




## Perishables

- Our company background
- Perishables and their hidden costs
- Corrosion in the cargo hold
- The science behind the solutions
  - Protective films to metal surfaces
  - Super absorbents
  - Odour absorbents
- Conclusions




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-  Sales support organisation with more than 25 years, combined experience in the air cargo industry
-  Associated with R&D experts in the areas of super absorbents, odour control, composites, insulation and ULD
-  Air Cargo Solutions act as the eyes and ears of these R&D facilities

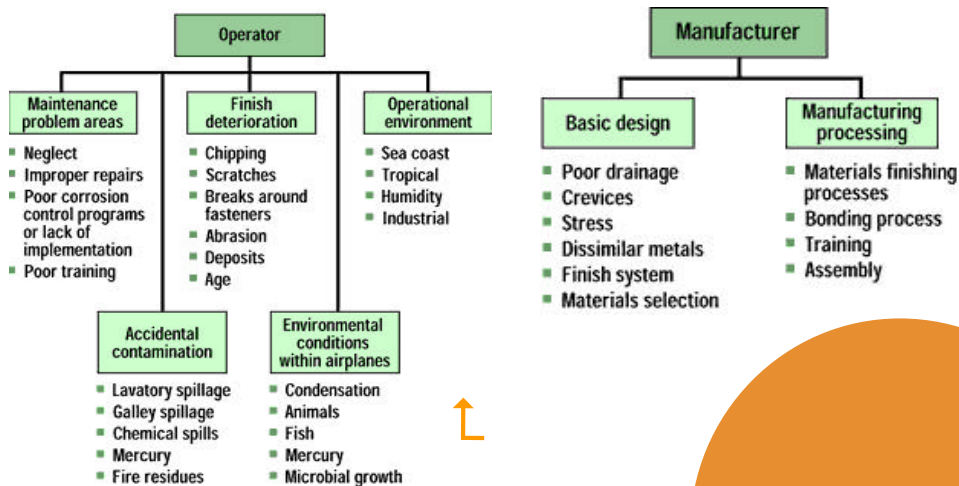
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Difficult to pin down costs

- Many intangibles including grounded aircraft, damage to cargo, damage to customer baggage
- Costs often fall under a general maintenance budget thereby masking costs due to spills
- There is no central database where these costs are recorded
- If the actual costs were known, many airlines would alter their approach to perishables

-  A grounded aircraft can cost an airline £200,000/day in lost revenue and this figure can be tripled when hanger space, labour and parts are considered
-  One airline surveyed suggested that 15-20% of maintenance man-hours were dedicated to repairing corrosion in the cargo hold
-  Maintenance department of one airline charged their cargo department USD1.5 million for 2 spills resulting in unacceptable odours within the cabin

- It can be seen the operators pay dearly for spills associated with perishables, with one of the major costs coming from rectification of corrosion
- The causes of corrosion are complex and there are many solutions
- Odour resulting from a spillage have perhaps fewer solutions



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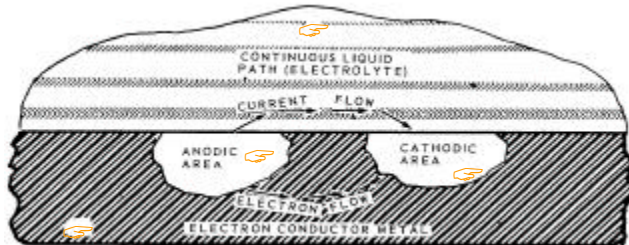
- ☐ Natural phenomenon which attacks metals by chemical or electrochemical action
- ☐ Metals want to return to their natural state
- ☐ Four conditions must exist simultaneously



Four conditions are:








- An Anode - a metal that will corrode
- A Cathode - a dissimilar, conductive material that has a lesser tendency to corrode
- An Electrolyte - a conductive liquid
- Contact - electrical connection between the anode and cathode

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Simplified corrosion cell showing conditions which must exist for electrochemical corrosion

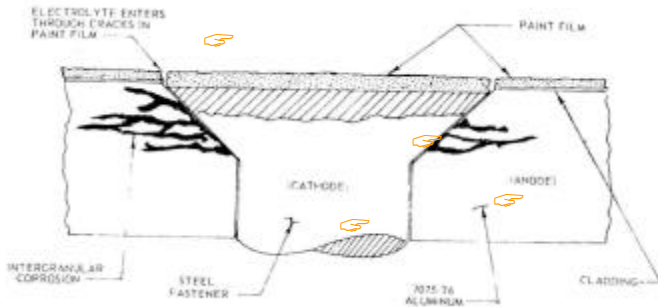
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-  Type and combination of materials
-  Temperature and humidity
-  Electrolytic solution
-  Availability of oxygen
-  Mechanical stress on the corroding metal
-  Presence of biological organisms
-  Time of exposure

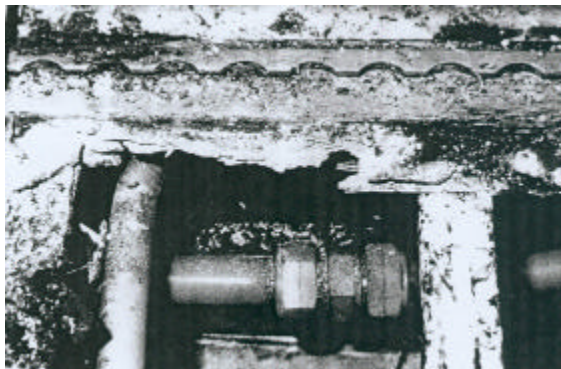
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- ❏ Corrosion takes many different forms
- ❏ The most common type found on aircraft is concentration cell corrosion (crevice corrosion) occurring when a liquid is trapped between two surfaces
- ❏ Can quickly develop into pitting or exfoliation corrosion

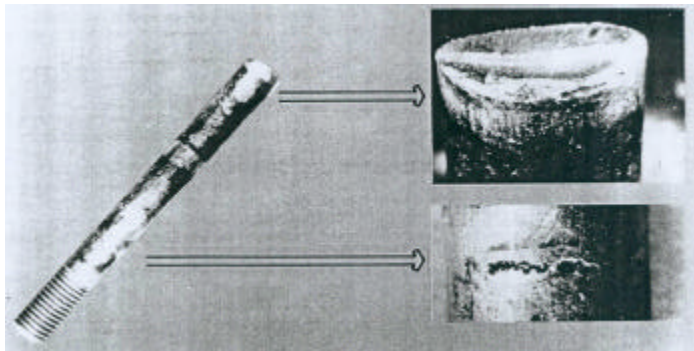
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Electrolyte	Class	Remarks
Water	A - B	Performance dependant on impurity levels, e.g. Cu, Pb, chlorides.
Brine	B	Slight attack. Can be prevented by anodising.
Vinegar	B - C	Corrosion mechanism is pitting.
Wine (red / white)	A - B	Dry wine is worse, sugar in sweet wine acts as a protective coating.
Urine (horse / people)	A - B	Level of attack depends on which alloy is in contact.
Blood	A	Aluminium is resistant to blood.
Fruit acids	B	Fruit acids attack aluminium depending on temperature. Best to anodise.
Apples	A	Assuming juice does not escape otherwise B.
Rhubarb	B	Has a uniform etching effect due to oxalic acid.
Pineapple	A - B	No attack on pure Al but attacks alloys.

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Electrolyte	Class	Remarks
Brandy	C	Causes pitting on aluminium.
Pickles	C	Causes deep pitting, due to combination of salt and vinegar.
Common salt	C	Solid and concentrated solutions have a corrosive action at room temperature.
Yoghurt	C	Causes pitting on aluminium, especially where air has access to the wetted surface.
Chlorine based cleaners	C	Often used in the cleaning up of spills and may be very corrosive to the aircraft.

## Class Designation

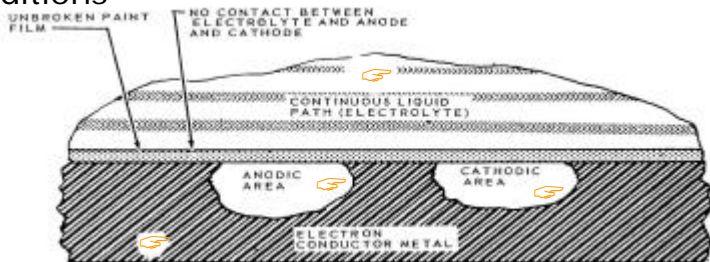
- A = Aluminium alloys are corrosion resistant to these liquids.
- B = Some surface wastage can occur causing infrequent maintenance or replacement of the aluminium structure unless the surface is protected.
- C = These liquids have an adverse effect on aluminium and possibly react violently with it. Therefore definitely not recommended.

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- Requires adequately trained personnel
- Regular scheduled inspections
- Prompt corrosion treatment after detection
- Reduction of the four conditions required for corrosion

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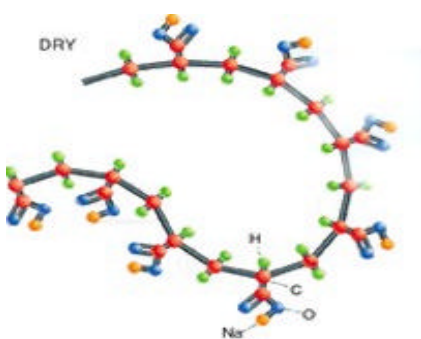
Prevention requires removal of one of these conditions



Elimination of corrosion by application of an organic film to the metal surface

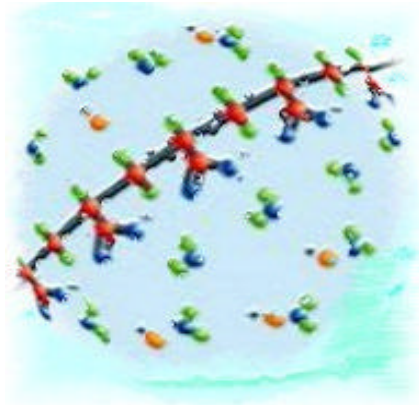
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- Basis of the guidelines found in the IATA Perishable Cargo and Live Animal Manuals
- Adequate packaging including super absorbents



- A typical super absorbent is a polymer of sodium acrylate ( $\text{CH}_2=\text{CH}-\text{COOH}-\text{Na}$ )
- This structure is stable when dry and it is the presence of sodium caboxylate which enables the acrylic chains to twist together in clumps of rock hard particles

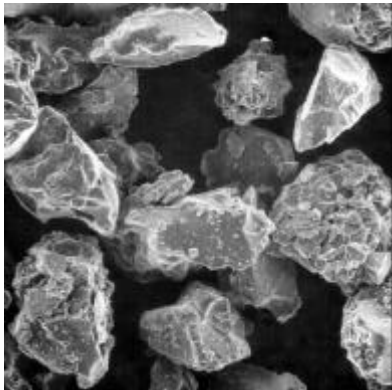
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-  When water is introduced, highly ionic sodium molecules are aggressively stripped off the acrylate chains
-  Once the sodium atom has been stripped, the molecules break their adjoining bonds and the tightly packed chains open up creating new bonds

- ❑ The structure becomes bipolar creating a “charged net” attracting water molecules
- ❑ The new polymer has weak cross-links creating a three dimensional structure
- ❑ The structure having a high molecular weight cannot dissolve but instead creates a gel

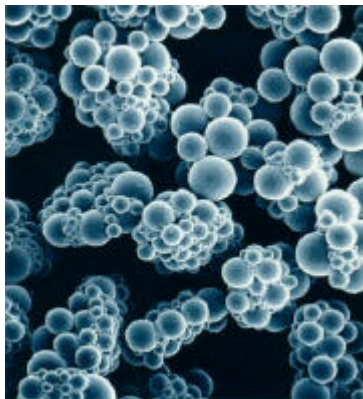
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The super absorbent  
in dry form is  
extremely hard and  
has a stone-like  
morphology

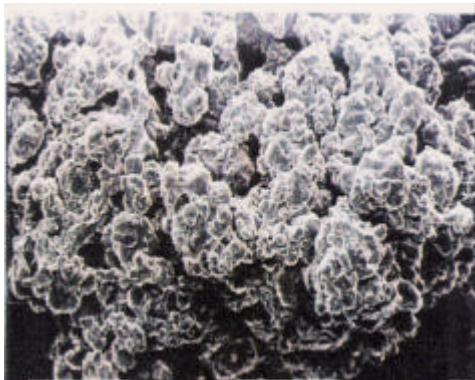
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Once in contact with an aqueous solution, the powder turns into a translucent gel, expanding up to eight hundred times of its original weight

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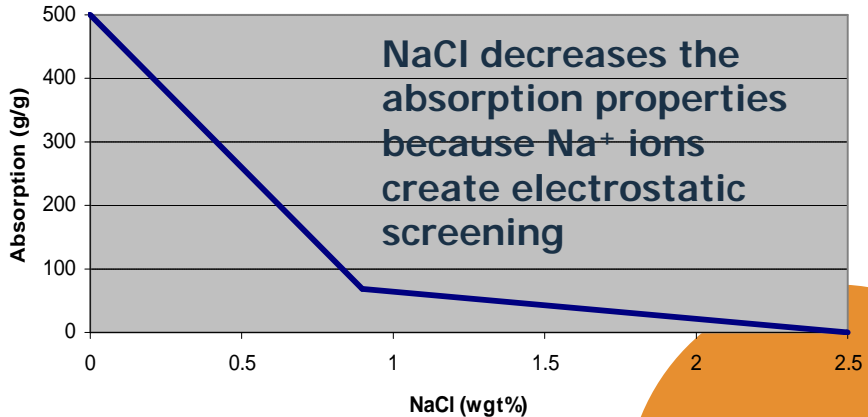


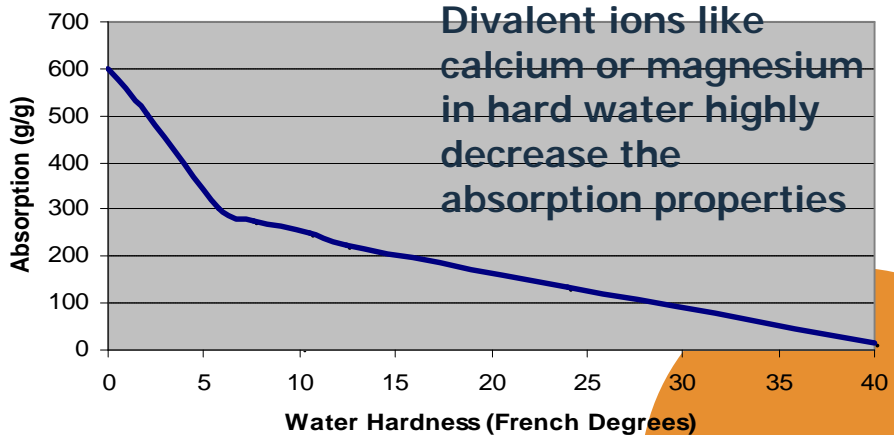
In the final stages of absorption, the super absorbent obtains a "Broccoli-like" morphology





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-  Aqueous solutions that contain highly ionic atoms such as saline, reduces the “sodium stripping reaction”
-  To overcome this limitation, scientists can design super absorbent molecules for a specific set of parameters often increasing saline absorption by up to 15%

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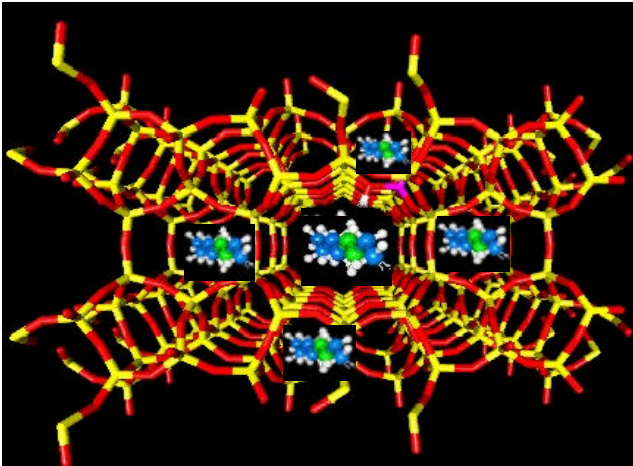




-  Absorbing an odour is much different than masking an odour
-  Odours are typically positively charged microbes and molecules
-  Zeolite is made of a series on chains which interweave to create a positively charged tunnel
-  Performance enhanced through air circulation

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## How Odour Absorbers Work



The airborne odour particles are attracted to the electrostatic ring and are pulled down an “ionic exchange tunnel”, making way for another particle to enter

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- It's very difficult to pin down the costs associated with shipping perishables
- Estimate of these costs are very high
- Despite efforts by the airframe manufacturers to design corrosion resistant structures, there are limitation to what can be achieved
- Relative costs of the operator taking preventive measures is much lower than dealing with the rectification of cargo spills and odour leaks