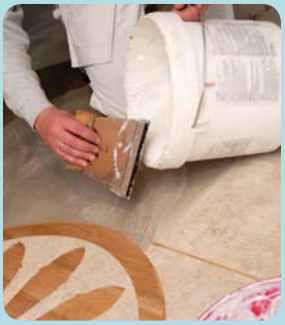
LAMBIOTTE & CIE S.A.

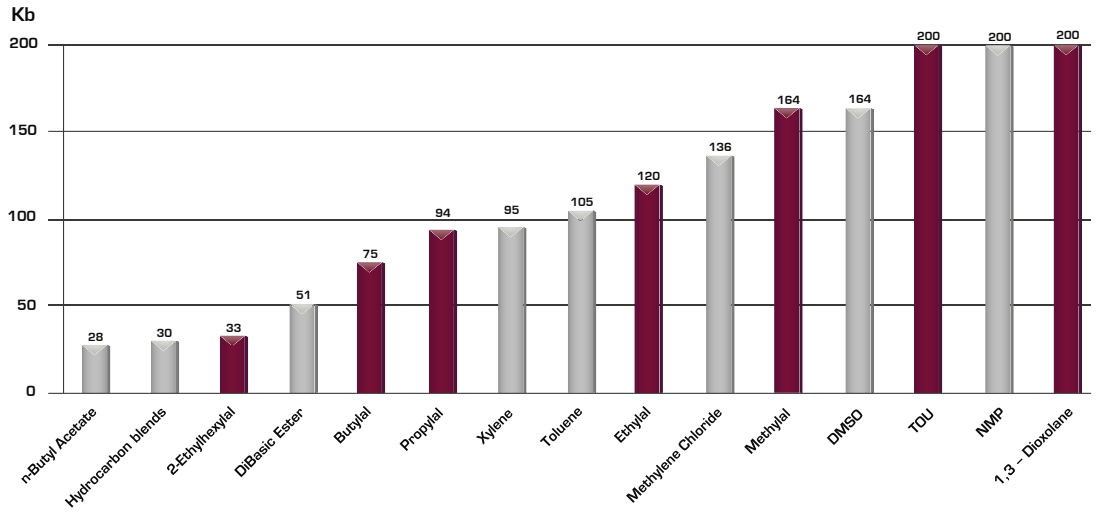




Acetals
in Coatings, Inks and Adhesives

Lambiotte &Cie

I. SOLVENT POWER

The Kauri-Butanol is an international, standardized measure of solvent power, and is governed by an ASTM standardized test, ASTM D1133. The result of this test is a scaleless index, usually referred to as the "Kb value". A higher Kb value means the solvent is more aggressive or active in the ability to dissolve certain materials.



The solubilization even in high amounts of different types of resins and polymers, including polyurethanes and epoxies, can be achieved with acetals. In the formulation of paints, graffiti and adhesive removers, dichloromethane or N-Methyl Pyrrolidone can be substituted by Methylal, Dioxolane or TOU.

II. ORGANIC SOLVENTS MISCIBILITY

Acetals are miscible with all organic solvents. This feature allows working on tailored solvent/co-solvent systems to reach specific properties (solvency, evaporation rate, etc…).

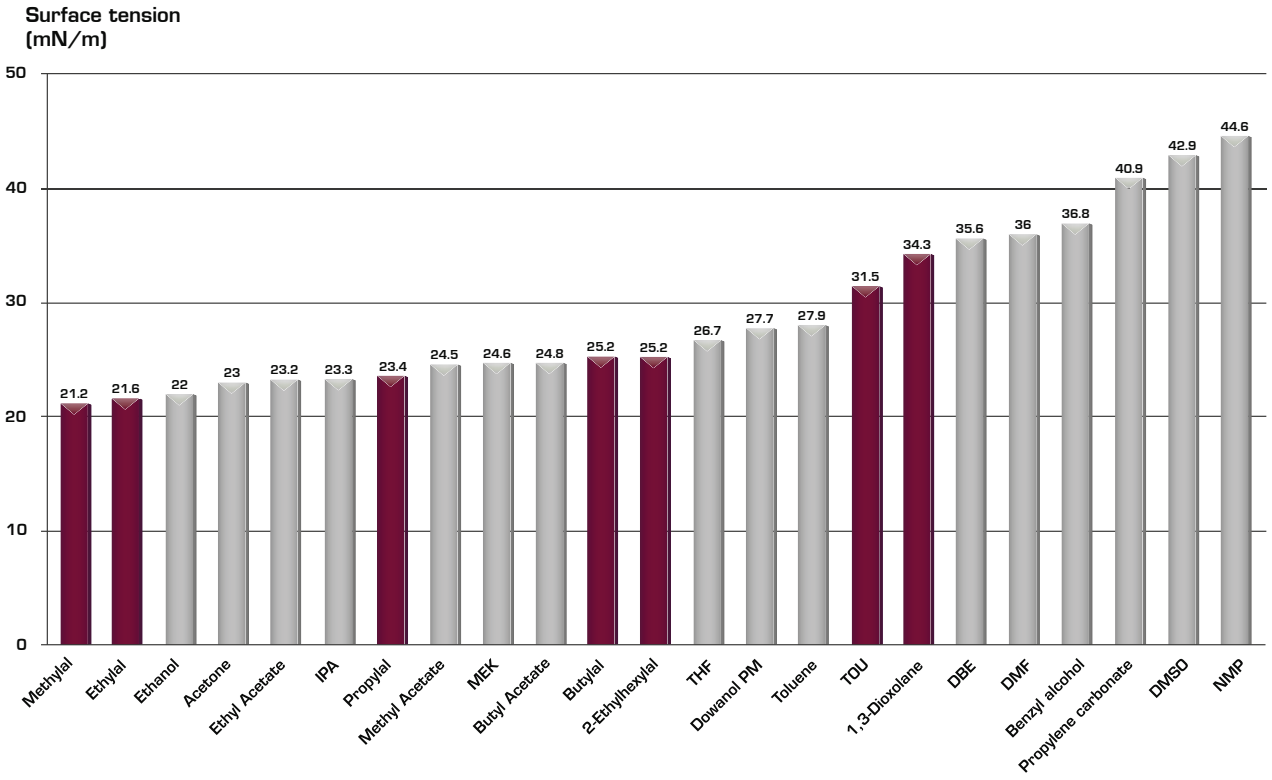
III. WATER MISCIBILITY

Acetals are miscible with water to various extents and therefore act as co-solvents in waterborne systems. Acetals that are partly miscible with water become fully miscible in presence of an alcohol.

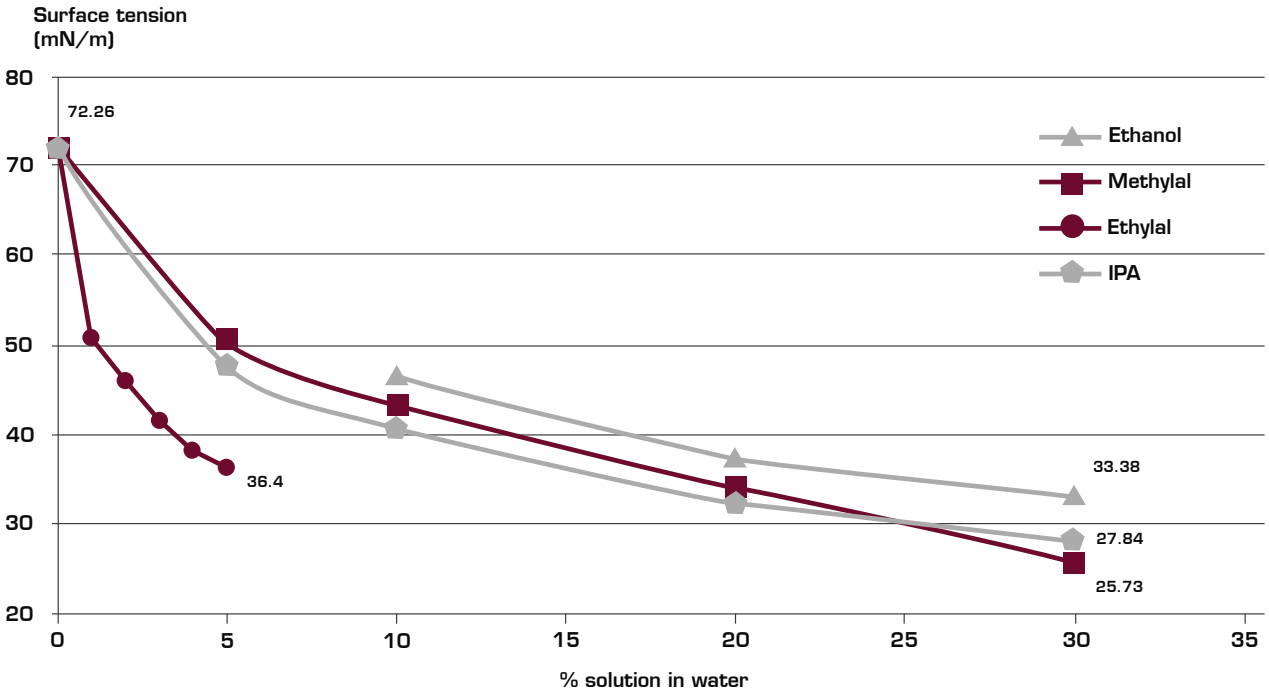
Acetal	Acetal solubility in water (g/l)	Water solubility in acetal (%)
Methylal	330	4
Ethylal	70	1.21
Propylal	3.65	0.45
Butylal	0.22	0.24
TOU	Fully miscible	Fully miscible
2-Ethylhexylal	Not miscible	Not miscible
1,3-Dioxolane	Fully miscible	Fully miscible

IV. WETTING ENHANCEMENT

Thanks to their low surface tension, acetals can enhance the wetting ability of coatings and inks; this can be highly beneficial in the case of application on substrates of low energy surface such as plastics, where additives typically are required.



Methylal and Ethylal can significantly enhance the wetting ability of water-based systems. While Methylal slightly outperforms IPA at same ratio, a 5% Ethylal solution into water is found to have a surface tension value equivalent to a 20% Ethanol solution.

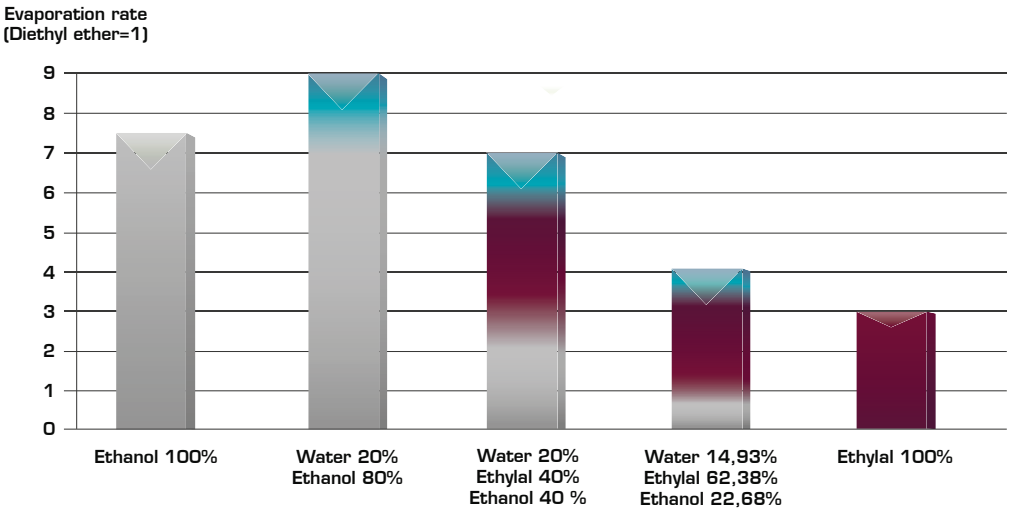


V. EVAPORATION RATE

Another key feature of acetals is their evaporation rate, as they can considerably positively impact the drying time of the coating or the ink.

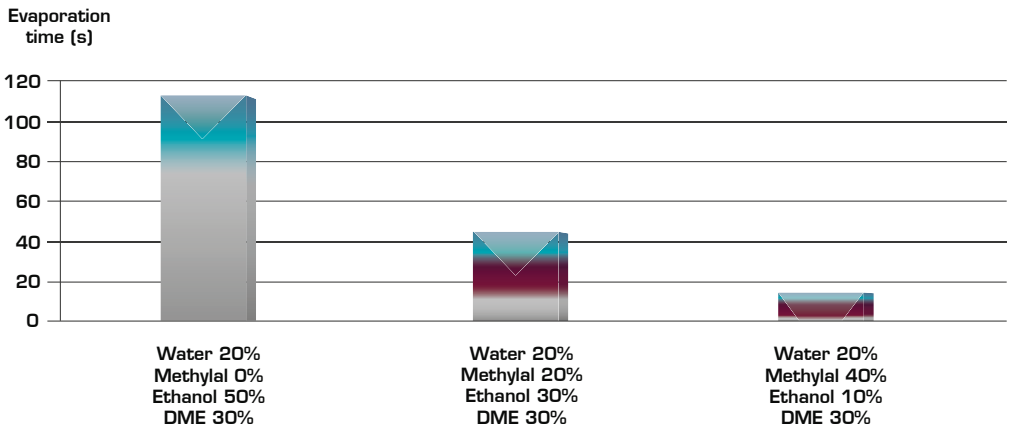
Acetal	Evaporation rate (Diethyl ether = 1)	Evaporation rate (Butyl acetate = 1)
Methylal	1.36	0.11
Ethylal	3.0	0.25
Propylal	14.0	1.25
Butylal	Not available	5.54
TOU	Not available	17.38
2-Ethylhexylal	No evaporation	No evaporation
1,3-Dioxolane	3.6	0.29

The drying time of waterborne systems can also be dramatically decreased in presence of acetals like Methylal, Ethylal or Dioxolane, compared to Ethanol, Ethylal Acetate, etc....



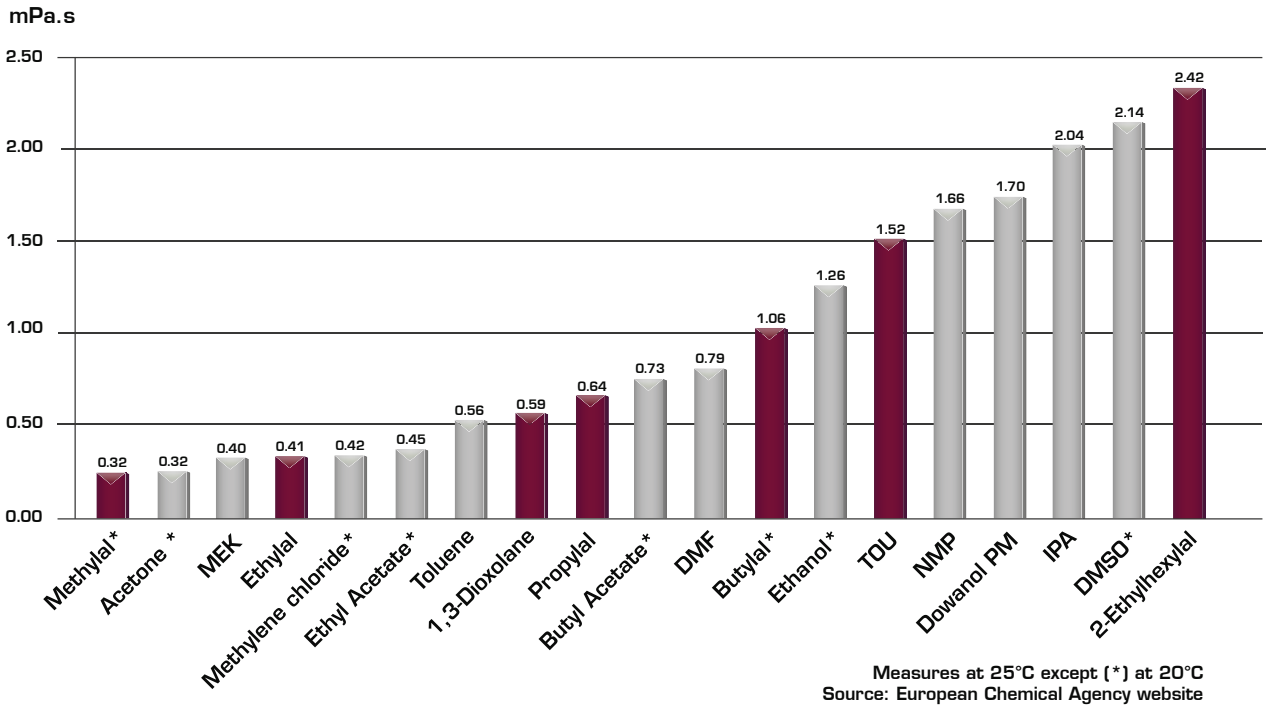
In aerosol and spray applications, Methylal is reducing significantly the drying time of hydro alcoholic mixtures.

Below, formulations propelled with DME :



VI. VISCOSITY

Acetals exhibit a range of low to very low viscosity values. The lowest viscosities are ideal for deep penetration into porous substrates; they also enable low shear during application by spray. If used as co-solvent they may help tailoring the rheology of the system.



Measures at 25°C except (*) at 20°C
Source: European Chemical Agency website

Once in water, acetals such as Methylal and Ethylal are known to increase the viscosity of the solution; this effect might lead to a lower need of rheological additive.

VII. SUSTAINABILITY

⇨ Bio sourcing

- Ethylal is produced from bio-ethanol
- Other acetals can potentially be manufactured from bio-alcohols

⇨ Low eco-toxicity

- Acetals have low to no eco-toxicological labeling
- In Germany, acetals listed under the terms of the Federal Water Act on the Classification of Substances Hazardous to Water in Water Hazard Classes (VwVwS), are assigned WGK 1 - low water hazard

VIII. SAFETY, LABELING AND REGULATORY COMPLIANCE

Further to the adoption of the "Globally Harmonized System of Classification and Labelling of Chemicals (GHS)" by many countries around the world these last years, substances traditionally used in the Coatings, Inks and Adhesives industries are progressively heavily re-classified and consequently subject to limitation or restriction.

Many mixtures containing these substances now see their labeling negatively impacted and are in need of reformulation in order to comply with local regulations and/or consumer products standard criteria (Ecolabel,…). Although alternatives to these substances of concern are identified, some are not appreciated because of the drowsiness and dizziness effects they can cause to operators and/or end users, while the use of others is limited by indoor VOC emissions standards.

Under the terms of CLP in Europe or GHS in the rest of the world, acetals are granted exceptionally low toxicological and eco-toxicological labeling, and therefore are ideal candidates for substituting a wide range of hazardous components, such as:

Carcinogenic, Mutagenic and Reprotoxic hazards 	Effects on Central Nervous System/ Narcotic hazard 	Other hazards 
Trichlorethylene Perchlorethylene Methylene chloride N-Methyl Pyrrolidone (NMP) N-Ethyl Pyrrolidone (NEP) Tetrahydrofurane (THF) Dimethylformamide (DMF) Toluene …	Ethyl acetate Butyl acetate Isohexane White spirit Methyl Ethyl Ketone (MEK) Isopropyl Alcohol (IPA) Acetone Heptane …	d-Limonene Xylene …

Source: European Chemical Agency website

⇨ Volatile Organic Compound emissions

2-Ethylhexylal is non-VOC under the terms of the following regulations:

- European Directive 1999/13/EC (Vapor pressure < 0.01kPa at 293.15K)
- European Directive 2004/42/CE (Boiling Point > 250°C at 101.3kPa)

Methylal and Dioxolane have Maximum Incremental Reactivity (MIR) values listed under:

- Title 17, California Code of Regulations, Article 1, Tables of Maximum Incremental Reactivity Values, Section 94700

⇨ Food contact

- Dioxolane is listed on COMMISSION REGULATION (EU) No 10/2011 on plastic materials and articles intended to come into contact with food
- Dioxolane, Ethylal and TOU are listed either on Annex I or Annex 6 of the Swiss Ordinance SR 817.023.21 on Materials and Articles in Contact with Food
- Methylal and Butylal appear on the Combined Positive List Of Organic Substances in Contact with Drinking Water of the 4MS Group (France, Germany, the Netherlands and the United Kingdom)

Applications


Inks


Paint & Graffiti Removers

Spray Adhesives


Aerosol Paints


PVC Adhesives


Shrink Sleeves


Heat-sealable Adhesives


Paints


PU Adhesives

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