

Modified alcohols as an effective, sustainable and compliant cleaning solution

Featuring SAFECHEM



Practical, hands-on and independent, training in cleaning.

More Info
shsu.edu/pqcw
pqcw@shsu.edu



Darren Williams
Cleaning Research Group at SHSU
williams@shsu.edu



Barbara & Ed Kanegsberg
BFK Solutions LLC
barbara@bfksolutions.com
ed@bfksolutions.com



Michael Onken
SAFECHEM
m.onken@safechem.com

Hosts: The Product Quality Cleaning Workshop Team



Barbara and Ed Kanegsberg - "The Cleaning Lady and the Rocket Scientist"

- BFK Solutions - Consultants in Critical Cleaning
- Authors and Editors of the two-volume CRC Handbook for Critical Cleaning
- Independent evaluations and recommendations
- Co-chairs of the Product Quality Cleaning Workshops
- barbara@bfksolutions.com and ed@bfksolutions.com



Darren Williams - "The Professor"

- Professor of Physical Chemistry at Sam Houston State University
- Leader of the Cleaning Research Group
- Co-chair of the Product Quality Cleaning Workshops
- Performs cleaning trials and formulates cleaning chemistries
- williams@shsu.edu



Our Speaker



Michael Onken
Market Development Manager

- Graduated in chemistry and business
- Advises companies on the use of modified alcohols to
 - optimize the parts cleaning process
 - ensure worker and environmental protection
 - meet regulatory requirements

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**MODIFIED ALCOHOLS AS AN
EFFECTIVE, SUSTAINABLE AND
COMPLIANT CLEANING
SOLUTION**



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Who is SAFECHEM?

- The Service Company responsible for the sustainable and innovative use of chemicals
- We help customers meet the most demanding parts cleaning requirements while ensuring worker safety, environmental protection and regulatory compliance
- Established in 1992 and headquartered in Düsseldorf, Germany
- Present in Europe, USA, Mexico and China
- Inventor and developer of modified alcohols and stabilizers



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Current legislative status of halogenated solvents

FLUORINATED SOLVENTS

- Many hydrofluoroethers (HFEs) and hydrofluoroolefins (HFOs) are now facing an uncertain future due to increasing global regulatory pressure on PFAS.
- Their use as fluorinated solvents in industrial parts cleaning could be restricted or prohibited.

PFAS

- Currently, NO general ban of PFAS in the US / Europe
- Oct, 2021: EPA introduced PFAS Strategic Roadmap
- National Testing Strategy → increase understanding of the impact of PFAS

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Current legislative status of halogenated solvents

PERCHLOROETHYLENE

In June 2023, the EPA published proposed rule.

- Companies to set up a **Workplace Chemical Protection Program (WCPP)** – adhered to the principle of "Hierarchy Of Control"
- Cornerstone of WCPP: **ECEL (Existing Chemical Exposure Limit) requirement of 0.14 ppm (0.98 mg/m³)** for inhalation exposures as an 8-hour time weighted average (TWA)

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AS A RESULT, COMPANIES ARE
LOOKING FOR ALTERNATIVES ...

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In the case of fluorinated solvents ...

- Variations of HFEs and HFOs which are pfas-free as drop-in replacements in open degreaser
- Keep operations running with minimal disruptions

Will drop-in replacements used in **open and semi-open equipment** make for a **future-proofing** cleaning approach (considering increasing regulatory requirements on health, safety and environmental protection)?

Many fluorinated solvents are blended with Trans-1,2 dichloroethylene (t-DCE) – and t-DCE is under legislative pressure itself.

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In the case of perchloroethylene ...

Some companies might consider to convert to aqueous cleaning altogether



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**BUT THERE'S ANOTHER OPTION:
MODIFIED ALCOHOLS**

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Modified alcohols as an effective, sustainable and compliant cleaning solution



- 1** CHLORINE-FREE, BROMINE-FREE AND FLUORINE-FREE
- 2** **NOT** UNDER TSCA (THE TOXIC SUBSTANCES CONTROL ACT) EVALUATION
- 3** PRODUCED SYNTHETICALLY, HIGHLY STABLE / CAN CLEAN OFF NON-POLAR AND CERTAIN POLAR CONTAMINATIONS

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A viable cleaning solution should:

- ✓ **Fulfill technical requirements**
- ✓ **Be cost effective**
- ✓ **Support environmental protection / Sustainability**
- ✓ **Be compliant with regulation**

How can modified alcohols tick all these boxes?

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Modified alcohols as an effective, sustainable and compliant cleaning solution

Influencing factors for technical cleanliness			Economic Factors
Kind of contamination  	Materials  	Geometry / size of parts   1-Bromopropane Water-based cleaner Modified Alcohol	 EH&S 

What are the cleanliness requirements?

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AGENDA

- 01 - What are modified alcohols?
- 02 - How do they work?
- 03 - Is it useful for me?
- 04 - Conclusion

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What are modified alcohols?

Principle „Cleaning like with like“

Non polar / water insoluble Water soluble / polar

Oil & HC Solvents Water

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What are modified alcohols?

Non polar / water insoluble Water soluble / polar

Hydrocarbons

Water

Halogenated solvents (DOWPER™*/MECTHENE™*)

Modified alcohol (DOWCLENETM* 1601)

Modified alcohol (DUALENETM 1601 S)

Modified alcohol (DOWCLENETM* 1611)

Modified alcohol (DOWCLENETM* 1621)

Modified alcohol/Hydrocarbon in a hybrid process (DOWCLENETM* 1601 or 1621/Water)

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What are modified alcohols?

Properties and advantages of modified alcohols

Non Polar contaminant

Polar contaminant

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What are modified alcohols?

Properties

	DOWCLENE™* 1601	DOWCLENE™* 1611	DOWCLENE™* 1621
Density (20 °C)	0.88g/m ³	0.94 g/m ³	0.78 g/m ³
Boiling Point (°C)	170 – 175	170 – 193	175 – 200
Flash Point (°C)	63	79	59
Solubility in water (20 °C)	Ca. 6.3 %	Miscible	< 5 %
Solubility of water in solvent (20 °C)	Ca. 15%	Miscible	< 0.25 %

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What are modified alcohols?

There are various applications for modified alcohols

Coating	Developed for use:	Medical technology	
Cosmetic	<ul style="list-style-type: none"> Where high standards of cleanliness are demanded Where a high material throughput is important 	Automobile industry	
Ind. Cleaning		Aerospace industry	
Household	With the benefits:	Various high precision cleaning tasks	
Paints	<ul style="list-style-type: none"> Low surface tension Remarkably stable (temperature & pH) Synthetically produced High solvency power for polar and non polar contaminants Recovery by distillation Cost efficient 		

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How does solvent cleaning work in an airtight degreaser?

It is important to understand the cleaning system in its functions

The diagram illustrates a solvent cleaning system. A central rectangular machine sits on a pallet. Inside the machine, a circular drum is shown with gears and a basket containing parts. To the left and right of the machine are two solvent recovery units, each labeled 'SAFECHEM be responsible'. Pipes connect these units to the central machine, indicating a closed-loop solvent recovery process.

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How does solvent cleaning work in an airtight degreaser?

Efficiency of solvent cleaning in closed / airtight machines

The photograph shows a worker in a dark jacket operating a large industrial solvent cleaning machine. Thick white steam is rising from the machine, indicating a high-temperature cleaning process. The machine is situated in a workshop or industrial setting.

Amounts per 100 kg oil removed

solvent 745 kg	→ OPEN MACHINE	air emissions 520 kg waste 233 kg
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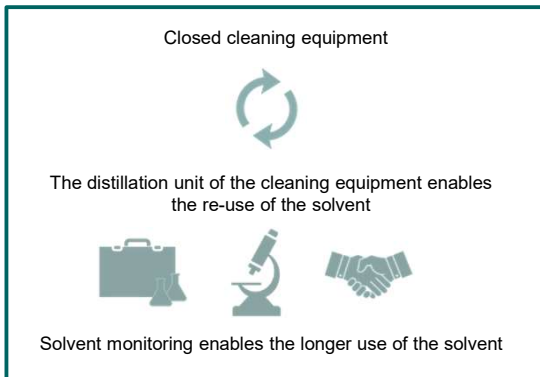
How does solvent cleaning work in an airtight degreaser?

Efficiency of solvent cleaning in closed / airtight machines

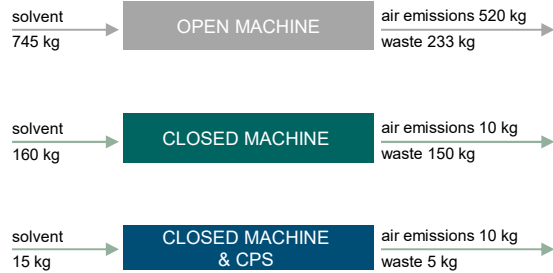


How does solvent cleaning work in an airtight degreaser?

Efficiency of solvent cleaning in closed / airtight machines



Amounts per 100 kg oil removed



Why do you need to stabilize?

The "LITTLE CHEMICAL REACTOR"

The diagram illustrates a chemical reactor process. On the left, there are three input streams: 'oil' with a red circle containing 'Cl', 'oil' with a purple circle containing 'S', and 'oil' with a cyan circle containing 'TMP'. Below these are two more inputs: 'oil' with a green circle containing 'Ester' and a grey box containing '-C-C-', and 'Solvent' (orange circle) and 'Water' (blue circle). These inputs feed into a central yellow box labeled 'HEAT'. On the right, there are three output streams: 'oil' with a red circle containing 'Cl', 'oil' with a purple circle containing 'S', and 'oil' with a cyan circle containing 'TMP'. Below these are two more outputs: 'oil' with a green circle containing 'Ester' and a grey box containing '-C-C-', and 'Solvent' (orange circle) and 'Water' (blue circle).

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Why do you need to stabilize?

The "LITTLE CHEMICAL REACTOR"

The diagram illustrates a chemical reactor process. On the left, there are four input streams: 'Volatile contamination', 'Weak acid', 'Sulfuric acid (+Smell)', and 'Hydrochloric Acid'. These inputs feed into a central yellow box labeled 'HEAT'. On the right, there are three output streams: 'Separated in water separator', 'Reused', and 'Disposed'.

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Stabilization for increased process safety and reliability

Process safety

DUALENE™ 1601 S and **DOWCLENER™* 1621** are already alkaline in their first delivery. **DOWCLENER™* 1601** can be stabilized to ensure they work in the safety zone from the very beginning.

Mandatory monitoring with **MAXICHECK™** test kits reveals potential challenging situations and provides recommendation on addition of stabilizer if required.

Continue solvent monitoring and stabilization (if required) to safeguard your equipment and extend solvent lifespan.

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Benefits of use of modified alcohols in airtight machine

COST EFFICIENCY

- Continuous solvent recovery via built-in distillation
- Long solvent lifespan
- Less solvent consumption
- Fewer bath exchanges
- Less solvent waste
- Modified alcohols' ability to process both polar and non-polar contaminations may reduce need for additional cleaning processes

PROCESS SECURITY

- Easy monitoring of solvent condition with test kits
- Reliable cleaning results
 - High solvent quality in rinsing step
 - Vapor degreasing as last cleaning step
- Vacuum drying reduces risk of solvent trapped in blind holes

ENVIRONMENTAL PROTECTION

- Virtually no air emissions
- Minimal risk of contaminating ground water (hermetically sealed construction)
- Operators have virtually no contact with chemicals

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Is it useful for me?

←

Non polar / water insoluble

Water soluble / polar

Hydrocarbons

Halogenated solvents (DOWPER™*/MECTHENE™*)

Modified alcohol (DOWCLENETM* 1601)

Modified alcohol (DUALENETM 1601 S)

Modified alcohol (DOWCLENETM* 1611)

Modified alcohol (DOWCLENETM* 1621)

Modified alcohol/Hydrocarbon in a hybrid process (DOWCLENETM* 1601 or 1621/Water)

Oil

Waxes

Petroleum

Fats

Resins

Corrosion Protection Inhibitor

Ester

Tensides

Water

Salts

Emulsions


Emulsion residues

EP additives

AW additive


Surfactants

→



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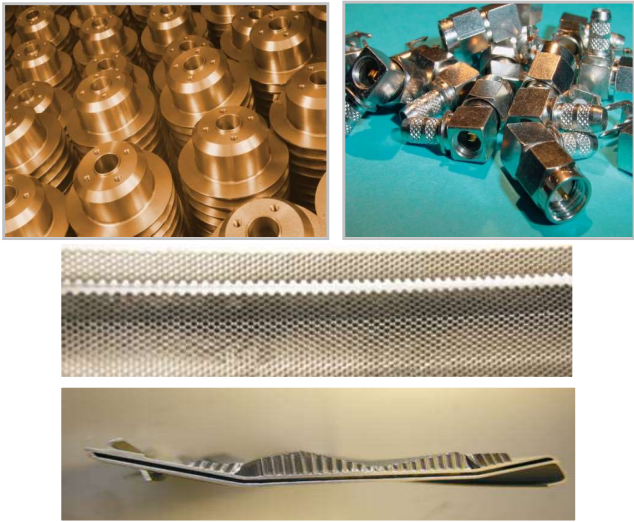
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Is it useful for me?

- Which type of metal gets cleaned?
(e.g. iron, brass, copper, aluminum, titanium)
- How big are the metal parts?
- What is the condition of the metal surface? (e.g. blind holes)




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Is it useful for me?

Requested surface tension of the metal surface after the cleaning process

General cleaning			Precision cleaning	
<p>With Hydrocarbons</p> <p>Wafer-thin film remains on the metal surface</p>	<p>With water</p> <p>Chemicals required Energy consumption Waste disposal</p>		<p>Halogenated Solvents or Modified Alcohol</p> <p>Residue-free drying on the surface</p>	<p>With water</p> <p>Same as normal cleaning + high space requirement</p>

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Customer example – HS Marston Aerospace Limited

Use of DOWCLENE™* 1601

- Supplier of aerospace industry
- Production of heat exchangers for aircrafts

Cleaning requirement:

- Cleaning of heat exchangers
- Brazing process after cleaning



Timeline:

Chlorinated Solvent → Water-based Cleaning → N-Propylbromide → Fluorinated Solvent → 2011 Modified Alcohol → 2020 3rd Machine Installation





Time →

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Customer example – HS Marston Aerospace Limited

 ↓225 Greenhouse gas emissions cut by around 225 tonnes of CO ₂ per year	 x10 CO ₂ reduction is equivalent to the energy usage of 10 homes per year
 x20 CO ₂ reduction is equivalent to the annual emissions from around 20 cars	 ↓50% Solvent spend is down by at least 50%

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What about aqueous cleaning?

Aqueous cleaning has its benefits too!

- For polar contaminations
- When working wet-in-wet (e.g. water-based painting, galvanization)
- Cleaning can be combined with surface finishes (phosphating, chromating etc) or deposition of protective coatings
- In-line processes possible
- Due to different formulations, potential to adapt to the cleaning requirements

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Key differences between solvent cleaning and aqueous cleaning



- | | |
|--|--|
| <ul style="list-style-type: none"> • Cleaner concentration remains constant for consistent cleaning results • Cleaning process in one working chamber – no product carry-over • Closed system under vacuum • Solvent recycling through internal distillation | <ul style="list-style-type: none"> • Cleaner concentration must remain constant for consistent cleaning results • Cleaning process takes place in several cleaning and rinsing baths – therefore product carry-over • Change in cleaner concentration due to evaporation • Regular re-dosing or replacement necessary |
|--|--|

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Cost-effectiveness



Low energy consumption

- Much less energy required to heat up solvent than water.
- No need for energy-intensive drying.



Especially effective for high oil entry

The higher the oil input and the higher the material throughput, the more advantages solvent cleaning can offer.



Minimal media monitoring & maintenance efforts



Minimal floor space



Lower chemical consumption

Solvent can be reused and recycled.



Fewer bath exchanges



No waste water treatment




Shorter cleaning cycles


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Consistent and superior cleaning results




Universal compatibility with metals



Parts come out dry




Highly effective in removing non-polar contaminations: machining oils, greases, waxes, resins




Repeatability of cleaning results

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Sustainability



Virtually no air emissions in closed machines




Zero water consumption in cleaning




Continuous solvent recovery via built-in distillation

- Long solvent lifespan.
- Less solvent waste.




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Worker safety



Parts fed automatically into working chamber
Minimized human contact.




Vacuum condition ensures non-flammability and no emissions



Availability of the SAFE-TAINER™ System enables emission-free and spill-free handling of solvents

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AGENDA

- 01** - What are modified alcohols?
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1. Types of metal components
- 2. Available cleaning agents on the market**
- 3. Polarity of the different cleaning agents**
4. Solvency power
- 5. Required grade of cleaning quality**
6. Drying behavior
7. Density of cleaning agents
8. Type of contaminations
9. Distillation behavior
- 10. Process safety**
11. Corrosion protection



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MANY THANKS!

SAFECEM Europe GmbH
Michael Onken
Market Development Manager
Phone: +49 211 4389-335 • Mobile: +49 172 294 5013
E-mail: m.onken@safechem.com

SAFECEM North America, Inc.
Chris Tivnan
Sales Manager North America
Mobile: +1 774 764 1492
E-Mail: c.tivnan@safechem.com

US Distribution Partners:



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PQCW On-Demand Workshop on Aqueous Cleaning



- Half day on-line program
- Includes 30 minutes individualized live consulting with a PQCW Instructor
- Convenient training modules
- Continuing education credit / certificate
- The Product Quality Cleaning Workshop Team
 - Barbara Kanegsberg, BFK Solutions
 - Ed Kanegsberg, PhD, BFK Solutions
 - Professor Darren Williams, Sam Houston State U.

Go to www.shsu.edu/pqcw to sign up for the course!



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PQCW - Workshops for Terrific Products

Quotes from attendees:

- ▶ “People with different functions within our company, including **Strategic Sourcing, Project Management, and Manufacturing Engineering**, attended.”
- ▶ “We learned a lot; and we have made changes. We are **refining our own cleaning requirements** and putting together training programs.”



See our other webinars at:

www.shsu.edu/pqcw

For Cleaning and Regulation Information

Sign up for the Clean Source Newsletter at

www.bfksolutions.com

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