



Update on the VOC Exemption of tert-Butyl Acetate (TBAC) and Overview of its Uses in Low-VOC, Solvent-Based Coatings

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Outline

- **Solvent in coatings – why they are used**
- **Solvent regulations**
- **Tertiary-butyl acetate as a compliance tool**
 - *TBAc solvent properties*
 - *Coating resin solubility*
 - *Plastics compatibility*
 - *Sample reformulation*
- **Conclusions**

Solvent Use in Coatings

- Resin synthesis
- Coating formulation
- Surface preparation
 - *Parts degreasing*
 - *Hand wipe cleaning*
- Application
 - *Viscosity reduction*
 - *Surface wetting*
 - *Adhesion to substrate*
 - *Film formation*
 - *Properties development*
- Cleanup
 - *Spray gun cleanup*
 - *Paint strippers*



Solvent Regulations Multiply...

- International regulations
 - *Montreal protocol on ozone depleting substances (ODS)*
- National regulations
 - *Control of Volatile Organic Compounds (VOCs)*
 - *Control of Hazardous Air Pollutants (HAPs)*
- State and local regulations
- Continued decrease in allowed VOC and HAP contents

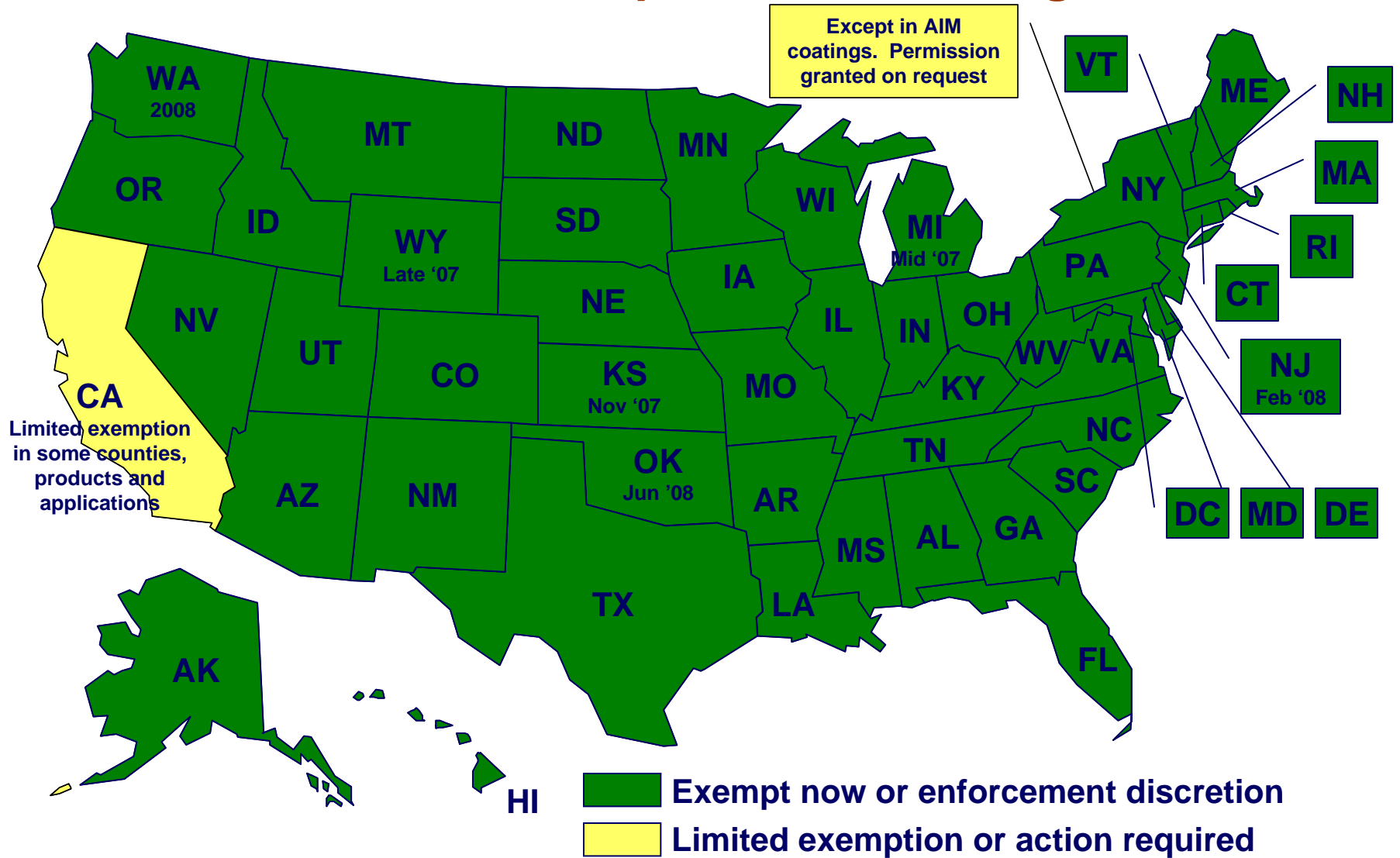
Low-VOC Technologies Have Limitations

- Water-based
 - + *Low odor, non-flammable, low VOCs & HAPs*
 - *Dry times, freezing, corrosion, energy, equipment, foaming*
- UV-cured
 - + *Low odor, non-flammable, no VOCs or HAPs, productivity*
 - *Energy, safety, equipment, substrates, performance range, field application, 3D curing, pigmented coatings, cost, training*
- Solvent-based with exempt solvents
 - + *Fast cure, ease of use, performance, cleanup, stable, inexpensive, low VOCs and HAPs*
 - *Odor, flammability, inhalation risk*

Solvent & Regulatory News

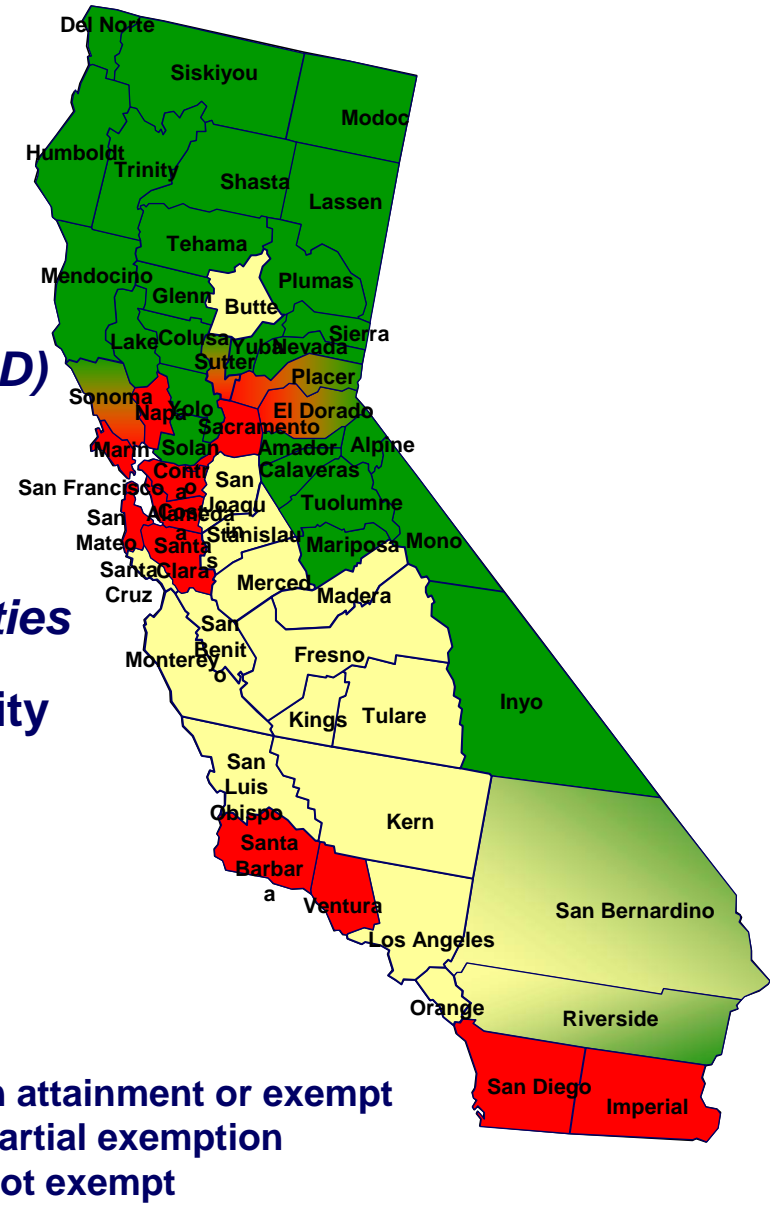
- TBAC added to the EPA list of VOC-exempt solvents on December 29, 2004.
- EPA, OTC, LADCO and CA districts continue to ratchet down VOC & HAP content limits for paints, coatings and cleanup.
- Nation goes to 8-hour ozone standard of 0.08 ppm, increasing the number of ozone non-attainment areas.
- Canada is enacting stringent new VOC limits based on OTC, CARB, and EPA rules.

TBAC State VOC Exemption Status – August 2007



California

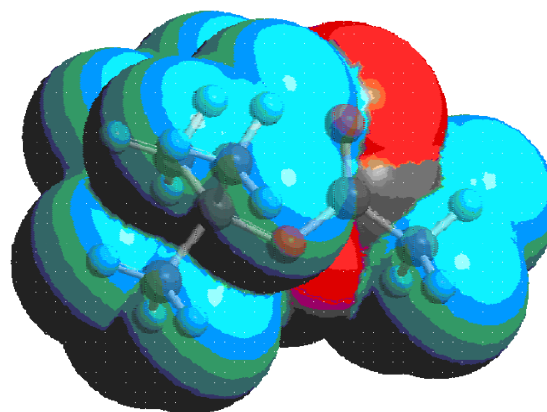
- All County and District regulators notified
- TBAC exempt in:
 - *Industrial maintenance coatings (SCAQMD)*
 - *Automotive refinish coatings (SCAQMD, SJVUAPCD)*
 - *Several product categories in other counties*
- CARB and SCAQMD were awaiting new toxicity studies
 - *New studies confirm that TBAC has low toxicity. EPA reviewing studies.*
 - *CA decision in 2008?*
- Canada to propose exemption in 2007



In attainment or exempt
 Partial exemption
 Not exempt

What is TBAC?

- Tertiary-butyl acetate (CAS 540-88-5)
- An ester solvent
- A substitute for medium to fast-evaporating HAP and VOC solvents
- A compliance tool for:
 - *Cleaners and degreasers*
 - *Solvent-based industrial coatings and aerosols*
 - *Cleaning substrates and equipment*



TBAC Regulatory & Environmental Profile

- VOC-exempt in most of the US
- Non-HAP
- SNAP-approved as an alternative to ODC solvents
- Not a SARA-313, EPA 17, or AFMC 24 chemical
- Not on Prop 65 list
- Not a listed or suspected carcinogen or reproductive toxin
- Biodegradable
- Not an ozone, PM or SOA precursor
- Not a global warmer or ozone depleter
- Not bioaccumulative or persistent (BCF < 5)
- Low mammalian and aquatic toxicity – limited water solubility (<1%)

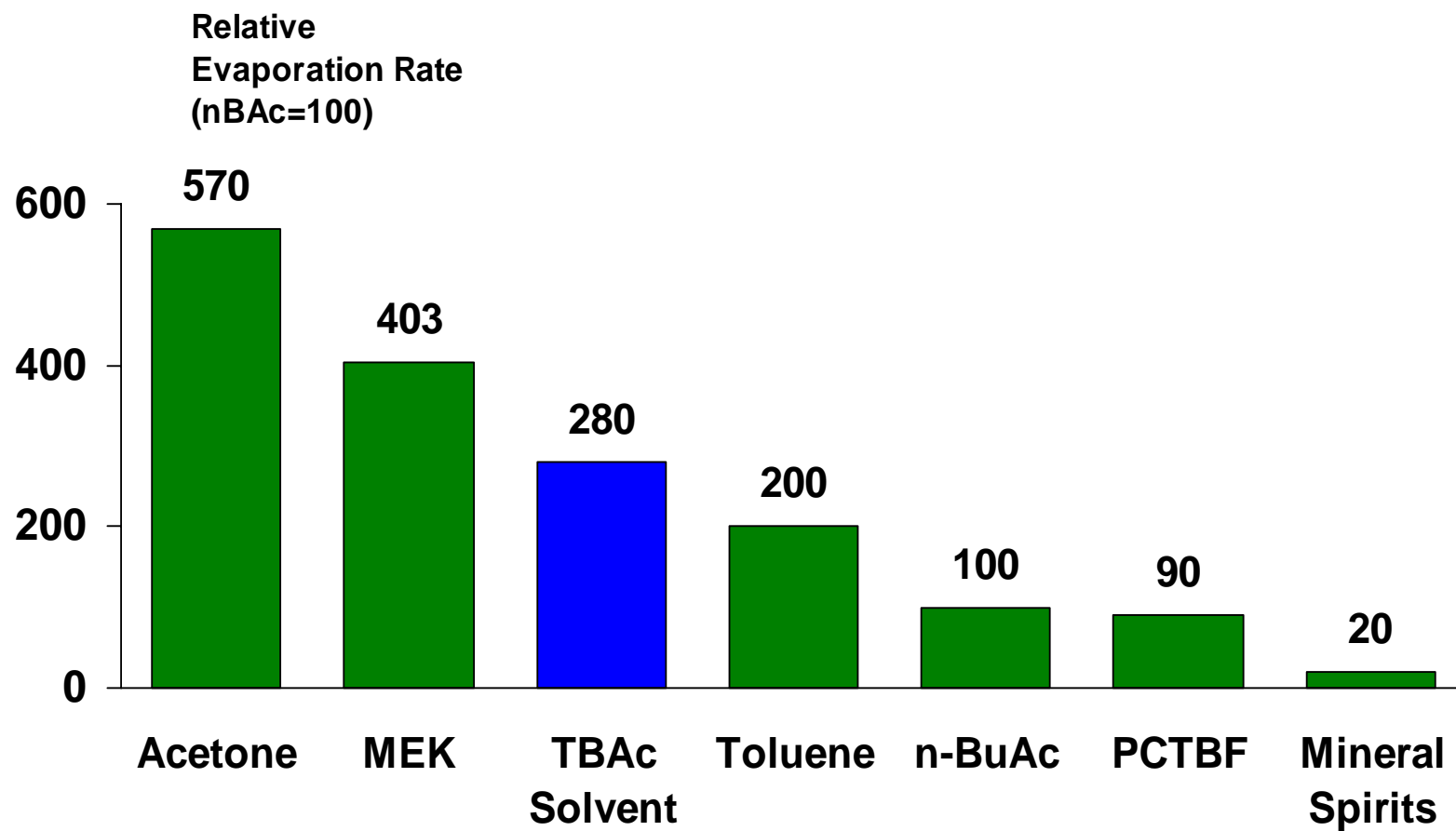
TBAc Solvent Properties

- Broad solvency
- Water insoluble
- Low surface tension
- Low density
- Aprotic solvent
- Recyclable
- Non-corrosive
- Biodegradable
- Cost effective

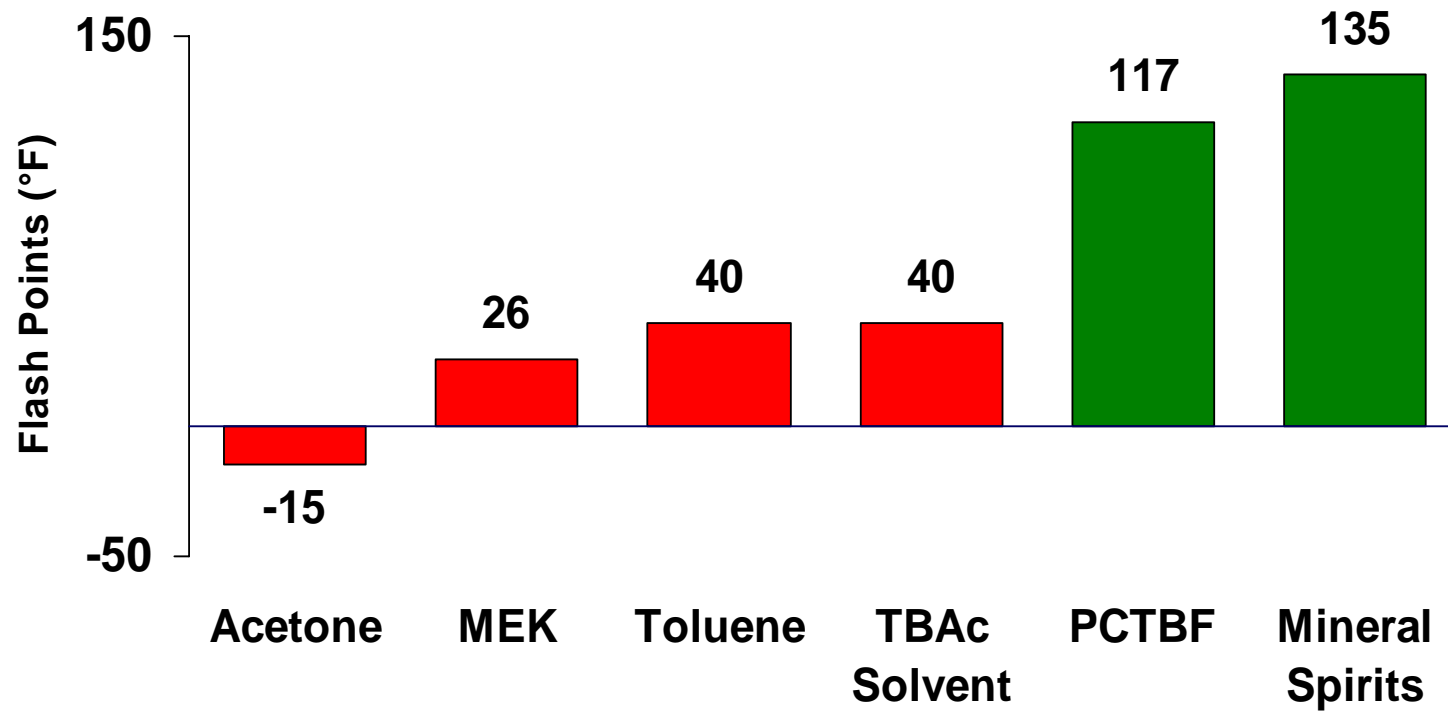
Physical Properties

CAS Number	540-88-5
MW, g/mole	116.16
Water Solubility	<1%
Boiling Point	98°C
Melting Point	-62°C
Evaporation Rate	278 (n-BuAc=100)
Flash Point	40°F
Vapor Pressure (mm Hg)	34 @ 25°C
Density @ 25°C	0.867 g/ml (7.24 lbs/gal)
Surface Tension @ 25°C	22.4 Dynes/cm ²
Kauri-Butanol (KB) value	114
Viscosity (cps @ 25°C):	<1
Hansen Solubility Parameters, cgs	
	D 6.97
	P 1.66
	H 2.91
	Total 7.73
OSHA PEL	200 ppm

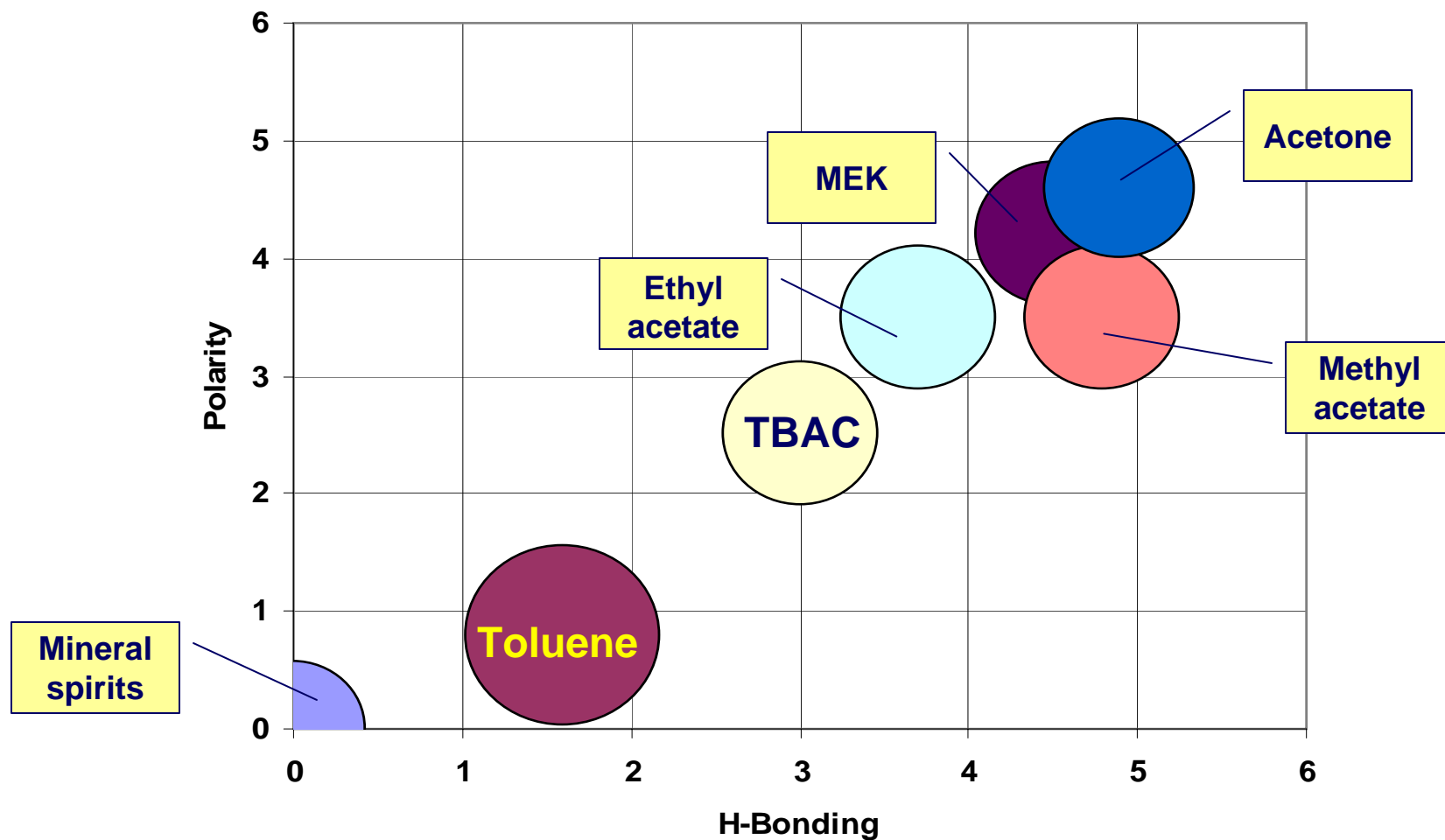
Evaporation Rate Comparison



Flash Point Comparison



Solubility Parameters of Coating Solvents



Compatibility with Plastics

- **Active solvent for:**
 - *Acrylics & styrenated-acrylics*
 - *Styrenics: ABS, SBR, PS*
 - *Unsaturated polymers: PolyBD,*
- **Not a solvent for:**
 - *PE, PP*
 - *PVC*
 - *Saturated hydrocarbon polymers*

Compatibility with Plastics

- TBAC less aggressive than ketones, aromatics, other esters, including butyl acetate isomers.
- Cf. DuPont US patent 6,207,224
 - *Compared TBAC-based 2K urethane coating for plastics to same coating based on:*
 - MAK, EtAc, Acetone, MEK, MPK, DIBK, PrAc, Hexyl acetate, Propyl propionate, Methyl butyrate, xylene, and toluene
 - *Coatings applied to ABS and PC showing splay marks.*
 - *Only TBAC-based coating did not telegraph surface defects.*

Reichhold Resins in TBAC

- Amberlac® 13802-E2 acrylic-alkyd in TBAC-Aromatic 100
- Beckosol® 11081-E2 medium soya alkyd in TBAC-Aromatic 100
- Beckosol 12035-E2 short coconut alkyd in TBAC-Aromatic 100
- Beckosol 12054-E2 short TOFA alkyd in TBAC-Aromatic 100
- Beckosol 12079-E2 phenolic alkyd in TBAC-Aromatic 100
- Beckosol 12102-E2 short TOFA chain-stopped alkyd in TBAC-Aromatic 100

Amberlac® and Beckosol® are registered trademarks of Reichhold Chemical Company

CCP Acrylic Polyols in TBAC

Resin	317-4191	317-8013
Type	Acrylic Polyol	Acrylic Polyol
% solids	50	55
Wt. / gallon	8.15	8.15
GH viscosity	Z2 - Z4	Z4 - Z6
Solvent	TBAC/Aromatic	TBAC/Aromatic
	100	100
%TBAC by wt.	50	38

Other Suppliers of Acrylic Polyols in TBAC

- Cognis developmental resins:
 - *G-Cure 192 TB70 (450 EW)*
 - *G-Cure 196 TB70 (1,000 EW)*
- Rohm & Haas
 - *Developmental polyols and thermoplastic acrylics*
- Johnson Polymer (BASF)
 - *6 developmental polyols in TBAC solvent:*

Sample	Similar Product	% Solids	EW on Solids	Viscosity (cPs)
JPX-528X155-91	J500	75	400	3220
JPX-528X155-92	J510	75	400	4480
JPX-528X155-93	J902	71.3	500	13260
JPX-528X155-94	J906	64.5	600	6780
JPX-598T63-1	J587	51	600	4800
JPX-598T63-2	J550	55	600	4000

2K Urethane Clearcoat Formulations

Components	Conventional	TBAC-Based	Conventional High-solids	TBAC-Based
G-Cure 105 P70	100.0	100.0	50.0	50.0
JONCRYL 920	0.0	0.0	50.0	50.0
T-12 (1% in toluene)	1.9	1.9	0.3	0.3
FC 430 (10% in toluene)	0.3	0.3	0.3	0.3
HDI Trimer	28.3	28.3	33.9	25.4
IPDI Trimer	0.0	0.0	0.0	15.6
MAK	25.0	25.0	24.0	24.0
n-Butyl acetate	25.0	0.0	24.0	0.0
TBAc Solvent	0.0	25.0	0.0	24.0
Total lbs	205.5	205.5	206.5	213.6
% solids	46%	46%	51%	51%
lbs VOC/gal*	4.40	3.28	3.96	2.86

G-Cure® is a registered trademark of the Cognis Corporation
 JONCRYL® is a registered trademark of Johnson Polymers

2K Urethane Clearcoat Properties

Properties	Conventional	TBAC-Based	High-solids	TBAC-Based
lbs VOC/gal*	4.40	3.28	3.96	2.86
Viscosity, sec #2 Zahn	21.2	21.1	20.9	20.8
Dry Time, hours	3.2	3.5	7	4
20 degree gloss	88	88	90	90
60 degree gloss	95	95	95	95
DOI	90	90	90	90
Reverse Impact, lbs	160	160	160	160
Direct Impact, lbs	160	160	160	160
Cross hatch adhesion, %	100%	100%	100%	100%
10% acid resistance (30 min)	pass	pass	pass	pass
100 MEK double rubs	pass	pass	pass	pass

- Significant VOC reductions possible*
- No change in performance

Conclusions

- VOC regulations spreading & getting tougher
- TBAC exemption almost complete in US, Canada
- Reformulating with exempt solvents can:
 - *Maintain product performance.*
 - *Reduce product cost, environmental impact, and hazards.*
 - *Boost sales.*
- TBAC is VOC- and HAP-compliance tool for:
 - *Lacquers and enamels*
 - *Two and one-component systems*
 - *www.tbac.com*

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