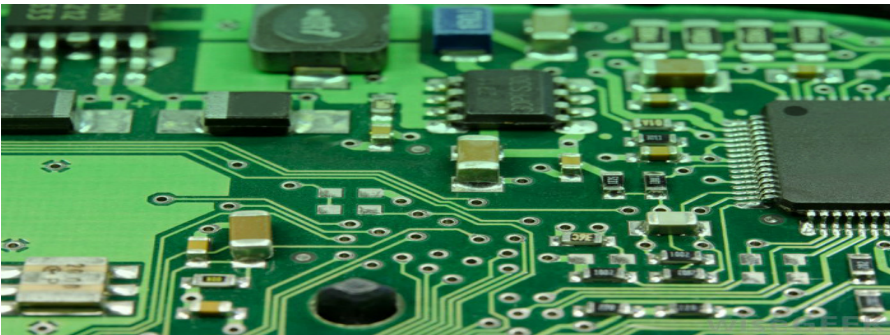


# Best Practices To Control Humidity In Enclosed Spaces

To Prevent Moisture Caused Corrosion on  
Critical Surface Mounted Technologies Parts



By Dan Jenkins

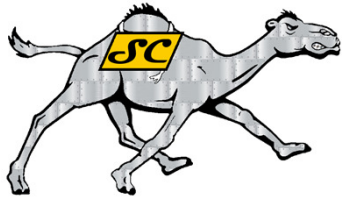


# Water IS Everywhere!!!



Good and Bad

**About**



*Steel Camel*

**Accident  
Prevention**



**Reliability**



**EPRI**  
ELECTRIC POWER  
RESEARCH INSTITUTE





## About



## Prevention

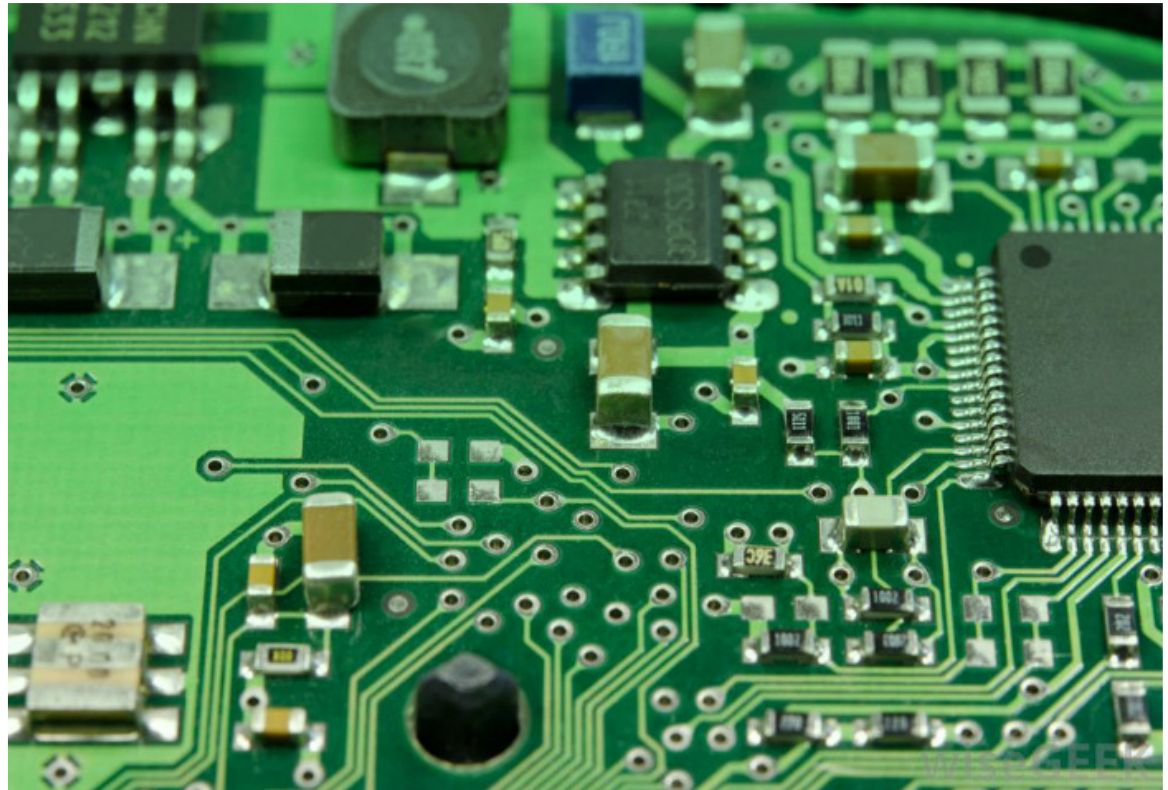
- ✓ **Accidents**
- ✓ **Corrosion**
- ✓ **Part Failure**
- ✓ **Disruption**



**Microbial Influenced Corrosion**



## Similarities Between Cranes and Circuit Boards & Electrical Panels

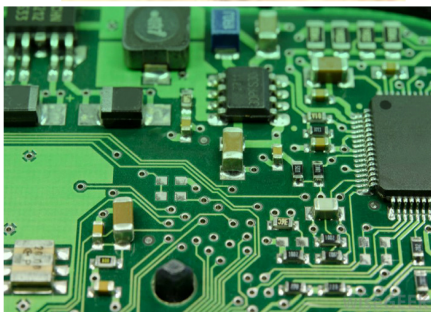


# Similarities Between Cranes and Circuit Boards



	Crane	Board
Assembled Hardware	✓	✓
Transfers Energy / Loads	✓	✓
Uses Fasteners	✓	✓
Exposed to Harsh Environments	✓	✓
Welding / Soldering	✓	✓

# Similarities Between Cranes and Circuit Boards



	Crane	Board
Subject to Vibration	✓	✓
Subject to Overload	✓	✓
Subject to Heat Damage	✓	✓
Subject to Expansion & Contraction	✓	✓
Subject to Corrosion	✓ ✓ ✓	✓ ✓ ✓
Subject to Fail	✓ ✓ ✓	✓ ✓ ✓



## Problems / Risk - Overload





## Problems / Risk - Assembly / Rigging





## Problems / Risk - Fatigue / Weak Points / Stress





## Problems / Risk - Corrosion



## Problems / Risk - Spark - Fire



## Problems / Risk - Harsh Environments





# What Is Moisture and Why Is It So Destructive?

- Ingredient in Corrosion Process
- Destroys / Eats Surfaces
- Creates Pits & Holes
- Causes Expansion of Metal Parts
- Part of Microbial Corrosion

➤ **Changes in Temperature**

➤ **Acidification**

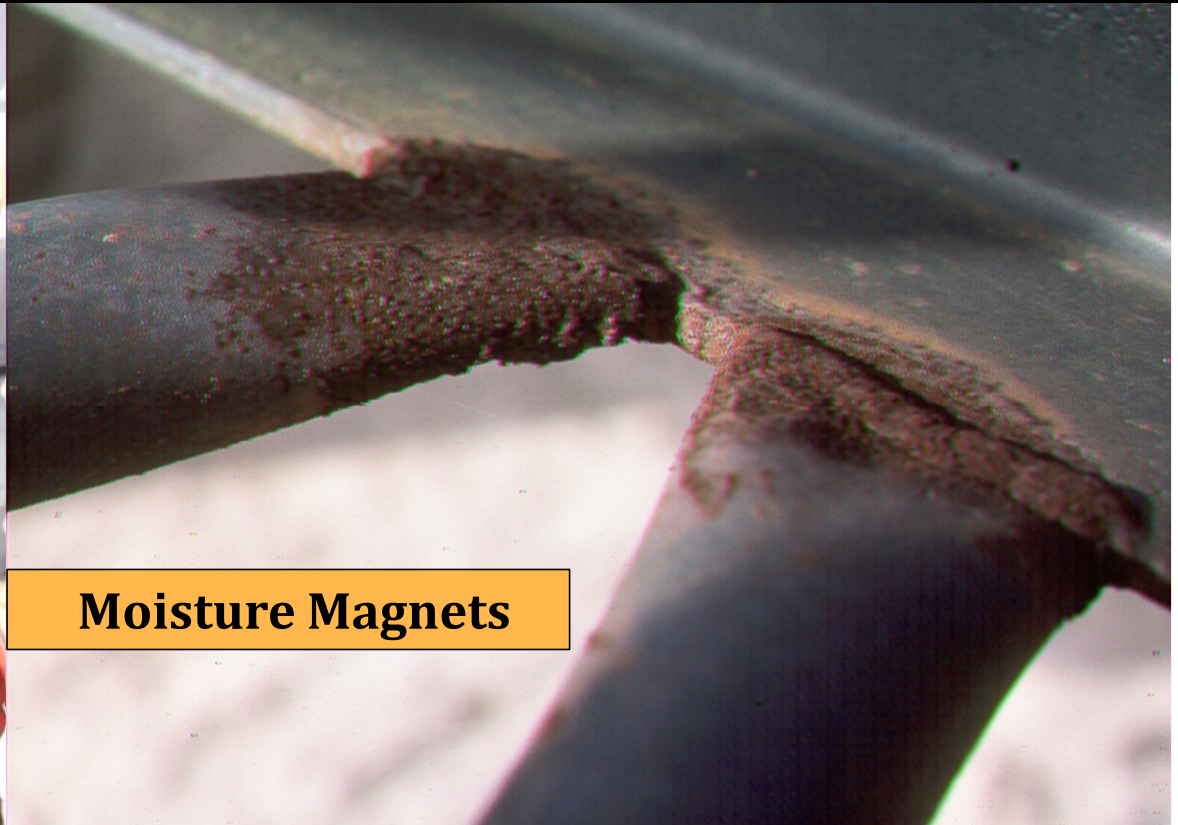
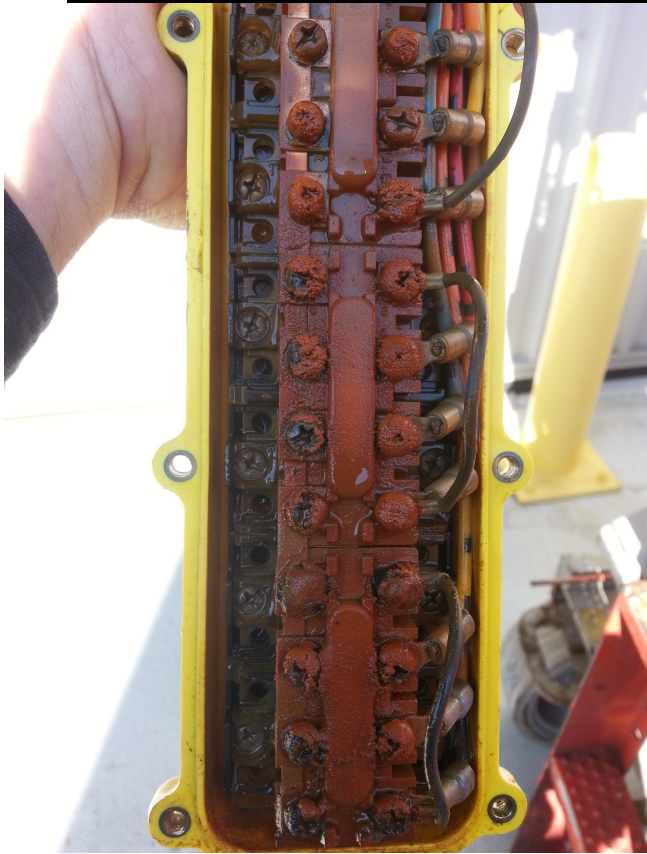


## Condensation & Corrosion In Enclosed Spaces



Steel Camel DNA

# What Is Corrosion?

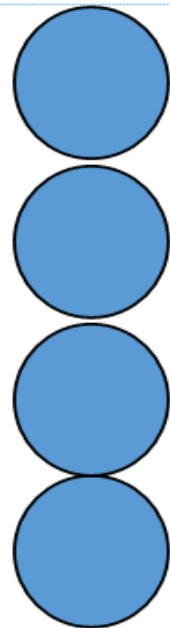
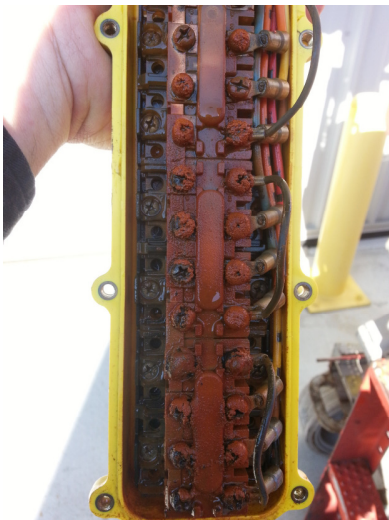


**Moisture Magnets**

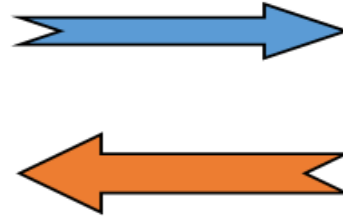
**Parts Being Eaten / Destroyed by a Process**



# Review Principles



Metal  
Negative



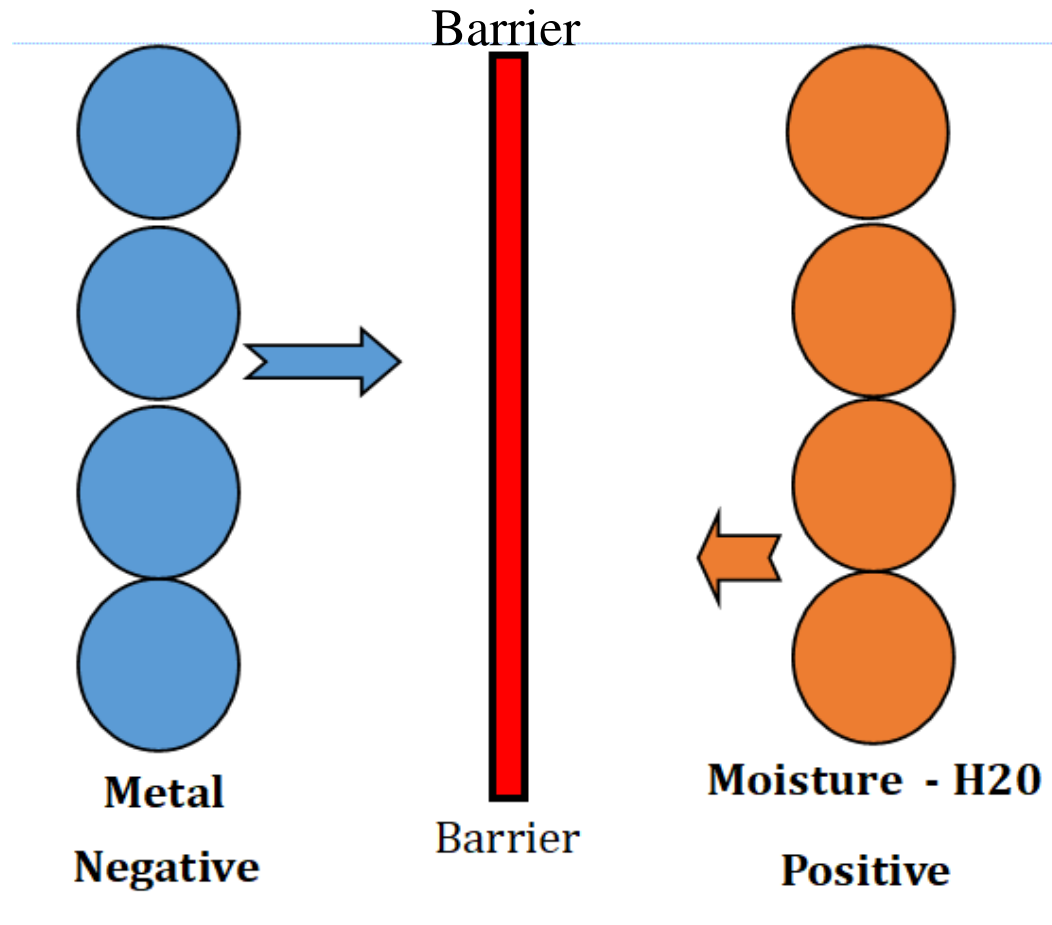
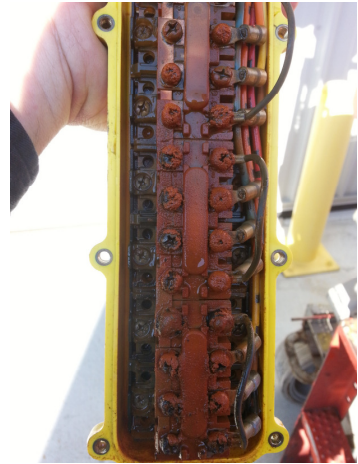
Moisture - H<sub>2</sub>O  
Positive



Iron Oxides - Rust



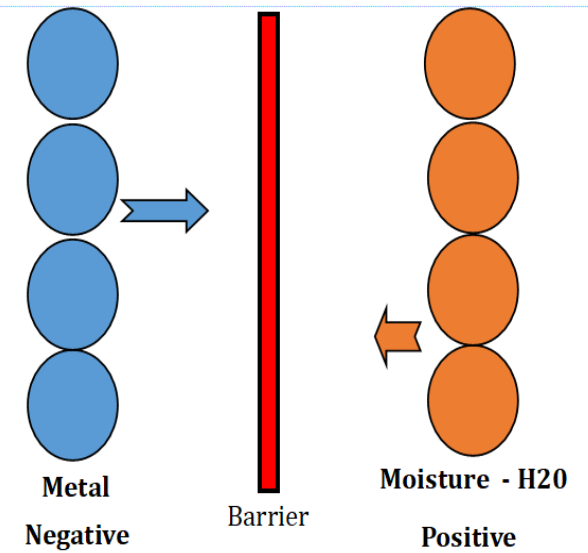
## Metal Preservation Techniques - Barriers



# History of Corrosion Protection



**Whale Blubber**





## Armour worn in Europe

500 BCE



100 CE



800s



1066



1200s



1300s



1400s



1500s



1600s



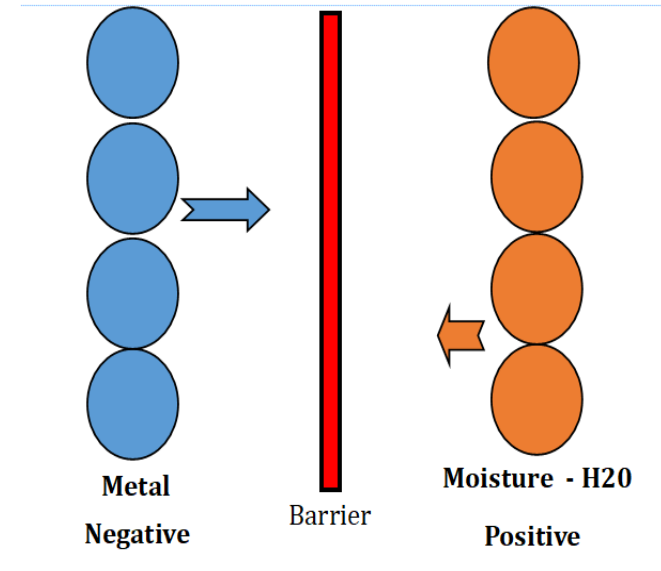
today



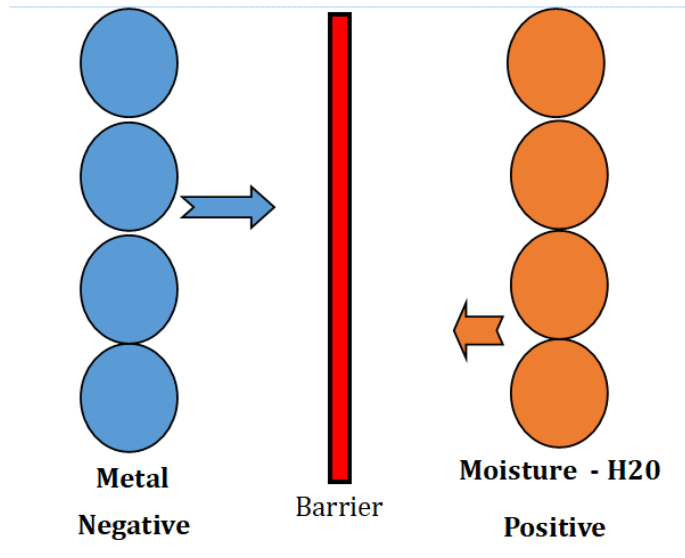
# History of Barrier Protection Method



- Waxes
- Oils
- Greases
- Lanolin



## Modern Types of Barriers For Electronics



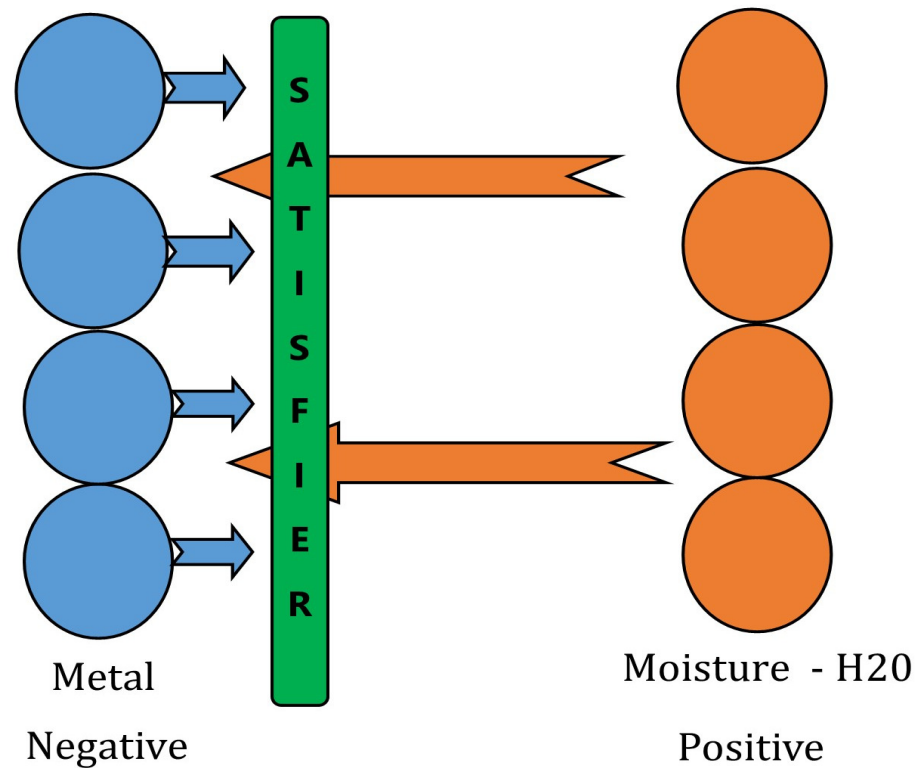
- Conformal Coatings ...Synthetic Latex
- Seals & Films ...Oils
- Potting ... Resins

Many Successes





# Modern Types of Barriers For Electronic



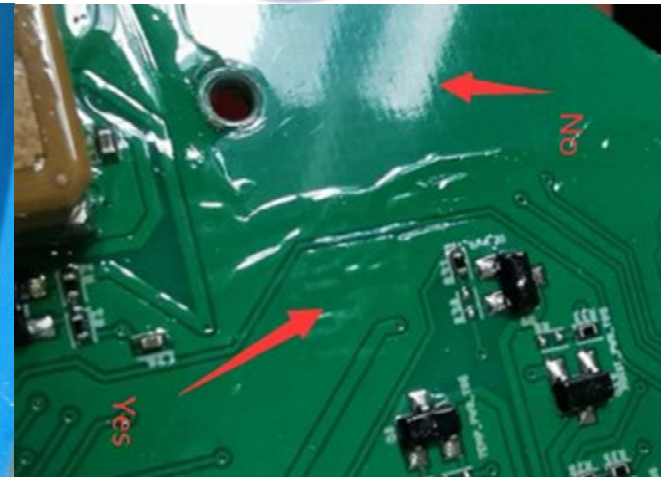
Many Successes



## Potential Problems With Barriers & What Inspectors Should Look For



- Surface Prep
- Moisture Trapping
- Swelling
- Cracking
- Adhesion



## What Moisture Problems Should Inspectors Be Looking For



Corrosion	Bending / Flexing	Damage
➤ Pitting / Popcorning	➤ Cracks In Coating	➤ Delamination
➤ Disconfiguration	➤ Cracks in Metal	➤ Swelling



# Metal Preservation Techniques – Moisture Control - Desiccants

## History



- \* Originally Industrial use consisted of dried sand and clay 400 years ago
- 1940's – Military Used in World War War to Protect Medicine
- 1966 – First Mil Spec 3464 - Moisture Sensitive Devices.
- 1990's Adoption By Electronics and Computer Chip Industry
  - JEDEC Joint Electronic Device Engineering Council
  - IPC Institute of Printed Circuits
- 2020 – US Military / JEDEC and IPC – Looking at new technology

# Desiccant Types, What Do They Do? and How They Work ?

## Silica



- Rigid
- **Ad**hesion
- Coats Surface

## **Ad**sorb vs. **Ab**sorb



## Polymeric



- Expands
- Gains Weight
- **Ab**sorbs





# Let's Talk Desiccant Types

Name	Type	Expansion
Silica (Sand)	Adsorbent	No
Clay	Adsorbent	No
Polymeric	Absorbent	Yes



## Desiccant Types and How They Work - Change Indicator

### Silica & Clay



- Color Change

### Polymeric



- Blows Up
- Gets Hard
- Changes Shape

# Desiccant -Regeneration

Silica & Clay



➤ Unlimited



Polymeric



➤ Limited



## Desiccant - Regeneration Challenges

### Silica & Clay

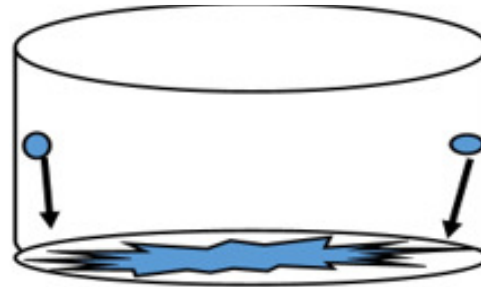


### Polymeric

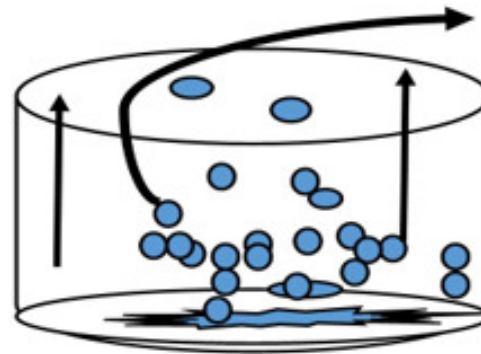


- Hot,
- Long Intensive
- Labor
- Moisture Accumulations

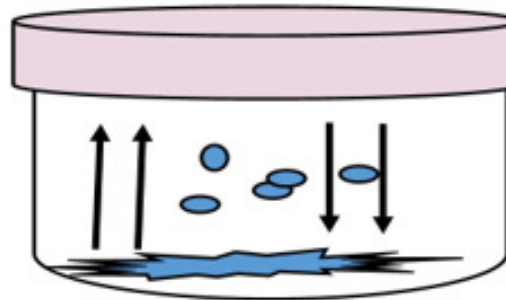
# What Happens To Humidity In Enclosed Spaces Without Desiccants



➤ Puddles



Rises as Heat Turns  
to Gas ... Escapes



With Lid

- Falls Back Down
- Puddles

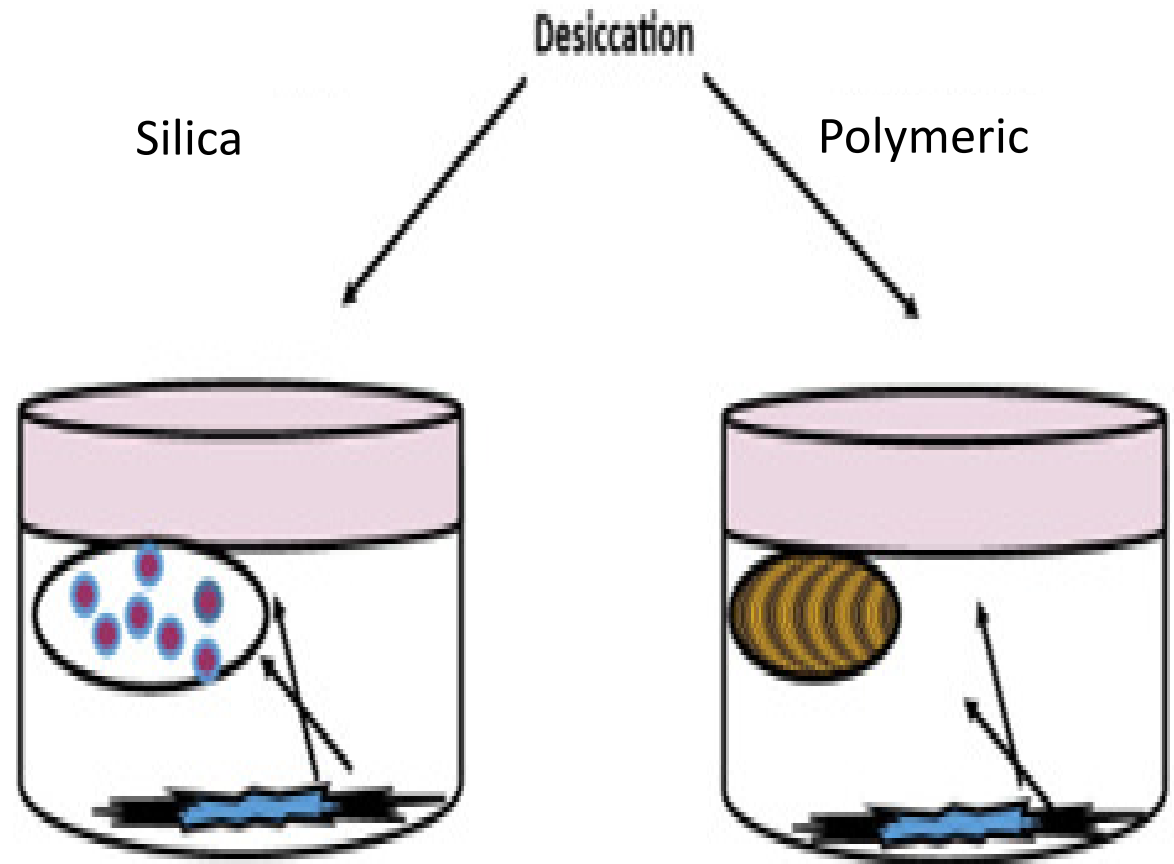
## With Desiccants

### Naturally Occurring Equilibrium:

**Silica Begins To Have  
Moisture Adhere to  
Surfaces -**

### Synthetic:

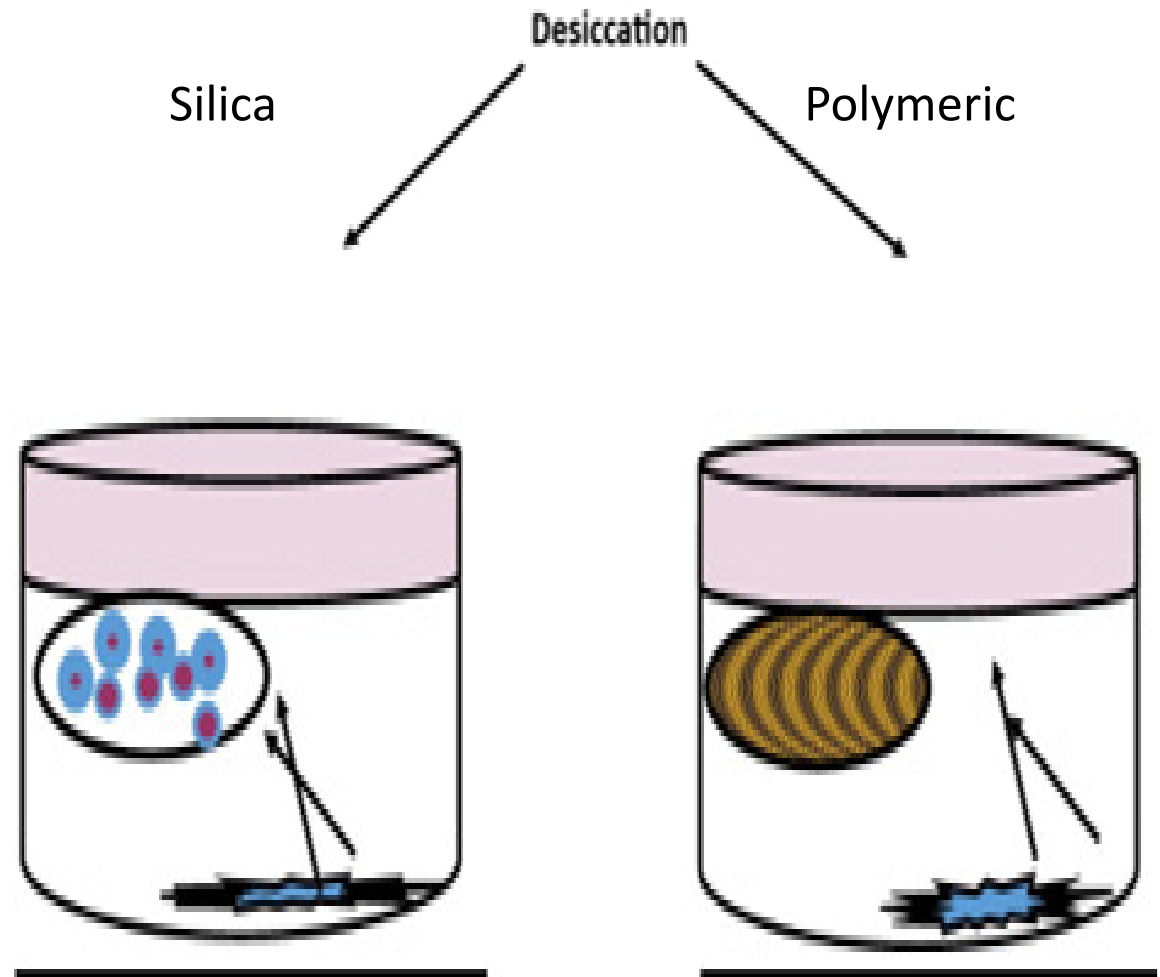
**Polymeric Begins to  
Attract Moisture to  
Chemistry**





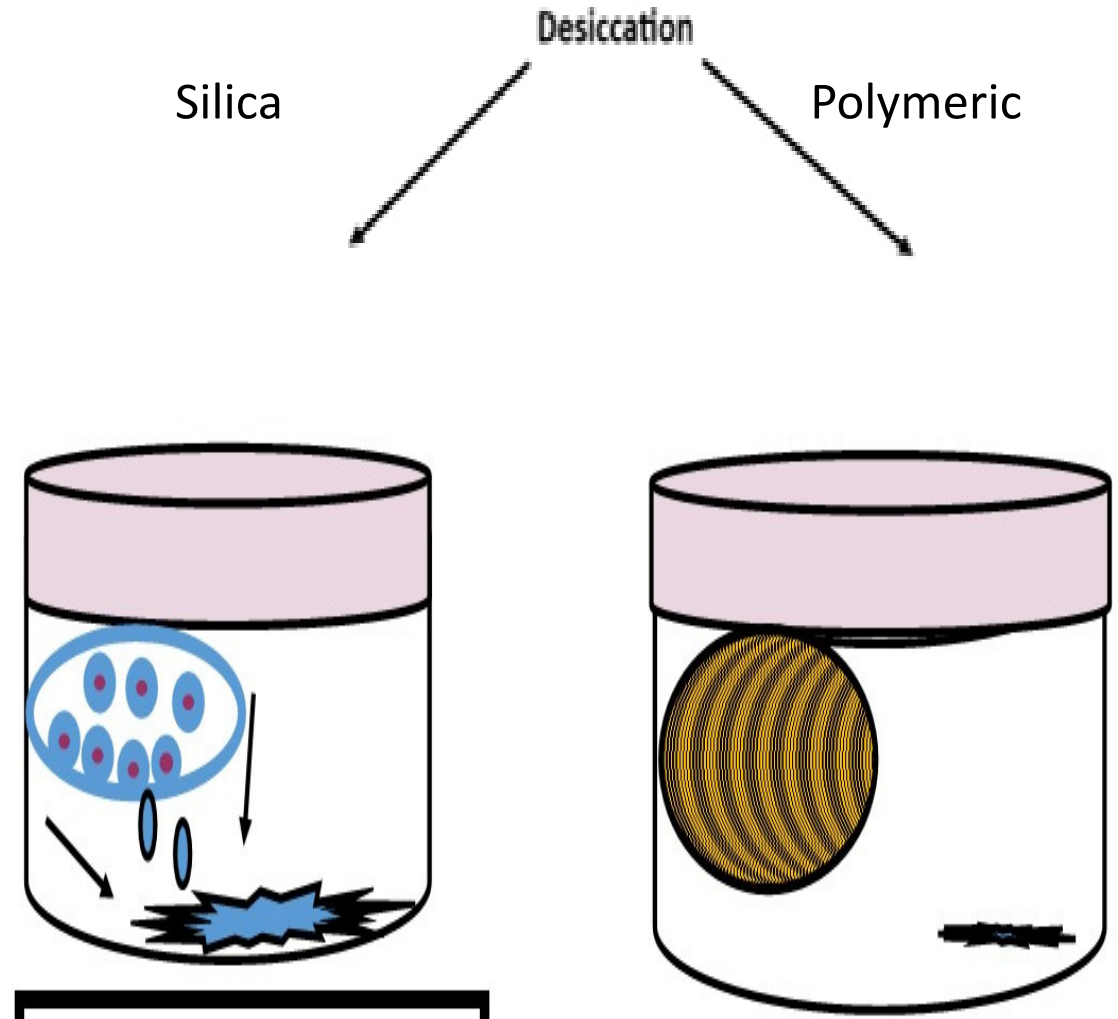
**Silica Beads Continue  
To Adsorb and Moisture  
Coats Surfaces**

**Polymeric Bags Attracts  
and Holds Moisture**



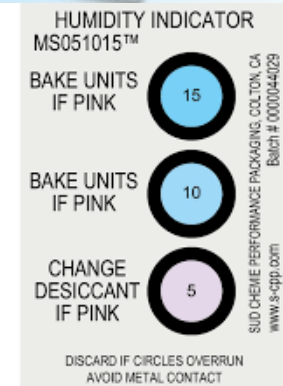
**Silica Reaches Saturation Point and Moisture Falls Off Back Into Atmosphere**

**Polymeric Continues To Attract and Hold Moisture.... Leaving Enclosed Space Drier**



## Industry Standards - Desiccants

Organization	Standard	Desiccant
US Military	Mil Spec 3464	Adsorbent (Silica)
JEDEC	J-STD-0333 Mil Spec 3464	(Silica)
IPC	1602 Mil Spec 3464	(Silica)





## Mil Spec 3464 - Today

MIL-D-3464E  
21 April 1987  
SUPERSEDING  
~~MIL-D-3464D~~  
17 May 1966  
(See 6.7)

### MILITARY SPECIFICATION

#### DESICCANTS, ACTIVATED, BAGGED, PACKAGING USE AND STATIC DEHUMIDIFICATION

This specification is approved for use by all Departments and Agencies of the Department of Defense.

## Desiccant Adsorbents



# How To Conduct Performance Tests



➤ Humidity Chamber

➤ Measure Weight Gain

1) Silica 2) Clay 3) Polymeric



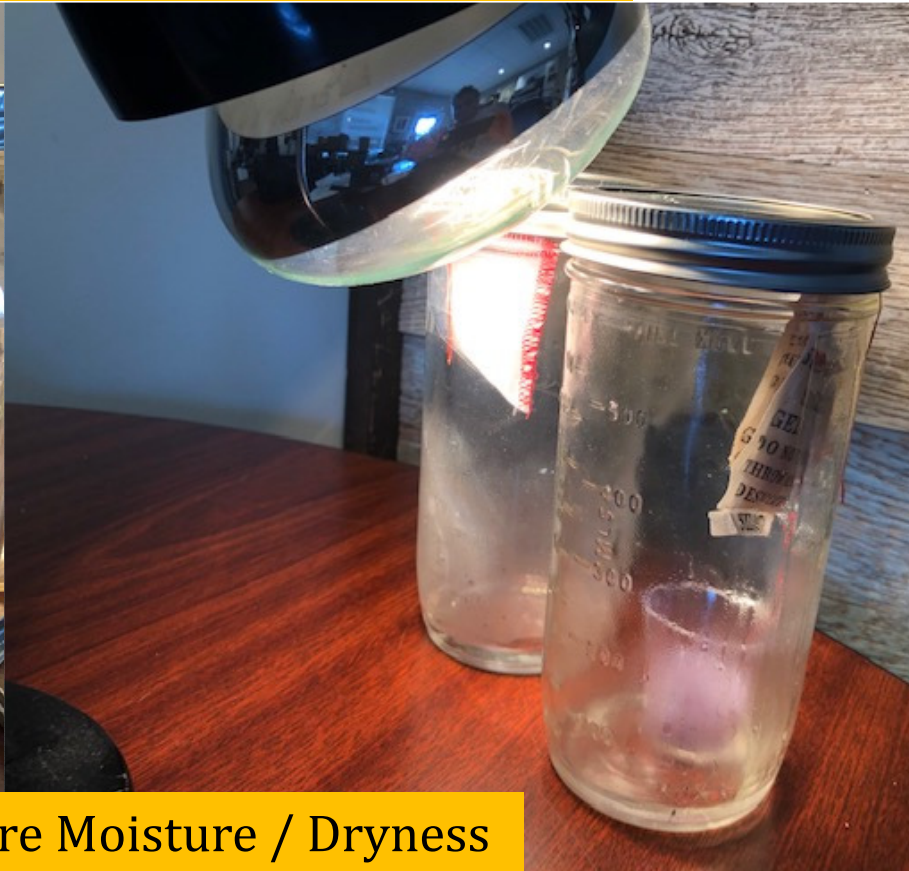
Military Testing Specifications and Engineer  
Contact Available Upon Request

# How To Conduct Performance Tests

Window Sil and/or Heat Lamp



Measure Moisture / Dryness





# How To Conduct Performance Tests



➤ Real World Experience & Measurement

# What Measurements Should Be Tested for Comparison?

1) Silica 2) Clay 3) Polymeric

# 1 How Long Does Each Desiccant Last?

#2 How Much Volume Of Air Can Be Desiccated?

#3 How Well Does Each Desiccant Retain Moisture?

#4 How Easy Is It for Operator To Determine When to Change?



# Who and Where Do You Share Test Results With?

1) Silica 2) Clay 3) Polymeric

# 1 US Military – Army Packaging Center

#2 JEDEC and IPC Committee Chairman

#3 Supply Chain





# Summary

Water Is Everywhere.....And Corrosion Can't Be To Far Behind





## Summary

The Best Defense Against SMT Corrosion is  
Understanding Moisture & Corrosion Control, and Test For Yourself



Thank You and Questions