Sorbead®

The versatile adsorption agent – superior quality, economical, environmentally friendly

ENGELHARD

Index

Fields of application

The use of adsorptive drying

Moisture in gases and fluids can cause difficulties and faults in many applications which can be avoided by the use of drying processes.

Substances

Air/compressed air

Industrial gases

Fluid and gaseous process flows

Advantages

Improved operational safety in pipelines and plant by avoiding:

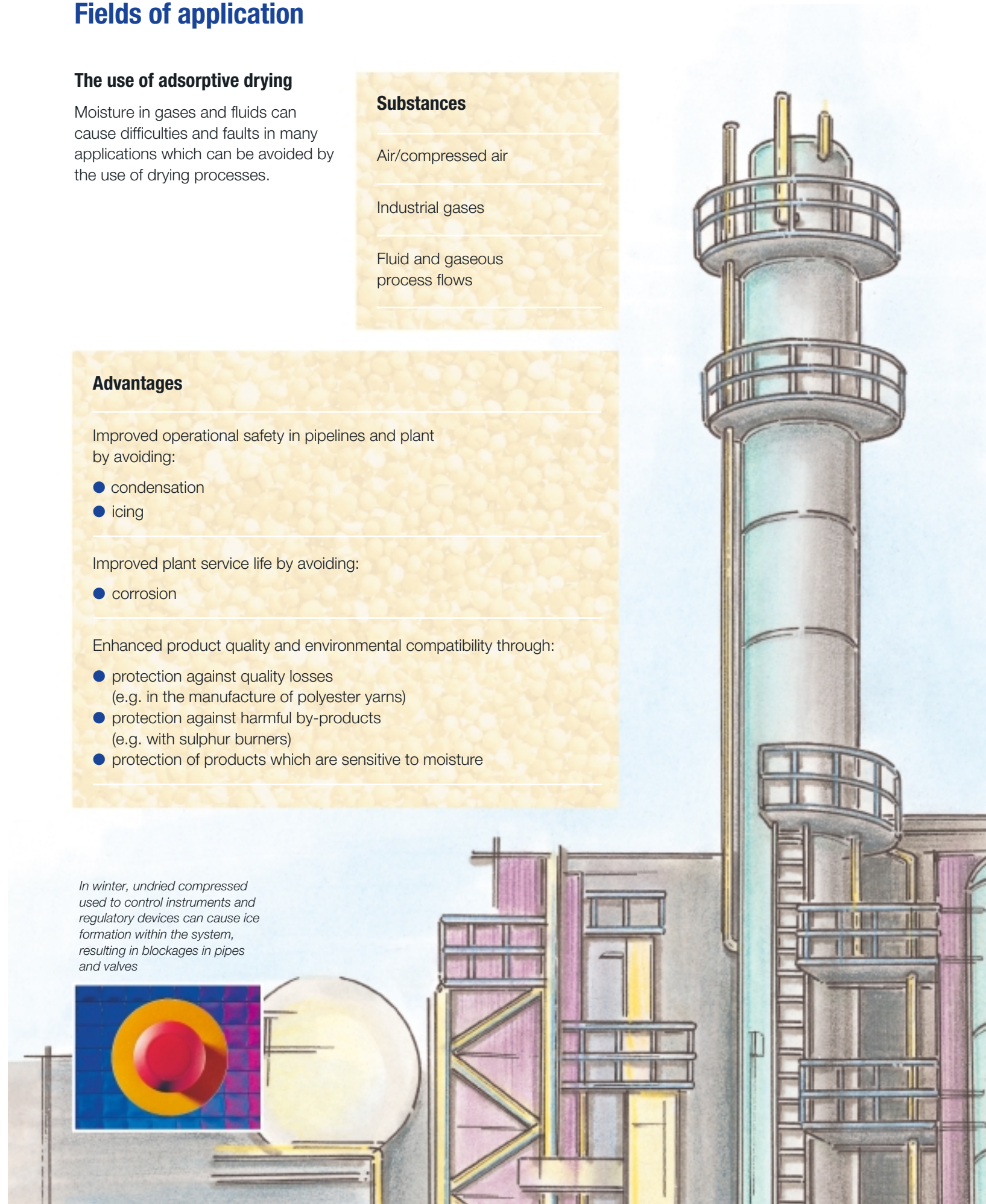
- condensation
- icing

Improved plant service life by avoiding:

- corrosion

Enhanced product quality and environmental compatibility through:

- protection against quality losses (e.g. in the manufacture of polyester yarns)
- protection against harmful by-products (e.g. with sulphur burners)
- protection of products which are sensitive to moisture



In winter, undried compressed used to control instruments and regulatory devices can cause ice formation within the system, resulting in blockages in pipes and valves

Dynamic drying

- Temperature-swing process
  e.g.
  – using an external heat source
  – through utilisation of the compressor heat
- Pressure-swing process
  (Heatless-dryer plant)

Static drying

- Insulating glass
- Dessicant bag for transport and storage
- Exsiccators

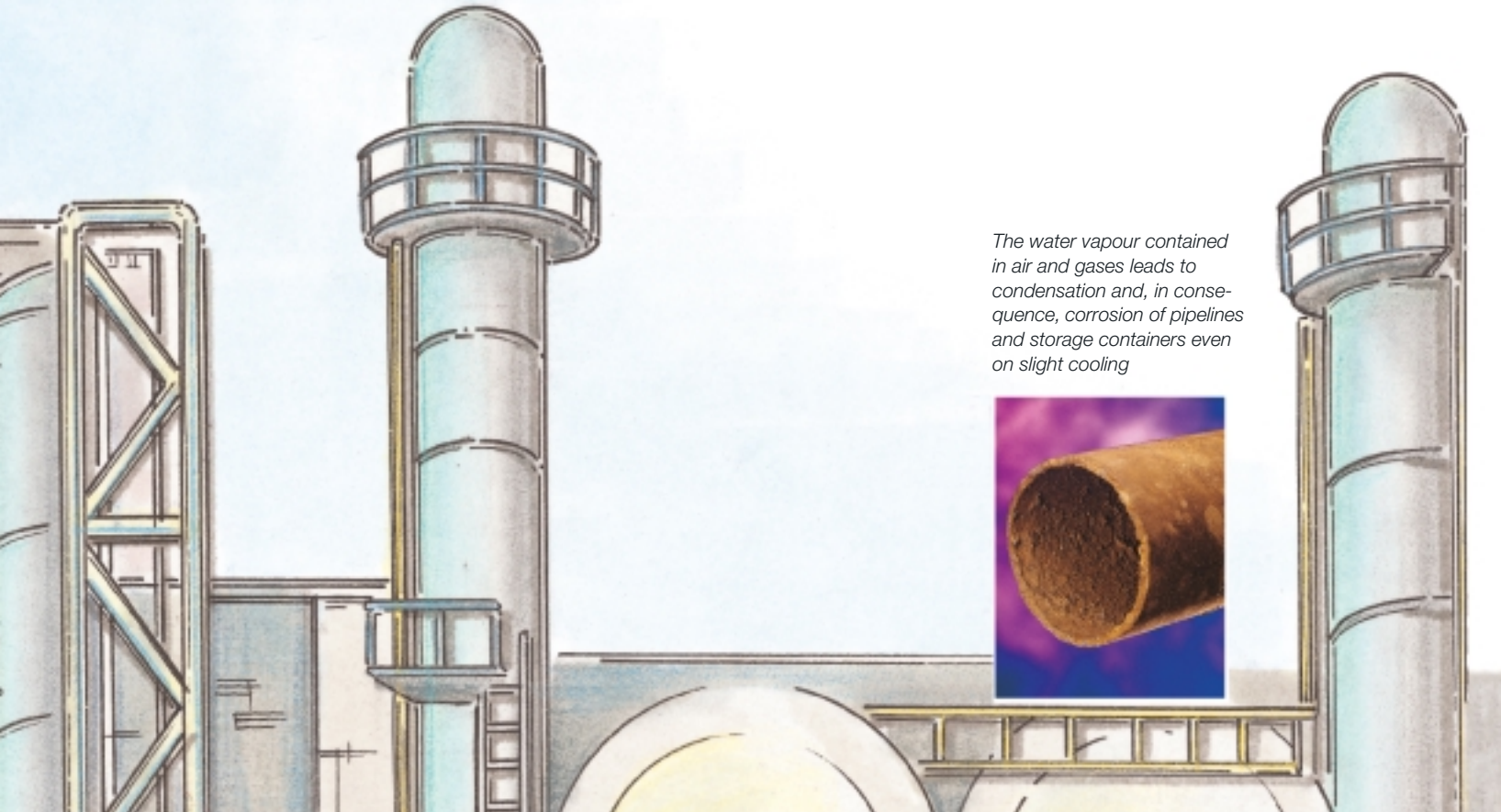
Drying filters

- Transformer dehumidifiers
- Coolant drying cartridges
- Laboratory devices (U tubes)

Compressed-air drying in a large chemical works

Desiccant bags

Transformer air-dehumidifier



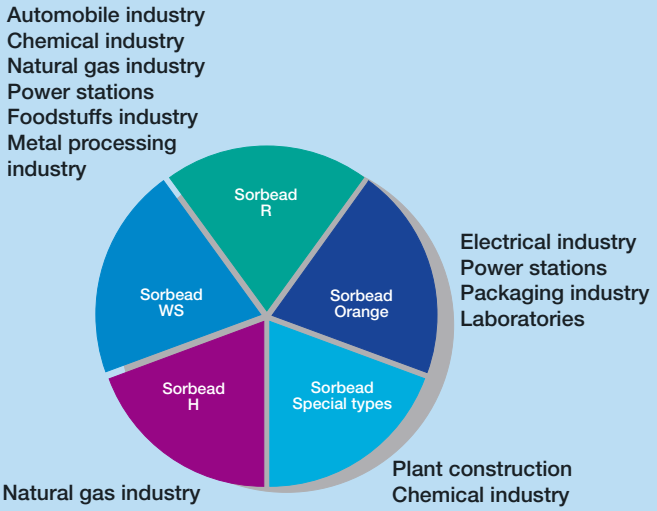
The water vapour contained in air and gases leads to condensation and, in consequence, corrosion of pipelines and storage containers even on slight cooling

Advantages of using Sorbead

Sorbead makes the operation of adsorption-drying plant both cost effective and more environmental-friendly. These special advantages derive from the typical properties of Sorbead.

On account of the wide range of Sorbead products and the breadth of their fields of application, we can offer suitable product types for your individual operating conditions.

Properties	Advantages
Low regeneration temperatures from 90 °C	Reduction of operational costs through low energy consumption and minimal hydrothermal ageing
Bead shape	High abrasion resistance and low pressure drop reduces energy and operational costs
Long shelf life, typical up to 10 years	Low service costs and reduced waste disposal expenses, as well as a reduction in operational costs
Large specific area	High adsorption capability and drying performance, as well as low dew points down to –70 °C
High bulk density and high breakthrough capacity	Savings in plant construction costs or drying-agent purchasing costs, as the adsorbent can be reduced in size Cost savings through longer regeneration cycles
Regular bead-size	Optimum flow of gas without distribution any channel effects



Sorbead in all branches of industry

Product types

Sorbead R

The standard, Sorbead R is an adsorbent with a wide range of applications. Its high level of economy derives from a combination of unique properties:

- above-average drying capacity, on account of its high specific area
- low material charges through high bulk density
- low level of wear on account of its pearl shape and high mechanical strength

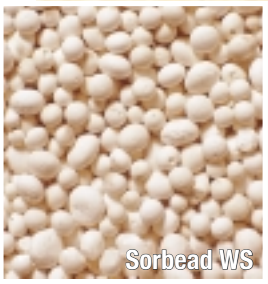
The main applications are:

- Drying of compressed air
- Drying of natural gas
- Drying of gases
- Drying of liquefied gases

In order to protect Sorbead R from the risk of water condensation, we recommend the application of an additional protective 20 % layer of Sorbead WS.

Sorbead WS

The Sorbead type WS is the only water-resistant, porous silica gel. Sorbead WS should be used, either as a 20 % protective layer in combination with Sorbead R, or exclusively in cases of extreme operational conditions, in all situations where water drops can occur. The same low dewpoints can be achieved as with the use of Sorbead R.



Sorbead Orange

Sorbead Orange permit a precise control of the drying process. By means of an environmental friendly indicator, Sorbead Orange change colour from orange to translucent when they have adsorbed about 6 % by weight of water. However, water adsorption continues after this point has been passed. The total adsorption capacity is identical to that of Sorbead R. As is the case with all other types, Sorbead Orange can be regenerated from a temperature of 130 to 160°C. Such regeneration is accompanied by a further change of colour from translucent back to orange, and the product is then again fully functional.

The main areas of application are in:

- viewing windows in drying plant
- transformer air-dehumidifiers
- laboratories (exsiccators, drying towers, U-tubes)
- dessicant bags

Sorbead H

Sorbead H are used for the recovery of the higher hydrocarbons from natural gas. By this means it is possible to reduce the dewpoint of the hydrocarbon and to extract natural petrol. The drying of the natural gas is carried out at the same time. If the occurrence of water drops is a possibility, a 10 – 20 % protective layer of Sorbead WS should be used in addition.

Special types

We are also in a position to produce a variety of modifications to our standard products, to conform to specific customer requirements. The following properties can be customised:

- grain size
- pore volume and diameter
- specific area
- chemical composition

Special products include:

- Sorbead AF 125 for use as protective layer in combination with other Sorbead products and as catalyst carrier
- Sorbead 22 for the adsorption of hydrocarbons, in particular acetylene in air-decomposition plant
- Sorbead for use in insulating glass, dessicant bags, pharmaceutical stoppers and filters
- Sorbead HD for heatless-dryer plant

Please ask for our separate information leaflets on these special products. We shall be pleased to forward them to you.

Packaging shapes and sizes

- Silo truck
- 850 kg (750 kg) Big bags
- 150 kg (135 kg) metal drum
- 50 kg (45 kg) metal drum
- 25 kg (23 kg) metal drum
- $33^{1}/_{3}$ kg paper sack
- 8 kg (7 kg) bucket with foil lining
- 3 kg tin, packed in boxes of 8 (2.1 kg)
- 1 kg tin, packed in boxes of 20 (0.7 kg)

(brackets denote packaging sizes for WS and H types)

Technical Service

We offer a comprehensive technical application service to assist in the successful implementation of your projects.
This service is free of charge to our customers and its features include:

- Answers to both general and specific enquiries relating to adsorptive drying
- Comprehensive support in the planning of new drying units, particulary in the selection of a suitable adsorbent
- Dimensioning of the desiccant bed layers
- Determination of optimum regeneration conditions
- Consultation and advice on the operation of existing plant

Being of relatively simple design adsorptive drying is not very susceptible to breakdown. So long as a regular programme of maintenance and servicing is carried out, several years of faultless operation can be expected.

During this period the unit should be constantly monitored, and samples taken in accordance with the recommendations of our technical application division. These samples are tested in our laboratories for their functional efficiency. In this way, you can be assured that any renewal of the Sorbead is only carried out when it is really necessary.

Support in unit design

Metrological monitoring service

Adsorptive drying processes and equipment

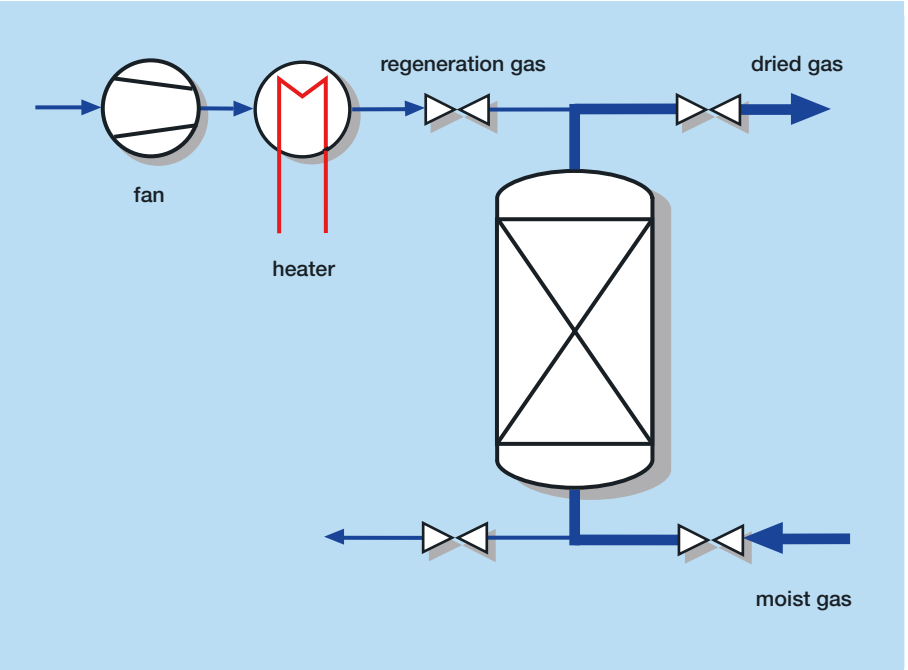
The drying unit must be designed in accordance with the intended application. In the case of discontinuous operation, a 1-adsorber system is sufficient, whereas for continuous operation, at least 2 adsorber units are required.

1-adsorber plant

The gas flow to be dried is fed from below through the adsorbent/desiccant bed. When the dew point rises, or after completion of the drying phase, the drying agent is regenerated.

In the case of an 8-hour period of operation during the daytime only, regeneration can be done overnight.

Products: Sorbead R, WS



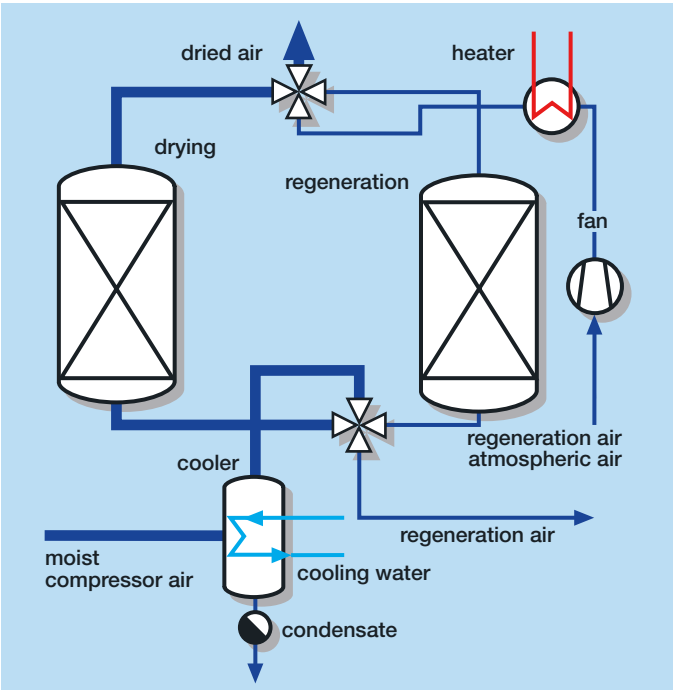
1-adsorber plant

2-adsorber plant

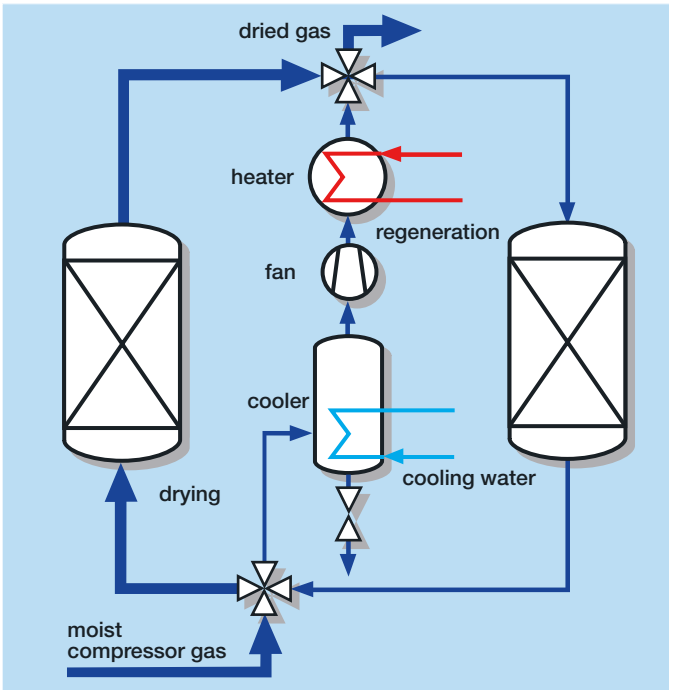
This type of plant allows continuous operation and can be adjusted to changing operational conditions. One adsorber is always available for drying while the other is regenerated or cooled.

The drying can be carried out in an open system (e.g. for compressed air) or in a closed cyclical system for special gases (e.g. SO_2).

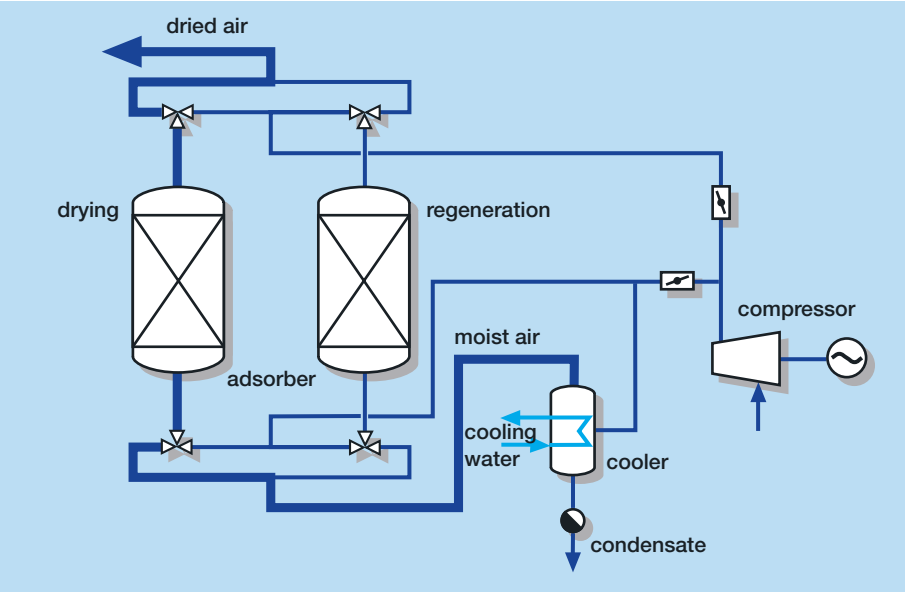
Products: Sorbead R, WS



Drying of compressed air with regeneration in an open system

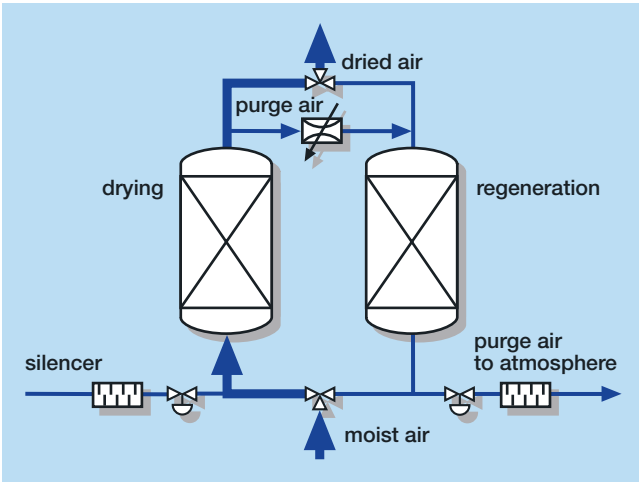


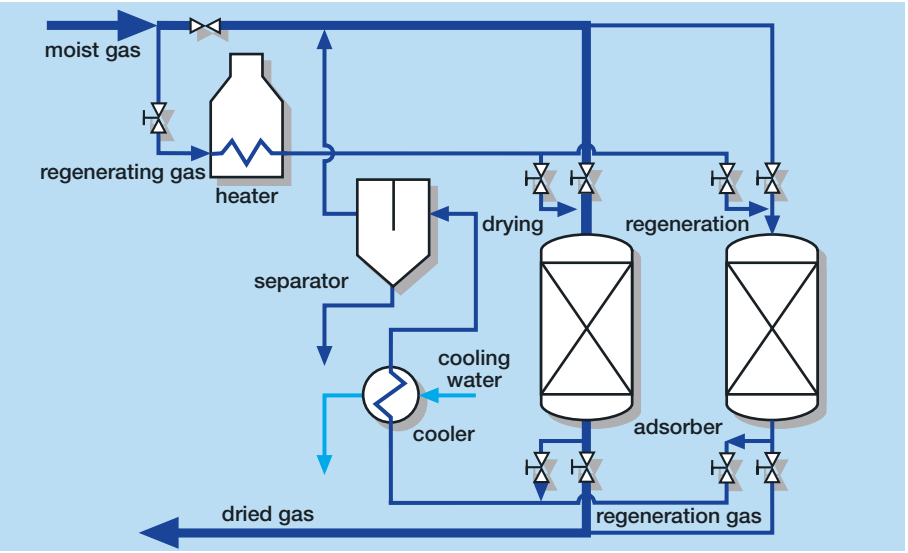
Schematic representation of a 2-adsorber plant with cyclic regeneration



Schematic representation of drying plant which regenerates using heat of compression

Heatless dryer plant





Schematic representation of a 2-adsorber natural-gas drying plant, with regeneration being carried out with a partial flow of moist gas

Regeneration with heat of compression

The heat needed to regenerate the drying agent is the prime source of the operational costs of a drying plant.

In a heat-of-compression unit, the heat which is released during the compression of the gas is used for regeneration. This process offers a more economical alternative than gas heating by means of external energy sources.

Product: Sorbead WS (these satisfy the requirements for regeneration capability at temperatures above 140 °C and dewpoints of 60 °C in regenerating gas).

Pressure-exchange drying plant (Heatless dryer)

In this process regeneration is carried out without the application of any external heat. All of the necessary energy is extracted from the system itself.

Regeneration of the drying agent is effected after a very low absorption of water (less than 1 % by weight) using a depressurised part of the dried gas flow. A sufficiently high pressure must be therefore present during the drying process.

Products: Sorbead HD, WS

Drying natural gas

Natural gas is usually dried under high pressure in plant with 2 or more adsorbers. In these processes, Sorbead distinguish themselves on account of their long residence times, even in cases where the regeneration is carried out with moist crude gas and at relatively high regeneration temperatures.

Products: Sorbead R, WS

Acetylene drying

Even acetylene can be dried with the aid of Sorbead. 2-adsorber plant is used for low-pressure drying, whereas multi-adsorber plant is used for high-pressure drying. Depending upon the operational conditions, residual water content levels in dried acetylene of from 100 to less than 5 ppm are achieved.

Products: on request

Processes for the simultaneous reduction of the water and hydrocarbon dewpoints in natural gas

Higher hydrocarbons (C_{5+}) must be separated from natural gas in order to reduce the hydrocarbon dewpoint. During the process, natural petrol is produced. For this particular purpose, Sorbead H are used. At the same time as these higher hydrocarbons are being produced, drying of the natural gas takes place.

Such plant usually features 2 or 3 adsorbers: one functions as an adsorber while the second is regenerated and the third cooled. The pressure is usually 35 – 90 bar, while the temperature ranges from 15 – 35 °C and the adsorption time 20 – 60 min or longer.

Products: Sorbead H and WS

The drying of liquids

The principles for adsorption from the gas phase also apply to adsorption from the liquid phase. However, there are fundamental differences in process procedures. For continuous operation, the plant also uses 2 adsorbers.

residence time:
5 – 10 min

drying cycles:
often > 24 hours

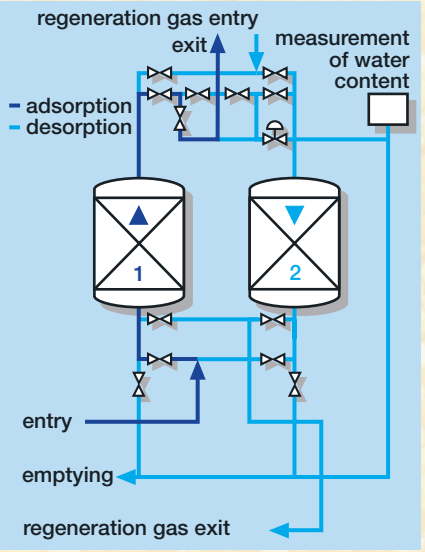
adsorption capacity:
propane or butane drying,
≥ 6 % by weight

shelf life Sorbead R and WS:
several years

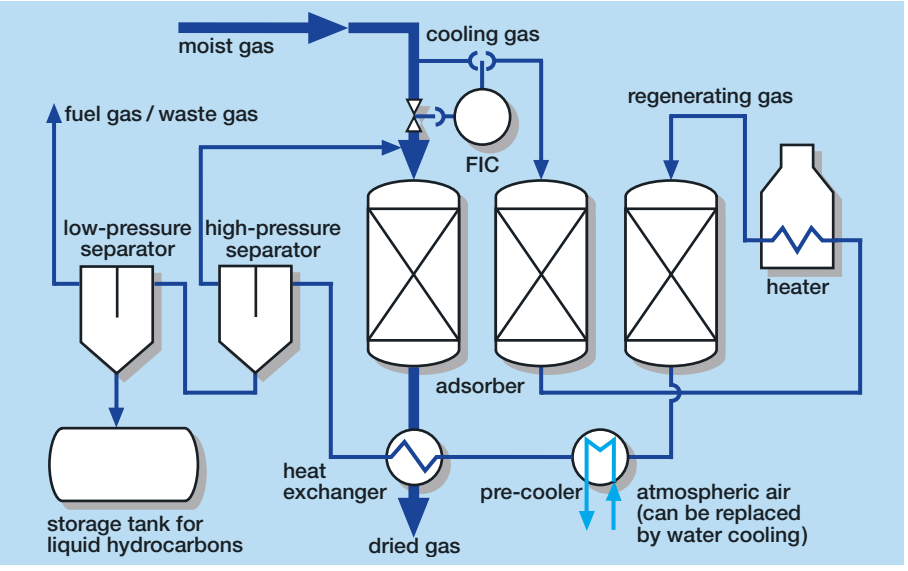
achievable residual-water contents:
< 10 – 20 ppm

Areas of application:

- Drying of liquidised hydrocarbons which cannot, or can only partially be mixed with water, such as propane, butane, pentane, light petrol, benzene, xylene etc. If the fluids to be dried have a high boiling point, or contain oxygen or are easily polymerised, we recommend the use of Sorbead Plus and AF 125.
- Drying of liquid hydrocarbons: drying with Sorbead Plus and AF 125 facilitates further processing of the substances in the production process. Very low residual water-content levels of less than 10 ppm H_2O can be achieved when drying fluid.



Liquids drying with rinsing phase



Schematic representation of 3-adsorber plant for the simultaneous hydrocarbon and water dewpoint control in natural gas, using a partial flow of crude gas for cooling and regeneration

Fundamental terminology in adsorptive drying

Adsorption

Deposition of a substance (the adsorptive) on the surface of a solid (the adsorbent). The advantages of Sorbead are especially based on their large pore surface area.

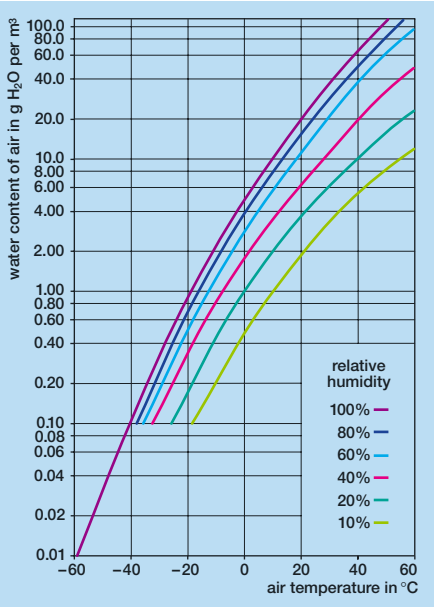


Fig. 1: Water content of air and ideal gases depends on temperature and relative humidity

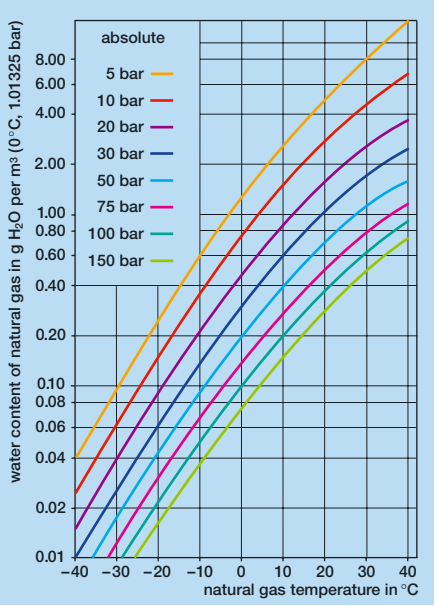


Fig. 2: Water content of natural gas depends on temperature and pressure

Adsorption drying: Moisture removal with the aid of adsorbents

This is a physical process for extracting moisture, in which the adsorbents (Sorbead) remain unchanged. Adsorption drying is an energy-saving and economical process which is also environmentally friendly.

Relative humidity

Depending on its temperature, a gas can only absorb a certain amount of water in the form of vapour (figs. 1 and 2). With increasing temperature, the maximum water-vapour content also rises. The relative humidity of the gas is the ratio of the actual water content to the maximum possible water content at the given temperature expressed as a percentage.

If a gas is compressed at constant temperature, the relative humidity increases until the saturation limit is reached, beyond which point the water vapour condenses. On expansion of the gas, the relative humidity sinks if the temperature is maintained at a constant level.

Static drying

Static drying means achievement an equilibrium of water content between stationary gases or fluids and the drying agent.

Equilibrium capacity

The equilibrium capacity (adsorption isotherm – fig. 3) signifies the maximum number of grammes of water which can be adsorbed from the gas or fluid by 100 g of Sorbead. This value is dependent upon the relative humidity and therefore upon pressure and temperature.

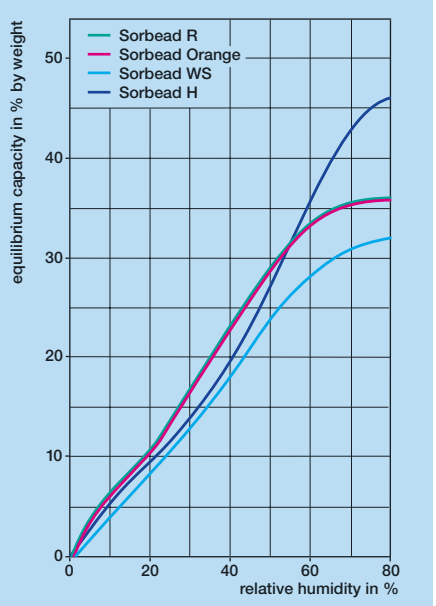


Fig. 3: Equilibrium capacity depends on the relative humidity of the gas

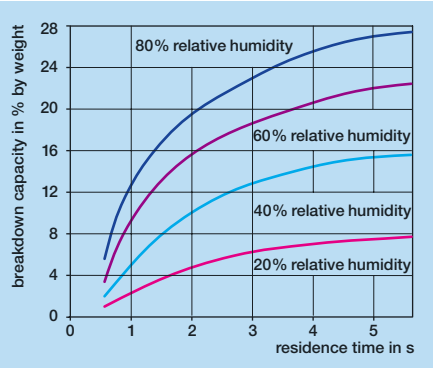


Fig. 4: Breakthrough capacity depends on residence time

Dynamic drying

Dynamic drying is the removal of moisture from gases or fluids which are flowing through a drying bed. This is the principle for all commercial drying plant.

If the maximum permissible moisture content in the dried gas has been reached, the drying process is terminated and the drying agent must be regenerated. The amount of water taken up by the Sorbead at this point, expressed as a percentage by weight of the uncharged drying agent, is known as the breakthrough capacity (see fig. 4).

The breakthrough capacity depends on the water content, temperature, pressure, composition of the gas to be dried, residence time in the adsorber, the target water content and the ageing of the adsorption agent.

With Sorbead, breakthrough capacities of up to 20 percent by weight can be achieved in the drying of air and ideal gases.

Dewpoint

The temperature at which a gas reaches the saturation point for the absorption of water as a result of cooling, and at which condensation begins, is termed the dewpoint. As the saturation point also depends on pressure, the pressure dewpoint is also given. The lower the dewpoint, the lower the ambient temperature can be without condensation or icing taking place. Dewpoints down to –70 °C can be achieved using Sorbead (fig. 5).

Regeneration

In the adsorption phase, Sorbead are charged with moisture. After such charging, a regeneration period must follow, in which the moisture is removed from Sorbead. This process is also known as desorption, which requires energy to overcome the binding energy of the moisture at the surface of the drying agent (see fig. 6).

Fig. 8: Expected life-time values and dewpoints achievable with Sorbead

application	expected life-time values under favourable operating conditions	achievable dewpoints
drying of air and commercial gases	up to 10 years	–70 °C
CO_2 drying	up to 10 years	–40 °C
acetylene drying	up to 10 years	–40 °C
natural gas drying	3 to 10 years	–70 °C
SO_2 drying	more than 3 years	–60 °C

In this way, repeated cycles of drying-agent charging and regeneration can be carried out.

Regeneration can be effected both by raising the temperature, and also by partial depressurisation with the aid of pressure reduction or rinsing with inert gas (the heatless-dryer principle, pressure-exchange adsorption).

Regeneration temperatures are usually in the region 120 – 150 °C (a typical temperature curve is shown in fig. 7). After regeneration, the Sorbead should be cooled before being used again. Sorbead Orange can also be regenerated in a drying oven at 130 °C.

If regeneration is carried out in the prescribed fashion, dewpoints of up to –70 °C can be achieved over long residence times in the drying of compressed air or gases (see fig. 8).

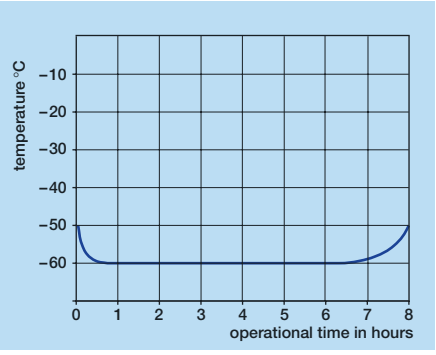


Fig. 5: Typical dewpoint curve for the dynamic drying of compressed air

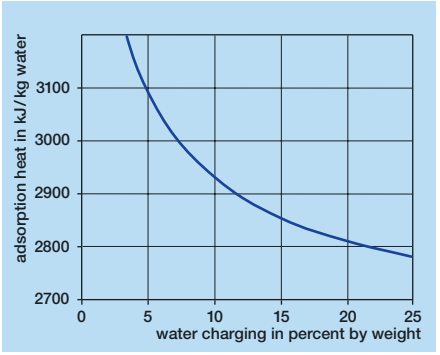


Fig. 6: Dependency of average adsorption heat on the charging of Sorbead R with water

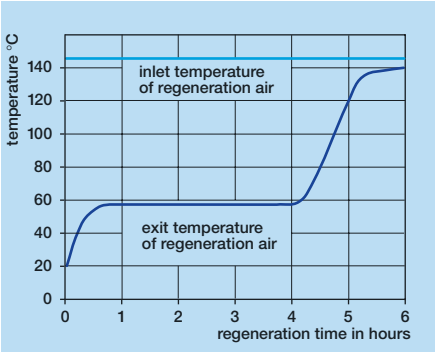


Fig. 7: Typical temperature curve for regeneration with suctioned and heated external air in counter-flow to adsorption

Properties of Sorbead

Product type	specific surface area	average pore diameter	pore volume	packed bulk density	equilibrium capacity for water vapour at 25 °C and relative humidity (% by weight)		
	m^2/g	nm	ml/g	kg/l	10	80	100
Sorbead R normal	750	2.5	0.42	0.8	6.5	42.0	–
Sorbead WS water resistant	650	3.0	0.44	0.7	4.0	42.0	–
Sorbead Orange indicator	750	2.5	0.42	0.8	6.5	42.0	–
Sorbead H for hydrocarbon adsorption	760	3.0	0.50	0.7	6.0	45.0	–
Sorbead Plus	750	2.5	0.45	0.60	7.5	45.0	–
Sorbead AF 125 aluminium-free. water resistant	300	12.5	0.95	0.50	–	9.0	75.0

For all product types:	
specific heat	1 kJ/kg K
heat conductivity	0.2 W/m K
grain size	2 – 5 mm
average grain diameter	3.5 mm
special grain sizes	on request
undersize-grain content	max. 2 % by weight
oversize-grain content	max. 2 % by weight
Chemical composition:	
R / WS / Orange / H	Al_2O_3 3 % SiO_2 97 %
Sorbead Plus / AF 125	Al_2O_3 0.3 % SiO_2 > 99 %
Orange contains as indicator substance	Phenolphthalein < 0,1 %
other indicators	on request

waste key code	101.201
customs tariff number	
R / WS / H / AF	28-11.22.000
Orange	38-23.90 98
disposal	in compliance with the regional authority regulations, usually as domestic waste
dangerous goods	According to current available information, Sorbead are not classified as dangerous goods according to the Chemical Act of 16.09.1980. The usual precautionary measures to be exercised in the handling of chemicals should be adopted. Sorbead are free of crystalline components (such as, for example, quartz).

Questionnaire for Technical Service

Please copy this page, then complete the questions and return to us in a window envelope.

Or send by telefax to: (601)360-0757

ENGELHARD CORPORATION
Separation Systems

600 East McDowell Road
Jackson
MS 39170

Sender

Description of the substance to be dried
Precise composition of the substance [% by volume, % by weight]
What impurities does the substance contain? [ppm] e.g. oil, ammoniac, dust
Total quantity of the substance or amount/h [m^3 (0 °C; 1.013 bar)/h or kg/h]
Under what excess pressure is the substance? [bar]
Temperature of the substance? [°C]
Water content of the moist substance? [g/m^3 or g/m^3 (0 °C; 1.013 bar)]
Desired dewpoint or residual water content [°C or ppm or g/m^3 (0 °C; 1.013 bar)]
How many hours per day is the drying operation to take place?
What switching cycle is required?
Do you intend to buy complete plant, or to build plant yourself?
In the case of existing plant, please complete the following information:
Type and age of drying agent used
Number of adsorbers
Direction of flow
Amount of drying agent per adsorber [kg]
Internal diameter of adsorber [mm]
Depth of bed [mm]

please copy and return

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Separation Systems

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