

MANAGING HUMIDITY IN COLD STORE INSTALLATIONS

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HUMIDITY – THE INVISIBLE PART OF THE CONTROL EQUATIONS

DIFFICULTIES GET DEALT WITH

Cooling goods for low-temperature storage can often lead to big problems with unwanted ice and condensation – all caused by humidity. Humidity is an invisible parameter that can ratch up operating costs and punch big holes in customer satisfaction.

Cotes adsorption dehumidifier solutions enable you to tackle the fundamental reasons why ice and condensation even arise – giving you full control over conditions, lower operating costs and greater customer satisfaction.

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TARGETING SYMPTOMS OR ROOT CAUSES?

DIFFICULTIES GET DEALT WITH

Cooling goods for low-temperature storage can often lead to problems because humidity present in the air makes ice and condensation form – resulting in loads of bothersome practical difficulties and revenue-nibbling costs.

Most companies that operate refrigerated or freezer storage facilities have learned to tackle the normal day-to-day ice and condensation problems, or have invested in ways to keep them to a minimum. Efficiency, customer satisfaction and profit margins depend on it.

SYMPTOMS OR CAUSES?

The problem is that this is only dealing with the symptoms – not the root causes. Patching not preventing.

Cotes adsorption dehumidifier solutions enable you to tackle the basic physics of why ice and condensation even arise – giving you full control over conditions, big savings because you don't need to spend money on costly preventive measures, and satisfied customers because goods don't get spoilt or get their packaging damaged while stored in your facility.

The sums add up – big time.

DO YOU HAVE A HUMIDITY PROBLEM?

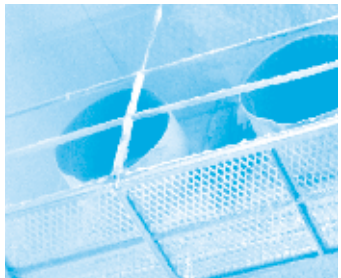
HUMIDITY CAN'T BE SEEN

It can be difficult to know how much humidity is actually present inside your cold store set-up. The moisture is in the air, and you can't actually see humidity – just the tell-tale signs that it's there.

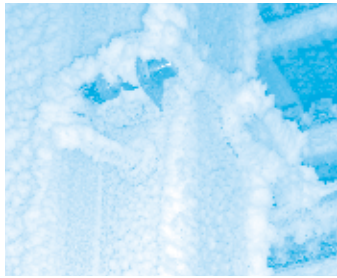
Nevertheless, humidity – and in particular the tangible results of uncontrolled humidity – can have big effects on a wide range of your operating costs. The problem is that the links between cause and effect aren't always obvious.

BUT THE SYMPTOMS CAN

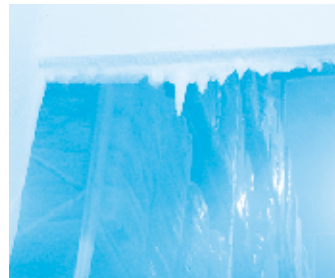
THE TELL-TALE SYMPTOMS ARE THINGS LIKE:



Ice forming on fixtures and equipment, and blocking evaporators



Water and ice accumulating and causing problems



Ice and ice pickles forming on cold surfaces



Stored goods getting wet and damaged



Mist forming in the air

THESE PROBLEMS USUALLY NEED DEALING WITH BECAUSE:

- > They give rise to additional costs that burden your budgets and affect profit margins
- > They represent damage to stored goods and their packaging – which is bad for business and soon means dissatisfied customers
- > They give rise to work environment issues and conditions that are dangerous for anyone working in or passing through the facility
- > They represent lack of control over operating conditions, thus affecting quality assurance and good practice in cold store management.

HOW BIG IS THE PROBLEM?

Ice and condensation will always form to some degree in any refrigerated or freezer storage facility – you can't escape the basic laws of physics.

The question is whether there is an acceptable level? At what point should you actually take any measures needed to limit or control any undesirable levels of humidity that give rise to such ice and condensation? When does an irritant and a bugbear become an unacceptable cost?

The deciding factor usually lies in the balance between cost and benefit. When ice and condensation start making a significant impact on your operating costs, customer retention statistics or work safety record, it's probably time to do something about it.

CAN YOU REALLY CONTROL HUMIDITY?

The formation of ice and condensation is pretty much inevitable in any refrigerated or freezer storage facility – and probably has been ever since mankind opened the door on industrial refrigeration.

The layman perception is that it's a persistent, nagging problem that seems unavoidable.

However, the basic laws of physics mean that ice and condensation can, in fact, be kept from forming by controlling and adjusting the conditions present in the air.

In many existing set-ups, the only realistic, reliable way to do this is by adsorption dehumidification – applied in the appropriate manner.

WHAT DO HUMIDITY PROBLEMS COST YOU?

What do humidity problems cost you? What will it cost to make changes in your cold store set-up, and to introduce humidity management? Will it actually pay to make any changes/improvements?

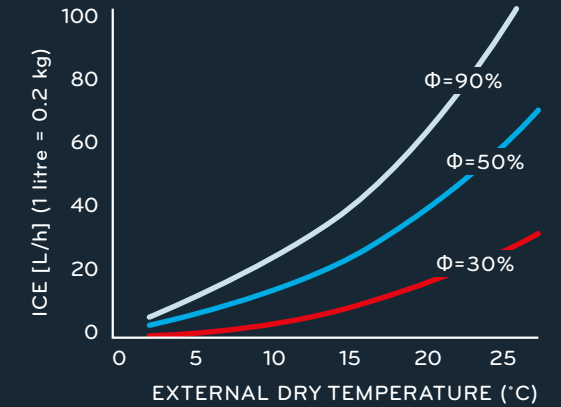
Cotes experts have solid practical experience with helping customers determine the exact costs and benefits associated with humidity and its control. Please contact us to hear more.

ICE BUILD-UP IN A FROZEN GOODS STORAGE FACILITY

-18°C

Ice build-up in a frozen goods storage facility as a result of different air conditions.

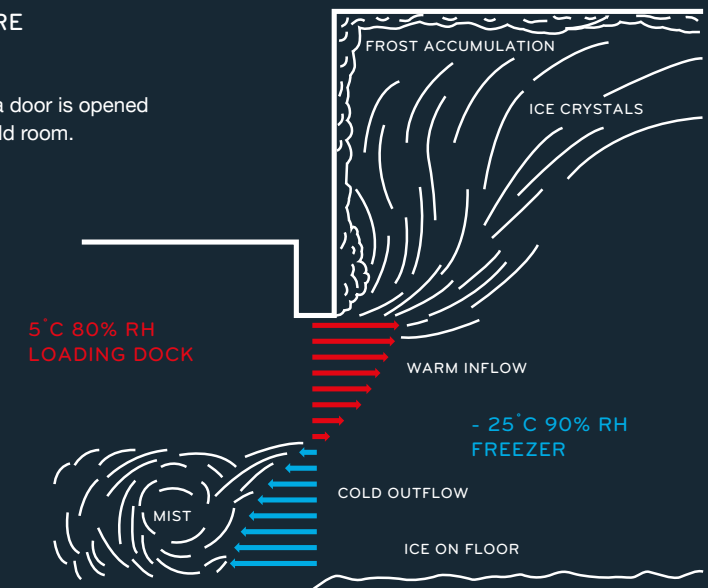
Moisture entry is through a 6m² opening with doors that open for 10 seconds, 10 times an hour (on average).



EXAMPLE OF MOISTURE LOAD FROM DOOR OPENINGS

TYPICAL COLD STORE DOORWAY

How the air moves when a door is opened between a warm and a cold room.



A door 3 metres high and 2 metres wide is opened 10 times per hour for 10 seconds. The external climate conditions are 8 °C and 80% relative humidity. The conditions inside the cold storage facility are -18 °C and T_{dew} = -20 °C).

The moisture load from such a door (disregarding draughts during opening) is then around 2.5 kg/hour.

A cold storage facility with four such doors will then be exposed to the ingress of 10 kg moisture/hour.



PRACTICAL ISSUES COMMON IN COLD STORE SET-UPS

SOURCES OF HUMIDITY

Ice and condensation stem from air laden with undesirable moisture, undergoing a phase change when certain specific conditions arise.

The most common sources of such moisture-laden air are:

- > Points of entry where doors/barriers are open for too long and/or close too slowly
- > Inappropriately sealed doors/openings in the outer structure
- > Ineffective sluices and other areas where goods are “in transition”
- > The goods stored within the facility
- > People and vehicles present within the facility
- > Pressure equaliser set-ups.

WHERE ICE AND CONDENSATION FORM

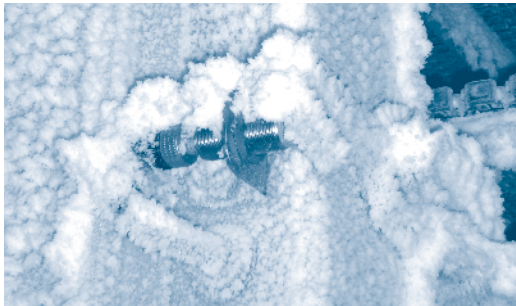
FLOORS



WALLS



OTHER TECHNICAL EQUIPMENT



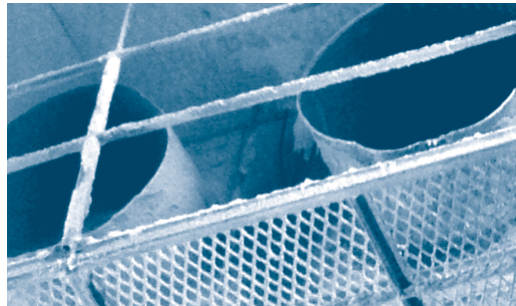
STORED GOODS



CEILINGS



AROUND EVAPORATORS



UNFORESEEN PLACES



A PLETHORA OF PRACTICAL PROBLEMS

Unwanted ice and condensation can cause a wide range of costly problems in cold store facilities. In consultation with industry experts, Cotes specialists have identified the following as the most serious and the most widespread problems.

REDUCED PRODUCT QUALITY AND CUSTOMER SATISFACTION

Melting ice or pooled condensation can damage the packaging of goods in the cold store facility
→ Greater waste, reduced profit margins and negative effect on customer relations

Undesirable moisture can result in both damage and contamination of goods in the facility
→ Health risks, greater waste, reduced profit margins and negative effect on customer relations

Depending on conditions, moisture can condense on the strip curtains through which people and/or vehicles and goods-moving equipment enter/exit the facility
→ Possible cross-contamination of other goods passing through the curtains

Any cleaning/washing of the interior of the cold store at temperatures above 0 °C can affect the viability of the freeze chain
→ Damage to the value/quality of the goods stored, including bacterial growth

SAFETY ISSUES

Ice and condensation result in slippery floors
→ Staff can slip/fall, forklift trucks, pallet movers and other equipment can skid and cause accidents and injuries as well as damaging goods, equipment and fixtures

Humidity in the air can cause mist and reduced visibility
→ Accidents affecting staff, vehicles, goods, equipment and fixtures

Ice deposits can fall
→ Injuries to staff and damage to goods, equipment and fixtures margins and negative effect on customer relations

REDUCED PRODUCT HANDLING EFFICIENCY

Ice and condensation can result in many small hindrances to effective, error-free transport, stacking and logistics
→ Reduced product handling efficiency and higher costs

Ice can form on the barcodes on products, packaging and pallets
→ Product IDs/labels falling off or cannot be read/scanned effectively, resulting in non-productive time and workflow inefficiencies margins and negative effect on customer relations

POOR WORKING ENVIRONMENT

Formation of ice makes it difficult to close doors and other openings properly
→ Draughts, additional ingress of moisture-laden air, etc.

Staff experience a cold working environment with high levels of humidity as colder/more uncomfortable than an environment with the same temperatures but low humidity
→ Lower staff morale, higher absenteeism statistics

WASTED MAN-HOURS AND REDUCED PRODUCTIVITY

Once formed, ice needs to be removed and condensation needs to be dried up before it freezes to ice
→ Constant need to use manpower for non-productive purposes

Ice and condensation result in slower movement and more accidents
→ Lower productivity and higher manpower costs for treatment/compensation/insurance, etc.

HIGHER ENERGY BILLS

Ice and condensation in cold stores need to be removed
→ Additional energy consumption for defrosting of fixtures, fittings and refrigeration equipment

Evaporators work inefficiently when iced up
→ Additional energy consumption

In some cold stores floors are heated to avoid icing
→ Additional energy costs for heating as well as for the cooling system needed to remove the heat again afterwards margins and negative effect on customer relations

HAVE YOU GOT PROBLEMS WITH ICE AND CONDENSATION?

NO

Because of effective, fully optimised cold stores set-up

Because of electric heating in the floors, low evaporation temperature, multiple defrosting cycles, heavy load on the refrigeration system, etc.

You can achieve savings on your energy bills via adsorption dehumidification

YOU ARE LUCKY

YES

Openings and cracks in the building structure

Humidity from goods in storage

Ineffectively configured sluices / transition areas

Ineffective defrost system

Slow-opening doors

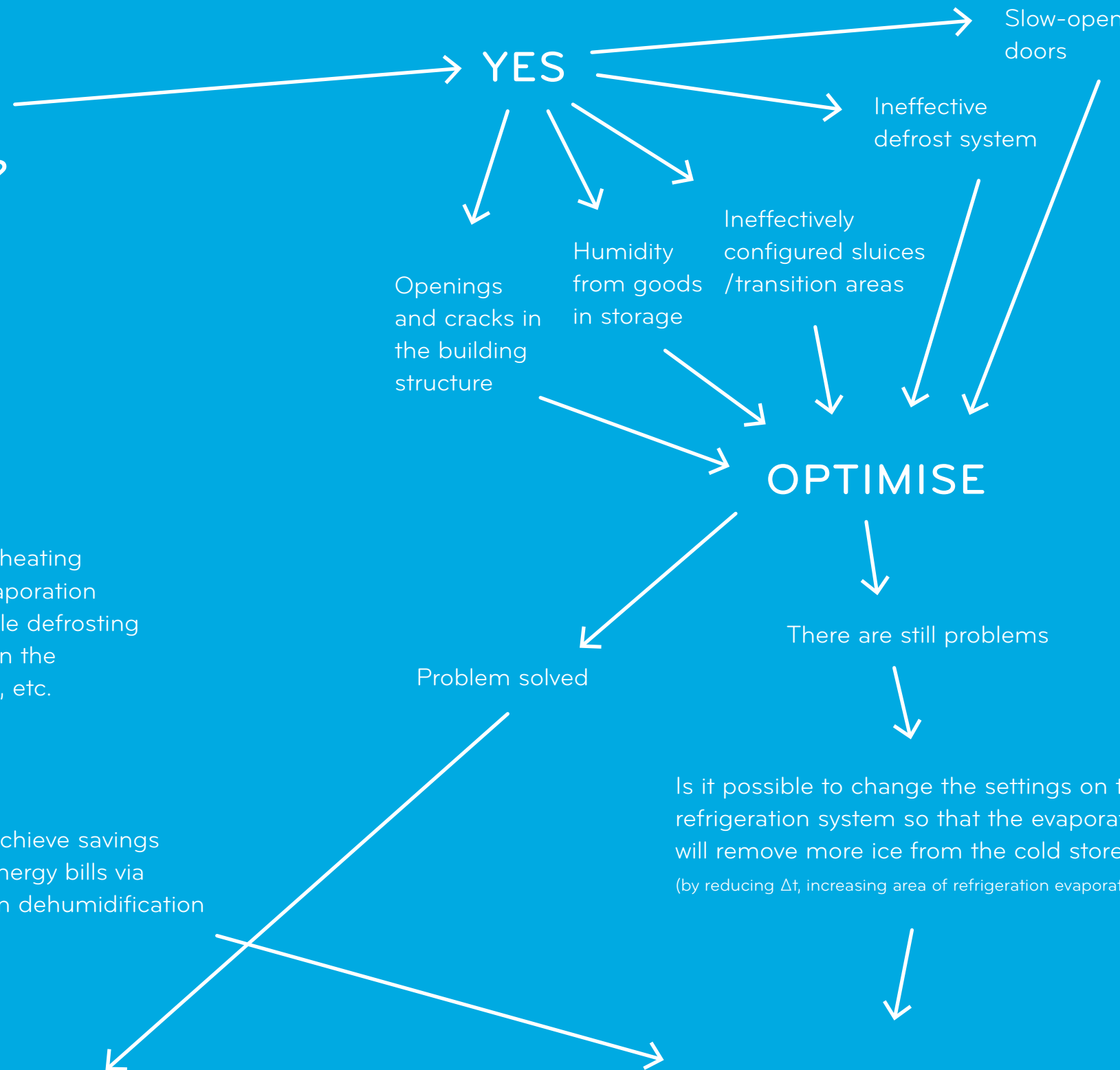
OPTIMISE

Problem solved

There are still problems

Is it possible to change the settings on the refrigeration system so that the evaporators will remove more ice from the cold store?
(by reducing Δt , increasing area of refrigeration evaporators, etc.)

CONTACT COTES







NO TWO COLD STORE SET-UPS ARE THE SAME

YOUR CHALLENGES ARE UNIQUE

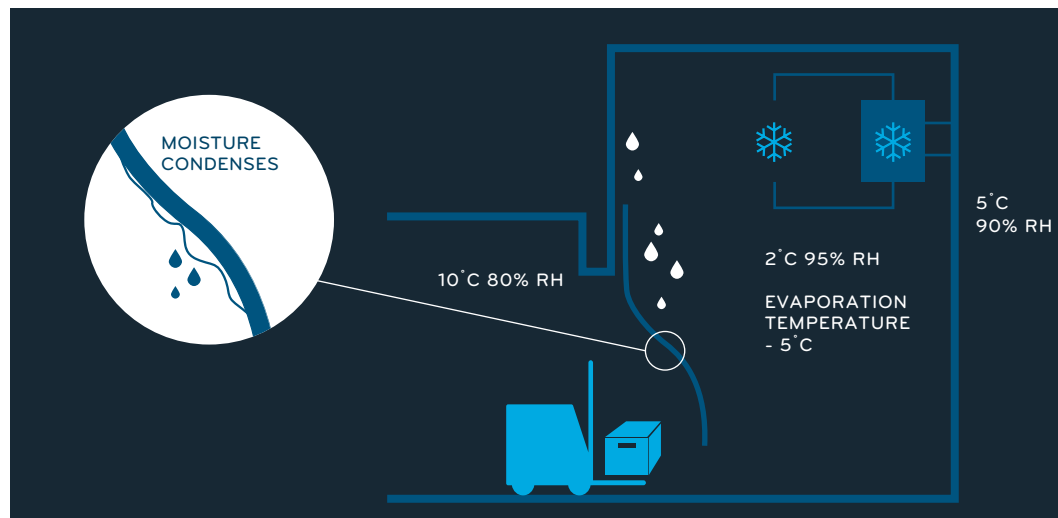
Your particular cold store set-up is probably unlike any other – either because of your particular operating profile and commercial parameters, the equipment and structure, or because of the climate and weather conditions.

Not all cold stores encounter (serious) problems with ice formation and/or condensation, and in each type of set-up the problems and solutions are different.

YOUR CHALLENGES ARE UNIQUE

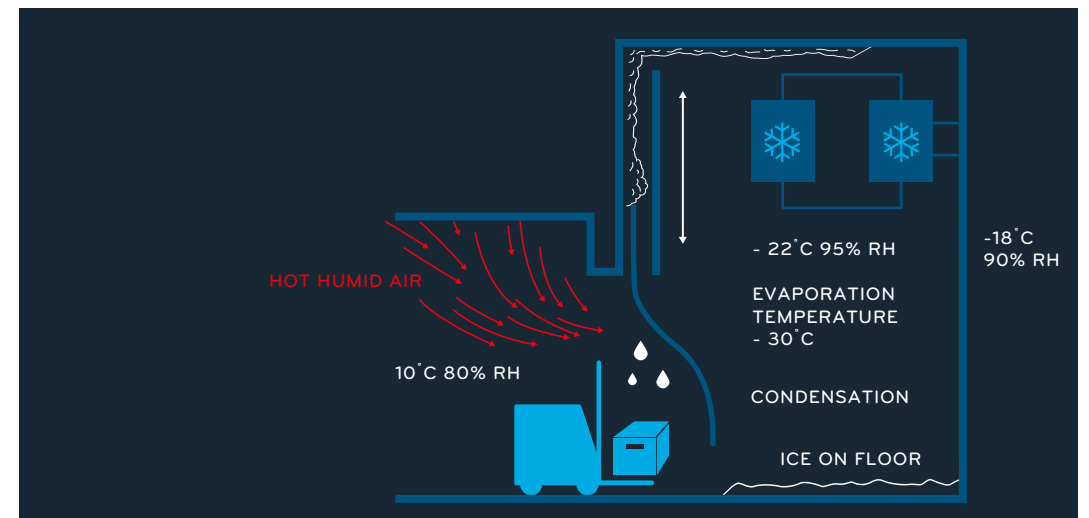
However, in general the situation is as follows:

1. REFRIGERATED STORAGE APPROX. 3-5°C



- > Here there is (normally) no ice formation because temperatures are above 0 °C
- > However, there *can* be ice formation on evaporators because the surface temperature is in fact often below 0 °C
- > In many countries/climates, refrigerated storage units are plagued by big problems with condensation due to moisture-laden air coming into contact with cold surfaces
- > Condensation dripping from ceilings and other surfaces and structures can give rise to bacterial growth and substantial hygiene problems

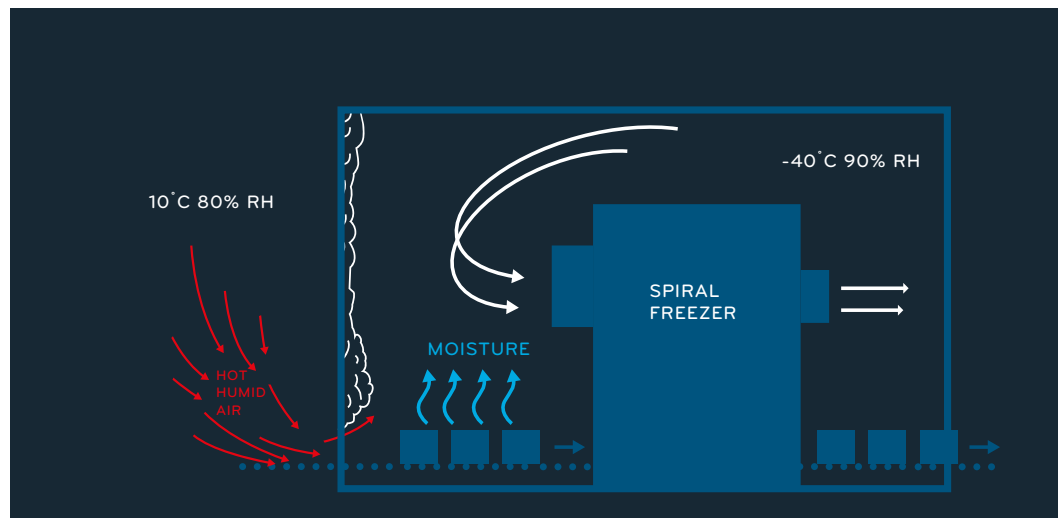
2. FROZEN GOODS STORAGE FOR GOODS ALREADY FROZEN ELSEWHERE



- > Here humidity problems usually stem from moving goods in/out, causing ingress of moisture-laden air via doors, openings, etc.
- > There can be problems with too little air circulation – perhaps resulting in pockets of stationary air – because the flow of air from the fans cannot reach everywhere within the cold storage space
- > The extent of the problem inside the actual cold store will usually depend on levels of humidity in the goods dispatch/reception area or sluice installations

WHAT NEEDS TO BE CONSIDERED?

3. FREEZING OPERATIONS/IQF FREEZERS WITH SPECIAL HUMIDITY PROBLEMS BECAUSE OF HIGH MOISTURE LOADS FROM JUST-FROZEN GOODS



Freezing of bulky goods

- > Although the goods are normally already packaged, the moisture load from such goods can be substantial
- > There is often considerable movement in/out of the freezing section
- > The air temperature is often very low (below -40 °C), which increases the moisture load

IQF freezers

- > There are a wide variety of IQF freezers on the market, and many of these involve substantial evaporation of water from the goods concerned. This moisture can be hard to deal with
- > In some cases, the moisture is present in the form of sub-cooled water droplets in a non-equilibrium state, similar to black ice. This means such moisture is difficult to remove effectively using a conventional dehumidifier set-up
- > In some IQF installations, it is advisable to install a droplet collector/filter/cyclone inside the IQF freezer facility

NEW OR EXISTING COLD STORE SET-UPS

The building of a new cold store facility often makes it possible to incorporate ways of dealing with humidity and ice problems into the design.

Cotes recommends:

- > Low evaporator temperature (or at least to configure the system so that it is possible to reduce the evaporator temperature a little if needed)
- > Rapid-action doors to minimise moisture entry
- > A minimum of gaps and openings of any kind in the building structure, to minimise moisture entry
- > Effective sluices

If you are encountering ice and/or condensation problems in an existing cold store facility, it's highly likely that some of the above considerations have been overlooked or de-prioritised – for all kinds of reasons.

One example is that the main focus in the design of cold stores often lies – quite naturally – on logistics and getting as much pallet storage space as possible, and less on the necessary space or configuration of the refrigeration or cooling set-up.

Here it may make good commercial sense to consider dehumidification as the best solution to your problems.

PACKAGING IS PART OF THE PROBLEM

The goods stored in refrigerated or freezer facilities are almost always in packaged form, as required by efficient logistics and by modern standards of hygiene and quality guarantees.

The materials most commonly used for such packaging are paper and cardboard, and most products are stacked in wooden or cardboard boxes and/or on wooden pallets. All these materials are hygroscopic – they absorb and release moisture from the surrounding air, converting latent thermal energy (energy stemming from the phase change from vapour to liquid) into actual temperature change – or vice versa.

The moisture absorbed by the packaging has to be included in any calculations about levels of humidity in your cold store set-up.

HYGIENE STANDARDS AND CONTAMINATION

A constantly increasing volume of the world's food is now stored and transported under refrigerated or frozen conditions. At the same time, legislative requirements about food hygiene are also becoming more stringent, everywhere in the world.

Uncontrolled humidity – and its consequences – can cause (often invisible) bacterial and fungal growth and food contamination of many kinds. This threatens the value of the goods stored in your facility – and of the contracts with your customers.

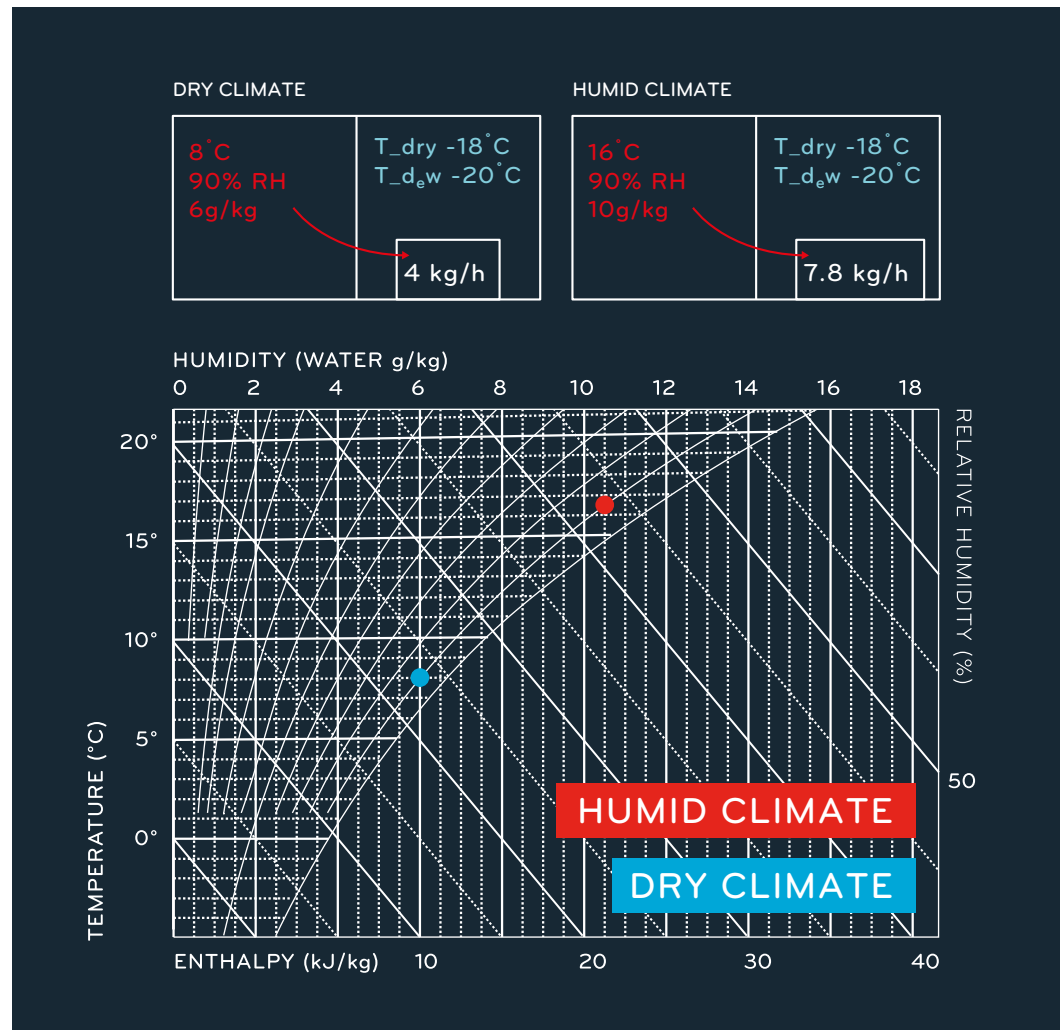
DIFFERENT CONDITIONS DIFFERENT SOLUTIONS

In the complex world of humidity management, there are no “one solution fits all” answers. We are dealing with some of the basic laws of physics, heavily dependent on temperature and pressure conditions as well as numerous other minor variables.

Different climates and seasons of the year involve radically different sets of conditions in different parts of the world. This means different sets of challenges – and solutions, too.

There can also be big differences on account of the goods stored there, and the customer requirements you have to meet.

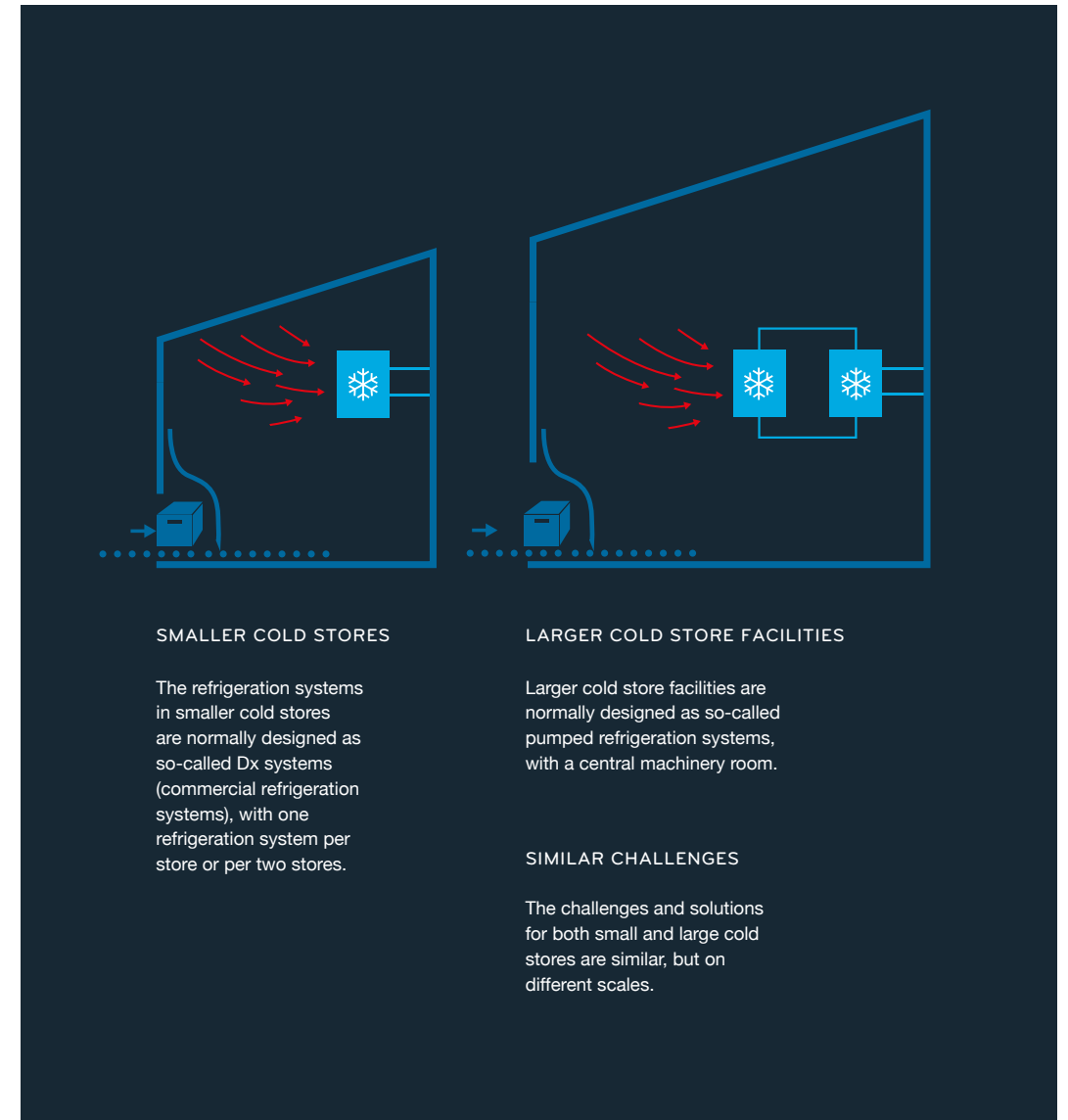
Here is an example of the performance and conditions in a virtually identical refrigerated storage set-up operating under the radically different conditions prevalent in cold and dry climates on the one hand, and hot and humid climates on the other.



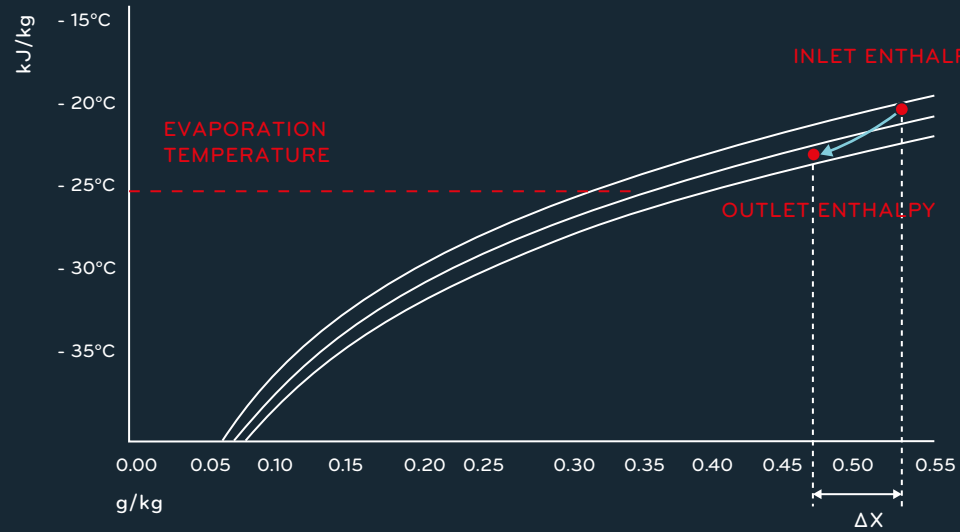
DIFFERENT REFRIGERATION AND FREEZING SET-UPS

The challenges and solutions for both small and large cold stores are similar, but on different scales.

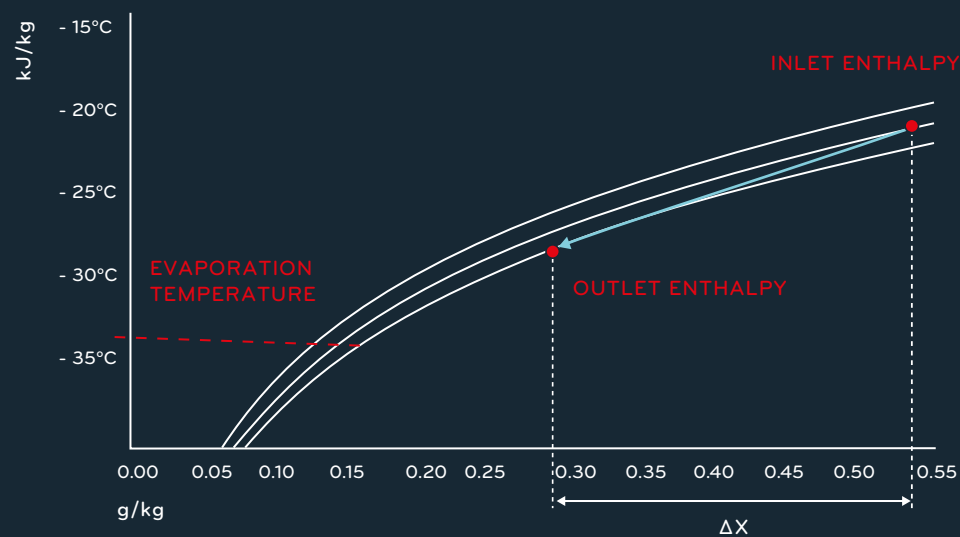
Depending on the overall set-up, the moisture in the air can form on the evaporators in the refrigeration set-up, rather than (or as well as) the walls, ceilings and floor of the facility.



AIR COOLING THROUGH AN ENERGY-EFFICIENT EVAPORATOR



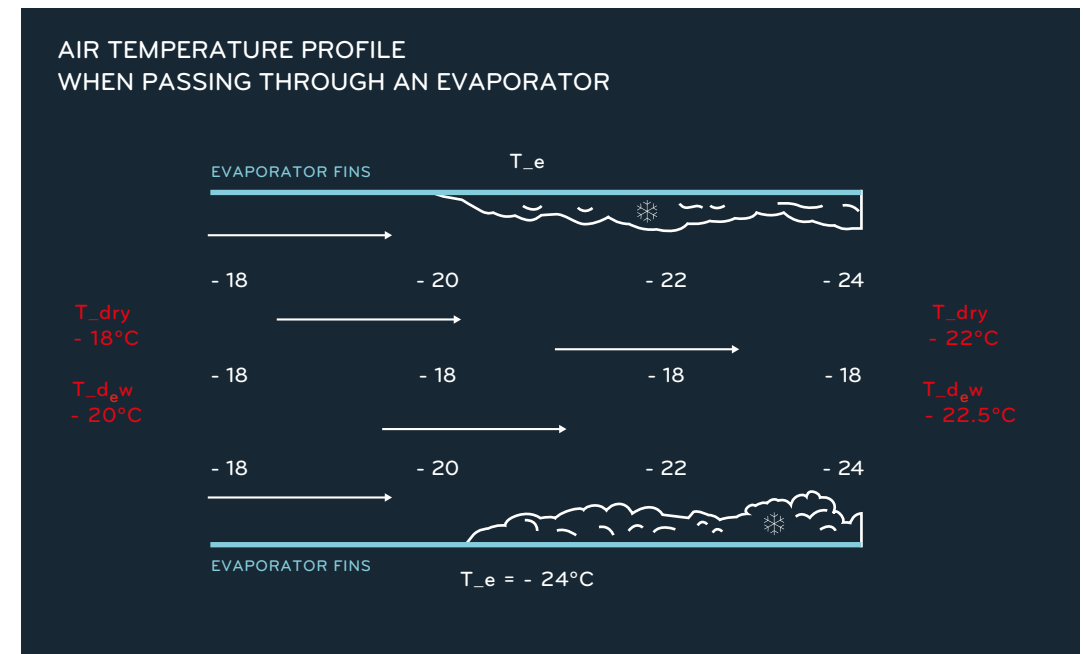
AIR COOLING THROUGH AN EFFICIENT DEHUMIDIFYING EVAPORATOR



Assuming that there is a significant moisture load in a refrigeration or freezer facility, much of this moisture will condense and turn into ice. The configuration of the refrigeration system, and its particular operating profile, will decide whether the moisture condenses and freezes on the evaporators or on the structures and surfaces inside the facility itself.

If moisture from the air is to condense and freeze on the evaporator surfaces, the air must be cooled so much that the dew point is reached. Even though the air leaving the evaporator is actually above the dew point, the dew point is often reached on the surface of the evaporator, resulting in a dehumidification of the air.

When there is a big drop in air temperature as it passes through the evaporators, there is a greater likelihood that the moisture will be deposited on the surfaces of evaporators.



An essential part of keeping a cold store facility free of ice lies in balancing the capabilities and operating profile of the refrigeration and freezer installations with those of a dehumidification system. In a well-configured set-up, both systems benefit – as do operating costs.

And there's the additional advantage that there is almost always waste heat and other forms of thermal energy available in refrigeration and freezer installations – and these thermal inputs can be used to fuel the dehumidification system, and ensure very low operating costs.



HOW TO TACKLE ICE AND CONDENSATION

TWO BASIC APPROACHES

Cotes in-depth technical know-how about the basic physics of humidity enables us to help you make the most appropriate/cost-effective investments (with the right balance of capital costs and operating costs) in the most effective remedial measures.

There are two fundamental approaches to dealing with the formation of ice and condensation in cold stores facilities.

1. Deal with the ice and condensation once it has formed – via de-icing and defrosting
2. Prevent the ice and condensation from actually forming – via humidity management.

THE BASIC CONCLUSIONS

Based on many years of Cotes practical experience, the basic conclusions are that:

1. You get the **best overall return on investment** by preventing the actual entry of moisture into the refrigerated/frozen storage area by closing off places where it can enter.
2. When ice is present, the **lowest energy cost** is achieved by using a combination of an energy-optimised adsorption dehumidifier that uses waste heat and an efficient hot gas defrost system.
3. You get the **lowest overall operating costs** (in many cases) by investing in an adsorption dehumidifier solution that is specifically designed and configured to bring humidity under control and prevent the formation of ice and condensation by establishing conditions in which these cannot arise.
4. You can **boost the efficiency of evaporators** and reduce the number of defrost cycles by bringing humidity under control using adsorption dehumidifiers.
5. **Optimised design/configuration of the refrigeration/freezing system is essential**, as is making sure it is configured to deal with your current usage profile.

DEFROSTING MAKES A DIFFERENCE

DE-ICING/DEFROSTING BIG BENEFITS FROM BOTH

De-icing of structures, surfaces and equipment and the defrosting of evaporators give both practical and technical benefits:

- > Practical = getting rid of ice on walls/structures, safety, etc.
- > Technical = there will always be some ice formation, regardless of how efficient the evaporators are – but the evaporators work more efficiently if levels of humidity are under control.

DEFROSTING

The energy required for defrosting depends on the quantities of ice that needs to be removed and the efficiency of the defrosting method. Both vary considerably – with big consequences.

The defrosting procedures used in cold stores vary widely, but two of the most common methods are electrically heated systems and hot gas systems.

HEAT SUPPLIED FROM EXTERNAL SOURCE VIA ELECTRICAL HEATING COILS –EXTRA ENERGY COST

In these systems, electrical heat is either used to warm the air that circulates through the evaporator or supplied to the evaporator coil itself.

This procedure requires that the supply of liquid refrigerant is stopped before any external heat is supplied.

After a pre-set period, the defrost cycle is stopped and refrigerant is supplied once again.

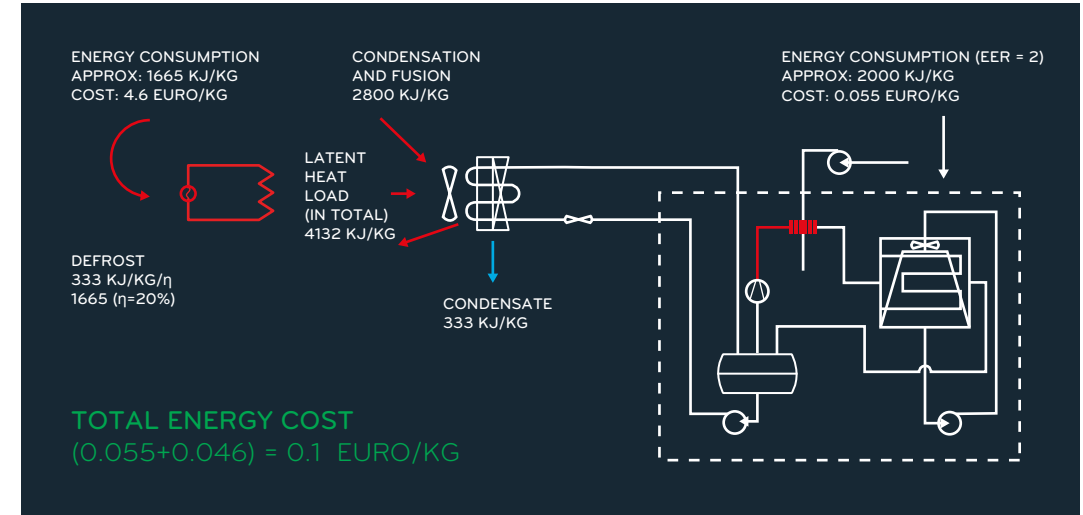
HEAT SUPPLIED FROM INTERNAL SOURCE USING WASTE HEAT FROM HIGH PRESSURE SIDE– THE 'HOT GAS' METHOD

When a defrost cycle is required, the condensing pressure is sometimes increased in order to have enough pressure/temperature to warm the evaporator. This increases energy consumption.

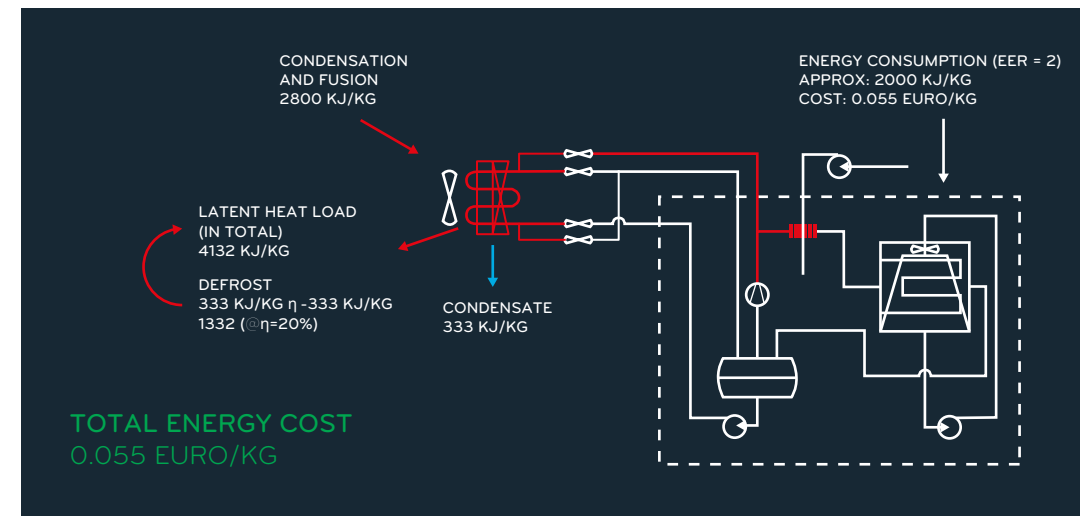
The refrigerant gas – which is at high pressure and high temperature – condenses within the evaporator, transferring heat to the evaporator from the inside, thus melting any accumulated ice.

The design and control of defrosting systems vary considerably, and the diagram can only show the main principle. There is often great savings potential hidden in malfunctioning or out-dated defrosting systems

HEAT SUPPLIED FROM EXTERNAL SOURCE



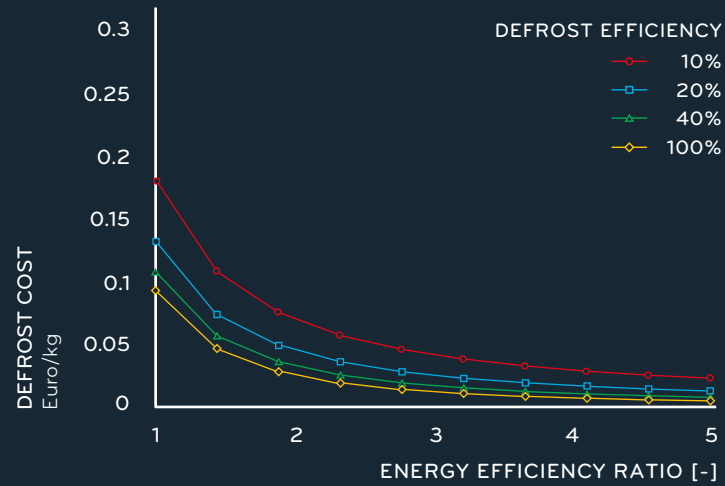
HEAT SUPPLIED FROM INTERNAL SOURCE



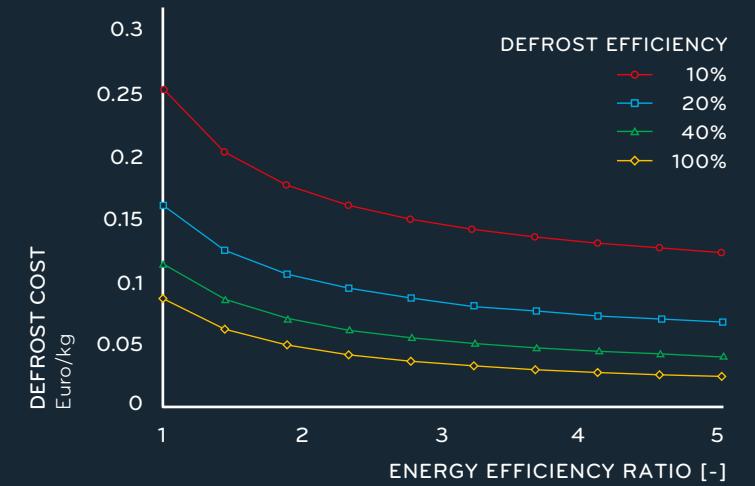
Based on the explanations above, it is possible to calculate the specific energy requirements and costs related to removing ice on the evaporator surfaces in typical cold store set-ups. This is shown in the diagrams below.

Typical defrosting efficiencies are normally in the range of 20–40%.

HOT GAS DEFROSTING



DEFROSTING WITH EXTERNAL HEAT SUPPLY



Cost of condensing and defrosting 1 kg ice at different energy efficiency ratios (EERs), with different defrost efficiencies and in different systems. The specific power cost used for this calculation is €100/MWh.

EXAMPLE

The energy cost related to moisture (10 kg/hour, 8700 hours/year, EER = 2), is:

- > For a hot gas defrosting system €4,350–6,960 per year
- > For an electrical defrosting system €6,090–14,790 per year

These calculations – necessarily approximate – provide a good benchmark against which you can compare the overall costs involved in other approaches designed to tackle undesirable humidity and its practical consequences in your particular cold store set-up.

THE DEHUMIDIFICATION APPROACH

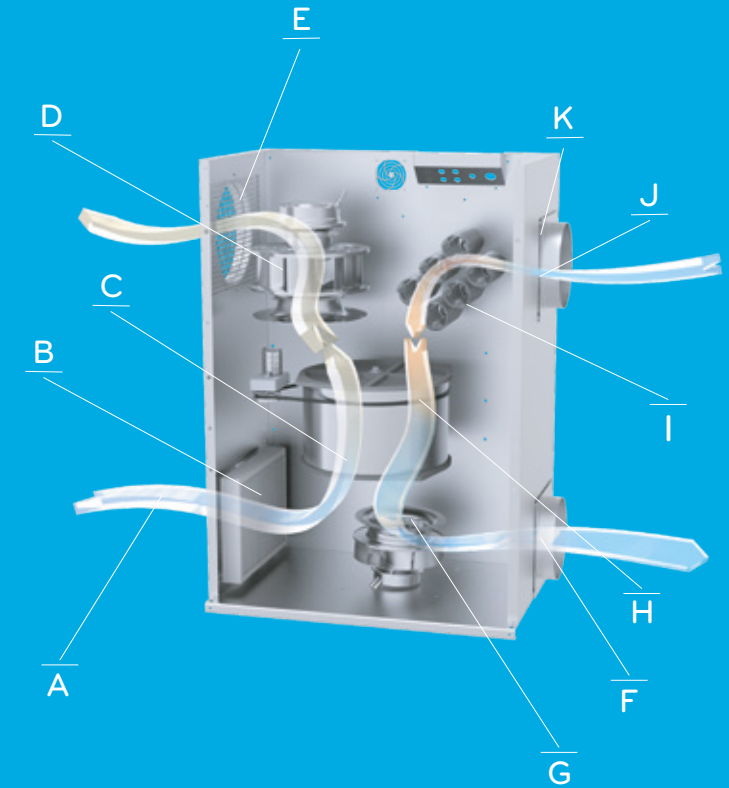
THE COST-SAVING ALTERNATIVE

Cotes adsorption dehumidification solutions are an approach that can either boost the effectiveness of traditional ways of tackling ice and condensation *post factum* – or enable you to establish full control over the levels of humidity in the air inside your cold store facility so that ice and condensation simply cannot arise

DEALING WITH THE CAUSE, NOT THE SYMPTOMS

The Cotes approach involves dealing with the root cause, rather than the continuous appearance of bothersome symptoms.

HOW IT WORKS



TWO FLOWS OF AIR

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

THE DRYING PROCESS A TO E

The incoming moisture-laden flow of air (process air) **A** enters one side of the cabinet and gets filtered by a process air filter **B**. The air then passes through a slowly turning rotor **C** 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 **E**. The process air is controlled by a process air fan **D**.

THE REGENERATION PROCESS F TO K

The second air flow (the regeneration air) **J** is filtered by a regeneration air filter **K**, and heated by heating elements **I**. On its way through the rotor **H**, 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 **F**. The regeneration air is controlled by a regeneration air fan **G**.

The thermal inputs for heating the regeneration air can be of virtually any kind suitable to the installation – electricity, gas, steam or waste heat from other processes or installations.

WHAT DOES IT COST?

Based on these technical assumptions, the approximate energy cost for dehumidifying using adsorption is as shown in the diagram below.

COST OF REMOVING 1 KG ICE

Cost of removing 1 kg ice using adsorption dehumidification units using different regeneration energy sources.

The specific power cost used for this calculation is €100/MWh. Gas purchase price is set at €40/MWh.

EXAMPLE

10 kg/hour, EER = 2, 8700 hours/year.

WASTE HEAT: €1,740/YEAR

Using 100% waste heat (for example hot gas) for heating the flow of regeneration air in the adsorption dehumidifier costs €1,740/year.

GAS: €10,440/YEAR

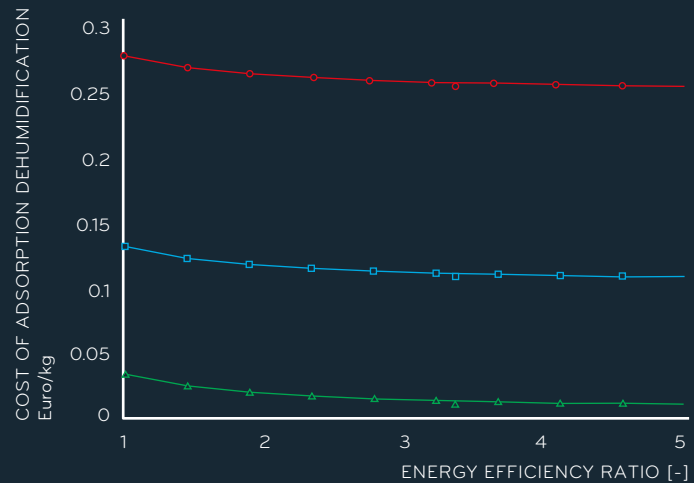
Using gas for regeneration costs €10,440/year

ELECTRICITY: €23,490/YEAR

Using electricity as heat source costs €23,490/year

REGENERATION WITH

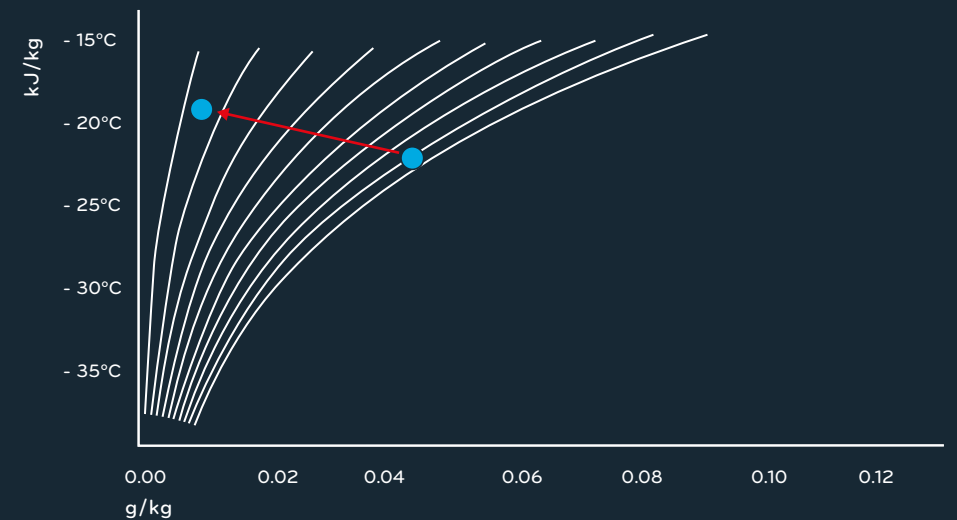
- ELECTRICAL HEATING
- GAS
- △— HOT GAS (FREE)



WHAT REALLY HAPPENS?

Using an industry-standard Mollier diagram, the dehumidifying process can be seen to more or less follow the isenthalp curve, as illustrated with the red line in the diagram below.

CHANGE IN AIR CONDITIONS WHEN MOISTURE IS REMOVED BY ADSORPTION



HOW IT'S INSTALLED

There are several ways an adsorption dehumidifier can be installed in order to deal effectively with unwanted moisture in cold stores.

Normally, the main kinds of installations are:

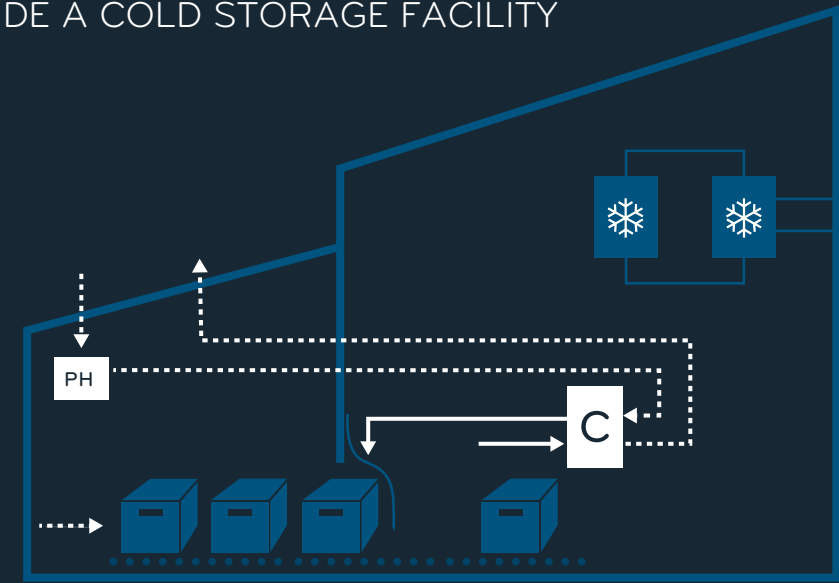
- 1) Inside the cold storage facility itself, with the dried air exiting over the entrance (on the inside)
- 2) Inside the sluice area, in order to keep the air here moisture-free

- 3) Inside a special room adjacent to the cold storage area, extracting air from this area for drying in the dehumidifier, before this air is ducted back into the cold storage area

- 4) Inside a goods reception/transport area in order to keep the levels of humidity here so low that any flows of air entering the cold store don't cause any significant problems.

Generally, it is important to install and operate the dehumidifier so that moisture will not freeze or condense inside or outside the dehumidifier unit.

INSIDE A COLD STORAGE FACILITY



PH PRE HEATER
E.g. hot gas, waste heat, ...

C COTES DEHUMIDIFIER

 REFRIGERATION SYSTEM

The dehumidifier is installed inside the cold store itself, and the dry air leaving the dehumidifier is ducted to right above the doors where the moisture enters the cold room.

The dehumidifier absorbs moisture from around the dew point (e.g. -25°C) and dries it to a dew point that is normally below the evaporation temperature. In such cases, all the moisture present within the facility is absorbed quickly and effectively by the dehumidifier.

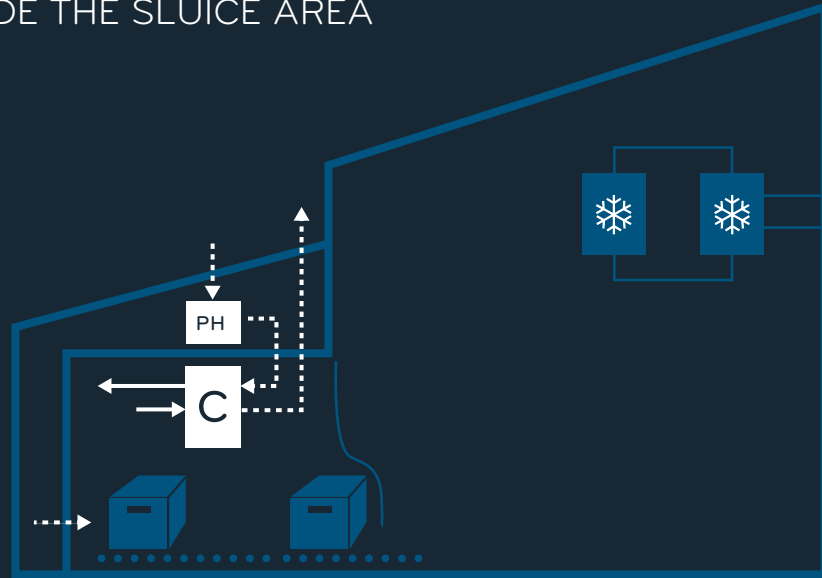
Ideally, the dehumidifier absorbs all the moisture that enters the cold storage area, so that it is no longer necessary to defrost the evaporators in the refrigeration installation. It will certainly reduce the extent of the problem.

This means that:

- > The refrigeration unit simply does not require any complex/costly defrosting system which is relevant for new installations.
- > For installation in existing cold stores, the number of defrost cycles can be reduced
- > There is no moisture available for ice and condensation to form within the facility or on the refrigeration/freezing installations.

This type of installation will be appropriate for cold stores that have to deal with the most difficult conditions and the heaviest moisture load.

INSIDE THE SLUICE AREA



PH PRE HEATER
E.g. hot gas, waste heat, ...

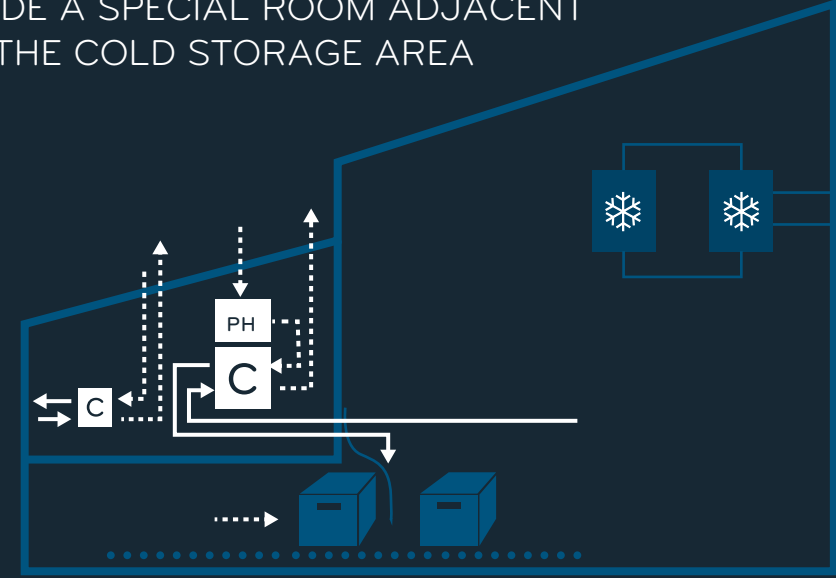
C COTES DEHUMIDIFIER

 REFRIGERATION SYSTEM

If possible, it is advisable to install a sluce area in which the air conditions are under control. This will then largely prevent moisture from entering the cold store itself. The process air used in the sluce area should be drawn from inside the cold store, and then dehumidified before it is vented into the sluce area.

The dehumidifier can either be placed inside the cold store or directly inside the sluce area.

INSIDE A SPECIAL ROOM ADJACENT TO THE COLD STORAGE AREA



PH PRE HEATER
E.g. hot gas, waste heat, ...

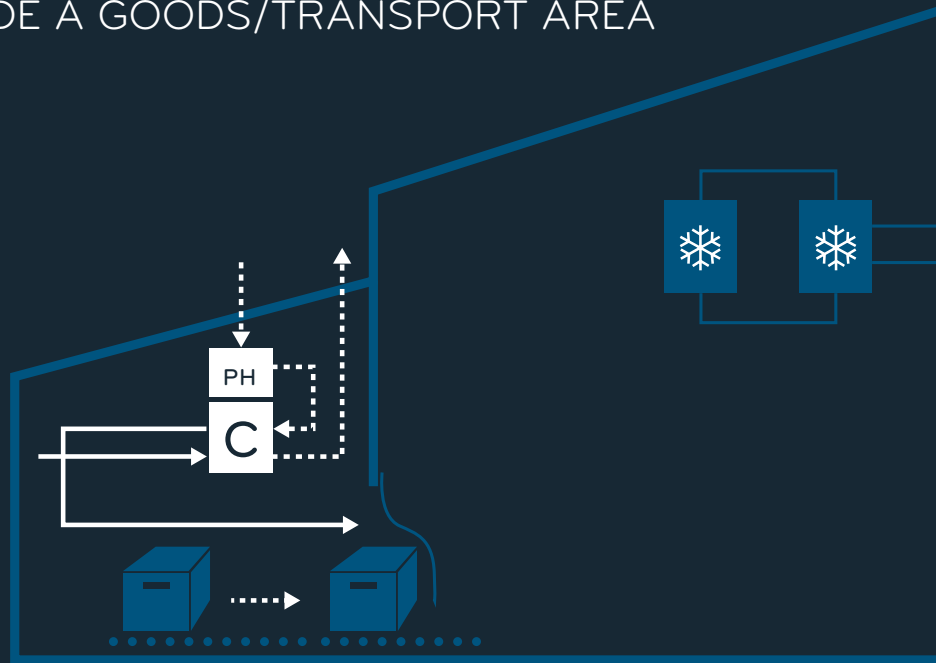
C COTES DEHUMIDIFIER

 REFRIGERATION SYSTEM

If there is not enough space inside the actual cold storage area, and it therefore proves necessary to place the dehumidifier outside this space, it needs to be in an enclosed, moisture-controlled space, where an extra adsorption dehumidifier keeps the dew point around the dehumidifier lower than the temperature inside the cold store.

If this is not done, moisture will condense locally on cold surfaces.

INSIDE A GOODS/TRANSPORT AREA



PH PRE HEATER
E.g. hot gas, waste heat, ...

C COTES DEHUMIDIFIER

 REFRIGERATION SYSTEM

The spaces surrounding the cold store can also be dehumidified, which will decrease the moisture load into the actual cold store.

This will not totally solve the moisture problem inside the cold store, but will perhaps reduce it to an acceptable level.

RECOMMENDED ACTION

Key parameters for achieving maximum effectiveness from a Cotes adsorption dehumidifier in a cold store facility include:

- > A sluce area should be installed in front of the storage area where the adsorption dehumidifier is fitted
- > Minimising moisture entry by sealing openings, cracks, etc. and installing rapid-action doors and similar measures
- > The adsorption dehumidifier should ideally be installed inside the cold room and distribute the dry air to the doors (product inlets/outlets)
- > The adsorption dehumidifier should be equipped with a device to recover thermal energy from the regeneration air leaving the unit



HOW COTES CAN HELP

KNOW-HOW HELPS YOU MAKE THE BEST DECISIONS

1. Cotes can help you analyse and identify the correct source/cause of a wide range of practical operating problems
2. Cotes can help you eliminate a key element of risk/uncertainty in your cold store operations
3. Cotes can help you quantify the costs involved, so that you can undertake a cost/benefit analysis that will provide a solid basis for any decision-making
4. Cotes experts can help you determine which priorities and which mix of technologies are most appropriate for tackling the specific requirements involved in your particular cold store setup
5. Cotes can provide exactly the right dehumidification system to meet the conditions prevalent in your cold store installation
6. Cotes can help you determine the most effective way to mount/locate dehumidification equipment

COTES RECOMMENDS

Based on consultations with both cold store customers and refrigeration technology experts throughout the world, Cotes experts have made a series of observations and recommendations about the design and configuration of cold store facilities with a view to establishing better control over humidity and the problems that can arise from this.

MOISTURE LOAD

A

Some quantity of moisture is always going to enter your cold store set-up, regardless of design and precautions taken

B

Depending on the design of your facility, this moisture will cause some degree of problems, whether large or small

C

Moisture/ice formation problems are particularly likely to occur in humid climates or if the internal moisture load is high (as when freezing products from high to low temperature, for example)

- - -

Much can be done in order to limit and reduce such moisture ingress, and the most cost-effective approach normally lies in optimisation of the doors/slucices.

DESIGN OF COLD STORE FACILITIES

A

Almost every cold store facility features a unique design and construction, and is used differently

B

Very few cold store facilities have direct passage between the ambient air outside the facility and the actual cold storage area. Most feature a "non-conditioned" distribution area between the ambient air and the cold room

- - -

Installing sluices to ensure controlled conditions between the distribution area and the actual cold store usually gives good results in limiting the ingress of undesirable moisture.

ENERGY CONSUMPTION ENERGY COSTS *

A

The specific energy cost related to moisture is normally in the range 0.02–0.25 Euro/kg, corresponding to 0.1–10 Euro/m³/year

B

In relation to the energy consumption, the specific design of the cold store and the way it is used are much more important than any local climate conditions

C

Using a well-designed and effectively operated hot gas defrosting system to combat the formation of ice and condensation normally has a specific cost of approx. 0.05–0.08 Euro/kg

D

Using an electrical defrosting system to combat the formation of ice and condensation normally costs in the range of 0.07–0.17 Euro/kg

E

The energy cost of a well-designed adsorption dehumidifier system is in the range 0.02–0.27 Euro/kg, depending on the degree to which waste energy is used (0.02 Euro = 100% utilisation combined with low regeneration temperature, 0.27 Euro = 0% utilisation and using electricity as energy source)

CHOICE OF TECHNOLOGY /APPROACH

Operators of cold store facilities can choose between a range of different basic approaches and different technologies to deal with the formation of unwanted ice and condensation. Most choose mixtures of all available methods, depending on cost/manpower parameters and priorities, etc.

Typical solutions can include:

A

Manual clearing and removal of ice and condensation wherever it forms – once the problem has arisen

B

Electrical heating units designed to deal with ice and condensation in particular places, once it has formed

C

Hot gas defrosting set-ups designed to remove ice from evaporators – once the problem has arisen

D

A range of preventive measures designed to prevent the ingress of moisture into the cold room – and thus prevent the formation of ice and condensation

E

Adsorption dehumidifier systems that ensure full control of air conditions so that ice and condensation simply cannot arise.

DIRECT COMPARISON

Direct comparisons between adsorption dehumidification and dehumidification via refrigeration-based techniques of the specific energy costs involved reveal that adsorption dehumidification can be both more and less efficient than refrigeration techniques, depending on circumstances. But if there is a substantial moisture load, a refrigeration

system will normally be incapable of dealing with this. If a refrigeration/freezer system has to be redesigned to deal with airborne moisture as efficiently as an adsorption dehumidifier, it will require a lower evaporation temperature, probably a larger evaporation surface, and more frequent defrosting.

Such measures reduce the overall efficiency of the refrigeration system – both in the case of hot gas defrosting and electrical defrosting. This means in such circumstances refrigeration-based techniques are not really a viable, cost-effective solution to typical ice and condensation problems.

* Cotes experts have undertaken wide-ranging background studies of these and many other cost and efficiency parameters. Please contact us to hear more.

COTES RECOMMENDS

COST OF OWNERSHIP

The prime benefit of using adsorption dehumidifiers to eliminate the root causes of ice and condensation, rather than using other means to deal with the symptoms, lies in the substantial cost reductions related to problems caused by ice formation.

These problems include:

A

Labour costs for ice removal

B

Personnel costs
(sick days, complaints, replacement staff, etc.)

C

Product quality

D

Lost orders/customer dissatisfaction

E

Insurance and safety

F

Maintenance

G

Energy costs

— — —

Another big cost-of-ownership advantage with adsorption dehumidifiers is that it is much cheaper to purchase and install a dehumidifier than to rebuild, modify or replace existing refrigeration/freezer systems because they can't deal with the moisture-related problems.

MOST COST-EFFECTIVE INSTALLATION OF ADSORPTION DEHUMIDIFIER

A

If possible, the adsorption dehumidifier should act on the air conditions in a sluice area installed in front of the cold storage area

B

Alternatively, the adsorption dehumidifier should be installed inside the cold storage area and distribute the dry air to the doors and any other points of entry/exit

C

The adsorption dehumidifier should be equipped to recover thermal energy from the regeneration air leaving the dehumidifier

D

The adsorption dehumidifier should be configured to use the cheapest, most energy-efficient thermal inputs. In many cases, waste heat from other processes and installations can be used to heat the regeneration air and remove the moisture absorbed by the rotor.

A QUESTION OF PERSPECTIVE

In new/high-efficiency cold store set-ups, dehumidification equipment is problem prevention and an extra cost. In a cold store that's designed right, a dehumidifier will normally not even be needed.

In existing/less efficient cold store set-ups working under pressure, dehumidification equipment is problem tackling and a cost-reduction measure.

PREVENTION IS BETTER THAN CURE

A wide range of different practical approaches is available for dealing with undesirable humidity in cold store facilities, making it possible to deal with causes rather than just alleviating symptoms.

These include:

- > Sealing off doors/openings, etc.
- > Installing rapidaction doors and other quick-closing openings
- > Installing effective sluices, etc.
- > Adjusting evaporator design, configuration and operation
- > Balancing the configuration and operation of refrigeration/freezer systems, and their moisture-removal capabilities, with the humidity management capabilities of an absorption dehumidification system
- > Removal of excess moisture from goods prior to entry into cold stores
- > Removing humidity from the air entering the facility

EFFECTIVE HUMIDITY MANAGEMENT BRINGS DOWN YOUR OPERATING COSTS

One of the prime benefits of adsorption dehumidifiers lies in the reduction of costs related to problems caused by ice formation and condensation.

These cost reductions include:

- > Labour costs associated with tackling condensation/ice formation
- > Personnel costs – sick days, complaints, claims for injury compensation, etc.
- > Costs of installing and maintaining safety measures
- > Reductions in product quality
- > Energy costs
- > Lost orders
- > Lost customers
- > Insurance premiums
- > Maintenance costs
- > Etc.

THE BENEFITS ADD UP

PRODUCT QUALITY + PACKAGING BENEFITS → IMPORTANT FOR YOUR CUSTOMERS

Focus on quality of stored products/product damage /value loss, reduced risk of product contamination, reduced product waste, etc.

TECHNICAL/PRACTICAL BENEFITS → IMPORTANT FOR YOUR STAFF

Focus on practical operating parameters, reducing formation of ice and condensation, boosting the efficiency of condensers/evaporators, safety issues, etc.

FINANCIAL/COST BENEFITS → IMPORTANT FOR YOUR OPERATING COSTS

Focus on cost parameters/total cost of ownership, reducing energy consumption, use of expensive manual labour to deal with practical issues/rectify the results of ice formation, damage /waste statistics and costs, etc.

COTES ALL-ROUND



C35C

The Cotes All-round C35C adsorption dehumidifier design is specially configured with extra insulation (to minimise energy consumption and prevent any formation of ice inside the unit) and special control system functionalities optimised for economical, ultra-reliable and energy-efficient use in a wide range of cold storage facilities.

Cotes All-round C35 is an innovative range of elegant, versatile dehumidifiers, with moisture removal capacities normally amounting to 3–5 kg per hour.

The spectacularly sleek stainless steel cabinet, featuring the best of modern industrial design, makes Cotes All-round dehumidifiers ideal for installation even in highly visible public locations.

Standardised, modular configurations are available so you can easily integrate any heating units, cooling systems, fans, filters, sensors, control set-ups, etc. that you need for your particular operating set-up.

COTES FLEXIBLE



COTES FLEXIBLE
/ CRP6000

CRP/CRT RANGE

This special range of Cotes adsorption dehumidifiers is designed so you can easily specify the exact configuration you need for your particular installation and your precise air flow requirements.

Cotes Flexible units enable you to install world-class dehumidification capabilities – exactly as you want them. You can choose precisely the air flow or moisture removal capacity you need, based on cost-saving, pre-defined modular configurations.

Designed for efficiency

The inside of the cabinets are designed to ensure the unhindered, energy-efficient passage of air through the unit, as well as good hygiene, low noise and minimal vibration. All fans and other equipment that generate vibration and noise are placed inside the unit, which can be insulated and soundproofed as you require.

Designed for cleanliness and good hygiene

Cotes Flexible cabinets and panels are designed for smoothness and ease of cleaning, making them ideal for use where hygiene requirements are particularly stringent.



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 5819 6322 or send a mail to sales@cotes.com

TALK TO US ABOUT WHAT'S POSSIBLE

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