Condensation Issues for Containers

Temperatures gradients of as much as 50°C between "summer in the southern hemisphere" and "winter in the northern hemisphere" are entirely possible. A sudden fall in temperature also leads to a higher probability of condensation water formation below the ship's deck or in the container. The resultant dripping sweat then causes considerable cargo losses. Overintensive cooling of the cargo surfaces may also lead to condensation water formation directly on the cargo (cargo sweat).

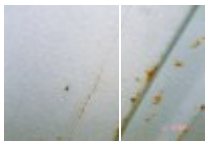

Figure 24

Saturated Air

For a given atmospheric pressure, air holds more water vapour at higher than lower temperatures.

The maximum amount of water vapour contained in a cubic metre of saturated air decreases with a decrease in temperature. At 40degC it can contain 51 grammes, at 20degC 17 grammes and at 0degC only 5 grammes.

Dew Point

Is the temperature at which a sample of saturated air will condense. Warm air has more capacity to support water vapour within it than cold air.

Relative Humidity

Expressed in percentage terms is the ratio of water vapour present in a given sample against the saturated level. If the Relative Humidity (RH) is said to be 100% then the air sample is saturated

Condensation

Occurs when moisture laden air releases its water vapour on to the surrounding surfaces in the form of water droplets. For condensation to occur the following conditions need to be present:

- Temperature gradient (Between air inside and outside the container)
- A source of water vapour (moisture).
- Pathway for it to move.

Container Sweat

Occurs when the skin of the container is cooled to a temperature below that of the dew point of the air enclosed within the container.

This results in water droplets forming on the interior roof and side panels, then dripping down on the cargo causing mould and water damage. Cargoes that spontaneously heat from within can increase the problem.

An example is:-

A cargo loaded in the tropical belt in warm conditions with high Relative Humidity, is transported to cold winter conditions in Europe. The temperature outside the container gradually cools down in transit until it experiences cold conditions in Europe. The steel container allows the chill to conduct from the outside of the panel through to the inside. The situation inside the container is now one of cool side panels and warm moist air in the header space above the cargo and within the stow. The temperature of the side panels is therefore below the dew point of the air inside the container and condensation occurs. Condensation will continue until the dew point of the interior air falls to that of the outside air. Different solutions

are discussed further in this procedure however the simple solution is to ventilate the container by passing air through it and replacing the warm moist air with similar air to outside the container.

Cargo Sweat

Occurs when the surface of the cargo is cooler than the dew point of the air enclosed within the container. Droplets of water then form on the surface of the cargo. An example is:- A cargo of canned goods is loaded in cold winter conditions in Europe and transported to the tropical belt. The container will gradually heat up during transit to the warmer moist climate however the cargo temperature will lag behind, slowly heating up and replacing the cold from loading.

If ventilation was allowed to take place the warm moist air from outside the container would condense on the cold cargo. In this case it is better to avoid ventilation during transit and allow the cargo temperature to gradually increase thereby restoring equilibrium between the cargo temperature and the outside air.

Radiation of Heat at Terminals and On Board Ship

Where possible cargoes sensitive to condensation must be protected from the extremes of radiant heat and extreme cold as under:

- Whilst container is in the terminal stack: shaded stow required.
- Aboard ship: underdeck stow or protected deck stow required.
- Long road/rail transit.

An example is:-

A non insulated container sitting on the terminal in Assab with a load of bagged coffee is subjected to the radiant heat of the sun. The air inside the container will become heated and absorb moisture from the coffee thus establishing high humidity conditions. Night cooling can cause the temperature of the container skin to fall below the dew point of the humid conditions within the container thus causing condensation.

The need to avoid radiant heat is emphasised in this example and late packing of coffee prior to export would also help. In addition long periods exposed at transhipment terminals such as Djibouti, in the summer, should be avoided.

At the other end of the journey it is important that early delivery is carried out for sensitive/hygroscopic cargoes arriving at terminals with near zero temperatures. In such cases the cargo can experience what we call the "cold shock" of first night ashore. When acceptable to the shipper it is often prudent to crack a door open to ventilate the container.

Hygroscopic Commodities

Are those which are permeable to water and which retain moisture under certain conditions.

Timber, coffee, cocoa and most materials of organic origin are hygroscopic. Coffee for example can have a moisture content of 12% and container sweat is therefore an issue.

Packaging

1. The importance of good packaging cannot be over-stressed in achieving good out-turns. It is also a key cost issue for our customers and therefore achieving an optimum packaging policy commensurate with good product delivery is an important element of cost control.
2. Each commodity must be individually assessed to determine the most suitable packaging. Several examples of packaging are listed below.
3. BAGGED CARGO : The physical composition of the cargo in terms of moisture content and sensitivity to contamination will determine the bags used which include:
    - Paper (single or multi-ply) which may be sewn or glued.
    - Plastic (which may be airtight).
    - Woven polypropylene (May also have an inner sealed bag made of polythene).
    - Jute, hessian (Traditional materials) and the type most likely to be re-used.
    - The danger of taint from residual cargo must be considered.
    - Open mesh sack of plastic fibre for maximum ventilation.
4. BALES & BUNDLES : Outer cladding usually of hessian or similar material with an inner plastic packaging. Some baled cargo such as straw or hay are not covered.
5. CASES, CRATES, CARTONS : Cases and crates are usually made of timber which may be plywood or heavier timber. Pallets or timber skids may also be part of packaging to facilitate lifting and ventilation. Excess moisture in the timber can cause damage to cargo! e.g. Canned cargo becoming rusty. Cartons of flimsy cardboard material and high moisture content are liable to suffer crushing and consequent damage to the cargo! The importance of good quality multi-wall fibreboard is stressed which may be wax impregnated to resist moisture. In stowing cartons the use of the recognised "bonded block stow" technique is necessary to ensure proper weight transmission within the stow of cartons.

De-Humidifiers

Rusty cans with peeling labels are the nightmare scenario for supermarkets! De-humidifiers are used in warehouses to create controlled conditions for goods and packaging prior to export. In very special cases de-humidifiers have been used in containers prior to loading to ensure a dry container is presented for loading.

The moisture content in the floors of containers is an important aspect of condensation control and maximum permissible amounts may be specified by customers, e.g. 15-18 % moisture.

Desiccants & Absorbent Materials

A basic desiccant is one which will absorb 27% (of its dry weight) of moisture when placed in an atmosphere of 50% Relative Humidity at 25 degrees C.

Desiccants can be very effective when used with certain cargoes (Steel reels, cars, cartonware). In the case of hygroscopic cargoes they may only be part of the solution because of the high moisture content present within the cargo (e.g. Coffee 12%). At the other end of the spectrum, in certain situations desiccants can extract too much moisture from the cargo and where the cargo is sold by weight this results in claims.

Silica-gel is probably the most familiar to us and others include activated alumina and activated clay. Brand names using desiccants include Dry Bag, Absormatic, Moisture-Grip and Grafo Therm.

Dry Bag: A Danish desiccant made up of roasted moler clay mixed with calcium chloride. Bags of kg are normally used in containers and the numbers utilised will be determined by the commodity.

Dry-Bag is successfully used with cars, machinery, milk powder and many other cargoes.

Absormatic: Uses water retaining poles in conjunction with a desiccant and are placed into the corrugation of the container side panels in order not to waste cubic space for cargo. Effective but vulnerable to forklift damage which can release moisture into the container.

Moisture-Grip: A product developed in Japan and is an absorbent polymer sheet taped to the container ceiling of the container. Sometimes used with cargoes of tobacco.

Grafo Therm: A porus paint application applied to the container ceiling which absorbs moisture within the container. This product has been championed as the solution to condensation in coffee shipments. Where major temperature gradients are present, as with coffee entering a cold winter climate, this may not have the capacity to absorb all the condensation. Requires maintenance and may absorb dirt and contamination.

Insulation

Insulation blankets are normally used to clad the inside of a GP container with temporary insulation. They are used mainly to combat cold being conducted through steel GP containers to cargoes such as red wine and liqueurs.

They are listed in this section to make the point that insulation can reduce extreme temperature gradients between inside and outside the container.

Ventilation

In cases of extreme "Container Sweat" the need to bring equilibrium between air inside and outside a steel container is paramount. Good ventilation serves this purpose by evacuating the warm moist air from the container and replacing it with ambient air from outside.

Vent-Containers having vent ducts along the side panels at top and bottom rails achieve this by convection effect. Warm moist air is expelled via the upper ducts and replaced with colder ambient air via the lower ducts. Plywood insulation on the interior of side panels is fitted only on part of the owned fleet and is preferable. High leasing costs are an issue with this equipment.

Fantainers are used successfully to carry onions and potatoes throughout the world. An extraction fan draws ambient air through the cargo to maintain equilibrium with the temperature outside the container. Control of ancillary equipment such as control boards and leads reduces the appeal of this method. The use of Fantainers for use with other cargoes is currently being evaluated.

GP Containers: A large number of owned containers have four small passive vents in way of top corner castings with each providing air paths with at least 5 sq cm total cross sectional area).

The above provides a small amount of ventilation and it is important for sufficient free space to be left in the header space for it to be effective. The majority of dry cargoes can be successfully carried in GP containers.

Taping off the passive vents in GP containers is also necessary when carrying hygroscopic cargoes as under and also for cargoes liable to spontaneous combustion :

The use of desiccants combined with lining the container with kraft paper or fibreboard are additional options according to the risk. (Details are available under coffee stowage). This amounts to parcelling the cargo effectively to avoid contact with the steel container and placing desiccant bags on top of the stow to absorb moisture in the header space.