Use of organic solvents in freeze dryers

Our pilot and laboratory freeze dryers are generally used for aqueous solutions. Nevertheless, but the use of some organic solvents, in aqueous solutions with low concentrations is acceptable. However, some aspects need to be considered, which are discussed below.

Corrosion resistance

The freeze dryer is designed to be chemically resistant to most compounds that are commonly used in freeze-drying processes. However, by necessity, the freeze dryer is comprised of several different materials, some of which may be attacked and degraded by certain chemicals. Sugar und proteins typically will have negligible negative effect on any of the materials of construction. In the difference to that, chemicals can attack e.g., plastic materials in several ways. The methods of fabrication and/or conditions of exposure of an acrylic chamber, as well as the way the chemicals are applied, can influence the results. Some of these factors are listed below:

- Fabrication: Stress generated while sawing, sanding, machining, drilling, polishing, and/or forming
- Exposure: Length of exposure, stresses induced during the life of the product due to various load, changes in temperatures etc.
- Application of Chemicals: by contact, rubbing, wiping, spraying etc.

The table in the appendix can be used as a general guideline for the degradation to be expected in normal freeze-drying processes of organic solvents with a total concentration of max. vol-% in aqueous solutions.

The chemical attack on devices and accessory components can be significantly reduced by immediate cleaning after the end of operation. The user must regularly check whether parts of the freeze dryer that were in contact with the product, e.g. acrylic hoods (risk of implosion), are attacked. In principle, components that are in contact with liquid solvents are exposed to a much stronger attack that components that only in contact with gaseous solvents. It is the responsibility of the customer to replace damaged components in good time.

Most common compounds used in freeze drying processes, if allowed to enter the vacuum pump, will degrade the oil and cause damage to the vacuum pump. The oil in the vacuum pump should be checked regularly. It must be changed if it is cloudy, shows particles or is discoloured. The useful life of vacuum pump oil can be extended if the vacuum pump is operated for an extended period after a freeze dry run with open gas ballast valve. This allows contaminants to be purged from the hot oil. Further details can be found in the manual of the vacuum pump.

Safety aspects for the use of solvents

In addition to corrosion resistance, other safety aspects, e.g. with regards to flammability, must also be considered. The generally applicable regulations for handling flammable substances in laboratories or workplaces must also be observed for freeze-drying. Hazardous materials such as strong acids or bases, radioactive substances and volatile organics must be handled carefully and promptly cleaned

up if spilled. If a sample is spilled in the ice condenser chamber it must immediately be cleaned up.

Use extreme caution and keep sources of ignition away from solvents. When using flammable or hazardous solvents, the vacuum pump must be vented to or operated inside a fume hood. The appropriate safety precautions must be observed during sample preparation, loading and unloading of samples and defrosting. Depending on the used solvent, hot gas defrosting of the ice condenser should be avoided. The standard H- and P-statements for the used chemicals should be considered. Please observe the generally accepted rules for the use of solvents in laboratories.

Applicability for solvents in freeze dryers

The following table contains in the column Low the maximum permissible concentration for normal freeze-drying processes with solvents in aqueous solution for the use of laboratory and pilot freeze dryers sold by us. Freeze-drying processes with higher solvent concentrations than indicated in the table/column Low are not permitted.

For applications with higher solvent concentrations, we offer special solutions.

Our pilot freeze dryers can be upgraded for use in medium concentrations (column Medium) with the expansion option.

For applications with high solvent concentrations (column High), we recommend our laboratory freeze dryer Alpha 3-4 LSCbasic or, as a pilot freeze dryer the Epsilon 2-6D Solvent or Epsilon 2-10D Solvent. These models were specially developed for use with high solvent concentrations in aqueous solutions.

If you have any questions, please contact us.

Maximum permissible concentration (aqu. vol-%) of solvents in freeze dryers

Lösungsmittel/solvent		Low	medium	high
Aceton, acetone		10	25	100
Acrylsäure, acrylic acid		10	25	80
Acetonitril, acetonitrile	ACN	10	50	100
Ameisensäure, formic acid		10	10	20
Calcium Chloride		10	10	10
Cyclohexan, cyclohexane		10	50	50
Didecyldimethylammoniumchlorid	DDAC-C10	10	10	10
Diethylendioxid, Dioxan, dioxane		10	25	100
Dimethylacetamid, dimethylacetamide	DMAC	10	15	50
Dimethylformamid, dimethylformamide	DMF	0	5	20
Dimethylsulfoxid, dimethyl sulfoxide	DMSO	10	15	100
Essigsäure, acetic acid		20	20	20
Ethanol, ethanol		10	50	100
Ethylacetat, Essigsäureethylester. Essigester, ethyl acetate		10	30	80
Ethylendiamintetraacetat, Ethylendiamintetraessigsäure, tetrasodium	EDTA	10	10	100
Ethylenoxid, ethylene oxide	EO	0	5	5

Lösungsmittel/solvent		Low	medium	high
Hexafluorisopropanol, hexafluroisopropanol	HFIP	0	5	5
Hexan, Heptan (Benzin), hexane, heptane		0	10	10
Isopropanol, isopropyl alcohol	IPA	10	50	100
Kaliumhydroxid, Ätzkali, potassium hydroxide		0	10	20
Methanol, methanole		10	50	100
Methansulfonsäure, methanesulfone acid	MSA	0	0	10
Methyl tert-Butyl Ether, 2-Methoxy-2-methylpropan, methyl-t-butyl ether	MtBE	10	10	10
Methylenchlorid (Dichlormethan), methylene chloride	DCM	10	10	10
Natriumhydroxid, Natronlauge, Ätznatron, sodium hydroxid		10	10	10
Natriumhypochlorit, Chlorbleichlauge, sodium hypochlorite		5	5	5
Natriumphosphat, sodium phosphate		10	50	80
n-Benzol, benzene		5	10	20
n-Butanol, butyl alcohol		5	10	50
N-Methyl-2-pyrrolidon, n-methyl-2-pyrrolidone	NMP	5	5	20
Peressigsäure, peracetic acid, wässrig / aqu. (6%)		0	0	6

Lösungsmittel/solvent		Low	medium	high
Phenol		0	0	5
Phosphorsäure, phosphoric acid		0	10	10
Propanol (1-Propanol, 2-Propanol)		10	50	100
Propylenglykol, Propylenglycol		10	50	100
Pyridin, pyridine		10	15	100
Stearinsäure, stearic acid		10	30	30
Tetrachlormethan, carbon tetrachloride		5	5	5
Tertbutylalkohol, Butylalkohol tertiär, 2-Methyl-2-Propanol, tert butanol	TBA	10	25	60
Tetrahydrofuran	THF	0	0	5
Toluol, toluene		5	25	50
Trifluoressigsäure, trifluoroacetic acid	TFA	10	15	20
Wasserstoff Peroxid, hydrogen peroxide		30	30	60
Zitronensäure, citric acid		10	25	100