Summary Report on humidity in container shipping and desiccants

Humidity and moisture damage has always been a major problem in the cargo shipping industry. Every day, thousands and millions of cargo containers are moved around the world and these cargoes are constantly exposed to humidity and temperature changes during their transit. Humidity and temperature changes can often be detrimental to the conditions of the cargo at destination if measures are not taken to protect the cargo from the effects of humidity.

Measures such as quality controls at loading, the type of packing material used, the limitation of the inherent moisture content of the cargo are all good ways to prevent moisture damage to the cargo. However, these measures are hard to quantify as one does not see the 'physical effects' of these measures. The use of container desiccant is also a measure that can be taken by shippers and the 'physical effects' are more apparent, i.e., the removal of moisture from the atmosphere inside the container.

There are many types of desiccant on the market. They range from the simplest to the more sophisticated one using advanced material such as Non-Woven or Tyvek®. They all have the same application, and that is, the removal of moisture from the atmosphere, thereby, reducing the Relative Humidity to a level that prevents condensation when the temperature changes. However, the level of absorption is reflected by how simple or sophisticated the desiccant is.

In this overview we describe all desiccants present in the market with both the positive and negative aspects based on practical experience as well as independent third-party practice and laboratory research.

A. Desiccants made from silica or silica gel.
B. Desiccants made out mostly out of clay.
C. Desiccants made from pure Calcium chloride.
D. Desiccants made from Calcium chloride and starches.

A. Silica or Silica Gel desiccants.

The most basic and most common of all desiccants are Silica or Silica Gel. It is also the cheapest desiccant on the market. Silica, or silicon dioxide is basically sand (silicon) fused with oxygen. During the fusion process, small capillaries (holes) are formed. As the surface of the Silica is cooler than the ambient temperatures, it allows moisture in the air to condense and rest on its surface/ capillaries. It is these capillaries that holds moisture giving Silica its 'absorption' capability. However, there are 2 distinct disadvantages in using Silica.

1. The absorption is limited

Amount of moisture removed from the air is dependent on the surface areas (number of capillaries). To remove a substantial amount of moisture, you would need lots of Silica. The published absorption rate for Silica ranges from 15 to 25% of its dry weight.

2. The ability to hold moisture is limited

Moisture 'removed' from the air is only 'resting' on the surface/capillaries of the Silica. It is not physically removed as such. When temperature rises to above 30°C, this 'removed' moisture will evaporate and goes back into the atmosphere.

In cool environment, Silica can have limited use, but it is not effective in container shipping. Modern shipping containers are made of steel with a wooden floor. During hot weather, the ambient inside the container can easily double from what is outside when the temperature is high. The container in this instance acts like a sauna during these hot temperatures.

Therefore, though Silica acts like a desiccant, its ability or inability to hold the removed moisture renders the use of Silica ineffective for use in container shipping.

B. Container desiccants made out mostly out of clay.

The next most common container desiccant used in container shipping is a desiccant made mostly out of Clay. In recent times, the word 'Drybag' has become a generic name for a desiccant, but these types of desiccants are bags filled with clay or Bentonite. Often, these desiccants are also known as 'Activated Clay'. The absorption rate for these clay desiccants is about 25% of its dry weight. By adding of Calcium Chloride to the product mix, the manufacturers can increase the absorption rate to about 40%.

The clay desiccants have been used in cargo shipping for a long time now and are commonly used in established agricultural cargo such as cocoa, coffee, rice, wheat etc. There are countless manufacturers mainly in Asia who offer such products. Clay desiccants come in a white or yellow cloth bags but variation of the packaging, like spun bond or Non-Woven material, can be seen from different manufacturers. While usage of cloth bags or spun bond bags keeps the price of the desiccant down, these materials do not create a barrier from the wet desiccant and cargo. The packaging becomes wet by the moisture absorbed by the clay and 'imprints' of this wetness can often be seen on the cargo and container floor. With Non-Woven material packaged desiccants, the level of seepage is reduced/eliminated, but not secured.

Again, like Silica, the removal of moisture from the ambient air can be seen as temporary with the clay desiccants. When the packing material of the desiccant is porous, moisture absorbed can easily goes back into the container when temperature rises. But unlike Silica, the emission rate back into the ambient air is much lower.

Nowadays we see variants on clay, for example Cocopeat (a by-product of the coconut, generated from the coconut husk), these products also do not work safely in vain. By adding extra calcium chloride, the bags absorb more moisture, which creates premature saturation and leads to leakage from the bag onto the cargo.

C. Container desiccants made from pure Calcium chloride.

The most recent type of desiccant that has been on the market is the ones using Calcium chloride as its active ingredient. Calcium chloride is a salt compound and is highly hygroscopic i.e., its ability to attract water molecules from the surrounding environment. In an ideal situation like a laboratory, Calcium chloride has the ability to absorb up to 700% of its dry weight. Due to its high hygroscopic nature, Calcium chloride is an ideal ingredient to use as a desiccant.

When water molecules are absorbed by Calcium chloride, it turns into a brine solution, not unlike a saline solution. Hence, desiccant manufacturers produced a packaged desiccant putting Calcium chloride on the top with the water receptacle/reservoir below. This packaged design is very common among the desiccants that are targeting the household market. This design works very well when the desiccant is static, but in the container situation, the water in the receptacle can easily tilted over and spill over the cargo when the container is moved or re-evaporate. Hence, the concept of introducing another substance into the product mix to solidify the solution is not inconceivable.

D. Container desiccants made from Calcium chloride and starches.

RJB International (RJB) started developing and producing RJB Drybags™ over a decade ago, it started dealing in clay and silica gel products, then the representation of Calcium chloride products and for 15 years we develop and supply our own products based on the knowledge and experience gained.

The aim is to provide a safe, economic, environmentally friendly, and efficient desiccant that is easy to use and dispose. Teamed with the expert knowledge of cargo shipping and packaging of food and animal feed products and knowledge of desiccant at the time, we produced what we now called, the pole.

It is the design with the Calcium chloride on top and the water receptacle below. Though it worked very well, as mentioned, it did create some problems especially at unloading. When speed is of the essence at unloading, unloading staff not familiar with such product often damage the Poles causing spillage onto the cargo. To minimise such problems, we started experimenting with solidifying the brine solution and came up with what we now called our Container Drybags™ also known as the RJB Drybags™.

The problem with redesigning the packaging is before the Calcium chloride brine solution turns to a gel or semi solid state, it is corrosive to most packing material. We need to find a material that is strong enough and yet allows air to pass through. Many materials were tested and the one that proves to be the best is a patented material from St. Dupont called Tyvek.

Tyvek is a one-way breathable material which allows air to move in one way but not the other. However, the lower grades Tyvek® are also not strong even to withstand the corrosiveness of the Calcium Chloride solution. After much experiment with the product mix and type of Tyvek®, RJB eventually came up with a product that is highly absorbent (up to 200 – 300%) and yet safe from leakages and breakages by developing an excellent new type of inner and outer bag.

Today, these RJB designed Container Drybags™ are unique in the market and we have done numerous testing in-house and with clients all over the world and have maintain a high level in the quality of our products. During the years since the company started selling desiccant, the amount of claim through product failure or leakages is reduced enormously. This is a tremendous boost of confidence to the quality of our product range.

BIJLSMA GROUP
THE SAFE MAKER

Examples of products available.

RJB DRYBAGS™
safe, solid, dependable.

BIJLSMA GROUP
THE SAFE MAKER

European Chemical Agency (ECHA) and REACH (Registration, Evaluation, Authorization, and restriction of Chemicals)

Any producer/supplier of desiccants that contains Calcium chloride and is distributed within Europe must comply with the official REACH registration of the European Chemical Agency. This is a mandatory European regulation that is strictly monitored per country by the Human Environment and Transport Inspectorate of the Ministry of Infrastructure and Water Management.

Desiccants contain chemicals, the chemicals used in the bags may be subject to registration. The rule of thumb is that a producer or importer imports or produces more than 1000 kilograms of material and subdivided it into the market, even if the raw material to be registered is not leading in the formula, but just present in the mixture.

The REACH regulation has existed since 2007, you can recognize this by the strict description in the language of the country and a warning sign on household products such as cleaning products including the indication of the registration number which can be traced back to the supplier or manufacturer. This also applies to desiccants.