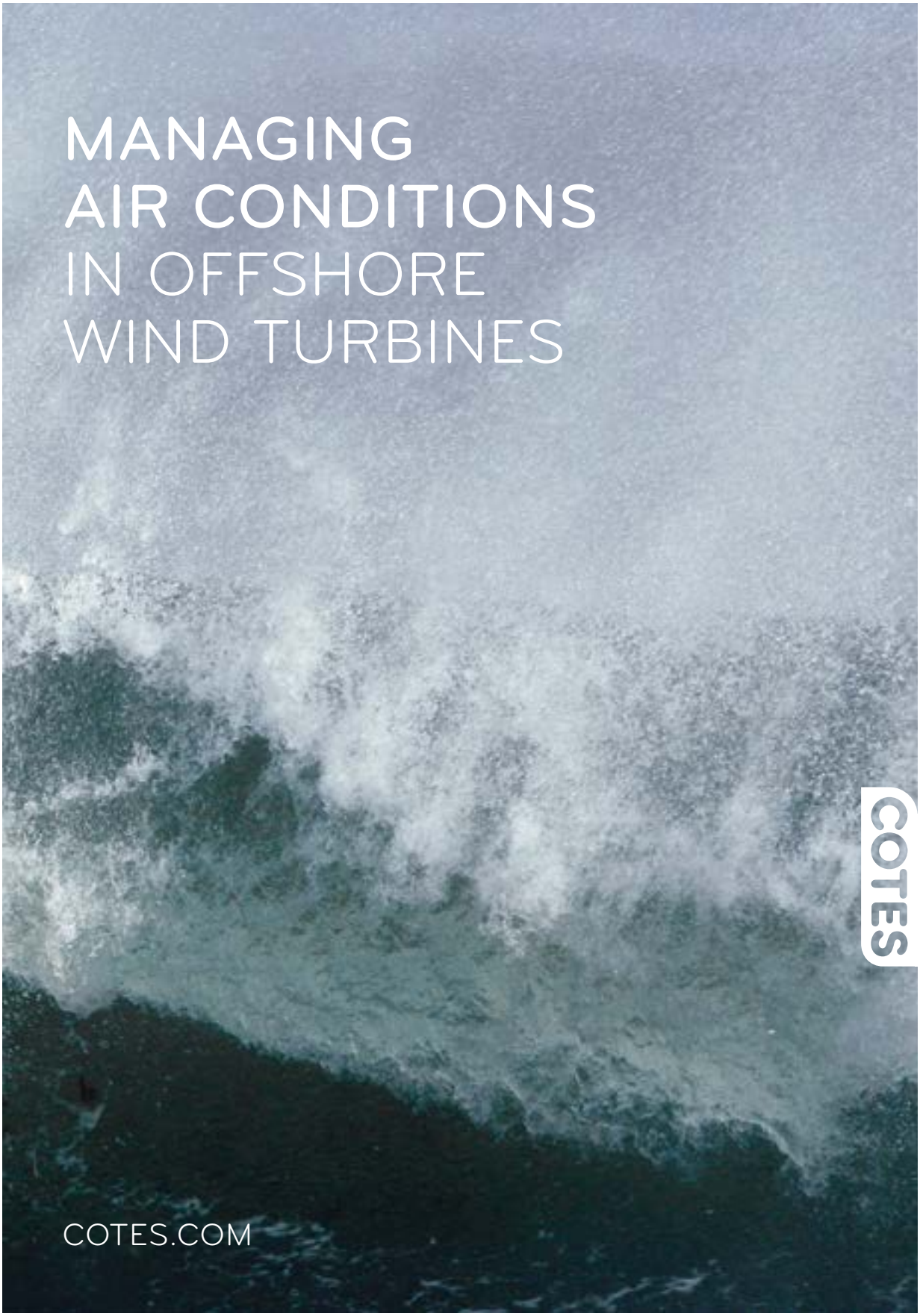
MANAGING AIR CONDITIONS IN OFFSHORE WIND TURBINES



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MANAGING AIR CONDITIONS IN OFFSHORE WIND TURBINES

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Offshore wind turbines have to operate under exceptionally harsh conditions, facing a combination of high levels of humidity and salts that are always present in the sea air.

It is seldom appreciated how much the conditions inside such wind turbines can be improved by intelligent management of the air conditions – so most problems don't even arise.

Controlled humidity helps you tackle – or even prevent – many of the difficulties encountered with supplying offshore wind turbines that wind farm operators can rely on for peak efficiency.

This opens up new vistas for savings and benefits.

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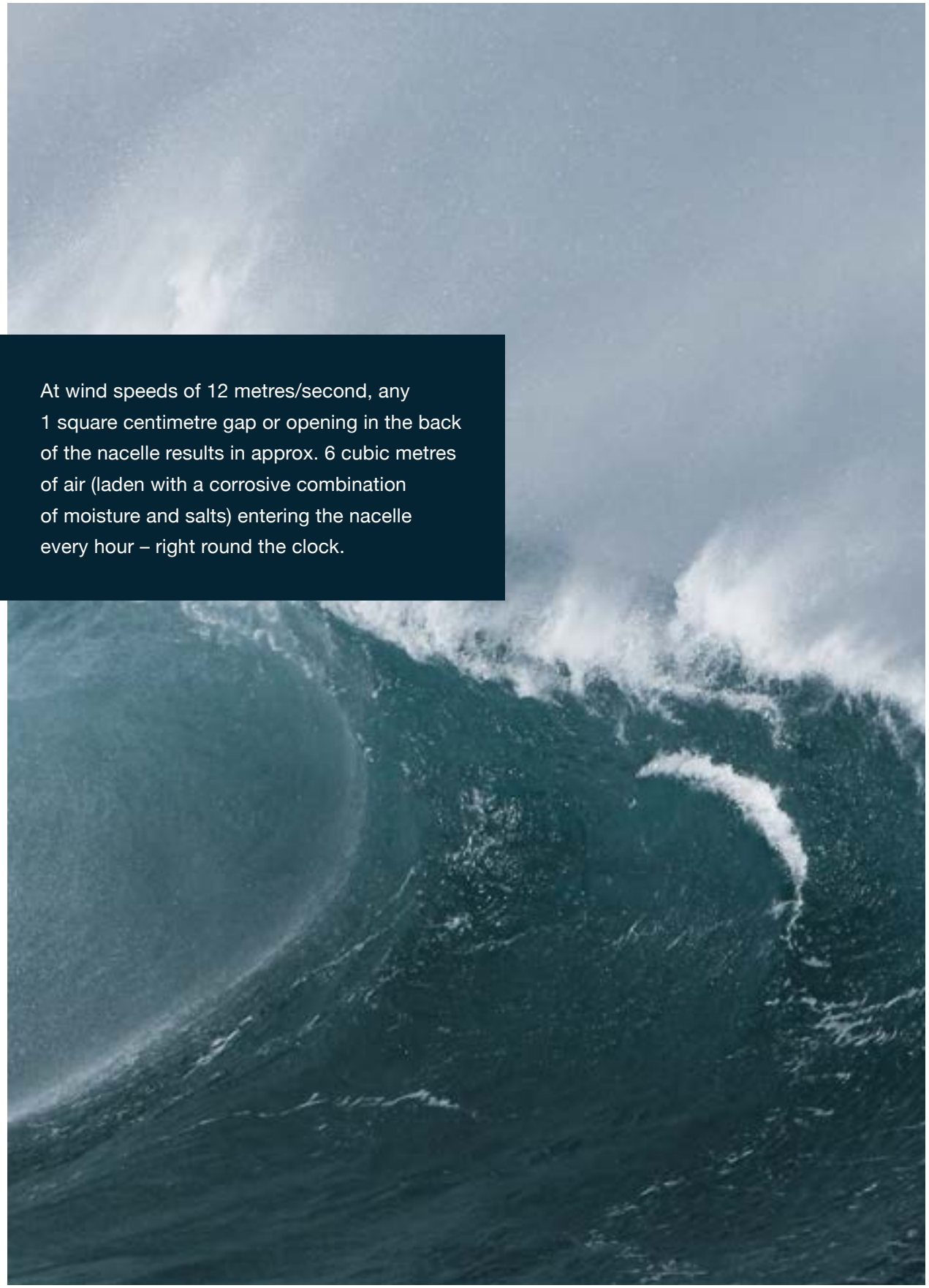


At wind speeds of 12 metres/second, any 1 square centimetre gap or opening in the back of the nacelle results in approx. 6 cubic metres of air (laden with a corrosive combination of moisture and salts) entering the nacelle every hour – right round the clock.

ROUGH CONDITIONS – TOUGH CHALLENGES

Corrosive cocktail
Offshore wind turbines have to operate under exceptionally harsh conditions. And glitch-free operation – regardless of conditions – is crucial for the basic economics of any wind farm.

Offshore, the natural action of wind and waves means all the air in and around each turbine is more-or-less constantly saturated with a corrosive cocktail of airborne moisture and salts that is potentially very disruptive.

Tackling the problem
The combination of high levels of humidity and salts present in sea air:

> Accelerates corrosion
> Increases the formation of condensation
> Encourages growth of mould, biofilms and microbial contamination.

These result in serious operating problems that can have big effects on the reputation of any wind turbine manufacturer:

> Deterioration/damage to both structures and equipment
> Revenue-busting glitches and breakdowns in electrical systems and electronics
> Problems stemming from mould and growths
> Unsafe working environment inside the nacelle and tower
> Higher maintenance/service costs
> Reduced service life for each wind turbine
> Unreliable revenue forecasts and ROI calculations.

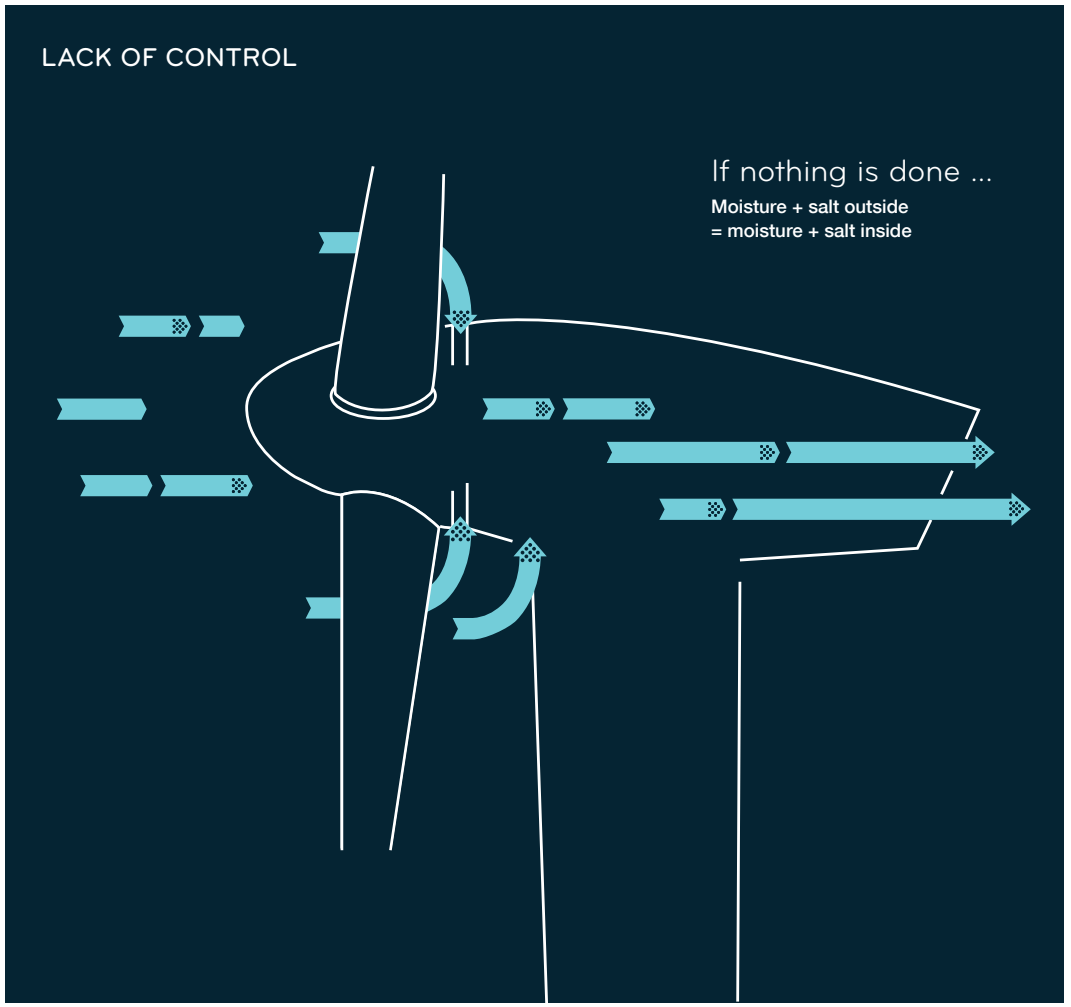
INTELLIGENT HUMIDITY MANAGEMENT

The best way to prevent these problems from arising is to establish control over air conditions inside the nacelle and tower.

And the most effective way to do that is by applying modern humidity management technology, enabling you to keep conditions under full control during storage, transport, erection and commissioning – as well as throughout the offshore service life of each wind turbine.

Cotes is the world's leading supplier of intelligent humidity management solutions for offshore wind turbines – ensuring capabilities and conditions that can make a big difference for any wind turbine manufacturer.

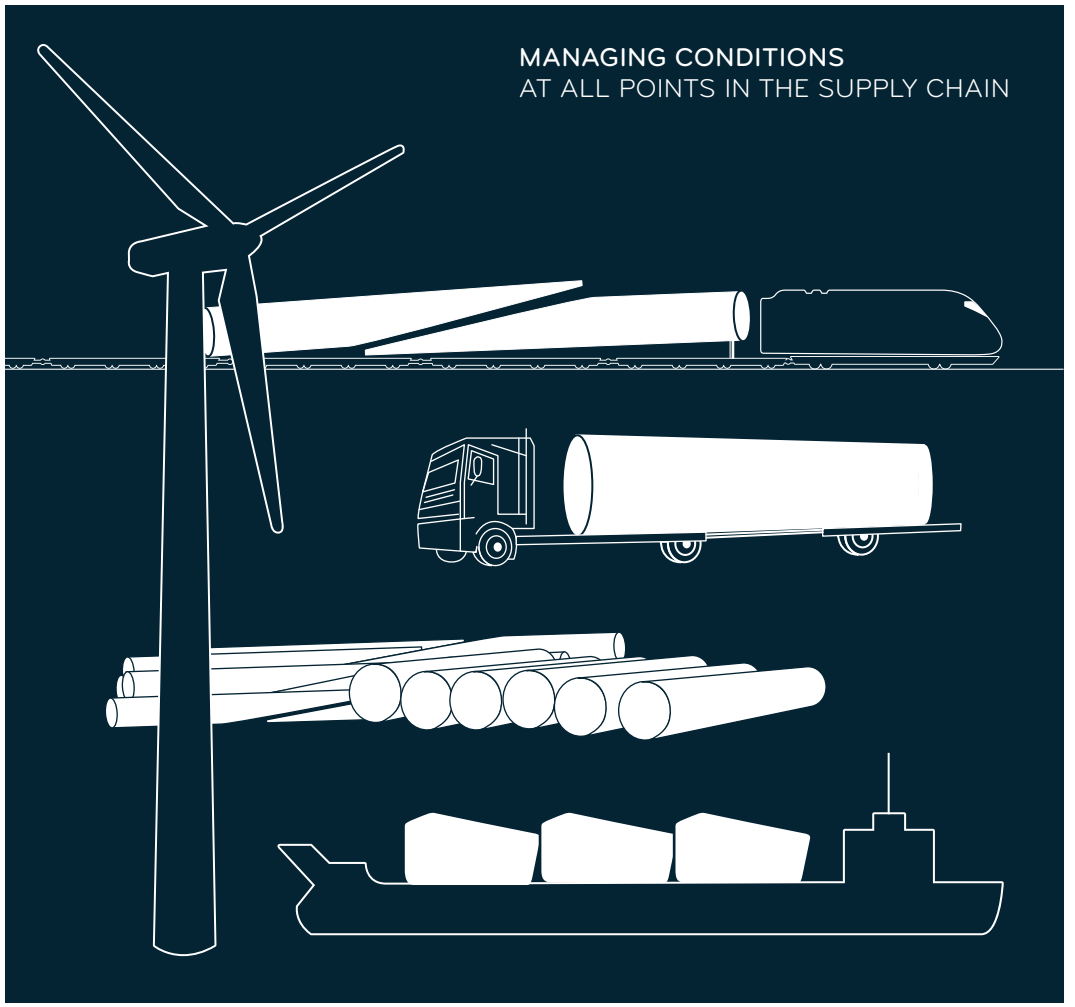
Cotes is also the only dehumidifier supplier capable of providing you with solutions that deal effectively with moisture and salts at the same time – in one small, lightweight box.



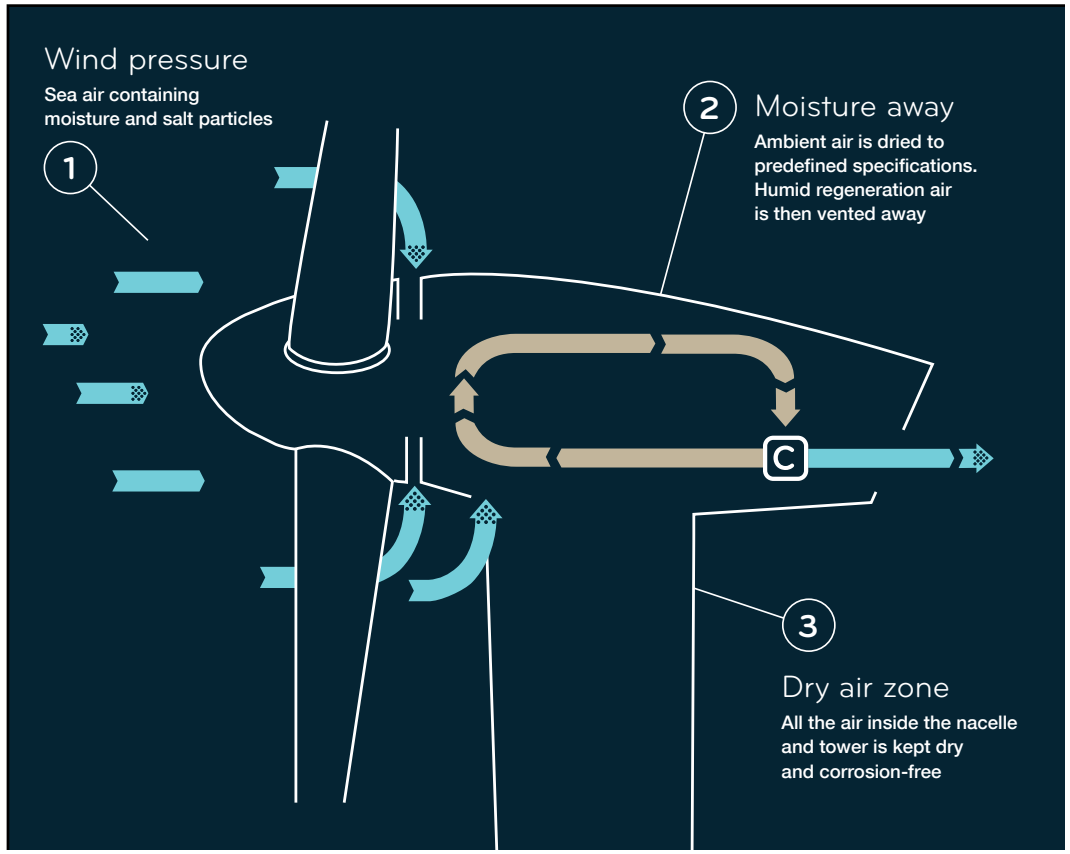
BIG-TIME BENEFITS

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

- Better uptime statistics and increased availability
- Better control of conditions and operating parameters throughout the nacelle and tower
- Lower development costs and faster time to market
- Lower ISO 9223 corrosion classifications, reducing costs for equipment, fittings and materials
- Condensation-free surroundings, reducing costs for surface coatings
- Faster, glitch-free commissioning
- Full protection during idle and power-down periods
- Lower maintenance/service costs
- Longer service life
- Safer working environment.



HUMIDITY MANAGEMENT – TWO APPROACHES



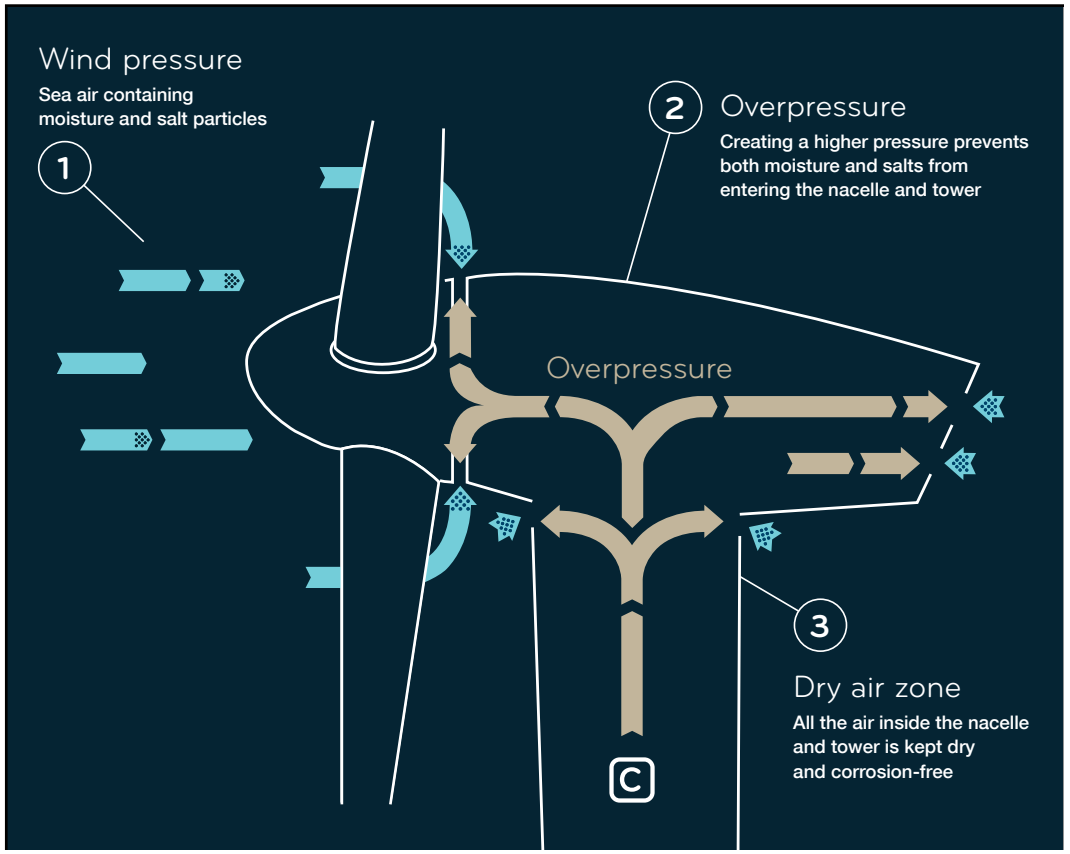
COTES WIND STANDARD

This is the standard Cotes adsorption dehumidifier unit for offshore wind turbines, designed 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. It is a limitation measure – not a preventative measure.

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

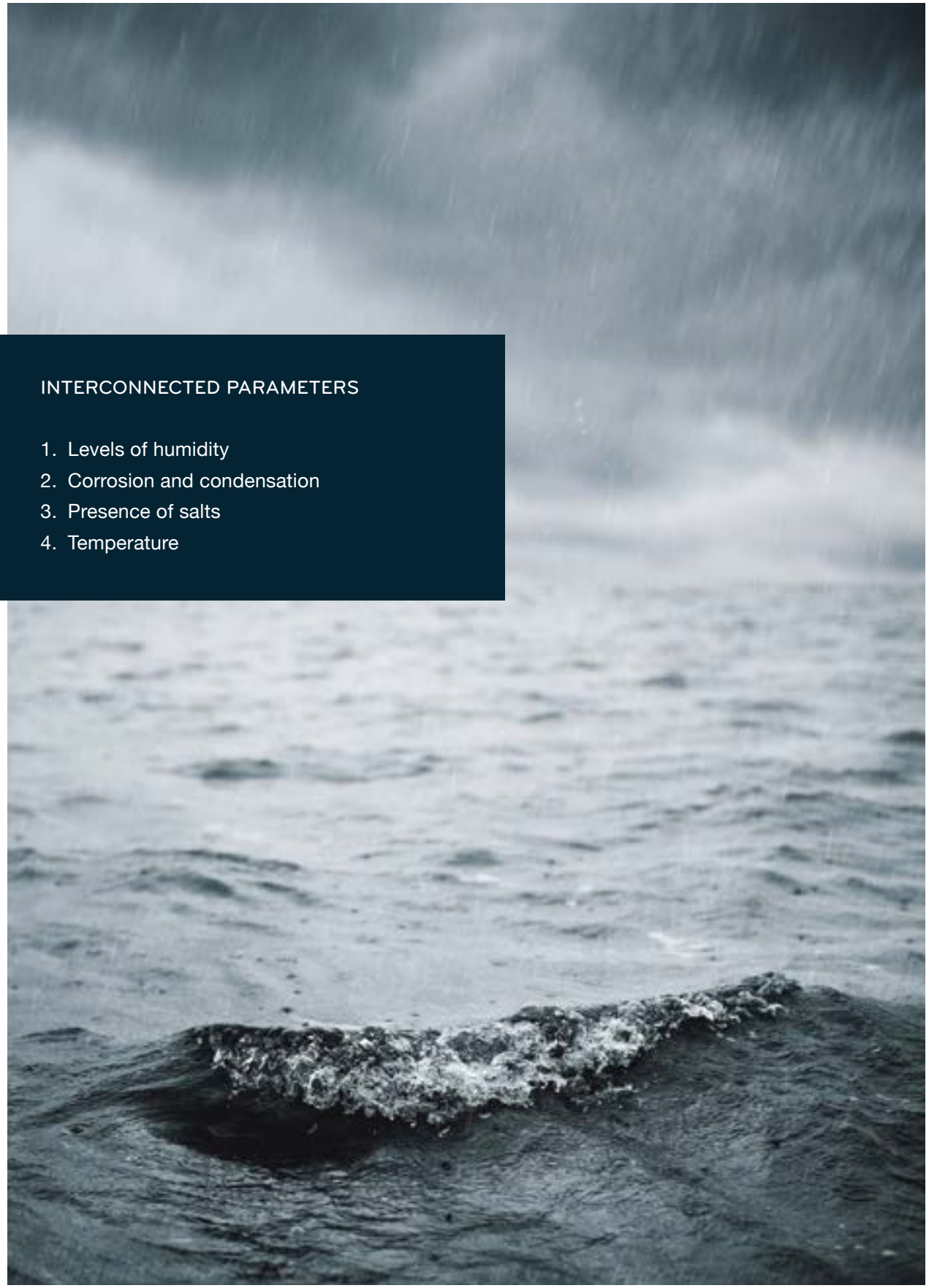
This is a patented Cotes adsorption dehumidifier unit specially designed to effectively prevent airborne moisture and salts from even entering the nacelle or tower of offshore wind turbines.

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

> Preventing corrosion is particularly important
> There are only limited numbers of openings or vents
> It is particularly important to address safety issues and manage the working environment inside nacelles/towers
> There is a big focus on protecting vital equipment.

WHY IS HUMIDITY MANAGEMENT SO IMPORTANT IN OFFSHORE WIND TURBINES?

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



INTERCONNECTED PARAMETERS

1. Levels of humidity
2. Corrosion and condensation
3. Presence of salts
4. Temperature

HUMIDITY MANAGEMENT – WHAT'S INVOLVED

Wet and nasty
The air continually flowing into and around the nacelles and towers of offshore wind turbines is almost always laden with a potent mixture of water and corrosive salts.

In addition to corroding structures, surfaces and equipment, this combination of moisture and salts can give rise to mould and other forms of microbial growth that affect both operating conditions and the working environment.

These can all be very damaging, and can wreak havoc with wind turbine operating costs and uptime statistics.

INTERCONNECTED PARAMETERS

Humidity management enables you to deal with the subtle interplay of numerous conditions and processes that have a very negative effect on wind turbine reliability.

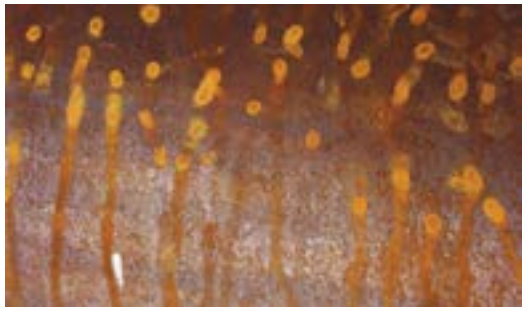
These combine to give a wide range of big problems in wind turbine operations.

HUMIDITY EVERYWHERE

The parameter that makes the biggest difference is humidity – the amount of moisture present in the air.

In offshore wind turbines, there are usually considerable quantities of moisture in the sea air, because of the non-stop action of wind and waves. This means the relative humidity often reaches levels as high as 95–100%.

CORROSION AND CONDENSATION



This airborne moisture causes corrosion, which is renowned as one of the major bugbears for offshore wind turbine operations, affecting sensitive equipment, structures and ancillaries as well as punching big holes in availability statistics.

A second problem lies in condensation, where airborne moisture turns into liquid form because of temperature differences. Pools of salty water forming on and around expensive, vulnerable equipment can never bode well for reliability.

SALTS ATTRACT HUMIDITY

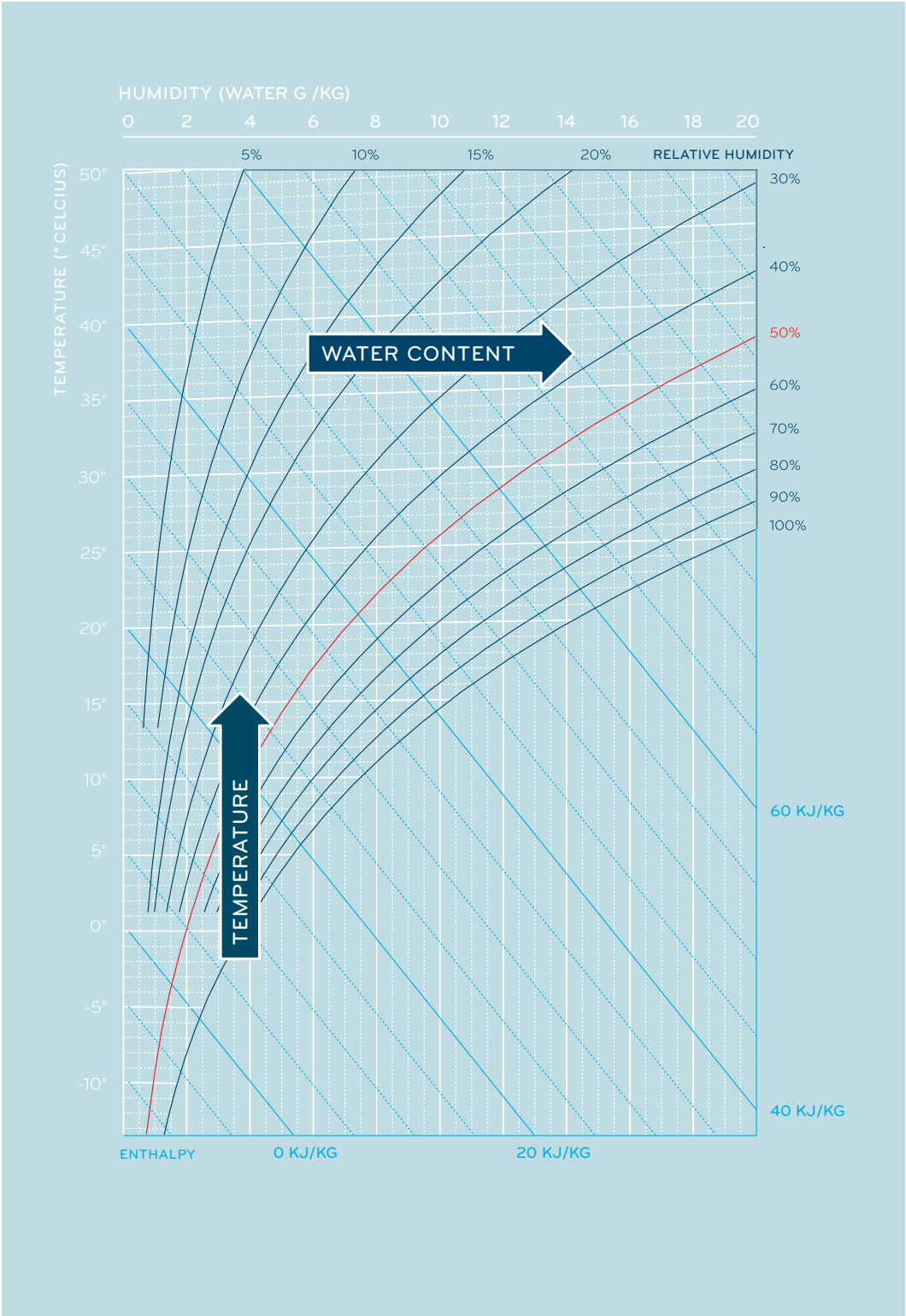
Salts are not normally corrosively active when they are dry. When wet, however, they accelerate the corrosion processes that wind turbine manufacturers and operators all wish to avoid.

But all the chemical salts present in sea air (predominantly sodium chloride) are intrinsically hygroscopic – they attract and absorb any moisture present, forming an aggressive corrosive cocktail that is an anathema to reliable operations.

TEMPERATURE SPEEDS UP CORROSION

At any given level of humidity, the rate of corrosion doubles for every 10°C increase in temperature. This is a particularly important consideration in turbines configured for use in hot, humid climate zones.

MOLLIER DIAGRAM



TACKLING THE PROBLEM

Cotes adsorption dehumidification technology is one of the few ways you can tackle these issues effectively.

If you can keep humidity at sufficiently low levels – normally below approx. 50% – the basic laws of physics mean that corrosion simply cannot take place, regardless of the quantities of corrosive salts present.

So if you can keep humidity at sufficiently low levels as well as reducing the levels of salts in the air, you have full control of conditions within the nacelles and towers you manufacture.

This is by far the easiest and most cost-effective way to get on top of corrosion issues.

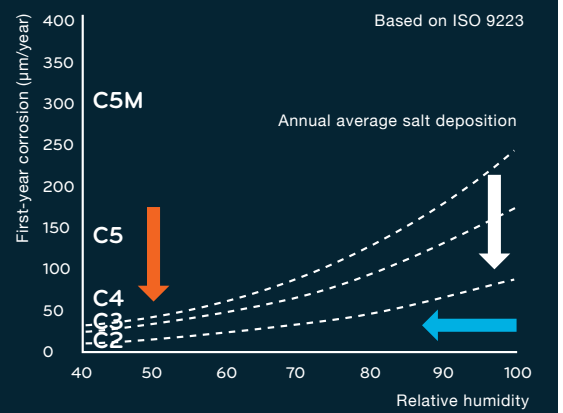
TACKLING CORROSION EFFECTIVELY

Corrosion can be reduced in two ways:

1) Reducing level of salts
(white arrow)

2) Reducing humidity
(blue arrow)

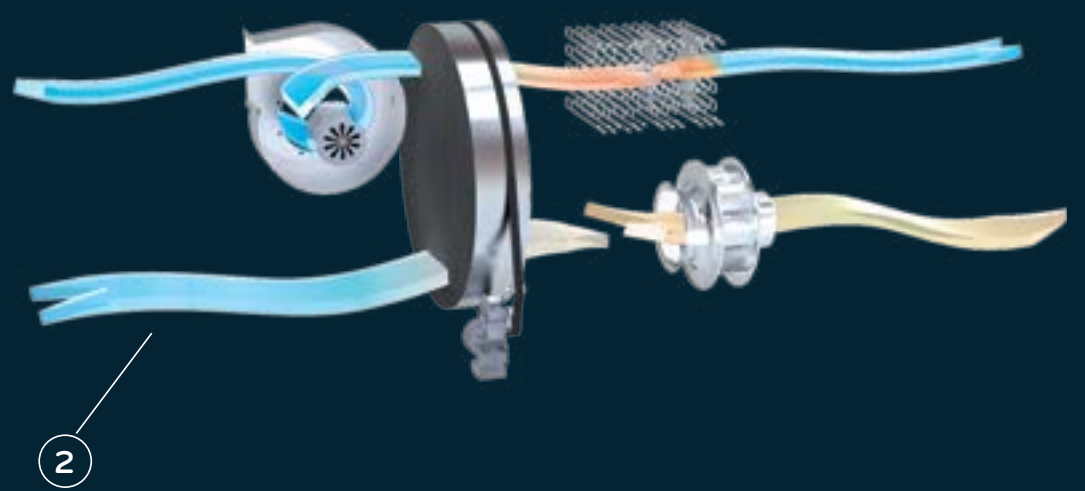
BENEFIT:
Lower speed of corrosion, resulting in lower corrosion classification
(orange arrow)



HOW DEHUMIDIFICATION WORKS

THE ADSORPTION PRINCIPLE

TWO FLOWS OF AIR ...



1 Regeneration air flow

Heated air is used to dry the rotor.
The humid air is then vented away,
leaving the rotor dry and ready for duty.

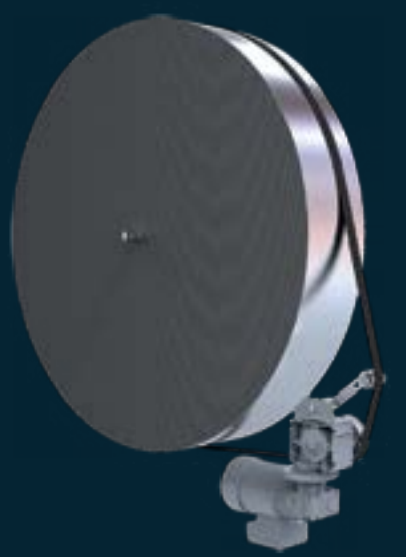
2 Process air flow

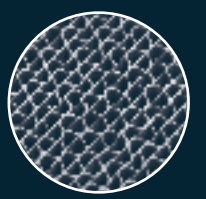
The rotor dries the ambient air so
that it meets predefined specifications.

Self-sustaining process

The process is self-sustaining.
Very little inspection or maintenance is needed.

ROTOR AND SILICA GEL





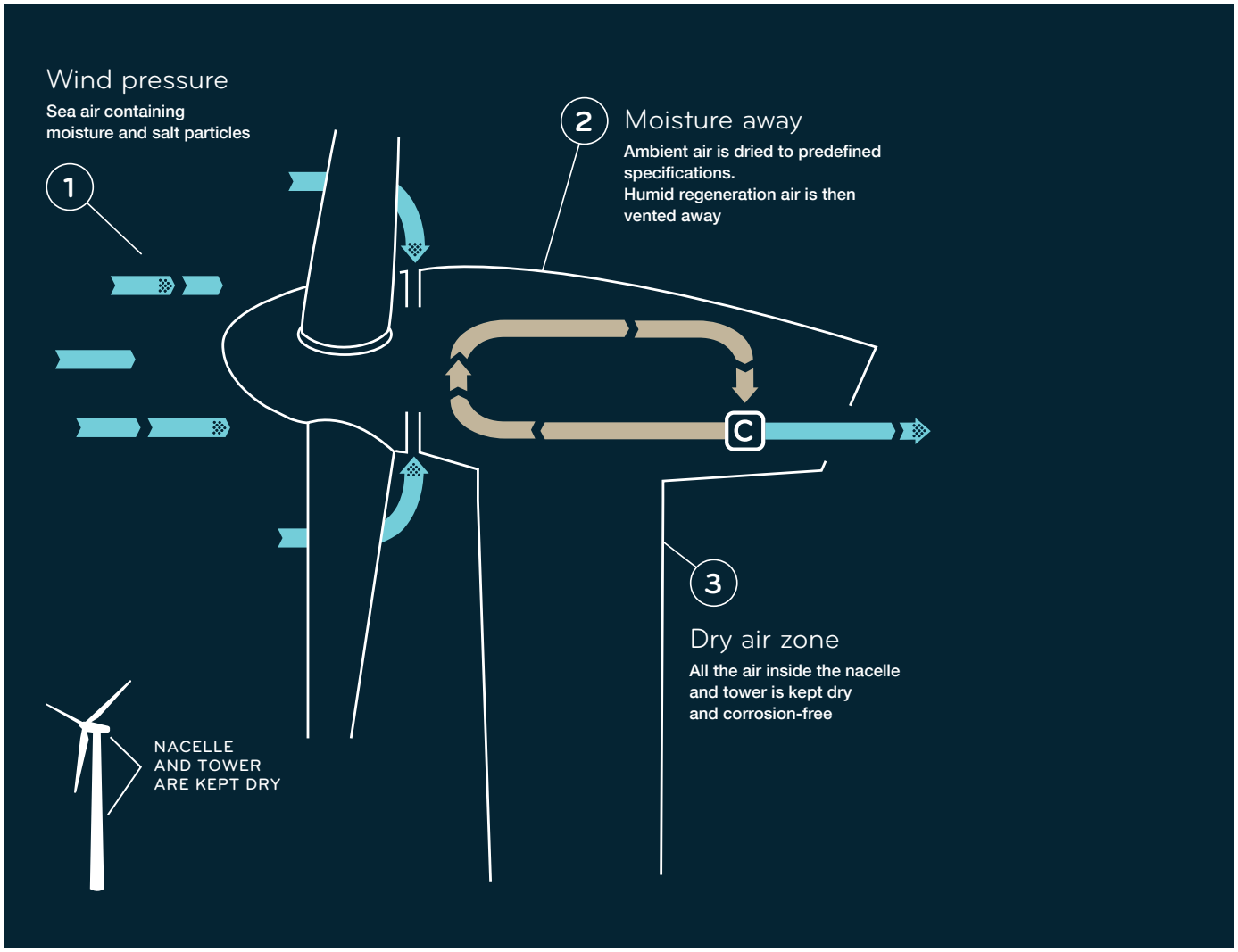
Rotor

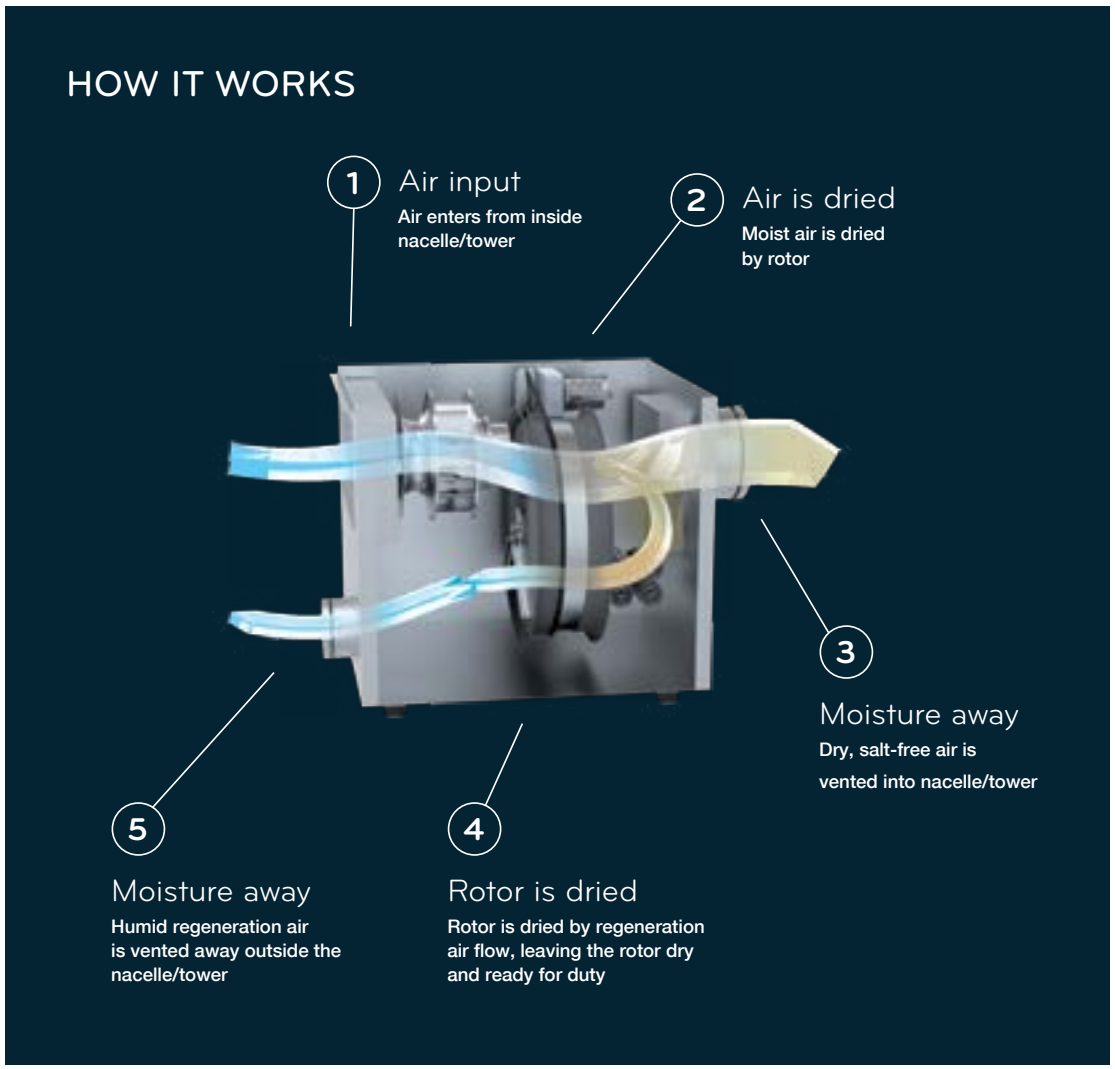
Detail of rotor with
silica gel

Silica gel

1 gram = 5–800m^2
(= 8 soccer fields)

COTES WIND STANDARD



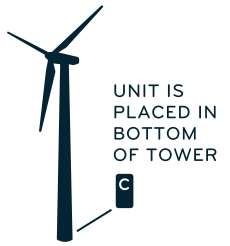


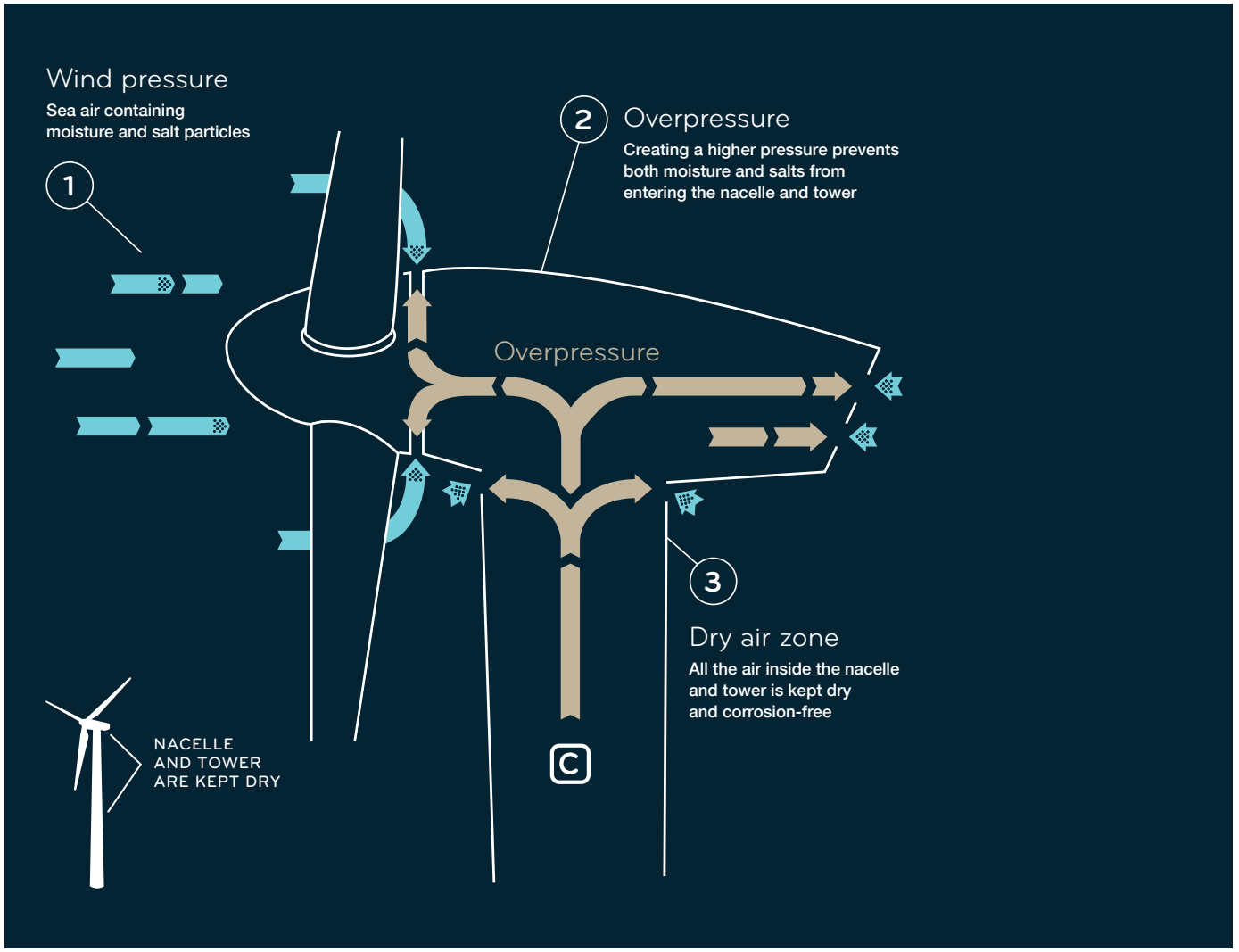
Cotes Wind Standard
One Cotes Wind Standard dehumidifier mounted in each nacelle and tower during storage, transport and erection.

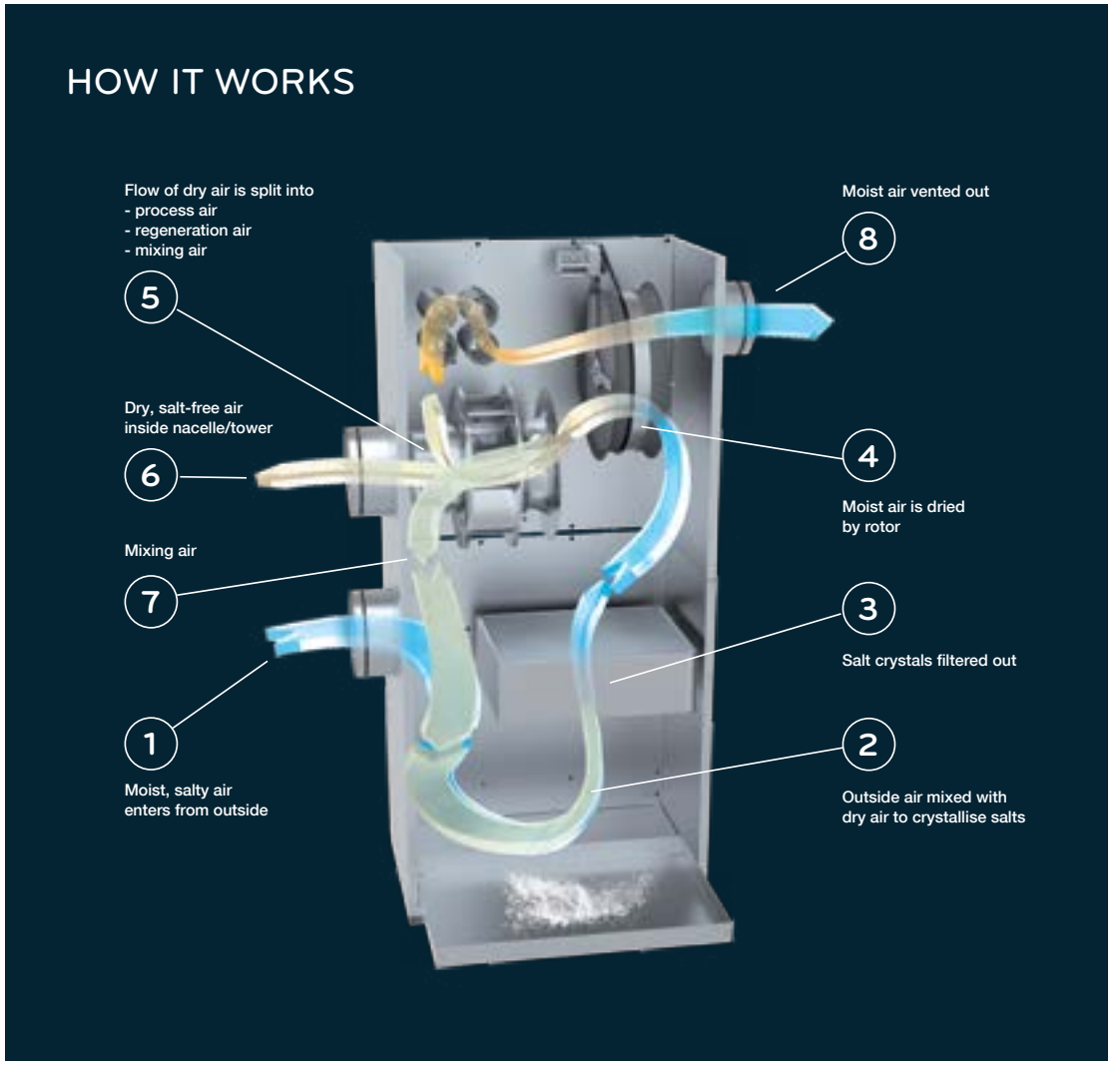
Cotes Wind Standard with salt filter and air flow

> Flow of drier air makes it possible to remove the salt content in air from outside the nacelle/tower
> Air from inside is filtered and dried when needed.

COTES WIND OVERPRESSURE







Cotes Wind Overpressure
One Cotes Wind Overpressure dehumidifier mounted in each tower helps prevent both moisture and salts from entering the nacelle and tower during normal operations.

Salt filtration
When dried, the salt can be filtered out using relatively straightforward filtration set-ups.

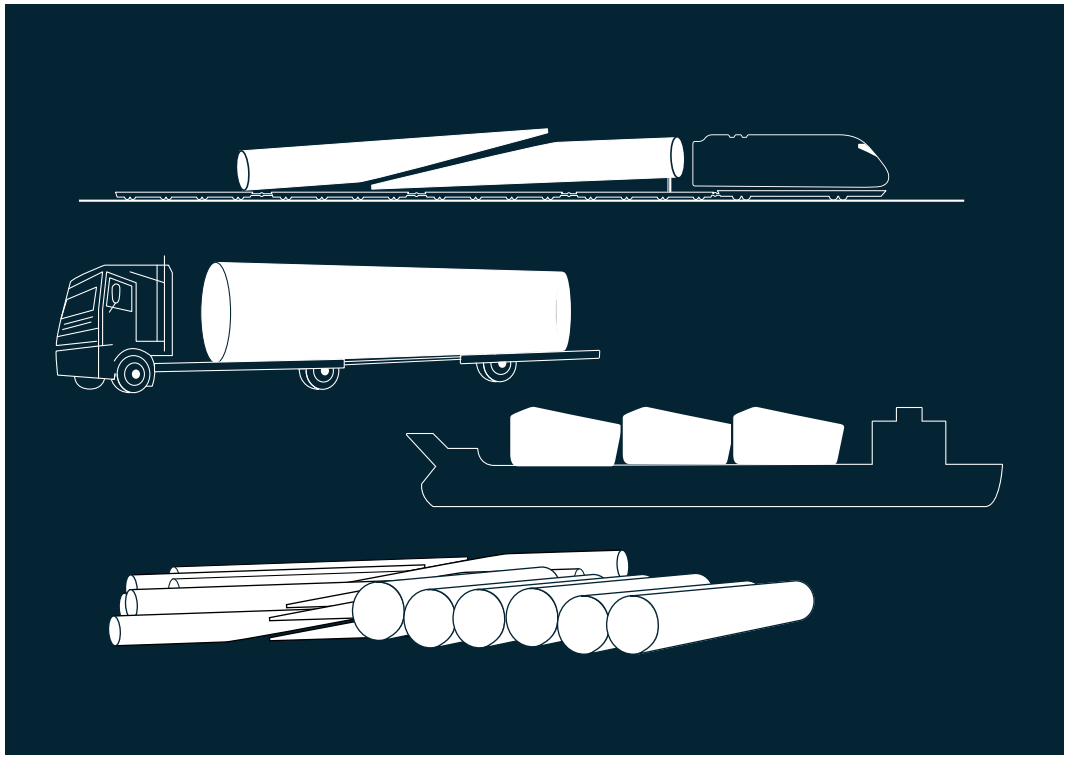
Cooling option
Cotes Wind Overpressure dehumidifier can be configured to use thermal inputs from the wind turbine's own cooling system to dry the air inflow.

BENEFITS

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

- Better uptime statistics and increased availability
- Lower development costs and faster time to market
- Better control of conditions and operating parameters throughout the nacelle and tower
- Lower ISO 9223 corrosion classifications, reducing costs for equipment, fittings and materials
- Condensation-free surroundings, reducing costs for surface coatings
- Faster, glitch-free commissioning
- Full protection during idle and power-down periods
- Lower maintenance/service costs
- Longer service life
- Safer working environment.

PROTECTION DURING TRANSPORT AND STORAGE



Exposed and vulnerable
The nacelles and towers for wind turbines can spend a long time in transit from your factory. They often spend a long time being transported by ship, road or rail en route to a pre-erection holding facility.

And they can also spend a long time in storage on quays and at unprotected terminals, exposed to the full spectrum of changing weather conditions.

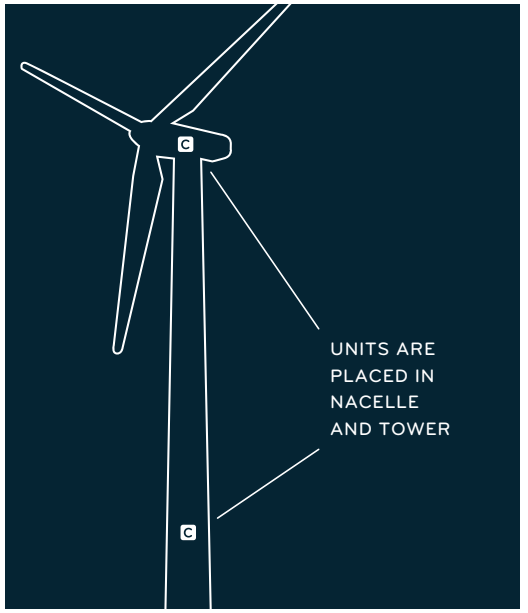
While in transit, they are exposed to unpredictable and uncontrollable conditions that affect the viability and reliability of your products, as well as making assembly and onsite commissioning more difficult and more glitch-prone. Your company's reputation can be at stake.

Dry and protected
A factory-installed Cotes Wind Standard unit enables you to make sure the internals of your wind turbines are in pristine condition when they finally arrive on site for erection.

Effective humidity management helps you make perfectly sure there aren't any corrosion or condensation problems in your products before they are even brought into service.

These relatively small, lightweight dehumidifiers are the ideal way to ensure commissioning goes without a hitch, with no expensive delays or penalty charges.

EASY TO MOUNT, EASY TO INSTALL



COTES WIND STANDARD

Small footprint
These lightweight, plug'n'play dehumidifiers only have a tiny footprint, making it easy to mount them just about anywhere without taking up 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:

> One vent in the tower door
> Mounting on a wall bracket or on the floor
> One single industry-standard humidity sensor mounted somewhere in the tower.

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, plug'n'play dehumidifiers are designed to ensure they don't take up too much space – that's why they are designed higher rather than wider.

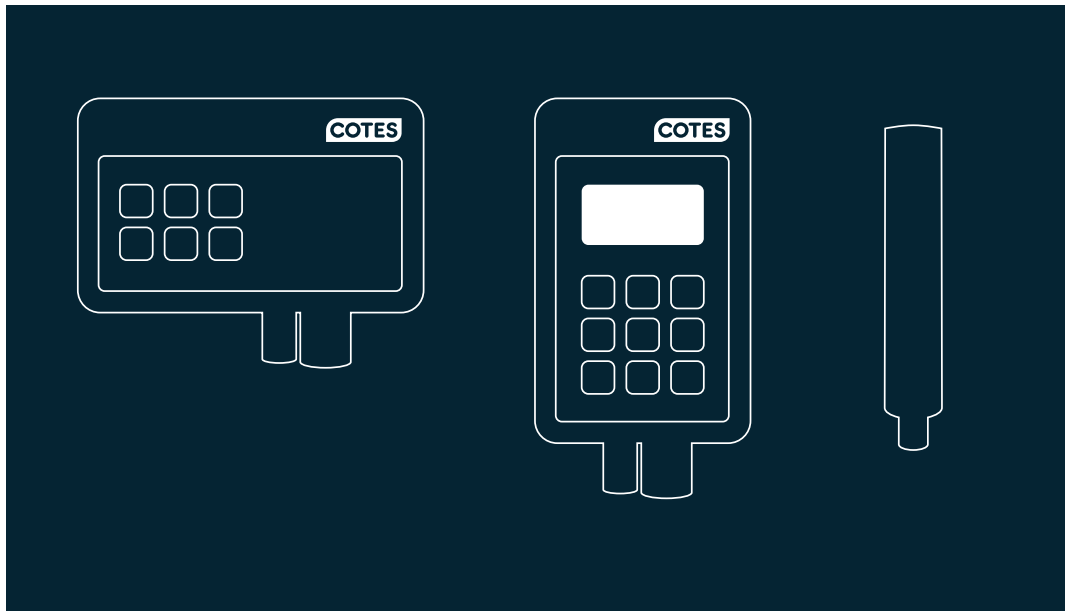
Easy to install
A single unit is normally mounted in the base of the tower.

The overpressure is controlled by supremely reliable sensors mounted in appropriate places within the nacelle and tower. Overpressure units can be connected to – and controlled by – the turbine's control system.

The only 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.

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.

EASY SERVICE
– MINIMAL MAINTENANCE

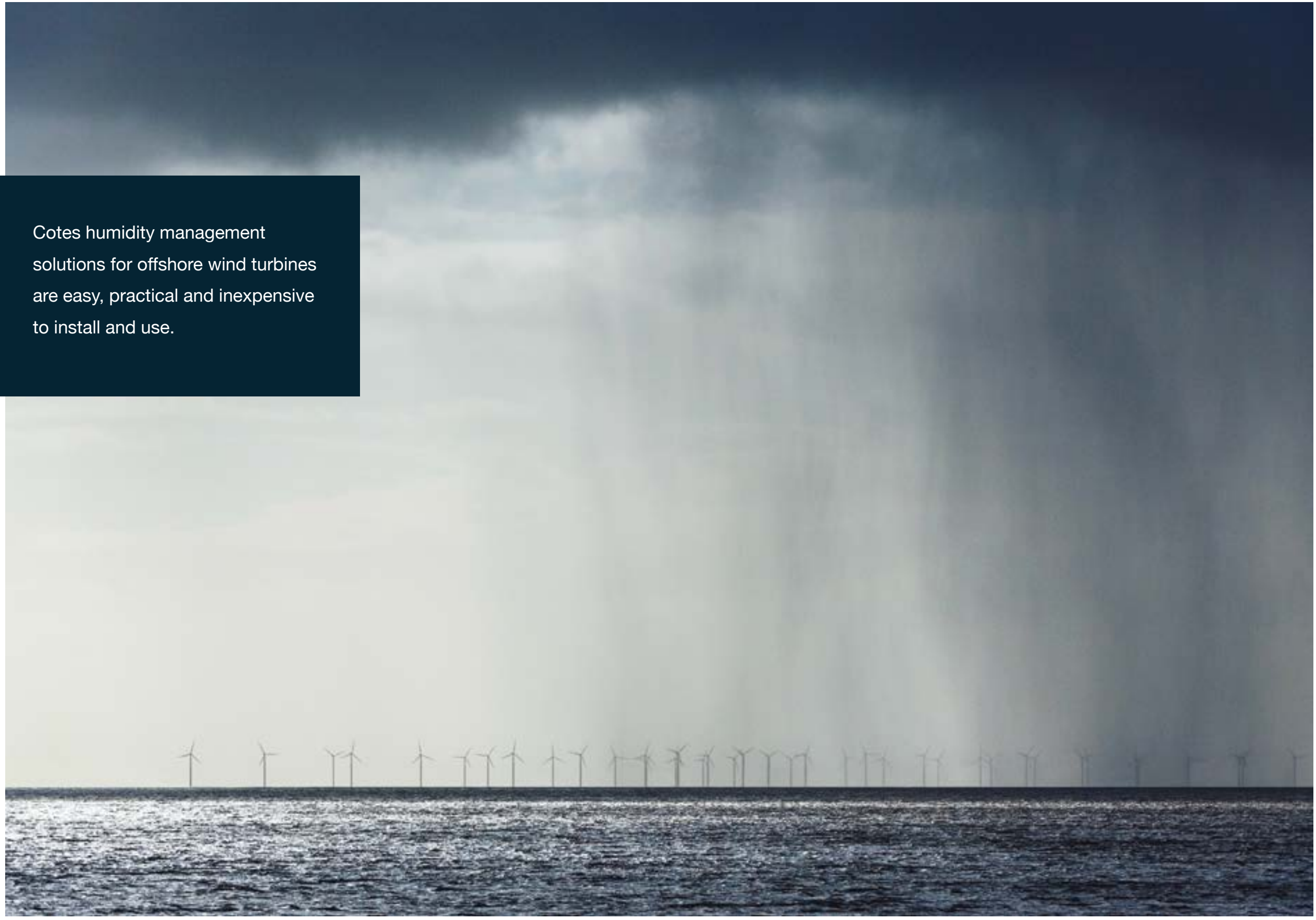
Out of sight, out of mind
Because of the location – and the costs for service staff access – offshore equipment has to be supremely dependable.

Cotes Wind adsorption dehumidifiers are therefore specially designed for use in offshore wind turbines, where reliability and uptime are paramount requirements.

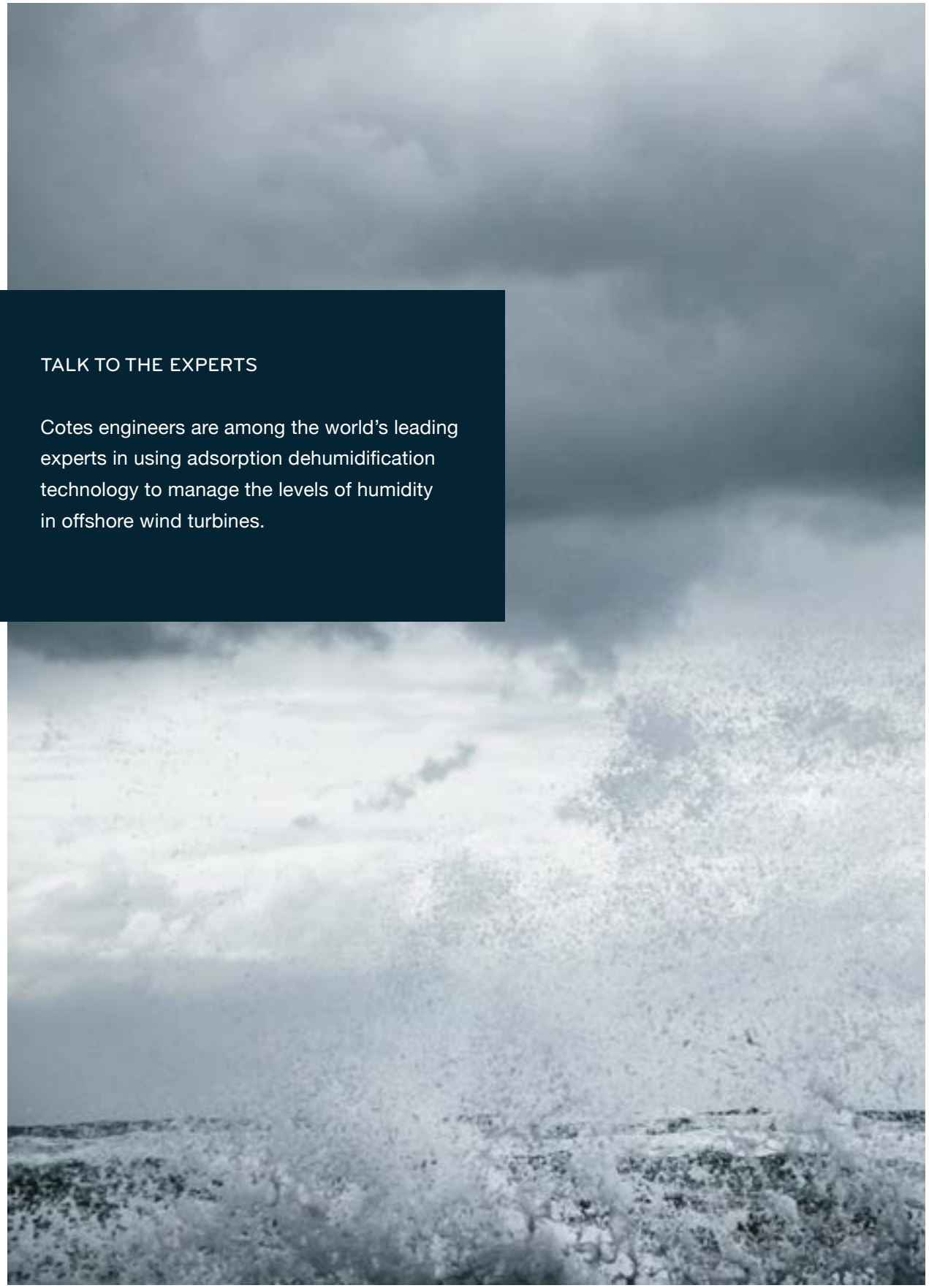
They only require minimal service and maintenance, which can easily be timed to coincide with normal service intervals and maintenance visits for other equipment.

Easy to look after
Once mounted, Cotes humidity management solutions 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).



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



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 offshore wind turbines.

COTES RECOMMENDS

Expertise makes the difference
Cotes is the world's leading supplier of intelligent humidity management solutions for offshore wind turbines. Cotes' practical experience in this specialist field helps manufacturers of 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 45–60%.

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 an effective choice of air recirculation and 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 ducting the dry air into the cabinet or enclosure that contains the particular item of equipment.

A QUESTION OF CHOICE

YOU SHOULD PROBABLY OPT FOR **COTES WIND STANDARD** UNITS IF ...

.. YOUR MANUFACTURING AND INSTALLATION PRIORITIES FOCUS ON

- Smaller wind turbines
- Standardised dehumidifiers with a lower price point
- Less complicated equipment with a proven track record
- Relatively straightforward/low-tech humidity control that is only used when needed
- Corrosion protection while turbines are idling or powered-down
- Low energy consumption

... YOU'RE LESS FOCUSED ON

- Keeping moist, salt-laden air out of your nacelles and towers
- Health and safety requirements

YOU SHOULD PROBABLY OPT FOR **COTES WIND OVERPRESSURE** UNITS IF ...

... YOUR MANUFACTURING AND INSTALLATION PRIORITIES FOCUS ON

- Keeping moist, salt-laden air from even entering your nacelles and towers
- Actively dealing with salt from sea air, to minimise any risk of corrosion
- Using enclosed-structure designs
- Being able to achieve a lower ISO 9223 corrosion classification
- Providing the best possible safety conditions and environment inside your nacelle and tower designs
- Boosting competitive advantage by using patented technology

... YOUR WIND TURBINE DESIGNS ENABLE YOU TO

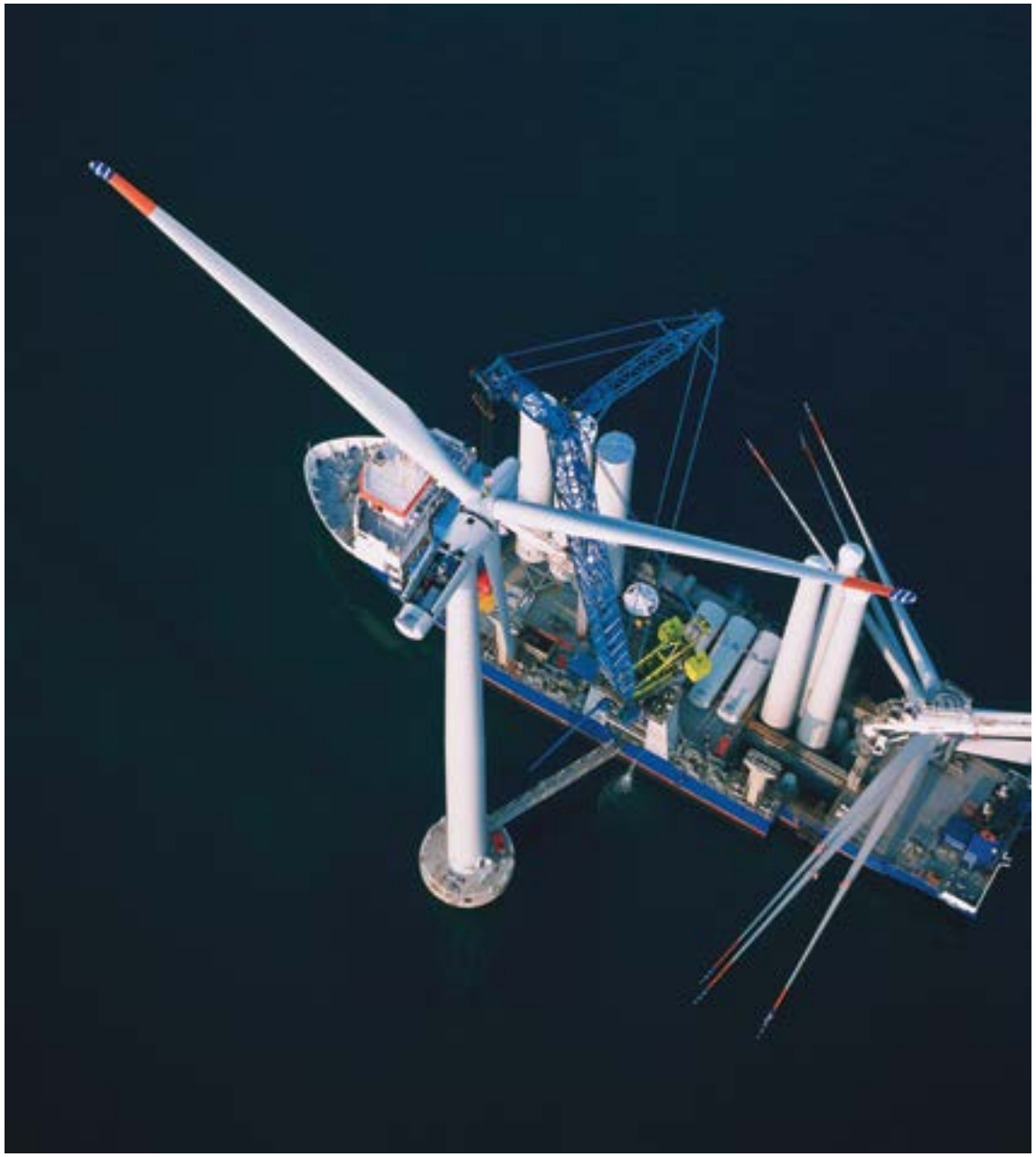
- Source thermal inputs from cooling systems installed elsewhere
- Combine Cotes dehumidifiers with other equipment to ensure cold/dry air to particular components
- Mount heavier, customised dehumidifier set-ups

THE BENEFITS ADD UP

Cotes 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
- > **PROBLEMS WITH SALT AND FILTERS** DONE AWAY WITH
- > GET TO MARKET QUICKER, WITH FASTER PRODUCT DEVELOPMENT
- > LOWER ISO 9223 CORROSION CLASSIFICATION REQUIREMENTS
- > 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 offshore wind turbines.

Patented Cotes solutions have dramatically altered the parameters for what's possible in humidity management – and for what offshore wind turbines can achieve.

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 means 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 under-the-radar technology can help your company get an additional edge in the fiercely competitive world market for reliable offshore wind turbines.

EXPERTS
IN MANAGING HUMIDITY

About Cotes
Cotes A/S in Denmark is the world's leading expert in adsorption dehumidification technology, providing high-quality, low-maintenance humidity management solutions that are remarkably energy efficient.

Cotes technology and expertise enable customers to gain full control of air humidity and enjoy the multiple benefits and savings made possible by effective humidity management.

For more information please call +45 5167 2903, or send a mail to info@cotes.com

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