

TBAc™ Solvent: A New Tool for VOC-Compliant Adhesives and Sealants

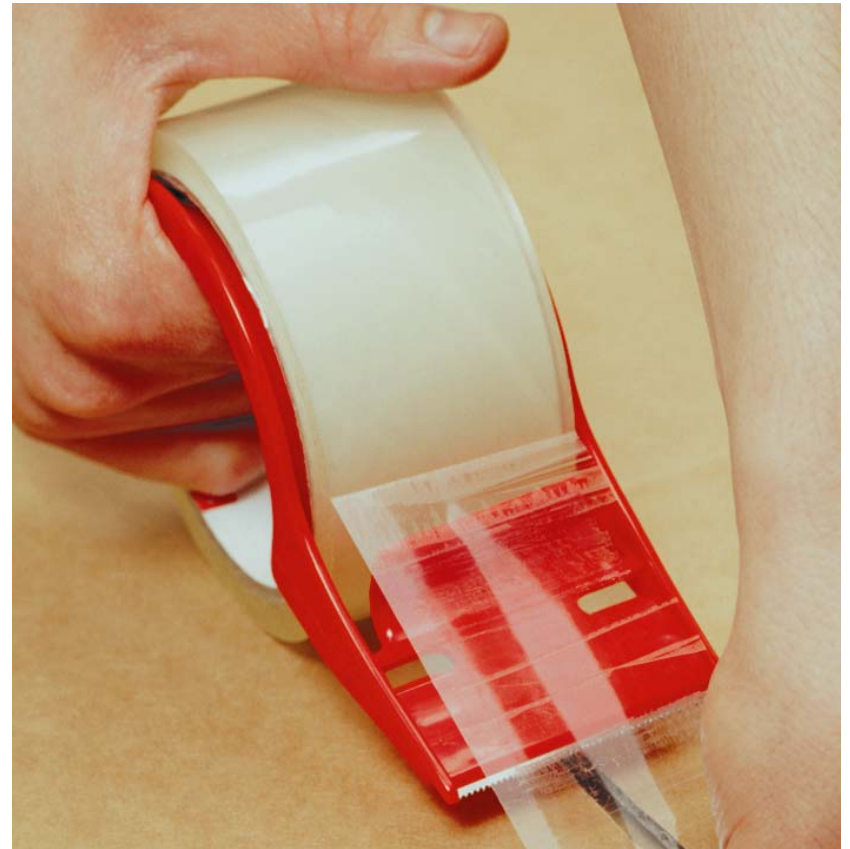


Outline

- Solvent use in adhesives and sealants
- Solvent regulations and Green Building initiatives
- Tert-Butyl Acetate as a compliance tool
 - **TBAC properties**
 - **Adhesive resin solubility**
 - **Sample reformulation**
- Conclusions

Solvent Use in Adhesives & Sealants

- **Resin Synthesis**
- **Adhesive/Sealant Formulation**
- **Surface Preparation**
 - Parts degreasing
 - Hand wipe cleaning
- **Application**
 - Viscosity reduction
 - Surface wetting and penetration
 - Green strength
- **Cleanup**
 - Spray gun cleanup
 - Adhesive and sealant removers



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
- Grass roots initiatives

Emerging Issues: Green Building and Indoor Air Quality

- **Health and environmental concerns:**
 - Indoor air quality (VOCs, HAPs, ozone, PM)
 - Materials safety (lead, asbestos, phthalates)
 - Efficient use of resources (energy and materials)
 - Environmental impact of products (global warming, persistence, ozone depletion)
- **Leading to new product certification requirements:**
 - Leadership in Energy and Environmental Design (LEED rating)
 - Green Seal product standards:
 - Commercial Adhesives (GS-36)
 - Paints and Coatings (GS-11)
 - Stains and Finishes (GS-47)

Benefits of “Greener” Products

- Protect the environment, workers and consumers
- Save energy and material resources
- Reduce liability risks
- Avoid impact of regulations
- Extend product life
- Expand markets and sales
- Promote a positive company image



Low-VOC Technologies Have Limitations

- **Water-based**
 - + Low odor, non-flammable, low-VOCs & HAPs
 - Dry times, tack build, peel strength, freezing, corrosion, energy, equipment, foaming
- **Hot melt & UV-cured**
 - + Low odor, non-flammable, no VOCs or HAPs, productivity
 - Energy, skin risk, equipment, substrates, performance range, field application, heat stability, training
- **Solvent-based with exempt solvents**
 - + Fast cure, ease of use, performance, cleanup, stable, inexpensive, low VOCs and HAPs
 - Odor, flammability, inhalation risk

What's a VOC?

- Volatile Organic Compound
 - A precursor to ground level ozone and particulate matter (smog)
- Regulatory definitions vary:
 - US and Canada exempt compounds that have negligible photochemical reactivity (ozone and PM forming potential)
 - Europe does not
- VOC exempt compounds include:
 - Persistent halocarbons regulated as ozone depleting compounds and greenhouse gases
 - Acetone, methyl acetate, PCBTF, TBAC (tert-butyl acetate)

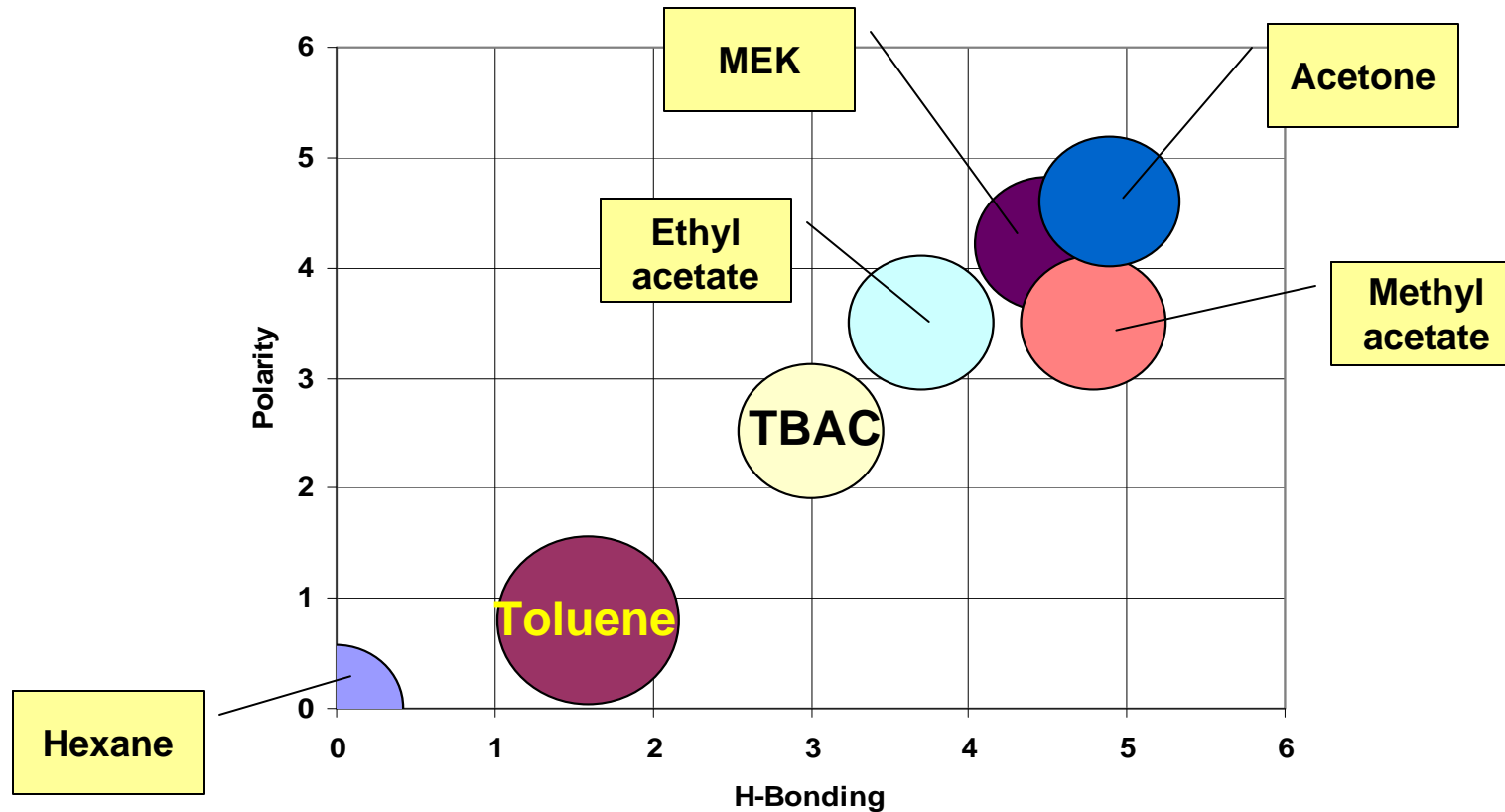
VOC-exempt Solvents for Adhesives and Sealants

- Acetone
 - Very fast and flammable
 - Powerful, inexpensive solvent
- Para-chlorobenzotrifluoride (PCBTF, Oxsol 100)
 - Medium slow and flash above 100°F
 - Dense, inefficient and expensive
- Tert-Butyl acetate (TBAC, TBACTM Solvent)
 - Medium fast, medium priced, versatile solvent
 - Strong odor, flammable
- Methyl acetate
 - Same as acetone but more expensive

Properties of Exempt Solvents for Coatings

Solvent Properties	TBAC	PCBTF	Methyl Acetate	Acetone
CAS number	540-88-5	98-56-6	79-20-9	67-64-1
Molecular weight	116.16	180.5	74.08	58.08
Boiling point, °C	98	139	57	56
Vapor pressure, Torr at 20°C	42	5.3	180	185
Electrical Resistance, Mohm	23.8	NA	4	<0.01
Density, g/mL at 20°C	0.867	1.34	0.932	0.79
(lb/gal) at 20°C	7.24	11.2	7.78	6.59
Evaporation rate, n-BuAc = 1.0	2.8	0.9	6.2	6.3
Surface tension, dyn/cm at 20°C	22.4	25	25.2	23.3
Solubility in water, %	0.3	<0.1	23	100
KB value	114	64	NA	NA
Hansen solubility parameters, Total	7.7	9.5	9.2	9.8
Hydrogen bonding	2.9	1.9	3.7	3.4
Dispersion (non-polar)	7.0	8.8	7.6	7.6
Polar	1.7	2.9	3.5	5.1
Flash point, °F	40	109	5	-4
MIR, g ozone/g	0.20	0.11	0.07	0.40

Solubility Parameters of Adhesive Solvents



- TBAC is most like toluene, hexane and hydrocarbon-based resins

TBAc Solvent Specifications

- **Purity, wt% by GC** 99.5 min
- **Alcohol, wt% as TBA** 0.5 max
- **Color, APHA/Pt-Co** 10 max
- **Water, wt%** 0.05 max
- **Acidity, wt%** 0.01 max

Urethane-grade solvent

TBAc Solvent Use in Adhesives

- **Construction adhesives and sealants**
- **Roofing adhesives**
- **Contact cements**
- **Packaging adhesives**
- **Pressure-sensitive adhesives**
- **Rubber and silicone-based adhesives, caulks & sealants**
- **Adhesive and sealant removers**

Viscosity of Kraton® Resin Solutions

20% Solids	Kraton D1107	Kraton D1101	Kraton D1102	Kraton D1111	Kraton D1117P
Toluene	500	1330	422	2010	188
TBAc Solvent	456	2850	579	296	219
Hexane	14000	insoluble	27400	insoluble	9800
MEK	insoluble	675	474	2160	insoluble
Mineral Spirits	insoluble	insoluble	insoluble	insoluble	insoluble
Heptane	28700	80600	80600	insoluble	ND
Cyclohexane	336	1500	516	462	245
Pentane	1900000	insoluble	insoluble	insoluble	165000
Acetone	insoluble	insoluble	insoluble	insoluble	insoluble
Xylenes	540	1620	377	374	215
Cypar 7	358	2010	266	368	148

35% Solids	Kraton D1107	Kraton D1101	Kraton D1102	Kraton D1111	Kraton D1117P
Toluene	5090	49374	7058	6920	11700
TBAc Solvent	4060	91321	38219	62519	X

Kraton® is a registered trademark of Kraton Polymers LLC

Viscosity of Natsyn® and Neoprene Resin Solutions

10% Solids	Natsyn 2200	Natsyn 2210	Neoprene AD20	Neoprene AG
Toluene	7100	9300	130	insoluble
TBAC Solvent	6790	3320	378	insoluble
Hexane	216	567	insoluble	insoluble
MEK	insoluble	insoluble	121	insoluble
Mineral Spirits	722	1540	insoluble	insoluble
Heptane	891	1670	insoluble	insoluble
Cyclohexane	8420	3630	insoluble	insoluble
Pentane	335	421	insoluble	insoluble
Acetone	insoluble	insoluble	insoluble	insoluble
Xylenes	24500	4300	446	insoluble

- **TBAC solvency similar to toluene**

Natsyn® is a registered trademark of Goodyear Tire & Rubber Company.

Viscosity of Tackifier Solutions

35 % Solids	Piccolyte® S25	Piccolyte® A115	Abitol-E®	Wingtack® 86	Wingtack® 95	Wingtack® Extra	Wingtack® Plus	Sylvares® ZT105LT
Toluene	2.5	2.5	0.5	3.1	2.8	3.9	3.2	3.0
TBAc Solvent	4.6	4.8	1.4	5.9	6.5	7.5	7.1	6.3
Hexane	1.7	1.7	0.9	1.6	1.6	2.3	2.0	1.9
MEK	insoluble	2.7	0.9	2.6	ND	ND	ND	1.9
Mineral Spirits	8.3	insoluble	6.0	11.8	9.2	15.3	13.0	2.7
Heptane	1.9	1.6	1.1	2.5	1.9	ND	7.2	2.3
Cyclohexane	5.4	5.5	3.8	6.2	6.8	9.0	7.4	6.3
Pentane	1.6	1.1	0.7	1.1	1.2	1.4	1.8	2.4
Acetone	insoluble	insoluble	0.8	ND	ND	ND	ND	insoluble
Xylenes	2.7	3.1	1.8	3.6	3.6	4.8	3.9	3.8
Cypar 7	3.4	3.9	2.3	3.9	4.6	5.3	4.2	4.9

Piccolyte® and Abitol® are registered trademarks of Hercules Inc.

Wingtack® is a registered trademark of Goodyear Tire & Rubber Company.

Sylvarez® is a registered trademark of Arizona Chemical.

Reformulation Example: Contact Cement

Product Features

% Solids

Solvents used

Evaporation Rate (n-BuAc = 1.0)

Flash Point, °C

grams VOC/L

grams HAP/L

Old

0.25

~~Toluene, n-hexane,~~
petroleum distillates,
~~acetone~~

0.52

-32

491

234

New

0.25

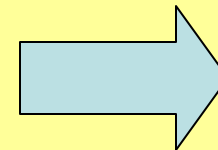
TBAC,
petroleum
distillates

0.55

4

240

0



- **New cement is safer and meets 250g VOC/liter limit**

Conclusions

- **Formulating with VOC-exempt solvents can**
 - Improve product performance
 - Reduce product cost, environmental impact and hazards
 - Increase sales
- **TBAC is a cost-effective VOC-exempt solvent for:**
 - Solventborne adhesives and sealants
 - Adhesive and sealant removers
- **www.tbac.com**

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