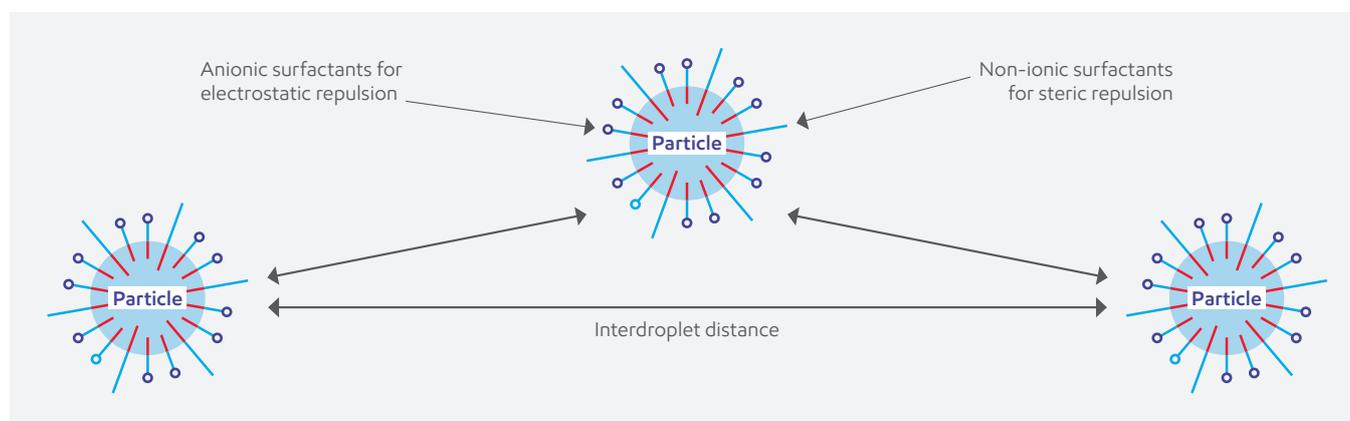


## Consumer and regulatory trends

- Ongoing shift from solvent-based to water-based paints
- Demand for formaldehyde-free, APE-free and low-VOC water-based paints is increasing in India
- Alcohol ethoxylates have a good environmental profile compared to APE/NPE and are increasingly being used as a replacement for APE-based products.



## Non-ionic surfactants for emulsion polymerization and paint formulations



Alcohol	CAS #	Pour point (°C) ASTM D5950 <sup>(2)</sup>	Purity wt% total alcohol <sup>(3)</sup>	Viscosity at 20°C mm <sup>2</sup> /s ASTM D7042	Average carbon number <sup>(3)</sup>	Average Branching per molecule <sup>(3)</sup>
Exxal™ 11	68551-08-6	< -40	> 99.0	27	10.9	2.1
Exxal™ 13	68526-86-3	< -40	> 98.5	48	12.8	3.0

(2) Modified method

(3) ExxonMobil internal method

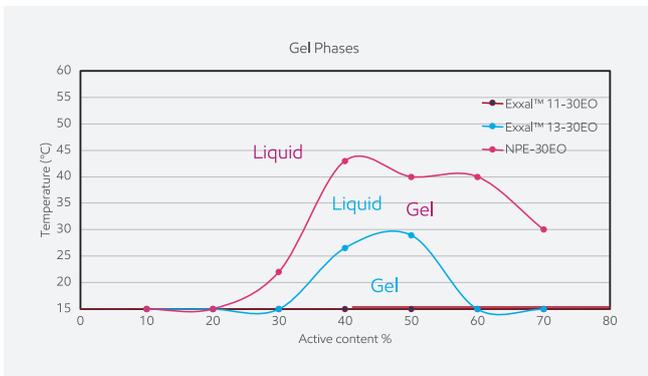
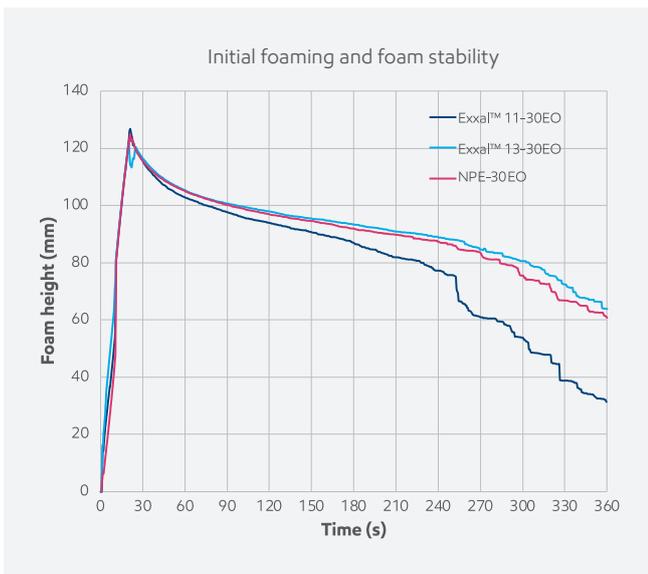
## High ethoxylates HLB for emulsion polymerization<sup>(4)</sup>

	Exxal™ 11	Exxal™ 13	Nonyl Phenol
Mole EO/mole (nominal)	~30	~30	~30
HLB	17.5	17.5	17.5
Aspect at 20°C	clear (70% active)	clear (70% active)	clear (70% active)
Dynamic viscosity @ 25°C (mPa.s) ASTM D7042	~650	1000	~1000
Surface tension (mN/m)	38.8	35.2	38.7

Benefits <sup>(5)</sup>	Surfactant properties
Could enable defects-free emulsion, stable dispersion Could enable clean polymerization process	Low initial foaming and foam stability, Low dynamic surface tension values Good emulsification power
High productivity, Potential for less-energy intensive processes	Low to no gel phases

(4) Data from tests performed by or on behalf of ExxonMobil™

(5) To be compared with corresponding APE surfactants



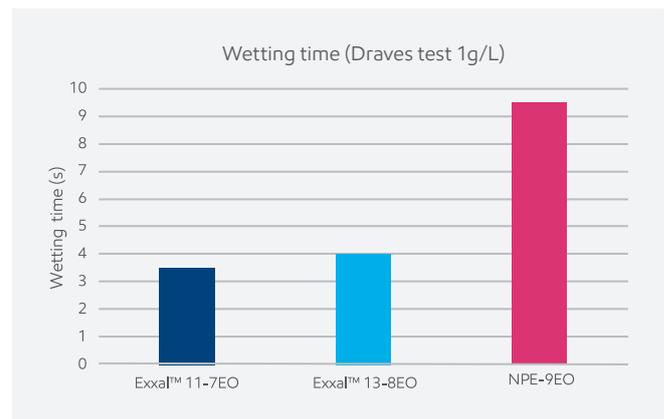
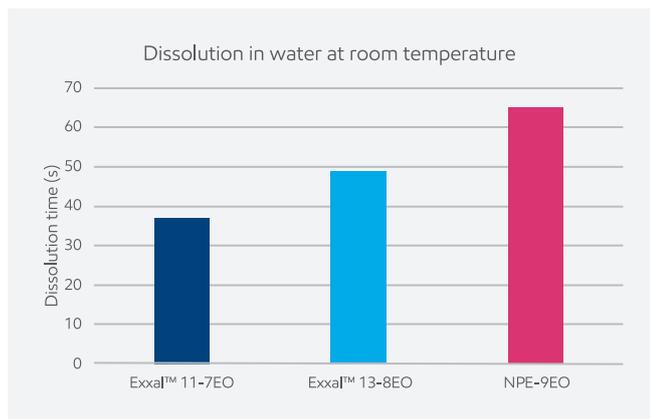
## Medium ethoxylates HLB for wetting of pigments (paint formulation)<sup>(4)</sup>

	Exxal™ 11	Exxal™ 13	Nonyl Phenol
Mole EO/mole (nominal)	~7	~8	~9
HLB	12.8	12.9	12.7
Aspect at 20°C	slightly hazy	slightly hazy	clear
Dynamic viscosity @ 40°C (mPa.s) ASTM D7042	27.5	36.8	177
Surface tension (mN/m)	26.1	26.7	31.9

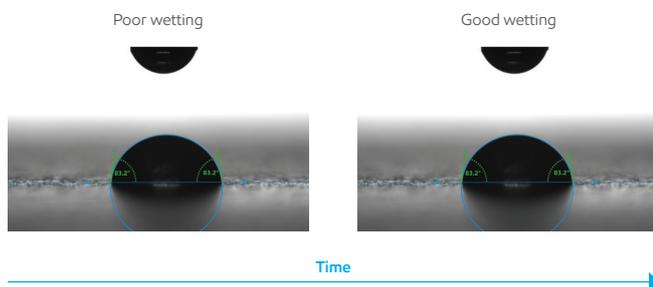
Benefits <sup>(5)</sup>	Surfactant properties
Could enable uniform surface coverage and defect-free coating	Low surface tension values, Fast and effective wetting (Draves test, low contact angle) Low initial foaming and foam stability
High productivity Potential for less-energy intensive processes	Rapid dissolution in water

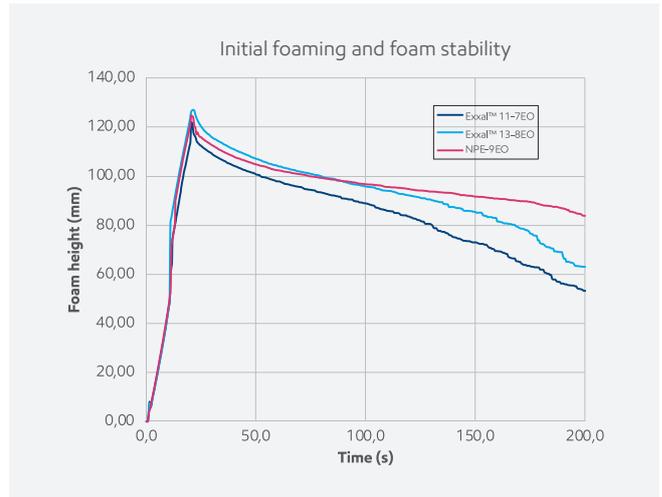
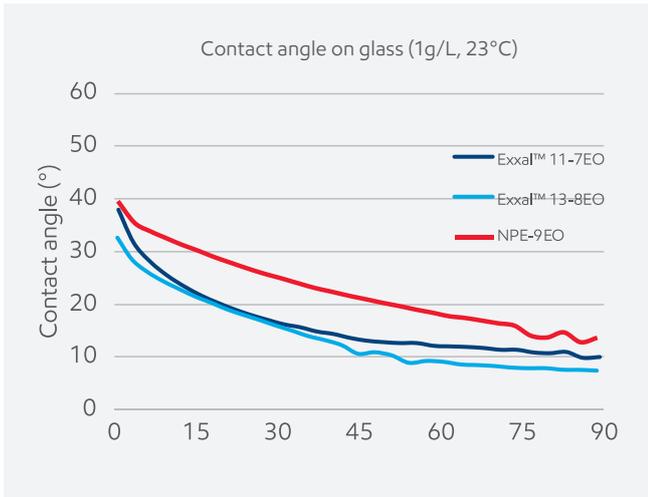
(4) Data from tests performed by or on behalf of ExxonMobil<sup>®</sup>

(5) To be compared with corresponding APE surfactants



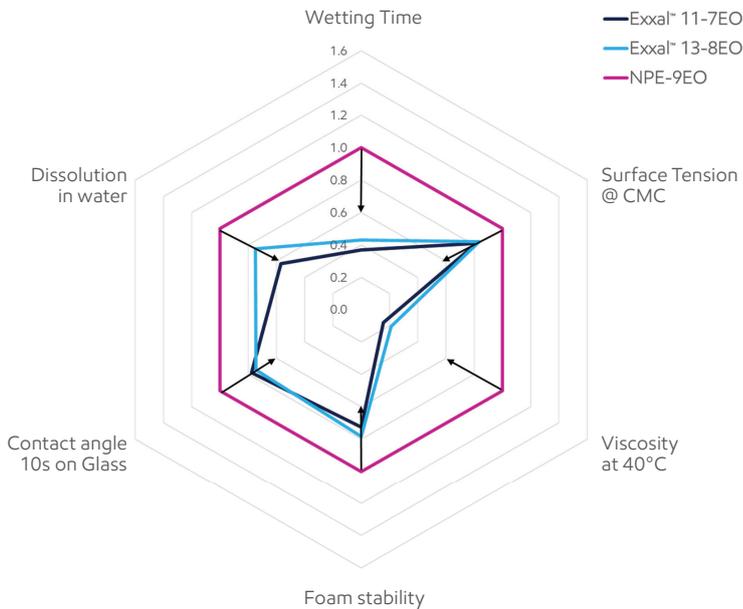
### Wettability via contact angle measurements





## Key properties

### Medium ethoxylates/HLB



### High ethoxylates/HLB

Biodegradability of branched alcohol	Biodegradability of branched alcohol ethoxylates
Exxal™ 11	Exxal™ 11 - 7EO
Exxal™ 13	Exxal™ 13 - 7EO
	Exxal™ 11 - 30EO
	Exxal™ 13 - 30EO

- ✓ Within 10-day window  
Readily biodegradable (>60%) per OECD 301F

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