

# WIND TURBINES NEED PROTECTING AGAINST THE EFFECTS OF HUMIDITY

**COTES**

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At wind speeds of 12 metres/second, any 1 square centimetre gap or opening in the nacelle results in approx. 6 cubic metres of moisture-laden air entering the nacelle every hour — right round the clock.

## TOUGH CONDITIONS BIG CHALLENGES

### Operating in challenging conditions

Glitch-free operation is crucial for the basic operating economics of any wind turbine, as well as for its service life, availability factor and the overall ROI.

But all wind turbines have to operate under challenging weather conditions. Furthermore, each turbine is more-or-less constantly enshrouded in air that contains a potentially corrosive cocktail of moisture and airborne contaminants of all kinds.

This combination of high levels of humidity and airborne contaminants:

- Encourages and accelerates corrosion
- Increases the formation of condensation — which under certain conditions can freeze to ice
- Supports the growth of mould, biofilms and a wide range of microbial contamination
- Helps cause electrical malfunctions, such as short circuits when powering up the turbine after a downtime period or during commissioning.

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## WHY IS HUMIDITY MANAGEMENT SO IMPORTANT IN WIND TURBINES?

- Humidity is a major contributor to corrosion
- Humidity increases the likelihood of condensation
- Humidity affects key electronics and can cause service interruptions as well as major breakdowns
- Humidity reduces the service life of individual components and the whole structure
- Humidity reduces uptime, availability and output

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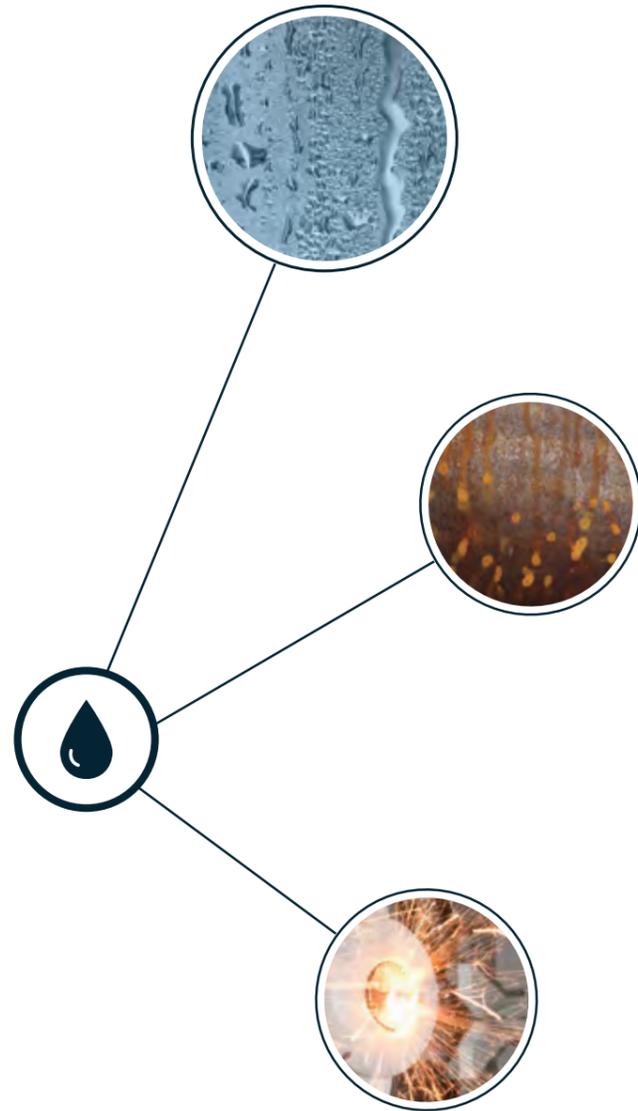
## BIG-TIME BENEFITS

There are big benefits to be gained, enabling you to provide wind turbines that feature

- Better uptime statistics and increased availability
  - Better control of conditions and operating parameters throughout the nacelle and tower
  - Lower ISO 9223 corrosion classifications, reducing costs of equipment, fittings and materials
  - Condensation-free surroundings, reducing costs for surface coatings
  - Faster, glitch-free commissioning
  - Full protection during idle and power-down periods
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# CHALLENGES



## BIG PROBLEMS BIG IMPACTS

### Condensation and corrosion

The two major humidity-related problems for onshore wind turbines are condensation and corrosion.

When moisture-laden air comes into contact with cold surfaces and structures, the moisture will often condense as water, and pool on surfaces, structures and equipment.

Any such condensed moisture accumulates and causes corrosion and a wide range of problems that affect operating efficiency and undermine the profitability of wind turbine operations. Any such corrosion is worsened and accelerated by airborne contaminants, particles and salts.

### Knock-on effects

These conditions result in serious operating problems that can in turn have big effects on the industry reputation and profit margins of any wind turbine manufacturer, and on the profitability of any wind farm or wind turbine operator.

- Deterioration/damage to both structures and equipment
- Glitches and breakdowns in mechanical systems, electrical equipment and electronics
- Revenue-denting service interruptions and reduced availability
- Higher maintenance/service costs
- Reduced service life for each wind turbine
- Unsafe working environment inside the nacelle and tower
- Unreliable revenue forecasts and ROI calculations.

These kinds of problems don't only arise during day-to-day wind turbine operations. Condensation and corrosion are also major problems during storage, transport, erection and commissioning.

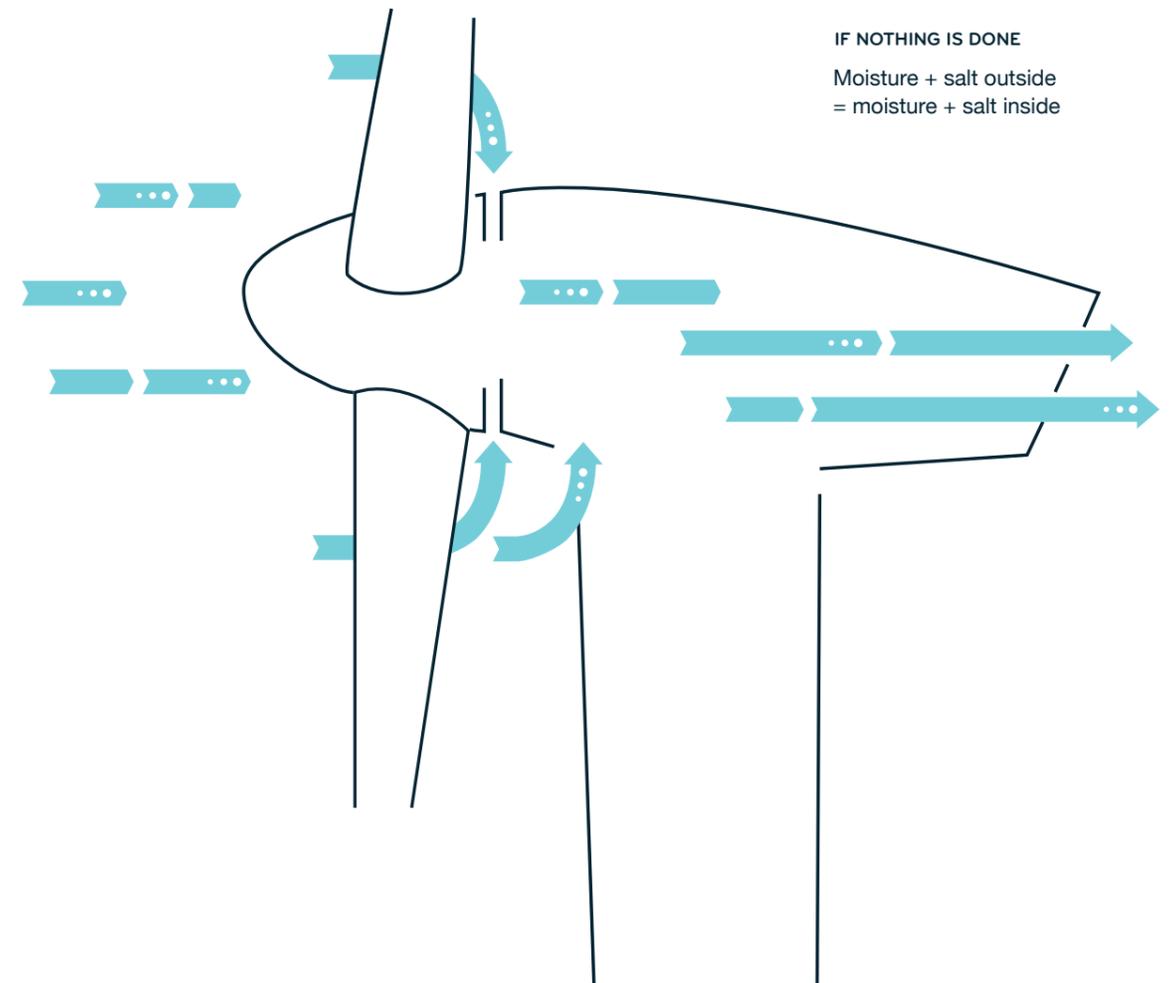
## IF NOTHING IS DONE

All nacelles have openings/cracks/holes/vents to the outside where air enters. At fairly common wind speeds of 12 metres/second, approximately 6 cubic metres of air enter the nacelle every hour through any hole only 1 square centimetre in size.

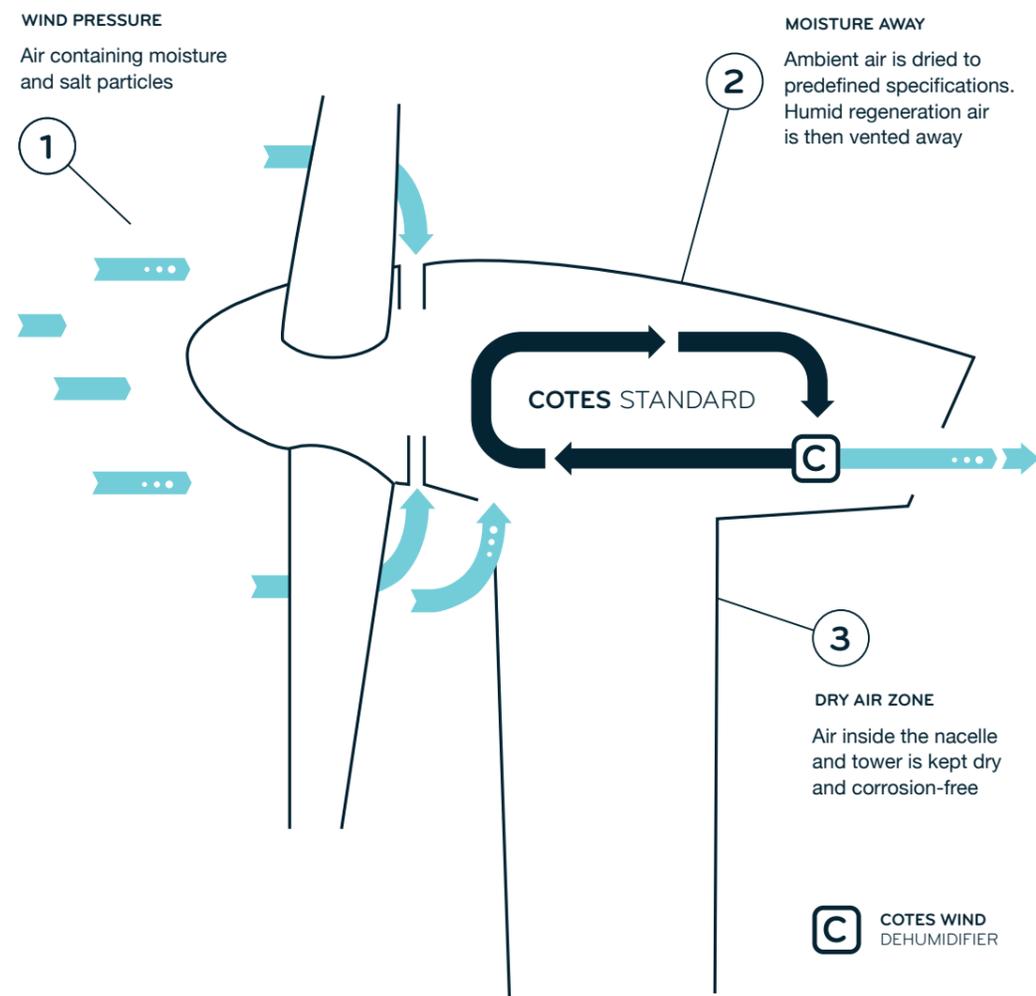
With up to 50 square centimetres of cracks/holes throughout the nacelle, 300 cubic metres of air enter the nacelle every hour. This air will often be very humid as well as being saturated with particles of corrosive salts.

This will create a variety of problems such as:

- Mould/films on inside surfaces
- Condensation
- Corrosion
- Electrical glitches



# SOLUTIONS



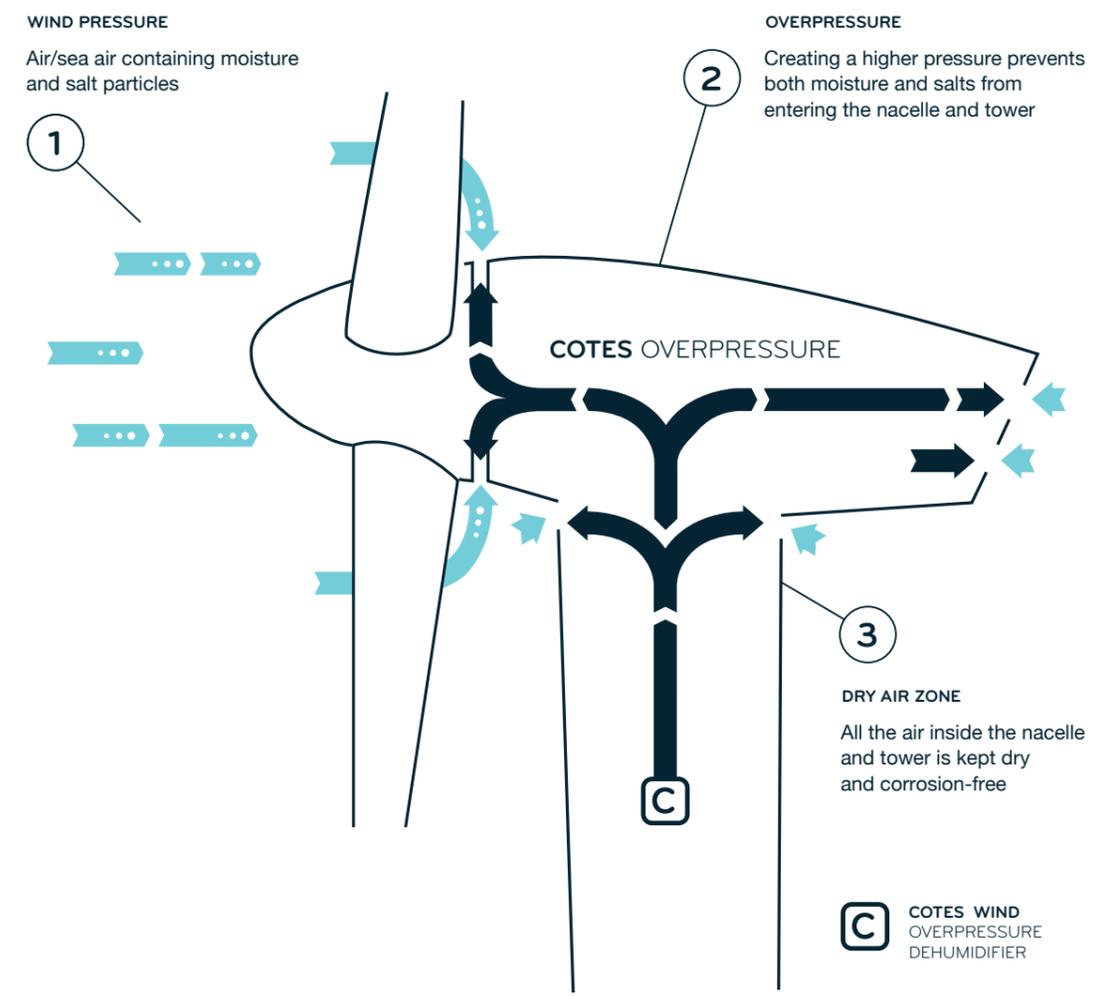
## COTES WIND STANDARD

This is the standard Cotes adsorption dehumidifier unit, designed primarily for onshore wind turbines, to deal with airborne moisture once it has entered the nacelle or tower.

Cotes Wind Standard units enable you to keep humidity under control by making sure that the air entering the nacelle or tower continually gets mixed with drier air. This reduces the relative humidity present and therefore cuts back on any risk of the kinds of humidity-related problems listed previously.

This type of unit is ideal for any wind turbine design where:

- There are big openings or vents
- It is particularly important to prevent corrosion and condensation during storage, transport, erection and commissioning



## COTES WIND OVERPRESSURE

This is a patented Cotes adsorption dehumidifier unit specially designed to effectively prevent both airborne moisture and salts from even entering the nacelle or tower of wind turbines, both onshore and offshore.

This type of unit is ideal for any wind turbine design where:

- Preventing corrosion is particularly important, for example in near-coastal areas
- There are only limited numbers of openings or vents
- It is particularly important to manage the working environment inside the nacelle or tower
- There is a strong focus on protecting key equipment inside the nacelle or tower.

And for larger wind turbine units where protecting the investment is of particular importance.

## EASY TO MOUNT — EASY TO INSTALL

Cotes humidity management solutions for wind turbines are easy, practical and inexpensive to install and use.



### COTES WIND STANDARD

#### Small footprint

These small, lightweight dehumidifiers only have a tiny footprint, making it easy to mount them just about anywhere without taking up precious space needed for other equipment.

#### Easy to install

Cotes Wind Standard units are small, unobtrusive and light in weight (approx. 13–35 kg, depending on capacity), and only require

- Two vents in the tower door
- Mounting on a wall bracket or the floor
- One single industry-standard humidity sensor mounted somewhere in the tower and/or nacelle

Cotes Wind Standard units are normally installed with one unit in the nacelle and one in the tower, placed wherever is most practical for each manufacturer or operator.

#### Inexpensive to run

The combination of sensor control and energy-efficient design means energy consumption is only minimal. The dehumidifier only runs when needed.



### COTES WIND OVERPRESSURE

#### Limited footprint

These high-performance dehumidifiers are designed so that they don't take up too much space – that's why they are designed higher rather than wider. A space of approx. 80 x 60 x 130 cm is normally required.

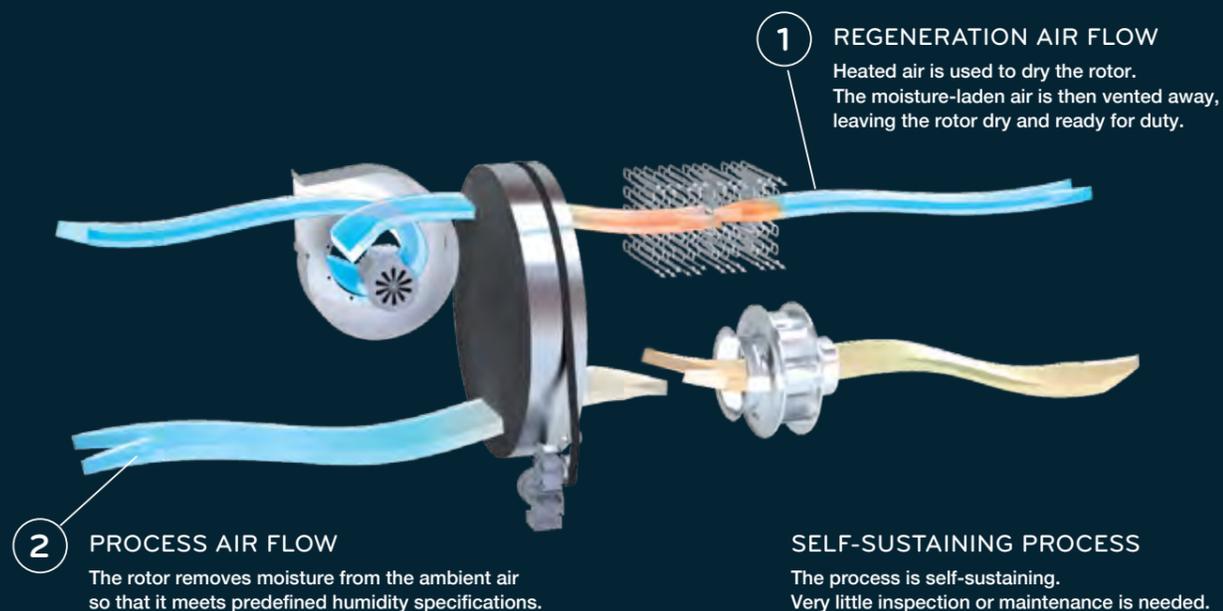
A single unit (normally weighing approx. 130 kg) is normally mounted in the base of the tower.

#### Easy to install

The only special fittings required to install Cotes Wind Overpressure units are:

- Ducting system to lead dry air from bottom of tower to nacelle
- Two vents in the tower door

# HOW ADSORPTION DEHUMIDIFICATION WORKS



## TWO FLOWS OF AIR

The effect of Cotes adsorption dehumidifiers basically stems from the action of two flows of air.

### 1. Drying the flow of air

The incoming moisture-laden flow of air (process air) enters one side of the cabinet and gets filtered by a process air filter. The air then passes through a slowly turning rotor whose inner surfaces are coated with desiccant silica crystals that attract the water molecules passing through.

When the moist air passes through the rotor, water molecules are adsorbed and lodge in the pores on the surface of the silica gel.

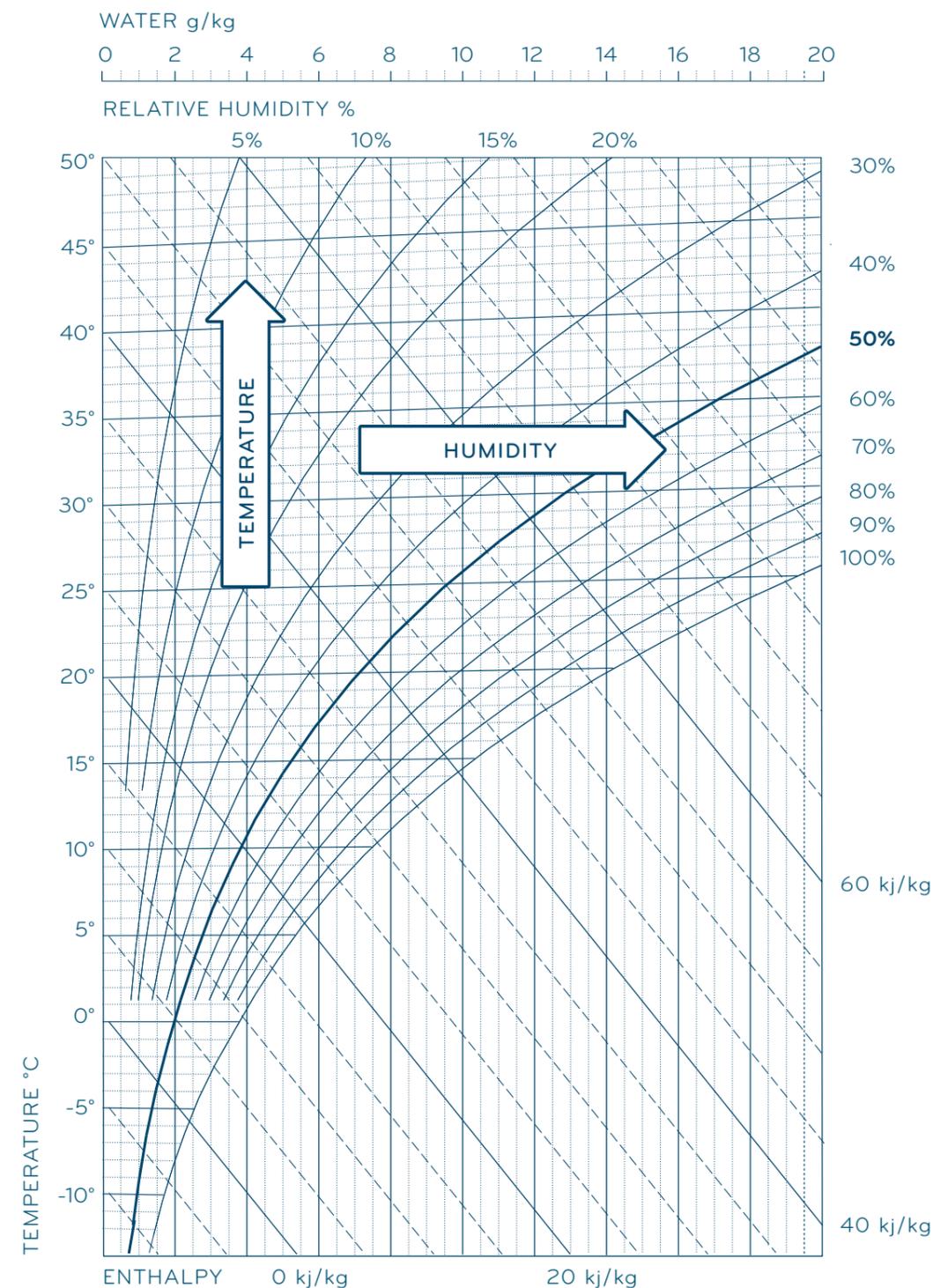
This means the air leaves the rotor containing less moisture (humidity) than when it entered. And because the adsorption process releases energy to the air, the temperature increases. The process air is controlled by a process air fan.

### 2. Regenerating the rotor with warmer air

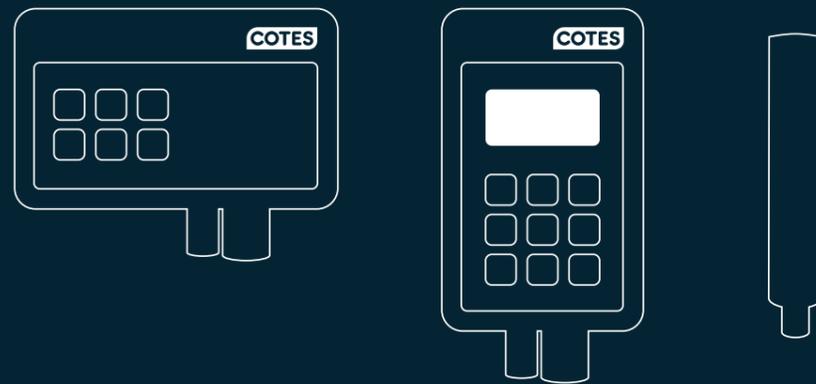
The second air flow (the regeneration air) is filtered by a regeneration air filter, and heated by heating elements. On its way through the rotor, this heat evaporates the moisture previously adsorbed by the silica crystals in the rotor. The resulting water vapour now leaves the dehumidifier in the outgoing regeneration air. The regeneration air is controlled by a regeneration air fan.

# CONTROLLING HUMIDITY ELIMINATES PROBLEMS

Keeping relative humidity below 50% is normally considered sufficient to eliminate all humidity-related problems



## EASY SERVICE — MINIMAL MAINTENANCE



## CONTROL SYSTEMS AND SENSORS

### Control is crucial

Any equipment used in wind turbines is only as good as the control systems that make sure it operates exactly as intended – so that wind farm operators get the full benefits.

### Easy to integrate

Cotes humidity management solutions feature industry-standard control systems and sensors that are easy to install, and easy to use.

They can be configured to your exact requirements.

### Out of sight, out of mind

The internals of wind turbines aren't easy to get at – any access for repairs or maintenance is time-consuming and relatively costly. That's why the equipment inside has to be exceptionally reliable, regardless of weather or operating conditions.

Cotes Wind adsorption dehumidifiers are therefore specially designed to ensure maximum reliability and uptime.

They only require minimal service and maintenance, which can easily be timed to coincide with normal service intervals and maintenance visits for other equipment.

### Easy to look after

Once mounted, Cotes Wind dehumidifiers are extremely easy and inexpensive to service and maintain.

- Filters only need changing once a year (this only takes 3 minutes)
- The fan, fan motor and gear system only need changing once every 5 years (this only takes 30 minutes)
- The silica-coated adsorption rotor only needs changing once every 10 years (this only takes 60 minutes).



**3 MINUTES**  
ONCE A YEAR



**30 MINUTES**  
EVERY 5 YEARS



**60 MINUTES**  
EVERY 10 YEARS

# COMPARISON WITH OTHER POSSIBLE TECHNOLOGIES

Adsorption dehumidification isn't the only technology that can be used to help regulate humidity levels inside the nacelles and towers of wind turbines.

## CONDENSATION DEHUMIDIFIERS CAN ALSO BE USED

ADVANTAGES	DISADVANTAGES
Cheaper up-front purchase costs	Don't work at low temperatures (normally below 8°C)
	Only effective at high levels of relative humidity
	Requires installations to dispose of/vent condensed moisture outside the wind turbine structure
	Difficulties withstanding the shaking and vibrations often encountered in wind turbines

## TRADITIONAL BLOWER HEATERS CAN ALSO BE USED

ADVANTAGES	DISADVANTAGES
Cheaper up-front purchase costs	Don't work at high humidity levels
	High energy consumption/energy costs/environmental impact
	Relatively heavy/bulky
	Control issues – when to switch on/off
	Relatively big investment for relatively limited range of possible use
	Cannot be placed near structures or equipment – fire dangers, etc.
	Vented moisture causes practical and structural problems

# ADSORPTION DEHUMIDIFICATION BENEFITS

Cotes has sold more than 20,000 adsorption dehumidifier units for use in wind turbines in service all over the world.

Cotes adsorption dehumidifier systems have the big advantages of working effectively

- At all temperatures
- At all levels of ambient humidity
- Under all weather conditions

They're also

- Compact
- Lightweight

and use only a bare minimum of energy.



# COTES RECOMMENDS



## Expertise makes the difference

Cotes is one of the world's leading suppliers of intelligent humidity management solutions for wind turbines. Cotes practical experience in this specialist field helps manufacturers of both onshore and offshore wind turbines improve the design of their products.

We help you access specialist know-how and humidity management capabilities that make a big difference to the operating availability statistics and turbine service life that you can promise your customers.

In general terms, you have to keep tabs on levels of humidity throughout the nacelle and tower. Depending on the outside temperature, Cotes normally recommends keeping such humidity levels from exceeding 50%.

## Keep it closed

In order to achieve best results, Cotes recommends structures that are as enclosed as possible. We also recommend installing a valve system to keep all kinds of air inlets and outlets closed whenever the wind turbine is powered down or not in operation for any other reason.

This results in a significantly smaller volume of air for dehumidification, paving the way for the most appropriate choice of air recirculation or overpressure systems. In some cases, an overpressure solution can be used to protect particularly critical components, such as the electrical converter and electrical panels. This can be done by venting the dry air into electrical cabinets or other enclosures that contain a particular item of equipment.

## Things to consider

- Keep structures enclosed
- Install a valve system
- Keep humidity levels below 50%

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## IF YOU'RE A WIND TURBINE MANUFACTURER

Installing Cotes humidity management solutions as part of the OEM configurations for your wind turbine products helps you:

- Keep manufacturing costs down by making it possible to use less expensive materials, fewer coatings and less equipment as well as fewer measures to protect against the effects of humidity
- Promise your customers lower operating costs, higher availability factor and longer service lives for your products
- Provide your customers with savings on service contracts as a result of lower service, maintenance and repair costs.

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## IF YOU'RE AIMING TO PURCHASE WIND TURBINES

Having Cotes humidity management solutions pre-installed in the turbines you plan to acquire provides you with advantages that include:

- Higher availability
- Less frequent downtime
- Fewer service requirements
- Increased service life expectancy for your investments
- Overall better ROI
- Increased working conditions for service personal.

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## IF IT'S YOUR JOB TO SERVICE WIND TURBINES

Installing Cotes humidity management solutions in the wind turbines you have to service gives you benefits that help you reduce costs:

- Less service work required
- You can do service easier and faster
- Better protection of in-turbine components, which means less replacement work
- Better/safer working conditions for your staff when working inside the turbines.

## THE BENEFITS ADD UP

Cotes Wind dehumidification units make it possible to effectively manage the humidity inside wind turbine nacelles and towers.

These relatively small, lightweight units provide you with big benefits for your products' reliability and operating costs.

**HUMIDITY**  
UNDER FULL CONTROL

**CORROSION PROBLEMS**  
DONE AWAY WITH

**CONDENSATION PROBLEMS**  
DONE AWAY WITH

**LOWER COSTS**  
FOR MATERIALS, COATINGS  
AND COMPONENTS

**RAPID, GLITCH-FREE**  
TURBINE COMMISSIONING

**FEWER MECHANICAL**  
AND ELECTRICAL FAULTS

**GREATER UPTIME**  
AND BETTER PRODUCTIVITY

**LOWER SERVICE**  
AND MAINTENANCE COSTS

**SAFER WORKING**  
ENVIRONMENT

# TALK TO US ABOUT WHAT'S POSSIBLE

## **Talk to the experts**

Cotes engineers are among the world's leading experts in using adsorption dehumidification technology to manage the levels of humidity in both onshore and offshore wind turbines.

## **A question of control**

Dehumidification is the best and most economical way to manage levels of humidity in the air, and managing humidity is the most cost-effective way to control conditions in turbine nacelles and towers.

Controlled conditions mean less risk and lower operating costs – and a solution your customers really feel they can rely on, because the uncertainties have been dealt with.

## **Keeping ahead of the competition**

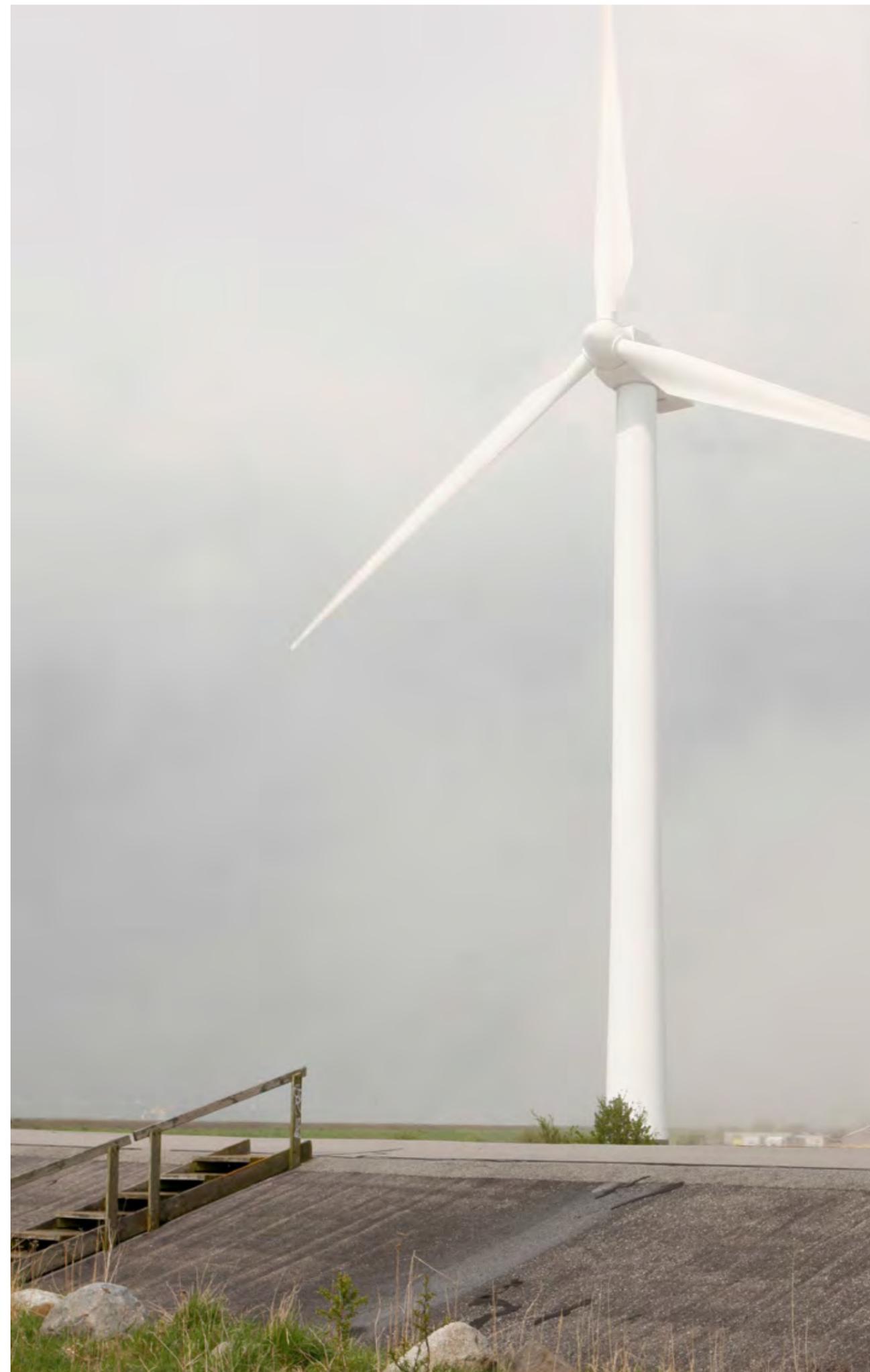
Talk to our experts about how this specialist technology can help your company get an additional edge in the fiercely competitive world market for reliable wind turbines.

## **Want to know more?**

Contact Cotes experts at

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TALK TO US ABOUT WHAT'S POSSIBLE

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