MilliporeSigma

Drying Agents

Optimize desiccation with absolute reliability

Supelco®
Analytical Products

Desiccators are mostly used to dry solids and chemicals which have hygroscopic properties

DEPENDABLY DRY

Our Drying agents (desiccants) are developed, produced and rigorously tested to ensure optimal drying processes, whether in the laboratory, during storage, or for transportation. Our comprehensive portfolio offers user-friendly solutions for a wide range of applications – from drying gases, liquids or solids using static or dynamic drying processes, to protecting sensitive goods and materials from moisture, mold or corrosion. Regardless of your application, you can always expect reliable, reproducible results. Because, at MilliporeSigma, **consistency is our standard.**

Our commitment

At MilliporeSigma, quality and safety are the basis of our product concept, and embedded in everything we do. In line with our commitment, all Drying agents are developed following stringent guidelines and devoid of hazardous components, such as blue gel indicator (see page 11).

Your benefits:

Reliable

Effective moisture reduction helps maintain your product's original condition, and ensures accurate results

Reproducible

All our drying agents undergo strict controls to ensure **consistently high quality** from batch to batch to save your valuable time

Convenient

User-friendly drying agents ensure optimal working conditions and easy handling

Economical

Optimal protection of goods, equipment or substances avoids replacement costs; **recoverable drying agents** can be used longer to reduce expenses

Safe

We strictly avoid the use of carcinogenic blue gel **to protect your health**

Flexible

Wide **choice of pack sizes** – from a few grams to several kilograms to meet your individual needs

Explore our complete range of drying agents on:
SigmaAldrich.com/drying-agents

Drying methods

Non-sensitive solids can be dried at higher temperatures in a drying cabinet. For gentler drying, it is preferable to use a desiccator at room temperature, or a drying pistol at higher temperatures. Applying vacuum facilitates the diffusion of water molecules from the solid to the drying agent, thus drying rate is somewhat faster.

Static drying

In classical drying, the drying agent is added to the liquid, the mixture is allowed to stand, then stirred (e.g. with a magnetic stirrer), shaken, or boiled under reflux. It is important that the liquid is moved in such a way that it comes into contact with the drying agent. The liquid is then filtered or decanted. Any compounds formed due to reaction with water must be subsequently removed by distillation. (For further details, please refer to relevant literature on organic chemistry.)

Dynamic drying

To increase drying rate and use drying agents more effectively, liquids and gases can be passed through drying towers or drying tubes filled with a drying agent. It is important to use a drying agent that is not susceptible to clumping or deliquescence, which can hinder diffusion and flow rates. Optimal drying agents for this method include magnesium perchlorate, silica gel, and molecular sieves.

Dynamic drying with phosphorous pentoxide

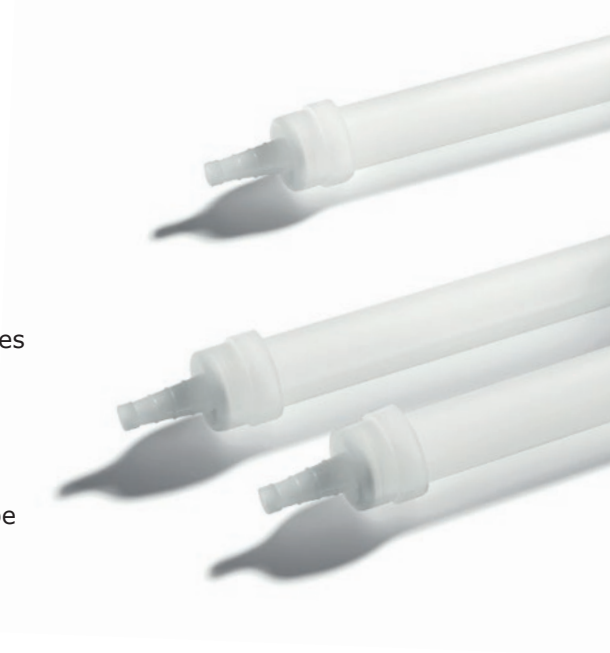
Untreated phosphorus pentoxide (P_2O_5) tends to clump when in contact with water, thus it is normally unsuitable for dynamic drying. However, with our SICAPENT® drying agent, phosphorus pentoxide is coupled to an inert carrier, thus it remains flowable even when completely loaded, and allows unhindered gas movement.

Dynamic drying with small particle sizes

The drying process can be optimized by using a drying agent of small particle size. This significantly increases the reaction surface, hence column length and packing material can be decreased. However, this method typically reduces flow rates, since smaller particle sizes increase flow resistance in the column.

Dynamic drying
in a column

Absorption tube



Applications

H_2O absorption tubes are used to keep reagents or solvents dry, for example during Karl Fischer titration or when working with solvent from withdrawal systems.

Additional information

Absorption tubes are 15 cm long and have a diameter of 2 cm. Hoses of various dimensions can also be connected: hoses with 3 mm external diameter can be pushed into the tube, while hoses with 8–12 cm internal diameter can be pushed over the opening. The tube must be opened on both sides before use by removing the two stoppers.

Product	Content	Packaging	Cat. No.
Absorption tube			
Absorption tube for H_2O (molecular sieve 0.3 nm with indicator)	3 units	Plastic can	**1.06107.0003**

Calcium chloride [$CaCl_2$]

For drying

Acetone; ethers; numerous esters; aliphatic, olefinic, aromatic and halogenated hydrocarbons; neutral gases

Unsuitable for drying

Compounds bound by $CaCl_2$: alcohols, ammonia, amines, aldehydes, phenols, several esters, ketones

Applications

Drying liquids; filling drying tubes; unsuitable for drying fast-flowing gases as pore diffusion is hindered due to deliquescene during water uptake

Capacity*

98%

Product	Content	Packaging	Cat. No.
Calcium chloride [$CaCl_2$]			
Calcium chloride anhydrous powder Reag. Ph Eur	500 g	Plastic bottle	**1.02378.0500**
	2.5 kg	Plastic bottle	**1.02378.2500**
	25 kg	Fiber carton	**1.02378.9025**
Calcium chloride anhydrous, granular ~1–2 mm	1 kg	Plastic bottle	**1.02379.1000**
	5 kg	Plastic bottle	**1.02379.5000**
	25kg	Fiber carton	**1.02379.9025**
Calcium chloride anhydrous, granular ~2–6 mm	1 kg	Plastic bottle	**1.02391.1000**
	5 kg	Fiber carton	**1.02391.5000**
	25 kg	Fiber carton	**1.02391.9025**
Calcium chloride anhydrous, granular ~6–14 mm	1 kg	Plastic bottle	**1.02392.1000**
	5 kg	Fiber carton	**1.02392.5000**
	25 kg	Fiber carton	**1.02392.9025**

* The capacity of our drying agent is defined by the mass of water adsorbed per 100 g anhydrous substance.
Example: 1 kg drying agent of capacity 20% can adsorb 200 g of water.

Calcium oxide [CaO]

For drying

Neutral and basic gases; amines; alcohols; ethers

Unsuitable for drying

Acids; acid derivatives; aldehydes; ketones; esters

Capacity

Capacity is limited as surface is coated with a less permeable layer, especially in presence of CO_2

Product	Content	Packaging	Cat. No.
Calcium oxide [CaO]			
Calcium oxide from small marble lumps ~3–20 mm	1 kg	Plastic bottle	**1.02109.1000**
	25 kg	Fiber carton	**1.02109.9025**

Desiccant sachets [SiO_2]

For drying

Humidity

Applications

Sachets filled with silica gel protect valuable and sensitive products from the effects of moisture. Packed along with sensitive machine components and tools, they prevent corrosion during storage and transport. Sachets maintain the function of sensitive optical, electrical and electronic components and instruments.

Capacity

Silica gel has a high adsorptive capacity for moisture: 20% of its own weight at 25 °C and 80% relative humidity

Indicator change in orange gel

At approx. 7–10 g adsorbed H_2O/100 g silica gel, color changes from orange to colorless

Regeneration

Silica gel (orange gel) can be regenerated in a drying oven at 130–140 °C; desiccant sachet should not be heated beyond 80 °C, as bag adhesive can melt

Product	Content	Packaging	Cat. No.
Desiccant sachets [SiO_2]			
Desiccant sachet 10 g silica gel with humidity indicator (orange gel), sachet: 7 x 9 cm	50 units	Metal can	**1.03804.0001**
Desiccant sachet 100 g silica gel with humidity indicator (orange gel), sachet: 15 x 14 cm	10 units	Metal can	**1.03805.0001**
Desiccant sachet 250 g silica gel with humidity indicator (orange gel), sachet: 15 x 20.5 cm	10 units	Metal can	**1.03806.0001**
Desiccant sachet 3 g silica gel with humidity indicator (orange gel), sachet: 4 x 7 cm	100 units	Metal can	**1.03803.0001**
	1000 units	Fiber carton	**1.03803.0002**

Further desiccant sachets (e.g. 500 g) available on request

Magnesium perchlorate [$Mg(ClO_4)_2$]

For drying

Inert gases; air; adsorbs ammonia as strongly as water

Unsuitable for drying

Any solvent in which the drying agent is soluble, e.g. acetone; dimethyl formamide; dimethyl sulfoxide; ethanol; methanol; pyridine; organic compounds

Applications

Designed for drying fast-flowing gases in drying towers; package becomes looser with increasing H_2O loading; $Mg(ClO_4)_2$ can be removed easily as it does not stick to equipment walls

Capacity

48%, corresponding to 6 moles crystal water

Safety information

Explosion risk when in contact with a reducing atmosphere, particularly in the presence of acids or compounds that can be hydrolyzed to form acids; $Mg(ClO_4)_2$ should only be heated in vessels made of inorganic materials

Regeneration

At 240 °C under vacuum

Product	Content	Packaging	Cat. No.
Magnesium perchlorate [$Mg(ClO_4)_2$]			
Magnesium perchlorate hydrate [about 83% $Mg(ClO_4)_2$], desiccant, about 1–4 mm	500 g	Metal can	**1.05873.0500**

Molecular sieves

For drying

Nearly all gases and liquids

Applications

Molecular sieves can be used in desiccators and drying tubes; for keeping absolute solvents dry; for drying gases or solvents in drying columns; for selective adsorption (e.g. phosgene from chloroform)

Advantages

- Easy to use: practically chemically inert, non-toxic, no disposal problems, dried liquids can be decanted
- High adsorption capacity even with low water content of substance to be dried
- High adsorption capacity even at high temperatures
- High adsorption affinity for polar and unsaturated organic molecules (however, H_2O is always preferentially adsorbed
- Selective adsorption: only molecules that can pass through the pores are adsorbed

Capacity

15–24% at 25 °C

Indicator

Brown gel indicator changes from brown to yellowish at H_2O uptake of approximately 7–10 g/100 g molecular sieve

Regeneration

Maximum regeneration temperature is 450 °C. Molecular sieves can be dried in a drying oven above 250 °C to a water content of 2–3 g/100 g molecular sieve. The remaining water can be removed at 300–350 °C using a vacuum oil pump (10–1–10–3 mbar), whereby a cold trap containing carbon dioxide coolant or liquid air should be connected. Due to their high partial water vapor pressure, water pumps are not suitable for this purpose. For safety reasons, molecular sieves that have been used to dry solvents should be freed from possible solvent by mixing water prior to regeneration. Molecular sieves with a moisture indicator should not be heated above 150 °C.

Chemical and physical properties

Molecular sieves are crystalline, synthetic zeolites. Their crystal gratings are similar to a cage with numerous hollow spaces. The cavities are accessible from all sides by pores of exactly defined dimensions. Depending on the type of molecular sieve, these can be 0.3, 0.4, 0.5 or 1.0 nm in diameter. If the water on the hollow spaces is removed due to heating, the material becomes an extremely active absorbent. However, this only occurs with molecules adsorbed that are small enough to pass through the pores (sieve effect).

Pore diameter	Type	Composition	Structure
0.3 nm	3A	Potassium sodium aluminium silicate	Zeolite
0.4 nm	4A	Sodium aluminium silicate	Zeolite
1.0 nm	13A/X	Sodium aluminium silicate	Zeolite

Physical properties

The molecular sieve crystallites obtained by hydrothermal manufacture are formed into rods and beads using 1-2% clay as binding agent. Vibration caused by transport may bring about some abrasion which collects in the first fraction during dynamic drying.

Bulk density	0.75 kg/l
Surface (BET)	800 m^2/g
Form supplied	Beads (~2 mm), rods (~1.6 mm)
Effective pore diameter depending on type	0.3, 0.4 or 1.0 nm
Hollow space volume	0.3 cm^3/g
Specific heat	>0.8 kJ/kg
Heat of absorption per kg adsorbed water	4,200 kJ

Product	Content	Packaging	Cat. No.
Molecular sieves			
Molecular sieve 0.3 nm beads ~2 mm (suitable for use in Karl Fischer titration)	250 g	Plastic bottle	**1.05704.0250**
	1 kg	Plastic bottle	**1.05704.1000**
	10 kg	Plastic bucket	**1.05704.9010**
Molecular sieve 0.3 nm beads, with moisture indicator ~2 mm (suitable for use in Karl Fischer titration)	250 g	Plastic bottle	**1.05734.0250**
	1 kg	Plastic bottle	**1.05734.1000**
Molecular sieve 0.3 nm rods ~1.6 mm (1/16")	250 g	Plastic bottle	**1.05741.0250**
	1 kg	Plastic bottle	**1.05741.1000**
Molecular sieve 0.4 nm beads ~2 mm Reag. Ph Eur	250 g	Glass bottle	**1.05708.0250**
	1 kg	Glass bottle	**1.05708.1000**
	10 kg	Plastic bucket	**1.05708.9010**
Molecular sieve 0.4 nm beads, with moisture indicator ~2 mm	250 g	Glass bottle	**1.05739.0250**
	1 kg	Glass bottle	**1.05739.1000**
Molecular sieve 0.4 nm rods ~1.6 mm (1/16")	1 kg	Plastic bottle	**1.05743.1000**
Molecular sieve 1.0 nm beads ~2 mm	1 kg	Glass bottle	**1.05703.1000**

Phosphorus pentoxide [P_2O_5]

For drying

Neutral or acid gases; saturated aliphatic and aromatic hydrocarbons; nitriles; alkyl and aryl halogenides; carbon disulfide

Unsuitable for drying

Alcohols; amines; acids; ketones; ethers; chlorinated and fluorinated hydrocarbons

Capacity

P_2O_5: 40%

Application note

On adsorbing water, phosphorus pentoxide becomes covered with a film of polymetaphosphoric acid, which hinders the diffusion of H_2O molecules. This effect can be avoided by using SICAPENT® since the polymetaphosphoric acid formed from phosphorus pentoxide and water is immediately adsorbed by the carrier substance. As a result, the drying agent is available as a fine, flowable granulate.

Regeneration

Not possible

Product	Content	Packaging	Cat. No.
Phosphorus pentoxide [P_2O_5]			
di-Phosphorus pentoxide extra pure	1 kg	Glass bottle	**1.00540.1000**
	25 kg	Plastic drum	**1.00540.9025**
di-Phosphorus pentoxide for analysis ACS, ISO, Reag. Ph Eur	100 g	Glass bottle	**1.00570.0100**
	500 g	Glass bottle	**1.00570.0500**

SICAPENT® Drying agents

Capacity

50%

Composition

25% inert inorganic carrier substance, 75% phosphorus pentoxide

Particle size of carrier

0.1–1.6 mm

Bulk density

Approx. 300 g/l

Flowable up to

100% water uptake

Indicator content

0.1%

Water content, indicator color

H_2O content [%]	Indicator color of drying agent
0	Colorless
20	Green
27	Blue-green
33	Blue

Application note

Drying liquids; filling drying tubes; particularly suitable for drying fast-flowing gases in drying tubes

Advantages

The main advantage of using granulated drying agents is ease of use. Even after significant water uptake (approx. 100% of its own weight), the substance remains in particle form. Hence, subsequent to drying, the agent can be easily removed from the vessel. SICAPENT® drying agents dries well due to its large surface area; it is around 20% faster than standard phosphorus pentoxide (i.e. 20% more water is absorbed in the same time).

Safety information

When opening the bottle, fine particles of drying agent may spray out; please adhere to label instructions, and open carefully while wearing safety spectacles.

Product	Content	Packaging	Cat. No.
SICAPENT®			
SICAPENT® with indicator (phosphorus pentoxide drying agent for desiccators) on inert carrier material	500 ml	Glass bottle	**1.00543.0500**
	2.8 l	Glass bottle	**1.00543.2800**

Safety information

Dangers of silica gel with blue indicator

According to the European Chemicals Agency (ECHA), cobalt dichloride ($CoCl_2$) is a substance of very high concern (SVHC), which is classified as carcinogenic and toxic for reproduction[1]. This hazardous inorganic compound is present in silica gel containing blue indicator. When working with the desiccant, any dust particles emitted may be easily inhaled, posing serious health hazards.

To protect users from these risks, we offer a broad range of non-toxic silica gels, which are based on iron-salt instead of cobalt dichloride indicator. Explore our safe and reliable silica gels.

1 Source: ECHA "Candidate List of Substances of Very High Concern for Authorization"

Silica gel [SiO_2]

For drying

Practically all gases and liquids

Unsuitable for drying

Alkaline liquids (bases and amines); silica gel with orange moisture indicator is also not suitable for strong acidic and basic gases or organic solvents

Capacity

20–27% at 25 °C

Applications

Use in desiccators; protecting moisture-sensitive substances during storage and transport; maintaining dryness of anhydrous solvents; packing drying towers to dry gases and solvents

Application temperature

Capacity is practically independent of temperature up to approx. 65 °C, but decreases significantly at higher temperatures

Indicator change in orange gel

At approx. 7–10 g adsorbed H_2O/100 g silica gel, color changes from orange to colorless

Indicator change in brown gel

At approx. 7–10 g adsorbed H_2O/100 g silica gel, color changes from brown to yellowish

Regeneration

Regeneration of silica gel	Temperature, duration in drying oven
White gel	Approx. 100–180 °C, approx. 3 hours
Orange gel	Approx. 130–140 °C, approx. 3 hours
Brown gel	Approx. 120–150 °C, approx. 3 hours
No longer capable of drying	Above 500 °C

Chemical and physical properties

Analytical data	98% SiO_2, remainder Al_2O_3, TiO_2, Fe_2O_3
Indicator in orange gel	Iron salt
Indicator in brown gel	Iron salt
Bulk density	Approx. 0.7 m²/g
Surface (BET)	700 m²/g
Particle size	0.2–1 mm, 1–3 mm, 2–5 mm
Pore size	2.0–2.5 nm
Specific heat	Approx. 1 kJ/kg °C
Heat of adsorption per kg adsorbed water	3,200 kJ

Product	Content	Packaging	Cat. No.
Silica gel [SiO_2]			
Silica gel granules, desiccant ~0.2–1 mm	1 kg	Plastic bottle	**1.01905.1000**
Silica gel granules, desiccant ~2–5 mm	1 kg	Plastic bottle	**1.01907.1000**
	5 kg	Plastic bottle	**1.01907.5000**
Silica gel with moisture indicator (brown gel), desiccant ~1–4 mm	1 kg	Plastic bottle	**1.01972.1000**
	5 kg	Plastic bottle	**1.01972.5000**
	25 kg	Plastic drum	**1.01972.9025**
Silica gel with moisture indicator (orange gel), granulate ~1–3 mm	1 kg	Plastic bottle	**1.01969.1000**
	5 kg	Plastic bottle	**1.01969.5000**
	25 kg	Plastic drum	**1.01969.9025**
Silica gel beads, desiccant ~2–5 mm	1 kg	Plastic bottle	**1.07735.1000**

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MilliporeSigma
400 Summit Drive
Burlington MA 01803

www.SigmaAldrich.com

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