Asahi Glass Co., Ltd.

ASAHIKLIN AK-225

INTRODUCTION

ASAHIKLIN AK-225 is an environmentally sensible hydrochlorofluorocarbon (HCFC) designed to replace chlorofluorocarbon (CFC), perfluorocarbon (PFC), and other HCFCs with high ODP values in a variety of applications. Its selective solvency, physical properties, and ability to form azeotropes make AK-225 ideal for general and precision cleaning, as a carrier for silicone and halogenated lubricants, and as a coolant.

ASAHIKLIN AK-225 is thermally stable, nonflammable and recoverable by distillation with no decomposition. It has substantially lower global warming potential (GWP) than PFCs and HFCs and an extremely low ozone depletion potential (ODP). AK-225 is exempt from VOC regulations by the U.S. EPA as described in the October 8, 1996 Federal Register.

PHYSICAL PROPERTIES

Physical properties of AK-225 are shown in Table 1.

Table 1 Physical Properties of AK-225

	AK-225	**CFC-113**
Molecular Weight	202.94	187.38
Boiling Point (°C)	54	47.6
Freezing Point (°C)	-131	-35
Critical Temperature (°C)	208	214.36
Critical Pressure (kg/cm^2)	30.2	34.78
Critical Density (kg/m^3)	558	570
Density (g/cm^3)		
Liquid (25°C)	1.55	1.57
Vapor (60°C, 1atm)	7.78	7.398 (50°C)
Viscosity (cP, 25°C)	0.59	0.65
Surface Tension (dyne/cm, 25°C)	16.2	17.3
Vapor Pressure (kg/cm^2, 25°C)	0.385	0.457
Latent Heat of Vaporization (cal/g, b.p.)	34.6	36.1
Relative Evaporation Rate (Ether=100)	90	123
Specific Heat (cal/g•°C)		
Liquid (25°C)	0.25	0.23
Vapor (60°C, 1atm)	0.173	0.1693 (50°C)
Ratio of Specific Heat (Cp/Cv, 60°C, 1atm)	1.076	1.096 (50°C)
Refractive Index (23°C)	1.326	1.356
Dielectric Constant (1MHZ, 25°C)	4.14	2.41
Solubility of Water (wt%, 25°C)	0.031	0.0109
Solubility in Water (wt%, 25°C)	0.033	0.017
Flash Point (°C)	None	None
KB Value	31	31
Solubility Parameter	6.9	7.5
Ozone Depletion Potential (CFC-11 = 1.0)	0.03	0.8
Global Warming Potential (CO_2=1.0, 100yr ITH)	370	5000

MATERIAL COMPATIBILITY

AK-225 has a broad range of compatibilities, similar to CFC-113, under typical cleaning conditions. However, certain plastics and elastomers are affected by AK-225. Compatibility can be affected by variations in material manufacture and it is advisable to recheck critical components under use conditions before a final commitment is made to AK-225.

Tables 2 and 3 show the effect of AK-225 on unstressed plastics under typical cleaning conditions (at the boiling point for five minutes) and also under extreme conditions (at the boiling point for 3 days). AK-225 is compatible with most plastics except polymethyl methacrylate. Some plastics such as stressed polycarbonate may crack or craze.

Table 2 Effect of AK-225 on Unstressed Plastics for 5 minutes at the Boiling Point.

	AK-225			CFC-113		
	Weight Change (%)	Linear Swell (%)	Extractables (%)	Weight Change (%)	Linear Swell (%)	Extractables (%)
Polyvinyl chloride (rigid)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polyvinyl chloride (plasticized)	0.9	<0.1	0.9	<0.1	<0.1	0.9
Polyethylene (HP)	0.1	<0.1	<0.1	0.1	<0.1	<0.1
Polyethylene (LP)	0.3	0.4	<0.1	0.1	<0.1	<0.1
Polypropylene	0.1	<0.1	<0.1	0.1	<0.1	<0.1
Polystyrene	0.4	<0.1	0.1	<0.1	<0.1	0.1
Polymethyl methacrylate (Acrylic)	crack	crack	crack	crack	crack	crack
Polycarbonate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polyacetal	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polyphenylene oxide	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenolic	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
ABS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nylon 6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nylon 66	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polyester (FR)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PTFE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCTRE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Epoxy (FR)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polyphenylene sulfide	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polybutylene terephthalate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table 3 Effect of AK-225 on Unstressed Plastics for 3 Days at the Boiling Point.

	AK-225			CFC-113		
	Weight Change (%)	Linear Swell (%)	Extractables (%)	Weight Change (%)	Linear Swell (%)	Extractables (%)
Polyvinyl chloride (rigid)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polyvinyl chloride (plasticized)	23.5	3.4	16.9	11.2	2.7	32.0
Polyethylene (HP)	3.0	0.7	<0.1	7.1	1.0	<0.1
Polyethylene (LP)	8.4	1.6	<0.1	6.3	1.4	<0.1
Polypropylene	10.6	2.5	0.2	17.0	2.5	0.2
Polystyrene	23.2	0.5	0.8	27.0	2.2	0.9
Polymethyl methacrylate (Acrylic)	Dissolve	Dissolve	Dissolve	<0.1	<0.1	<0.1
Polycarbonate	0.5	0.1	<0.1	-0.2	0.3	<0.1
Polyacetal	0.5	0.2	<0.1	-0.2	<0.1	<0.1
Polyphenylene oxide	9.0	0.4	0.8	2.4	<0.1	<0.1
Phenolic	-0.5	<0.1	<0.1	-0.1	<0.1	<0.1
ABS	2.4	<0.1	<0.1	-0.3	<0.1	<0.1
Nylon 6	-0.5	<0.1	<0.1	<0.1	<0.1	<0.1
Nylon 66	-0.4	<0.1	<0.1	<0.1	<0.1	<0.1
Polyester (FR)	0.2	<0.1	<0.1	<0.1	<0.1	<0.1
PTFE	2.8	0.6	<0.1	0.1	<0.1	<0.1
PCTRE	3.5	0.3	<0.1	0.1	<0.1	<0.1
Epoxy (FR)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polyphenylene sulfide	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Polybutylene terephthalate	0.2	<0.1	<0.1	<0.1	<0.1	<0.1

Tables 4 and 5 show the effect of AK-225 on elastomers under normal cleaning conditions (5 minutes at the boiling point) and also under extreme conditions (3 days at the boiling point). AK-225 affects some elastomers differently than CFC-113. Gaskets and/or seals used in cleaning equipment should be made of polytetrafluoroethylene, EPDM or chloroprene. Mechanical pump seals in solvent re-circulation pumps should be polytetrafluoroethylene. Seal-less pumps are ideal.

Table 4 Effect of AK-225 on Elastomers for 5 Minutes at the Boiling Point.

	AK-225			CFC-113		
	Weight Change (%)	Linear Swell (%)	Extractables (%)	Weight Change (%)	Linear Swell (%)	Extractables (%)
Polysulfide rubber FA (T)	4.2	1.2	0.9	<0.1	0.7	<0.1
Natural rubber (NR)	2.6	0.8	0.4	3.5	0.3	2.1
Urethane rubber (U)	7.2	1.7	0.1	1.1	0.3	<0.1
Isobutylene isoprene rubber (IIR)	2.1	0.5	1.2	4.7	0.3	3.3
Polychloroprene (CR)	1.7	0.8	0.5	1.1	<0.1	0.8
Fluoroelastomer E (FKM)	4.6	1.1	0.4	0.4	<0.1	<0.1
Chlorosulfonated polyethylene (CSM)	1.2	0.3	1.6	0.9	<0.1	0.8
Silicone rubber (Q)	32.4	8.8	0.3	19.3	4.8	0.3
Nitryl Rubber (NBR)	8.5	2.6	1.4	0.8	<0.1	0.5
Ethylene propylene diene terpolymer (EPDM)	2.7	0.2	1.4	4.7	0.3	3.6

Table 5 Effect of AK-225 on Elastomers for 3 Days at the Boiling Point.

	AK-225			CFC-113		
	Weight Change (%)	Linear Swell (%)	Extractables (%)	Weight Change (%)	Linear Swell (%)	Extractables (%)
Polysulfide rubber FA (T)	67.1	14.1	6.2	4.6	1.1	9.9
Natural rubber (NR)	23.5	6.1	2.9	29.5	4.9	13.2
Urethane rubber (U)	105.4	21.4	0.2	10.4	2.4	1.1
Isobutylene isoprene rubber (IIR)	9.2	-0.2	14.4	48.0	7.0	28.6
Polychloroprene (CR)	21.6	3.8	7.3	13.8	2.1	13.9
Fluoroelastomer E (FKM)	106.3	18.8	2.0	17.4	5.4	1.1
Chlorosulfonated polyethylene (CSM)	1.1	-3.1	17.4	6.2	-0.5	10.4
Silicone rubber (Q)	199.8	41.5	2.2	174.0	36.6	4.7
Nitryl Rubber (NBR)	102.5	21.7	11.4	13.4	1.8	17.7
Ethylene propylene diene terpolymer (EPDM)	9.5	-0.1	14.4	42.3	7.9	23.3

AK-225 is compatible with common metals. Table 6. shows the effect of AK-225 on common metals after 7 days exposure at the boiling point.

Table 6. Effect of AK-225 on Metals after 7 Days at Boiling Point.

	AK-225			CFC-113		
	Wt Change ($mg/dm^2 \bullet day$)	Cl (ppm)	Corrosion	Wt Change ($mg/dm^2 \bullet day$)	Cl (ppm)	Corrosion
Steel (SPCC-SB)	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Stainless Steel (SS-304)	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Magnesium	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Aluminum	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Zinc	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Silver	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Copper	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Nickel Silver	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Phosphorous bronze	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Brass	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Tin	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Solder	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Tin Plating	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Cadmium Plating	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Nickel Plating	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Nickel-Chrome Plating	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.
Aluminite	N.D.	N.D.	N.A.	N.D.	N.D.	N.A.

Note: N.D. – Not Detectable Detection Limit of Weight Change: $<0.1 mg/dm^2 \bullet day$
Detection Limit of Cl Ion: <0.1ppm
N.A. – Not Apparent Detection Method: Visual

SOLUBILITY

Table 4 shows solubility of various materials in AK-225. In general, it is completely miscible with hydrocarbons, chlorinated and fluorinated hydrocarbons, lower alcohols, ketones, esters and ethers.

Table 4: Solubility of Various Substances in AK-225 at Room Temperature.

Substance	Solubility (wt%)					
	0.1	1.0	5.0	10	25	50
Ethylene Glycol	I					
2-Methoxyethanol						S
2-Ethoxyethanol						S
Diethylene Glycol						S
Triethylene Glycol						S
Propylene Glycol			S	I		
1,3-Propanediol	I					
1-Methoxy-2-propanol						S
Glycerine	I					
1,3-Butanediol	I					
1,5-Pentanediol	I					
1,2,6-Hexantriol	I					
Phenol				S	I	
Tert-Amyl Alcohol						S
Methyl Ethyl Ketone						S
2-Pentanone						S
2-Heptanone						S
Methyl Acetate						S
Ethyl Acetate						S
Isopropyl Acetate						S
Methyl Propionate						S
Formamide	I					
Acylamide	I					
Acetonitrile						S
Tartaric acid	I					
Benzoic acid			S	I		
Urea	I					
2-Tioazole-2-thiol	I					
Triphenyl Phosphate					S	I
Silicone Oil KF-96 (Shin-Etsu Chemical						S
Fomblin LC-08 (Monteflous0						S

S: Soluble I: Insoluble

STABILITY

The stability of AK-225 is similar to CFC-113. Followings are results of stability tests of AK-225 compared with CFC-113.

1) Accelerated Oxidation Test

Test Method: Solvents were refluxed for 48hrs under tungsten lamp irradiation with moisture saturated oxygen bubbled through continuously. Test coupons made of carbon steel were located in both the vapor and liquid phases.

Test Results after 48hrs

Solvent	Corrosion	Acidity as HCl (ppm)
AK-225	None Apparent	Not Detectable
CFC-113	None Apparent	Not Detectable

Detection Limit of Acidity: <0.2ppm

2) Reflux Test

Test Method: Solvents were refluxed in presence of water, oil and test coupons made of carbon steel in both the vapor and liquid phases for 120hrs. Solvent 180ml, Water 1ml, Oil 20ml.

Test Results after 120hrs

Solvent	Corrosion	Acidity as HCl (ppm)
AK-225	None Apparent	Not Detectable
CFC-113	None Apparent	Not Detectable

Detection Limit of Acidity: <0.2ppm

3) Sealed Tube Test

Test Method: AK-225 contained in a cylinder made of SS-316 was heated in the presence of a carbon steel test coupon at 120°C for 3 days.

	Before Test	Test Results after 3 days
Acidity as HCl (ppm)	Not Detectable	Not Detectable
pH	7.0	7.0
Cl^- (ppm)	Not Detectable	Not Detectable
F^- (ppm)	Not Detectable	Not Detectable
Color (APHA)	10	10
Corrosion of Test Coupon	None Apparent	None Apparent

Detection Limit of Acidity: <0.2ppm
Detection Limit of Cl^- and F^-: <0.1ppm

CLEANING PROCEDURES

It is recommended that AK-225 be used in a vapor degreaser for cleaning efficiency, economy and emission control. Cleaning procedures for AK-225 are quite similar to those of CFC-113. The procedures consist of immersing a workload into the boiling solvent, rinsing or spraying with cool solvent and drying in solvent vapor.

RETROFITTING OF VAPOR DEGREASERS FOR CFC-113

AK-225 can be used in a vapor degreaser for CFC-113 with little modification. Followings are key items in retrofitting a degreaser to AK-225 cleaning.

1) Mechanical pump seals in solvent re-circulation pumps made of FKM (ex. Viton®) should be changed to polytetrafluoroethylene (PTFE). Seal-less pumps are ideal.
2) Gaskets, O-ring, and other seals made of FKM (ex. Viton®) should be changed to ones made of PTFE or PTFE lining. In case on elastomers is essential, use EPDM, chloroprene or CMS.
3) Lids or other parts made of polymethyl methacrylate should be changed to ones made of rigid polyvinyl chloride.
4) The temperature of cooling water in a cooling coil is to be maintained below 10°C in order to reduce solvent emission.
5) Extend freeboard in order to reduce solvent emission. Freeboard ratio (H/D) of greater than 1 is recommended.

CONTAMINATION LEVEL CONTROL

To maintain effective cleaning in a vapor degreaser, it is important to keep contamination levels in the boil sump below, for example, 20% by weight. The level depends on the required cleanliness. Contamination is monitored by measuring the specific gravity and boiling point of the solvent. Figures 1 and 2 offer typical specific gravity and boiling point curves which are used to determine when the boil sump should be recharged. When first utilizing AK-225 it is recommended that the boil sump be monitored weekly to insure that it is operating within the recommended guidelines. However, workloads vary from user to user and the frequency of monitoring can be shortened or extended based upon individual needs.

As with any solvent contamination such as oil will accumulate and it is important to maintain the pH of the solvent in the water separator above 5.

SAFETY

Although AK-225 is nonflammable, it can, like CFC-113, be decomposed by open flames or hot surfaces such as space heaters. Good ventilation minimizes the hazard from decomposed solvent vapors.

The AEL (Acceptable Exposure Limit) of AK-225 has been set as 100 ppm 8-hrs TWA. You should refer to the MSDS (Material Safety Data Sheet) concerning other safety items.

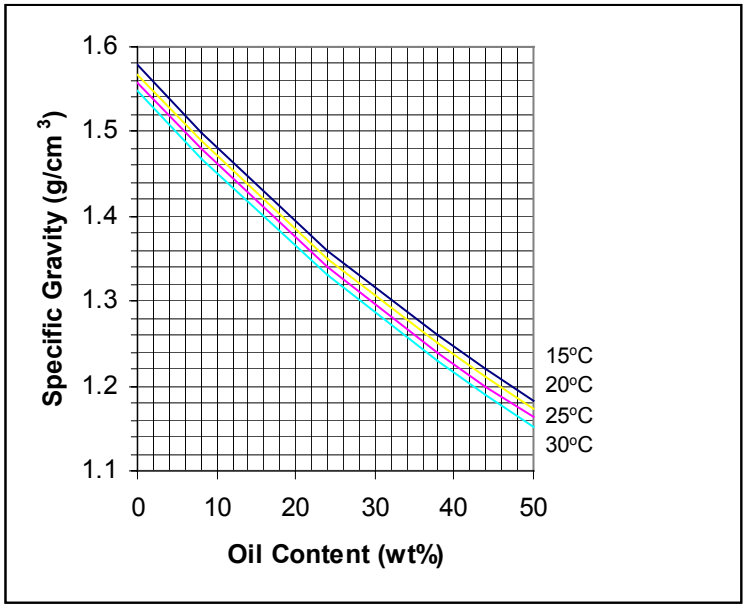

Fig. 1 The relationship between oil content and the Specific Gravity of AK-225.

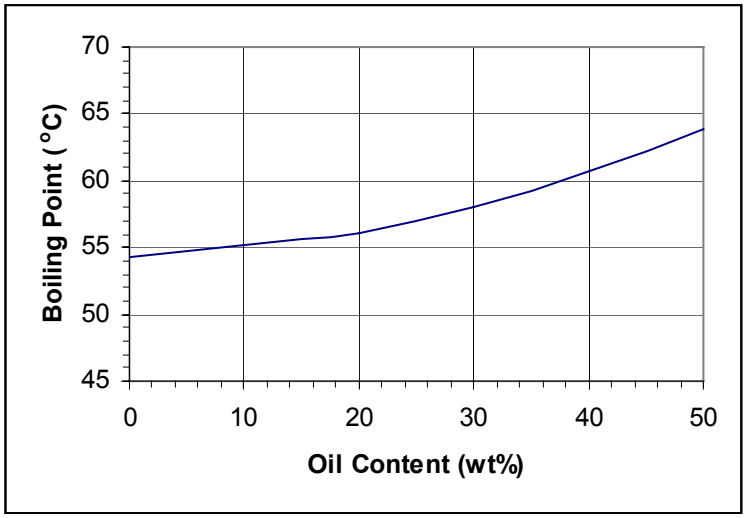

Fig. 2 The relationship between oil content and the boiling point of AK-225.