

BUILDING A GLOBAL NETWORK

Solvvetex V; Evaluation and performance of new solvents

Over the last years many new cleaning technologies and solvents have been introduced to the textile cleaning market. Due to changing dressing habits, new textile materials, sustainability profiles and legislation, developments and innovations are important to enable new business cases. These developments and innovations result in optimised performances, especially taking in consideration that the dressing habits, textile materials and type of stains are changing in the textile cleaning industry.

Many chemical suppliers have developed their own solvent system. Most of the new solvent systems are based on hydrocarbons and modified alcohols, also known as glycol ethers, in different formulations. For the textile cleaner this increased availability of solvents on the market makes it difficult to select the optimal cleaning system for their use. This review article provides an overview of the main properties and characteristics of the solvents, based on public test results of research institutes and test reports made available by the suppliers.

The recent introduced solvents are Ktex, Arcaclean, HiGlo, Intense and SENSENE. These solvents are available besides the more or less established solvents like Perchloroethylene (PERC), Hydrocarbon solvent (HCS), Solvon K4 and GreenEarth, evaluated in the Solvetex III study. Besides new solvents, alternative technologies are developed for professional textile cleaning like wetcleaning, evaluated in the Solvetex IV study.

Properties of the new solvents

One of the major differences between PERC and the alternative solvents is the flammability. PERC is a non-flammable solvent while the other solvents are flammable, requiring Class IIIA equipment with safety precautions. Also the volatility of the solvent is important for the energy required for distillation and drying. The higher the vapour pressure and lower the boiling point, the more easier it is to evaporate the solvent. This is often reflected in the drying temperature and cycle time. The density of the solvent and solubility of water is important to manage the water amount in the solvent. Modified alcohols or glycol ethers have a good interaction with water, attention is required to keep the moisture content well controlled. Differences in boiling point and solubility in water of the components of a solvent formulation can cause changes in the formulation after distillation and water separator. The composition and stability of the solvent should be checked regularly, this applies for all solvents on the market.

Cleaning properties explained

In the dry-cleaning industry the Kauri Butanol (KB) value is adapted as a value for the “power” of the solvent. Only a small part of the cleaning properties is related to the KB value. The cleaning power is a total result of the physical-chemical properties of the solvent and the type of stains. The KB value was original developed to evaluate the behaviour of petroleum fractions measuring the turbidity when titrated into a kauri-butanol standard solution. Solvents such as alcohols, ketones and glycol ethers cannot easily be evaluated using the KB method, since they can readily dissolve the kauri gum, so they can hardly form any turbidity.

Trade name	Tetrachloroethylene	DF-2000	GreenEarth	Solvon K4
Category	PERC or PCE	(Iso)alkane	Siloxane D5	Dibutoxymethane
Chemical composition	C2Cl4	C9-C12	C10H30O5Si5	C9H20O2
CAS	127-18-4	90622-57-4	541-02-6	2568-90-3
Boiling point °C	121	191-205	210	180,5
Flashpoint °C	non flammable	64	77	62
Vapour pressure Pa @ 20°C	1900	40-50	15	79
Density g/cm ³	1,62	0,77	0,95	0,84
Solubility in water g/kg	0,15	negligible	0,000017	negligible
KB Value	90	27	13	75
Drying temperature drum inlet (°C)	60-65	70-75	75-80	75-80
Time cleaning cycle (min)	45-50	63-70	70-80	70-80
Care label	P	P & F	none	none
Odour	ethereal	virtually odourless	odourless	characteristic

Table 1: properties of the more or less established solvents like Perchloroethylene, Hydrocarbon, Solvon K4 and GreenEarth [6]

Trade name	Ktex	HiGlo	Intense	SENSENE	Arcaclean
Category	HCS & glycol ether	HCS & glycol ether	HCS & glycol ether	Modified alcohol & HCS	Mixture (glycol ethers)
Chemical composition	-	-	-	-	-
CAS	-	-	-	-	-
Boiling point °C	160	184	180-210	180	165-235
Flashpoint °C	>61	62	64	65	84
Vapour pressure Pa @ 20°C	60	<100		54	50
Density g/cm ³	0,8	0,79	0,79	0,84	0,96
Solubility in water g/kg	yes	yes	yes	yes	yes
KB Value	75	45	73	161	78
Drying temperature drum inlet (°C)	70	75-80		65	70
Time cleaning cycle (min)	65-70	63-70		62-70	65-70
Care label	none	none	none	none	none
Odour	light	light	light	light	light

Table 2: properties of the new solvents Ktex, Arcaclean, HiGlo, Intense and SENSENE [1-5]

The cleaning properties of a solvent is determined by the viscosity, density, surface tension and chemical composition. Solvents with a high KB value are able to dissolve lacquer and varnish stains from the garments more easily. But the total composition of the solvents determine the cleaning performance of stains like greases, oils, particle soil, protein and tannin stains. To remove water soluble soils like salts, sugars, sweat and urine a certain amount of water is required. Modified alcohol or glycol ethers are polar molecules, the same as water, which means that these substances have a good interaction. Hydrocarbons are a nonpolar molecule, having a good interaction with greases and oils. Combining these properties in a formulation enhances the overall cleaning properties.

Performance evaluation

The evaluation is based on public test results of research institutes and test reports made available by the suppliers. The performance is based on comparison of the new solvents with PERC and HCS. The stains, materials and processes used for evaluation are different for each solvent. Also additional evaluations are required for some solvents to present a complete overview of performances.

Energy and water use

The energy use of the alternative solvents is higher compared to the energy use of PERC, but is in general comparable with the energy use of HCS. This is mainly due to the energy needed for the drying and distillation (if available) processes. The same applies for the water consumption. The use of cooling water for the new solvents is

higher than the cooling water for PERC but comparable to the cooling water consumption of HCS. Reuse of cooling water from the dry cleaning machine in the laundry process is recommended to reuse the energy and water. The exact figures depend of the machine configuration and process parameters.

Costs

To determine the operating costs the labour costs are the most important followed by consumption of water and energy. The energy costs in general are higher for HCS and the new solvents than for PERC. Also the purchasing costs of the new solvents are higher compared to HCS and PERC. Although the operating costs are dependent on the reuse and quality of the solvents in the machine. The purchasing costs of a multisolvent machine suitable for class IIIA solvents is higher than the cost of a PERC machine. In general the operating costs of the new solvents are higher than PERC and more or less comparable with hydrocarbon.



HiGlo

HiGlo is a hydrocarbon based formulation with glycol ether. The solvent is suitable for regular multisolvent or HCS machines. Comparing the results of HiGlo with PERC and HCS resulted in a good performance of the HiGlo solvent. The evaluation of the stain removal capacity of PERC, HCS and HiGlo showed that the results are equivalent compared to PERC and HCS. The stains evaluated are based on oils, tannins, proteins, pigments and particles. Especially a good stain removal is reported on fatty stains and particles (carbon black). Protein and tannic stains are hard to remove for all the solvents. [1]

HiGlo showed good results on different textile materials like wool, polyester, cotton, viscose, silk and polyurethane. In PERC, HCS and HiGlo PVC coated workwear was damaged after the first cleaning. No greying and yellowing of cotton is observed after cleaning in HiGlo. The dimensional stability is good for all the materials tested. The finishing effort is comparable with the effort required for PERC and HCS. [1, 5]



SENSENE™

SENSENE

SENSENE is a formulation based on modified alcohols. The solvent is suitable for regular multisolvent or HCS machines. The cleaning performance of SENSENE has been compared with PERC and HCS for different stains on wool, cotton and polyester fabric. The evaluated stains are a variety of oil, fat, and water based stains like lanoline, sebum, vegetable oil, milk, lipstick, motor oil and mineral oil. The overall cleaning performance of SENSENE is better compared to PERC and HCS. Especially on polyester SENSENE has a very good cleaning performance. The greying of the fabrics with SENSENE is comparable with the greying with PERC and lower than the greying with HCS, except for cotton, which is higher for SENSENE. The colour bleeding is acceptable and the results are equal compared with PERC and HCS in the bath process. In the spray cleaning process the colour bleeding is higher due to an increased temperature (43°C versus 20-30°C for a bath process). It is recommended to run the spray cleaning process at normal temperature, as the solvent characteristics of SENSENE do not need an increased temperature to achieve good results. [2]



The solvent Ktex, produced by Bardahl, can best be described as a boosted hydrocarbon solvent. The solvent is suitable for regular multisolvent or HCS machines. The cleaning properties of this solvent is evaluated in relation to the performance of PERC and HCS, without additional detergents. The cleaning performance of Ktex is equal or better than the hydrocarbon solvent and comparable or lower than PERC. Protein and tannic stains are hard to remove for all the solvents. The results of greying and yellowing of cotton is good after cleaning in Ktex. In general the Ktex showed the same results on textile materials as hydrocarbons. Finishing of the garments can take slightly more time compared with PERC and HCS. [3, 5]



Arcaclean

Arcaclean, produced by Arcane Industries, originates from the metal degreasing process. This new solvent was developed to be as efficient as perchloroethylene and to be the solvent which is not classified as hazardous for humans and environment (GHS/CLP regulation). It is a mixture of several glycol ether solvents and about 2-3% water. The density of the solvent is 962 kg/m³, slightly lighter than water with its 997 kg/m³. Until a certain amount, the solvent can be mixed (miscible) with water, resulting in a difficult water separation. The cleaning system, patented by Arcane Industries, does not use a water separator, merely a distillation to purify the solvent and remove excess water. Therefore specialized dry cleaning machines are developed with ILSA.

The cleaning performance is evaluated in comparison with PERC and HCS. The stains evaluated are based on oils, tannins, proteins, pigments and particles. The Performance of Arcaclean is equal to hydrocarbon and PERC. Especially good results are reported on the removal of glue and egg yolk. Protein and tannic stains are hard to remove for all the solvents. The overall results of cleaning different textile materials like wool, polyester, cotton and viscose are good. Slight decolouration is noticed for acetate and silk materials. The dimension stability is acceptable and comparable with HCS. [4, 5]



Intense

The solvent Intense is a boosted hydrocarbon solvent formulated with glycol ethers. The solvent is suitable for regular multisolvent or HCS machines. The solvent has a KB value of 73 and a flashpoint of 64°C, which is slightly higher compared to the standard hydrocarbon solvent. Due to the glycol ethers the solvent has the ability to take up some moisture. This makes it easier to remove water soluble soil and stains from the fabric. More information on the cleaning performance will follow. [5]

Conclusion

The new solvents are all formulations based on hydrocarbons and/or modified alcohols. The review of available documentation shows a good cleaning performance with care for the garments for the new solvents. In many cases this can be seen as good alternative for PERC. Especially taking in consideration that the dressing habits, textile materials and type of stains are changing for the textile cleaning industry.

TKT

TKT is the Dutch technical knowledge centre for the textile care industry, for both the dry cleaning industry and the laundry industry. TKT initiates and coordinates technical and sustainable innovation projects for the Dutch and the International textile care industry. TKT is imbedded in international and networks and has extensive expertise about technological aspects of cleaning and washing such as (amongst others) sustainability of cleaning, alternative cleaning processes, energy saving, hygiene of cleaning and washing, life cycle assessments, environmental legislation for dry cleaners & laundries, textile functionalities and their relationship to washing processes. There are many ongoing projects about these aspects. Additionally, practical knowledge is transferred to the companies in the form of online educational material, both on a national and on an international level. TKT is closely affiliated to the Dutch national associations FTN (laundry) and Netex (dry cleaning), as well as the umbrella association CINET (the international committee of professional textile care).

References

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