Moisture Sensitive Devices a real production problem

Totech dry cabinet

Background

- Moisture and Surface Mount Components do not mix
- Plastic packaging material very often is permeable to moisture
- If moisture levels become critical, component damage may occur when heated during soldering (popcorning)
- Moisture induced failures are often undetectable, causing malfunction within 2 and 6 months
- Higher processing temperatures of unleaded solder will intensifythe problem

Lead Free and Popcorning

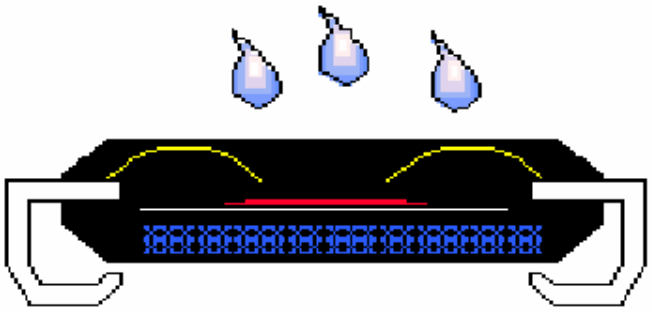
Temperature	Saturated vapor pressure
180℃	10ATM
.	.
.	.
.	.
230℃	29ATM
240℃	**34ATM**
	ATM:Air pressure

Increases up to 3 times

Totech dry cabinet

Popcorning

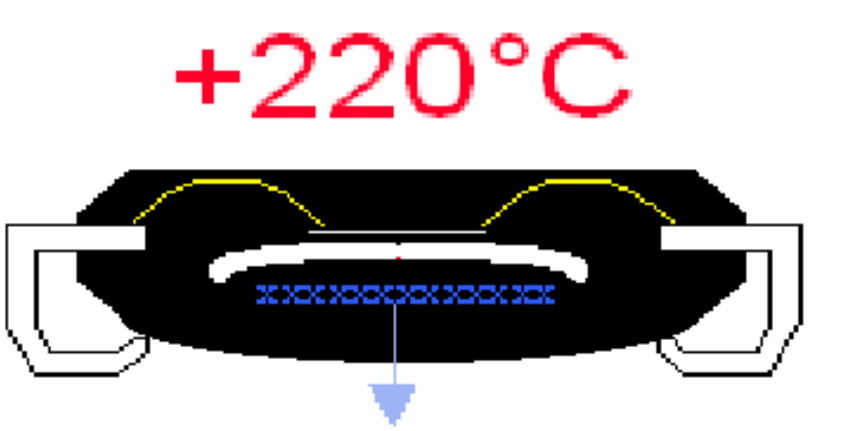
- The epoxy moulding compound used in most plastic encapsulated devices is hygroscopic
- While processing, temperatures reach 260ºC
- Fast ramps and high temperatures prevent moisture from escaping



Totech dry cabinet

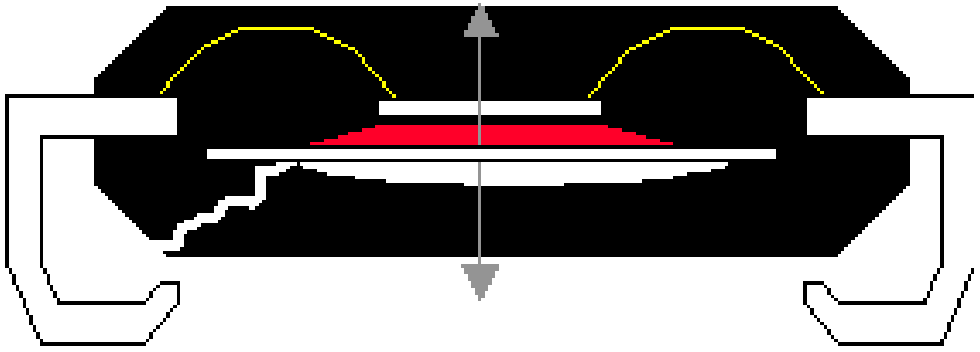
Popcorning

- This leads to delaminating the encapsulated interface of the die, resulting in a gas bubble
- This is not always visually apparent



Popcorning

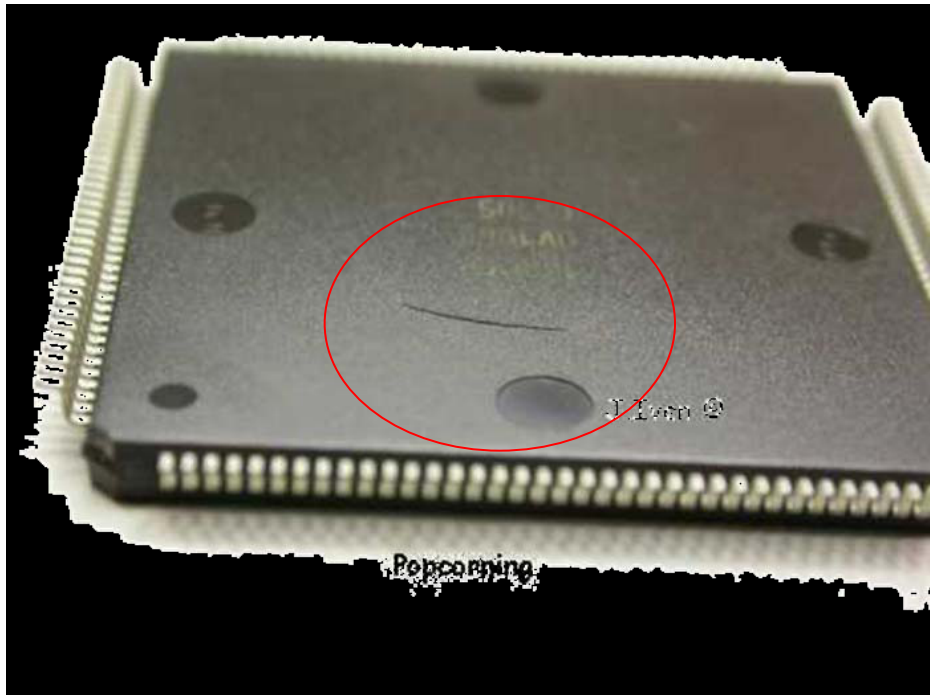
- Exceeding the technical elastic limit results in cracking of the plastic packaging, water vapour escapes with a sudden burst
- The plastic packaging has a „leak“permeating oxygen slowly destroys the components



Totech dry cabinet

Popcorning Example 1

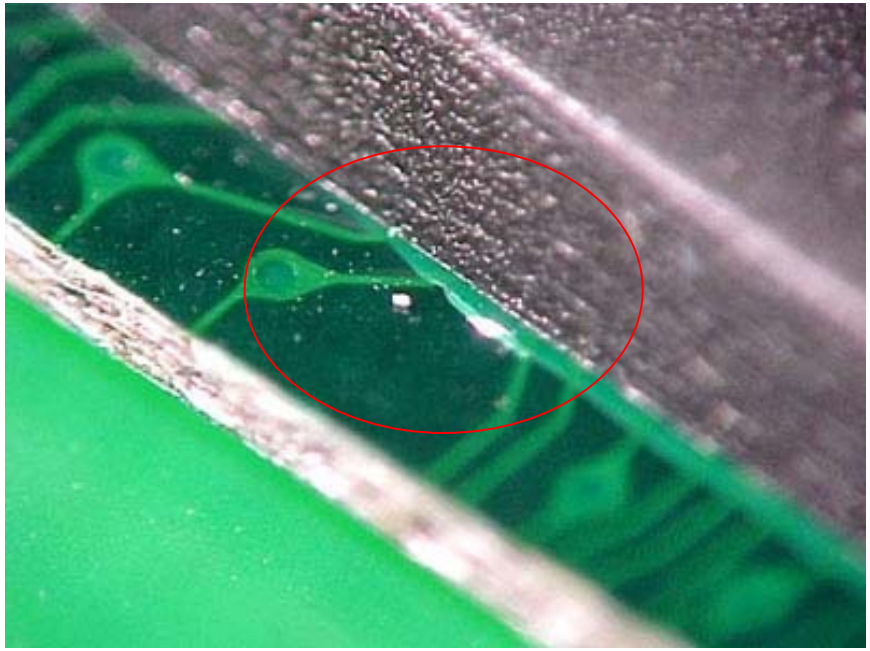
- QFP 208 device, with crack on the underside of body moulding



Totech dry cabinet

Popcorning Example 2

- BGA device, showing crack between fibreglass substrate and plastic body moulding



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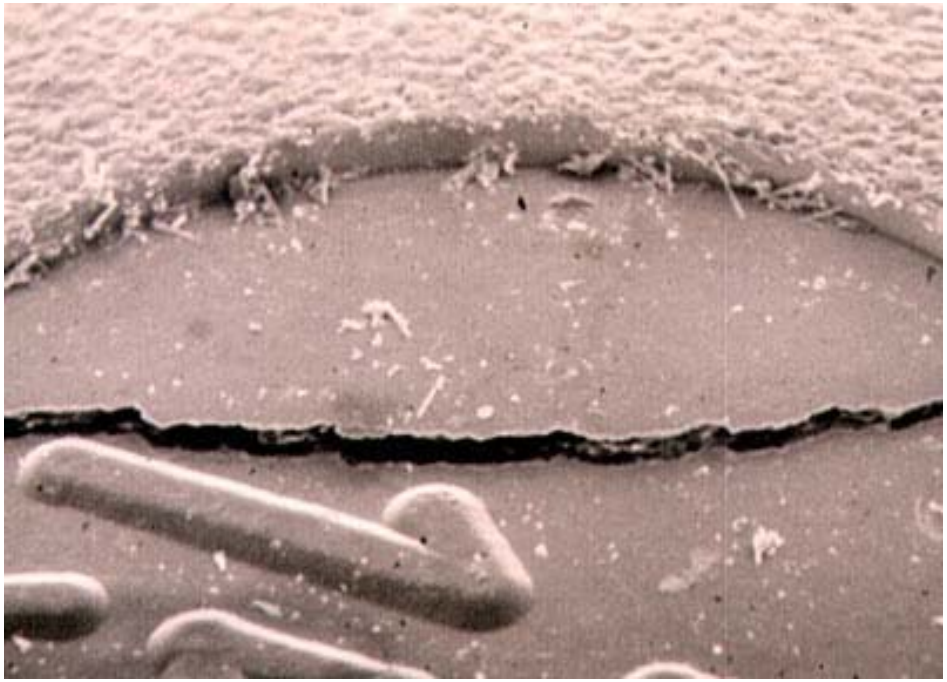
Popcorning Example 3

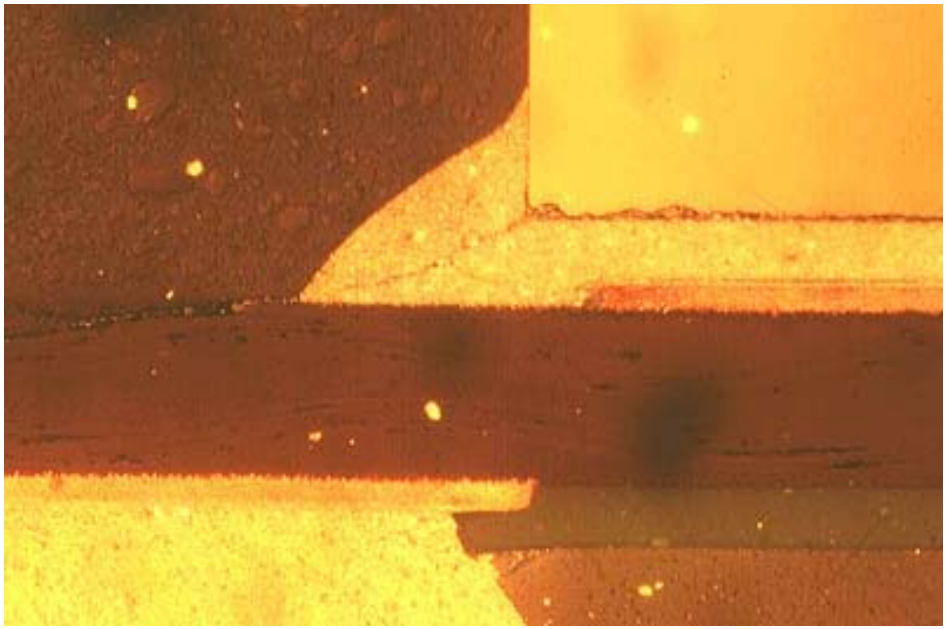
- QFP device, showing crack on top of plastic body moulding



Totech dry cabinet

Popcorning Example 4

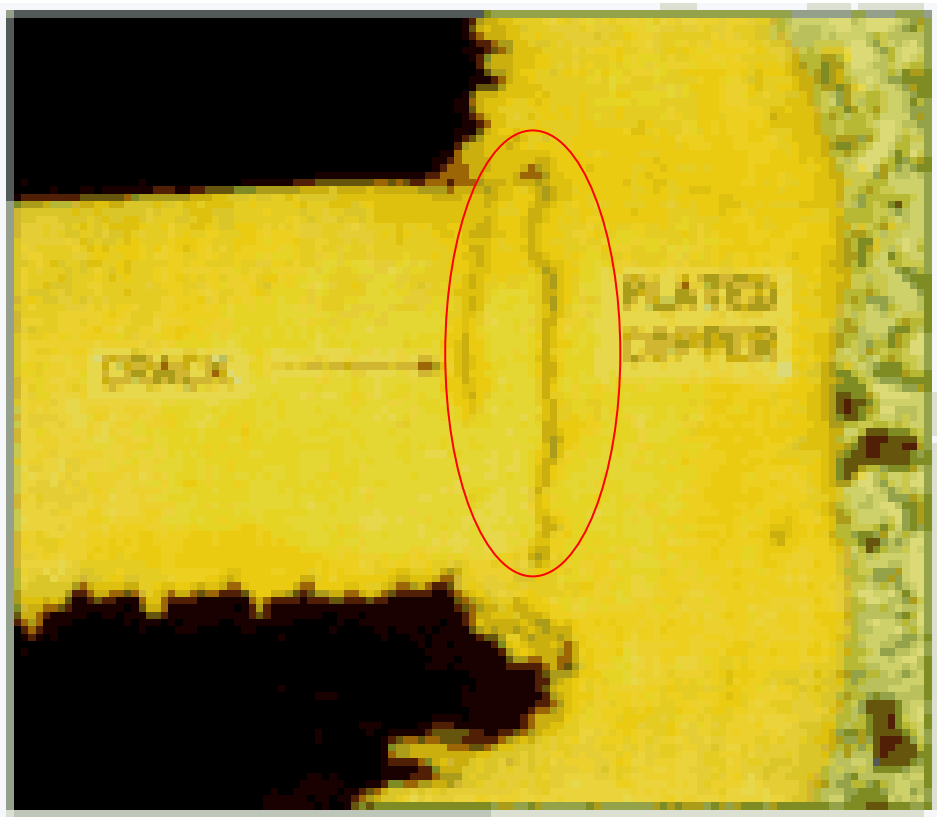
- Micro section through BGA device, showing delaminating and crack through conductive adhesive and fibreglass substrate



Totech dry cabinet

Popcorning Example 5

- Thin film cracking under wire bonds



Totech dry cabinet

IPC-Levels for IC's

A lead-free MSD has a different moisture classification level than a leaded MSD.

Table 5-1 Moisture Classification Level and Floor Life

Level	Floor life (out of bag) at factory ambient ≤30℃/60%RH or as stated
1	Unlimited at ≤30℃/85%RH
2	1year
2a	4 weeks
3	168 hours
4	72 hours
5	48 hours
5a	24 hours
6	Mandatory bake before use. After bake, must be reflowed witin the limit time specified on the label.

Totech dry cabinet

IPC-Levels for IC's

An equivalent lead-free component will have a higher classification level and a shorter allowable exposure time

Table 5-1 Table 5-1 Moisture Classification Level and Floor Life

Level	Floor life (out of bag) at factory ambient ≤30℃/60%RH or as stated
1	Unlimited at ≤30℃/85%RH
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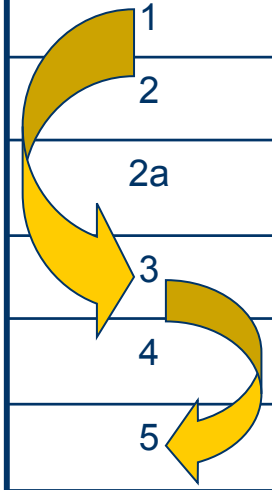
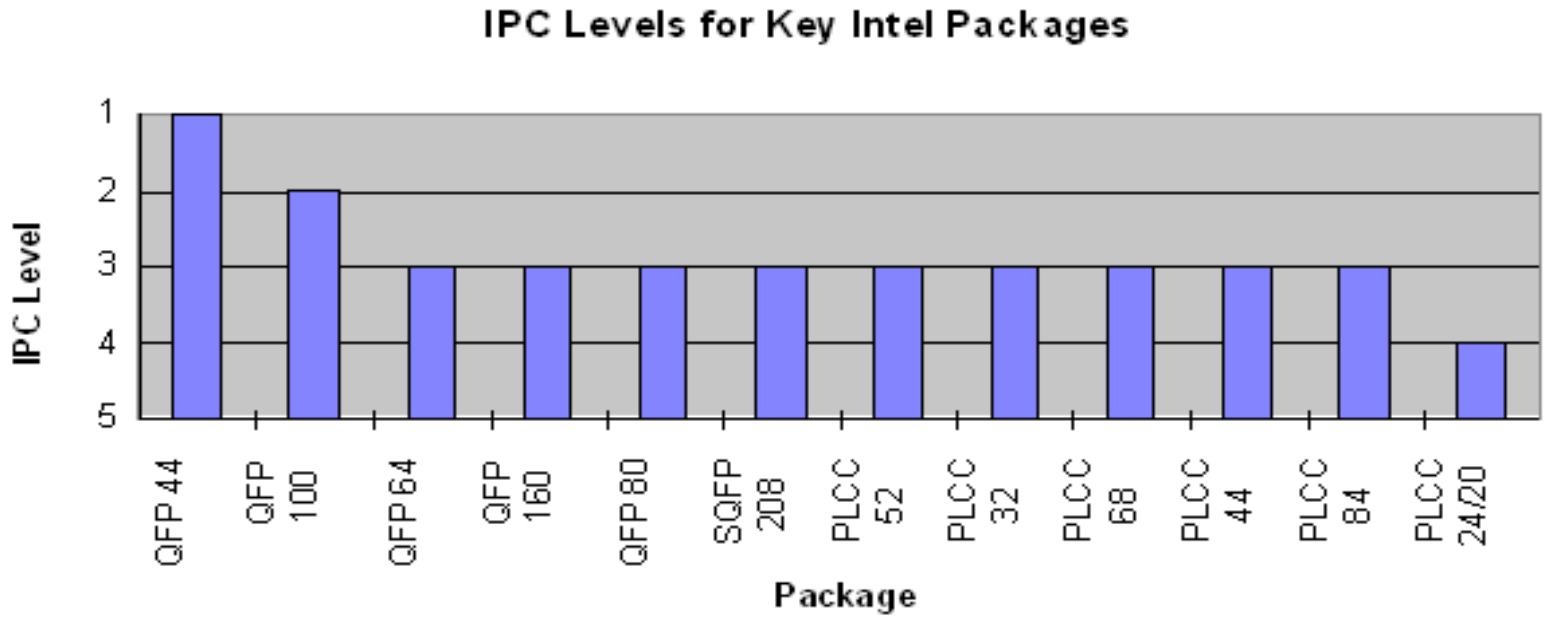


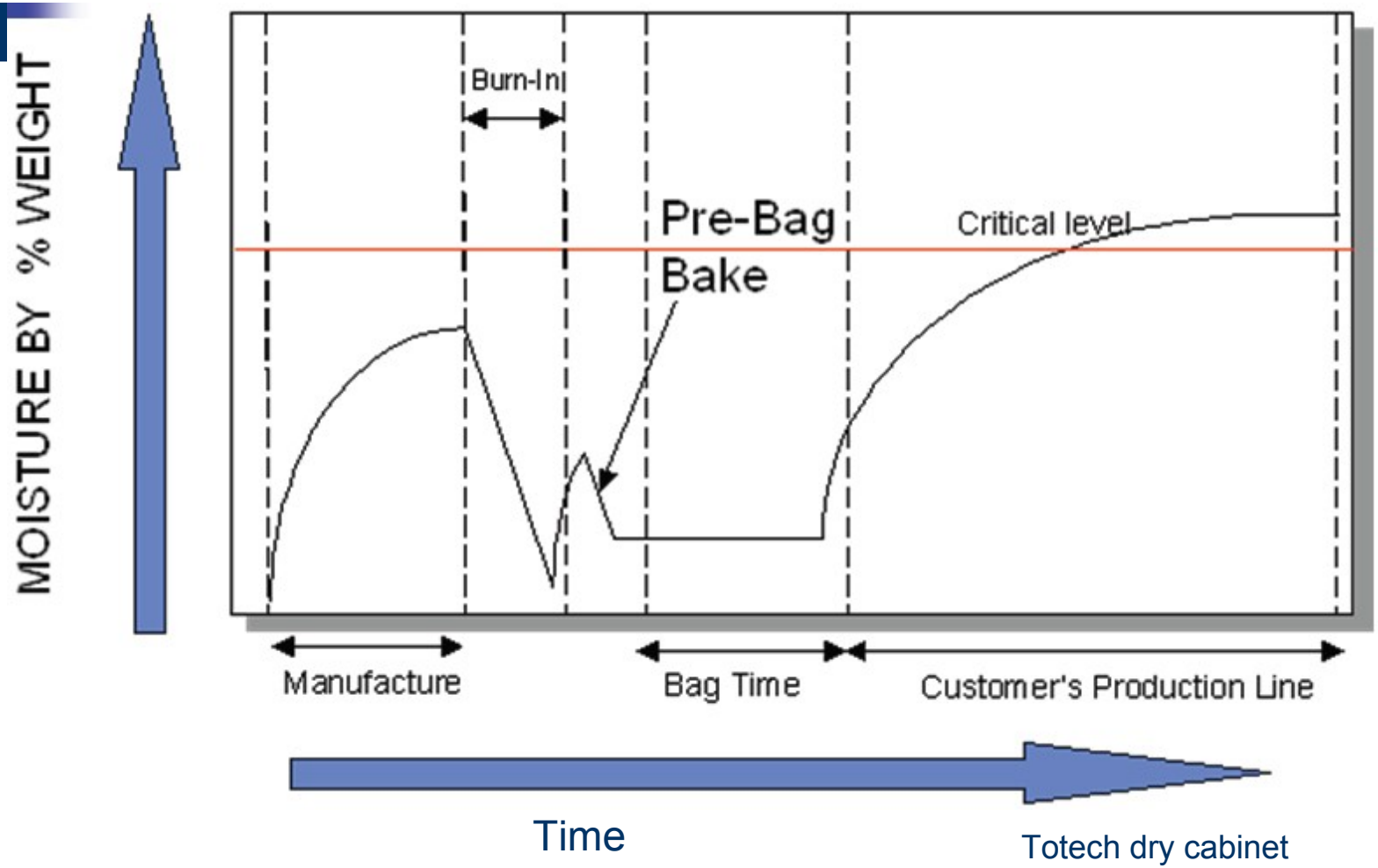
Totech dry cabinet

IPC-Levels for IC's



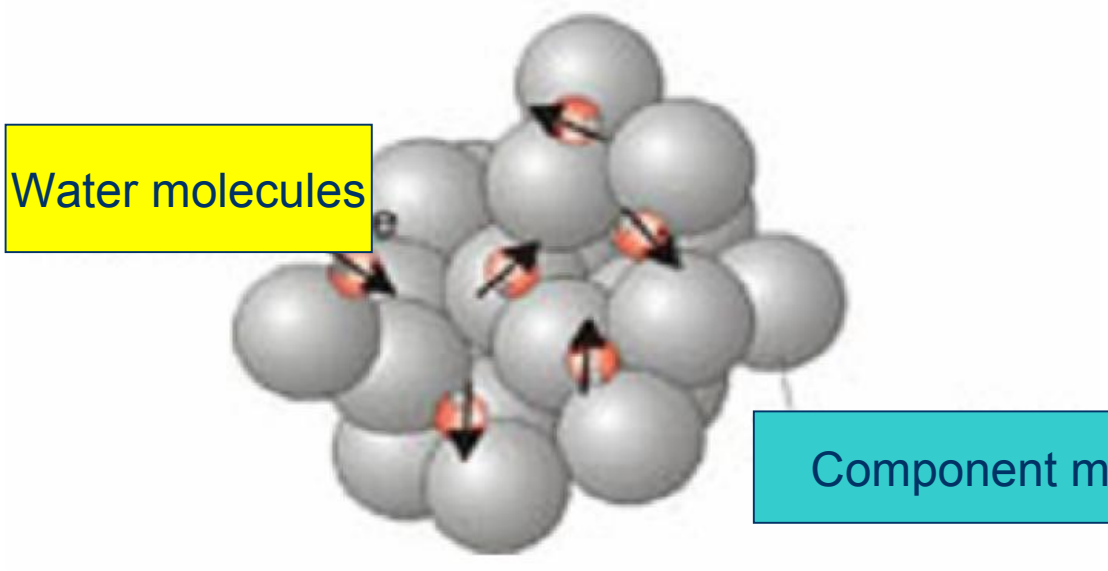
Totech dry cabinet

Component Humidity



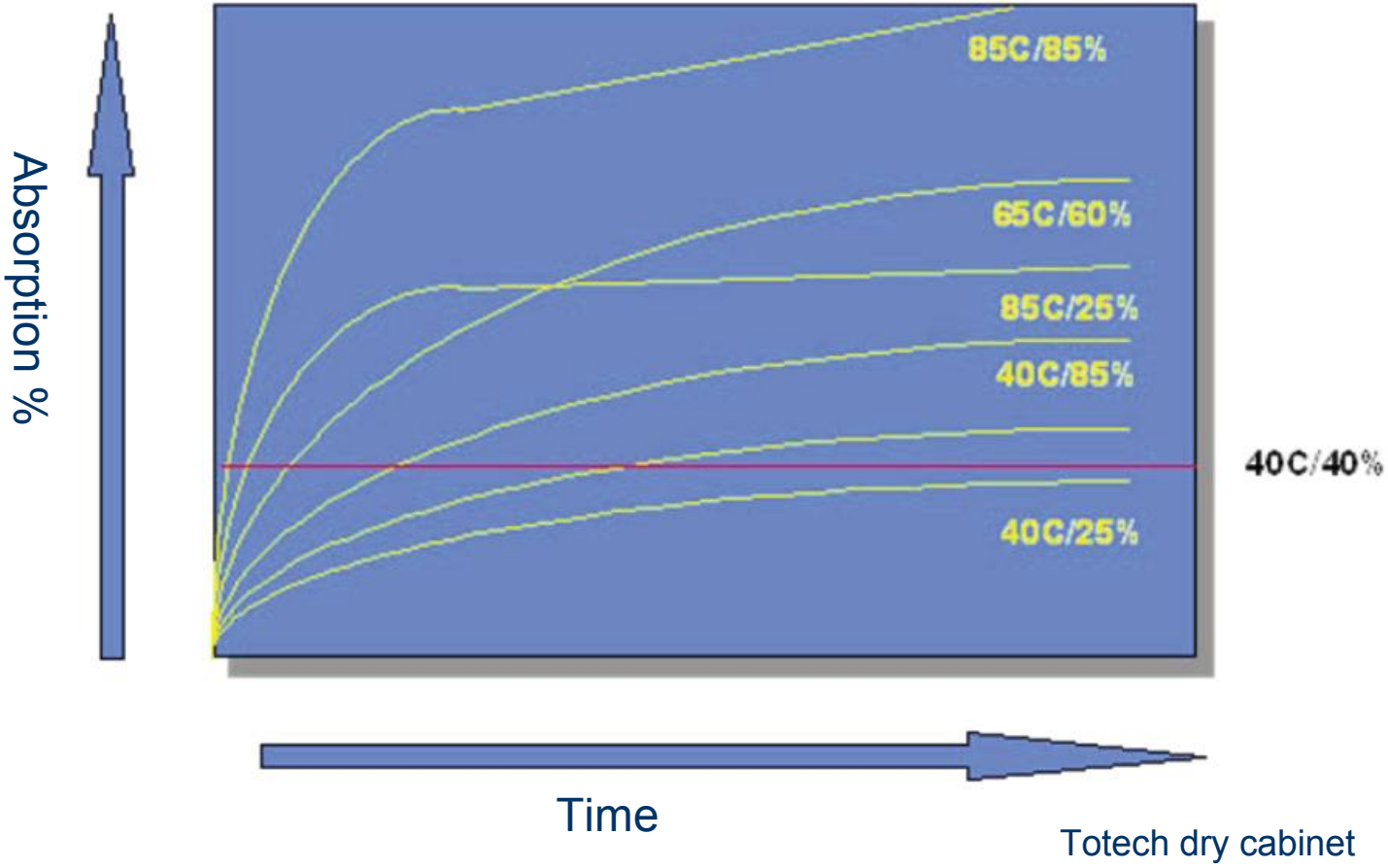
Absorption

Component embedded water molecules



Totech dry cabinet

Absorption



Totech dry cabinet

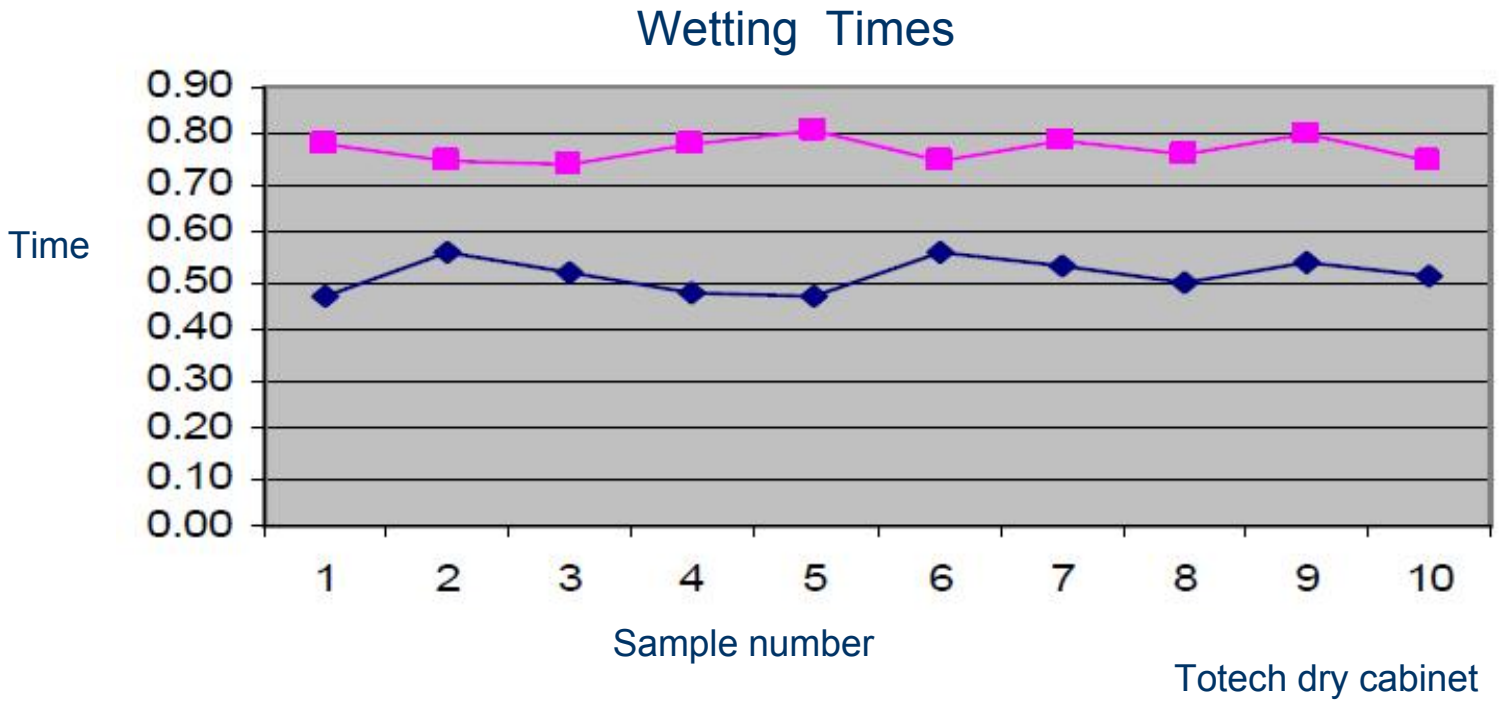
Traditional Prevention

- Historically, components and printed control boards have been baked to remove moisture
- Typically temperatures from 40 to 125°C and times between 1 hour and 1 week have been used
- This adds time and costs to production
- Backing is still possible, but only according to IPC specification

Problem:Solder Ability

SOIC 14 Chip, 60/40 Sn/Pballoy, type R flux, 4 hours @ 100 C

SOIC 14 Chip, 60/40 Sn/Pballoy, typeR flux, as received



Totech dry cabinet

Problem: Problem: Inter Metallic Growth

- Inter metallic growth depends on time and temperature
- Total inter metallic thickness has shown to increase by approximately 50% when baked at 125°C for 4 days
- Concerning copper metallisation, this is mainly the Cu6 Sn5 layer, but all layers are effected
- The thicker inter metallic layers can lead to a reduction in solder joint integrity and in extreme cases reduce solder ability

Summary Summary
Problems with Baking

- Surface solder ability is reduced
- Growth of inter metallic layers is promoted, also at low temperature (40°C)
- Baking is only possible one time (according to IPC)
- Ovens are expensive to operate, mostly needing N^2-purging systems
- They occupy valuable space on the production floor

Variety of Dry Storage

- Moisture Barrier Bags (MBB)
- Nitrogen Cabinets
- Dry Air cabinets
- Desiccant Dry Cabinets

Totech dry cabinet

Pros / Cons of MBB Storage

Pros

- Inexpensive start up, little investment required

Cons

- Bags can/do remain unsealed for extended periods
- Silica Gel packets used ‘’past their prime’’
- Silica Gel packets improperly stored
- Labor intensive

Totech dry cabinet

Pros / Cons of Nitrogen cabinets

Pros

- N2 often available
- N2 cabinets familiar

Cons

- Often poorly maintained
- Rarely monitored for effectiveness
- Costly to operate
- Installing is necessary
- Not available everywhere
- Very pure N2 is needed to dry components, expensive!!
- Can hardly dry components

Totech dry cabinet

Pros / Cons of Dry Air Cabinets

Pros

- Air is easy to get
- Fast dehumidification

Cons

- Pipe and Installing is necessary
- Not convenient to move
- May cause noise by air compressor
- May have impurity substance into the cabinet, causing pollution to the components.

Totech dry cabinet

Pros / Cons of Desiccant Dry Cabinets

Pros

- Dries without heat
- Fast de-humidification
- Zero maintenance
- Constantly monitored for effectiveness
- Low cost operation
- Air tight
- Mobile

Cans

- Higher initial investment required

Totech dry cabinet

IPC/JEDEC 033C Application

Dry Cabinet at 10% RH

- Storage of MSD packages in these dry cabinets should be limited to a maximum time(IPC Table 7-1).
- If the time limit is exceeded they should be baked according IPC to restore the floor life

Totech dry cabinet

IPC/JEDEC 033C Application

Dry Cabinet at 5% RH

- Storage in these dry cabinets may be considered equivalent to storage in a MBB with unlimited shelf-life
- the floor life time stops
- it is not possible to restore the floor life with this cabinet humidity

Totech dry cabinet

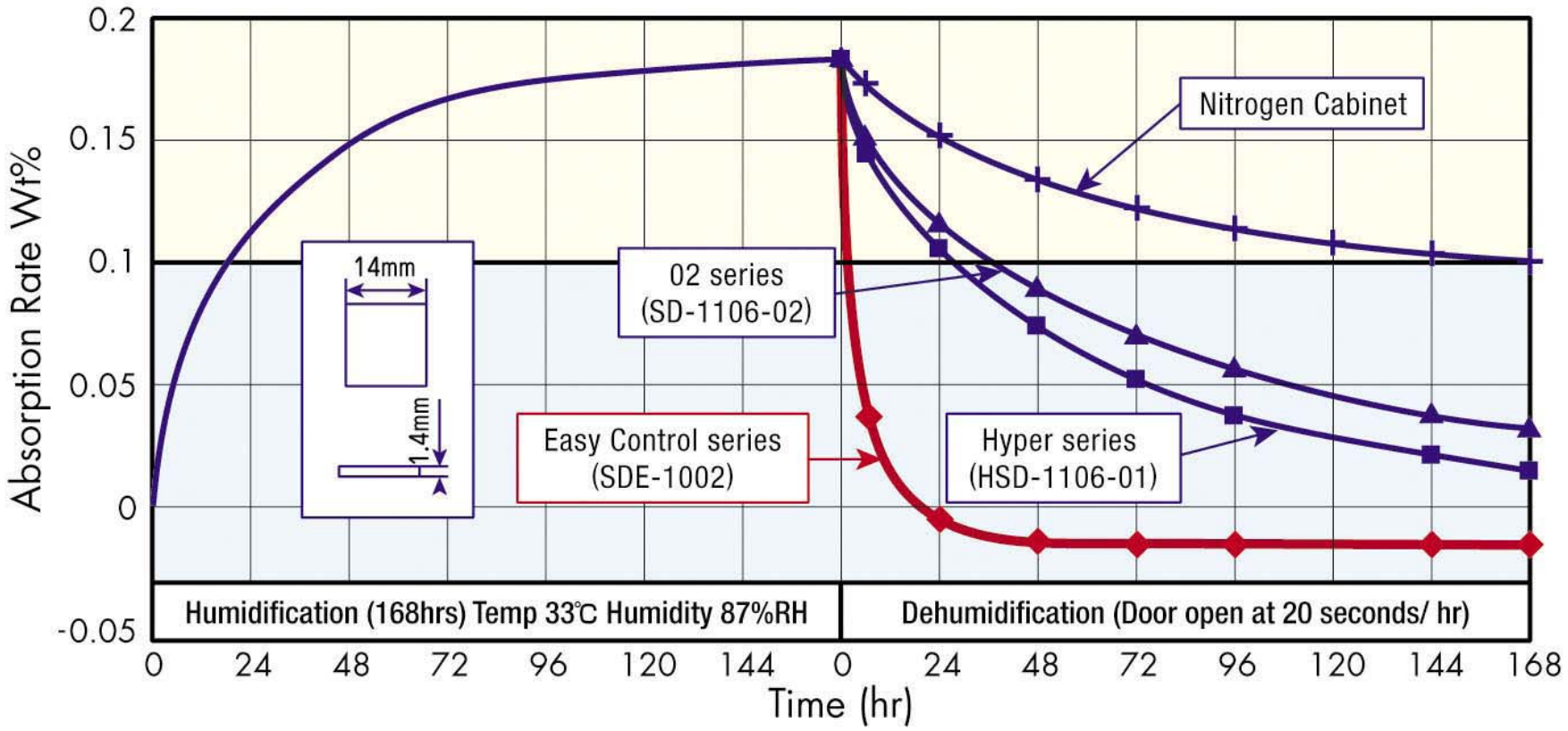
IPC/JEDEC 033C Application

Dry Cabinet at 1% RH

- Storage in these dry cabinets with unlimited shelf-life
- the time turns back and **restores** the floor life
- This type of dry storage systems provide additionally a protection of oxidation

Totech dry cabinet

Drying efficiency of Drying efficiency of different Cabinets



Totech dry cabinet

Reference Conditions for Drying SMD Packages that were exposed to Conditions at 60% RH

Body Thickness	Level	Drying at 1% RH (HSD-Series)		Drying at 2% RH (SD-Series)		Drying at 5% RH (according to IPC)	
		25°C 1% RH	40°C 1% RH	25°C 2% RH	40°C 2% RH	25°C 5% RH	40°C 5% RH
Thickness £1.4 mm	2a	2 days	1 day	5 days	2 days	18 days	5 days
	3	3 days	1 day	8 days	3 days	24 days	8 days
	4	4 days	2 days	9 days	4 days	28 days	9 days
	5	5 days	2 days	10 days	5 days	31 days	10 days
	5a	6 days	2 days	10 days	6 days	35 days	10 days
Thickness >1.4 mm £2.0 mm	2a	10 days	3 days	22 days	10 days	50 days	22 days
	3	11 days	3 days	23 days	11 days	56 days	23 days
	4	14 days	4 days	28 days	14 days	75 days	28 days
	5	16 days	5 days	35 days	16 days	100 days	35 days
	5a	18 days	5 days	56 days	18 days	120 days	56 days
Thickness >2.0 mm £4.5 mm	2a	20 days	6 days	67 days	20 days	120 days	67 days
	3	22 days	7 days	67 days	22 days	120 days	67 days
	4	22 days	7 days	67 days	22 days	120 days	67 days
	5	22 days	7 days	67 days	22 days	120 days	67 days
	5a	22 days	7 days	67 days	22 days	120 days	67 days

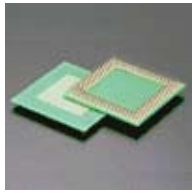
Totech dry cabinet

Alternative Prevention Alternative Prevention Drying Cabinets

- No reduction of solder ability as no heat is involved
- Oxidisation is prevented by reducing humidity
- All moisture is removed by a desiccant drying system with automatic recycling
- Low operating cost (compared to baking)
- Unlimited drying and storage time in the cabinet

Totech dry cabinet

Various component examples for dry cabinet applications

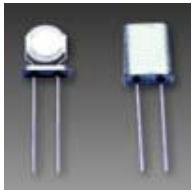


CSP,
BGA,
QFP

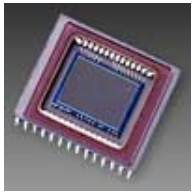
Printed
Circuit
Boards

Wafers

Ceramics



Crystal Resonator



Optical Fiber, CCD etc

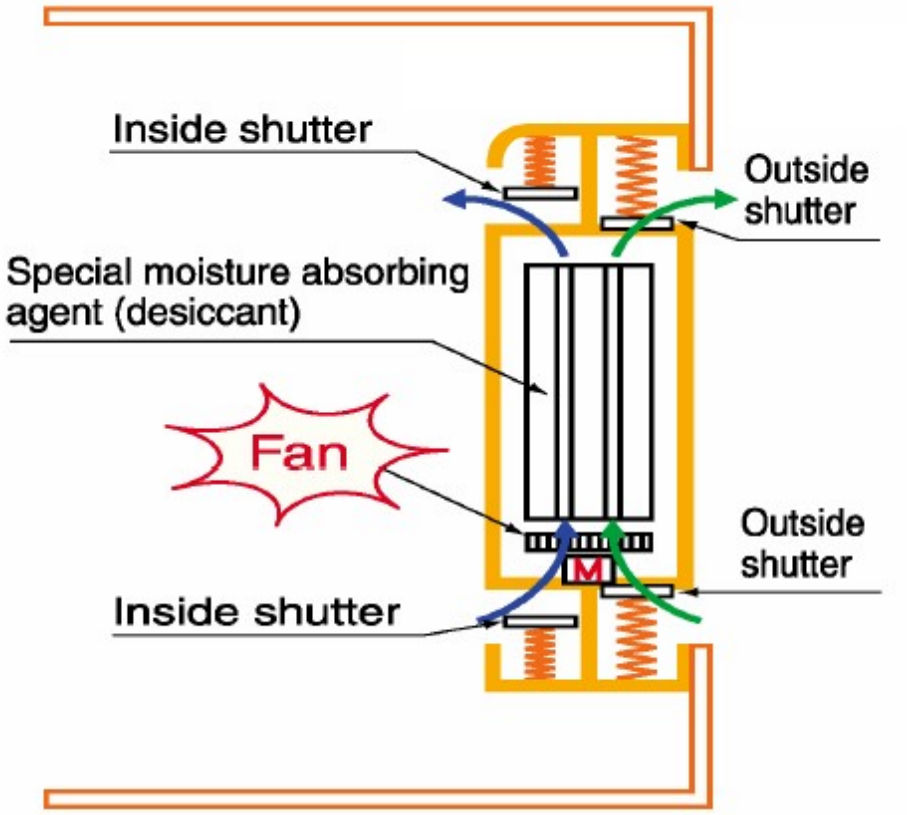
(LCG) Liquid Crystal Glass

Totech dry cabinet

Functional Principles

- An interlocked fan causes the air to circulate through the dry unit
- While passing through the dry unit moisture in the air is absorbed by the zeolite desiccant
- During periodic regenerating of the zeolite desiccantby heating, the absorbed humidity is evaporated and exhausted through the external shutters of the dry unit

Function of Dry Unit



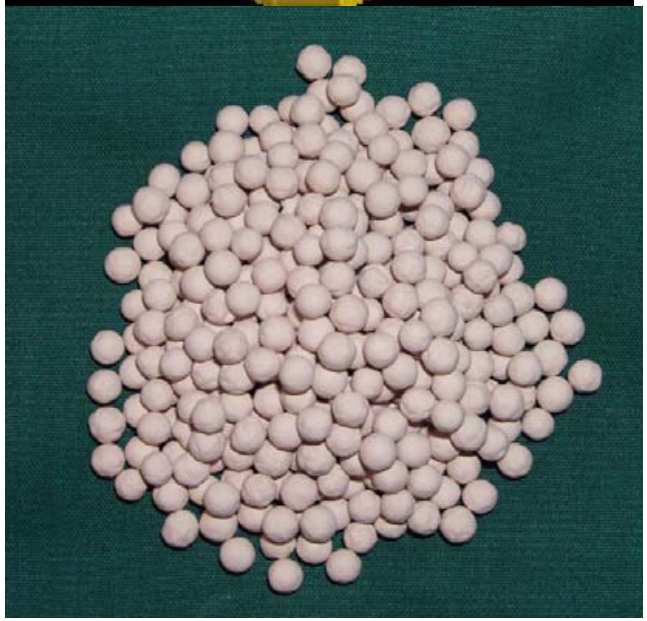
(Moisture being exhausted during recycling period)

Totech dry cabinet

Zeolite

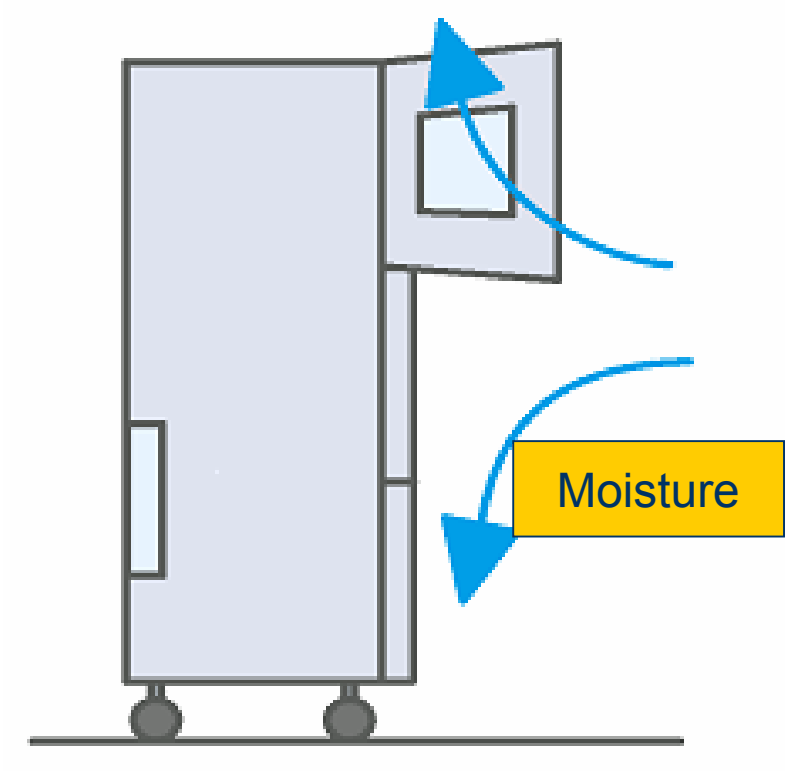
Zeolite

- Synthetically produced zeolite A
- 47% open space
- High rate of absorption at low RH levels
- Excellent ability to regenerate



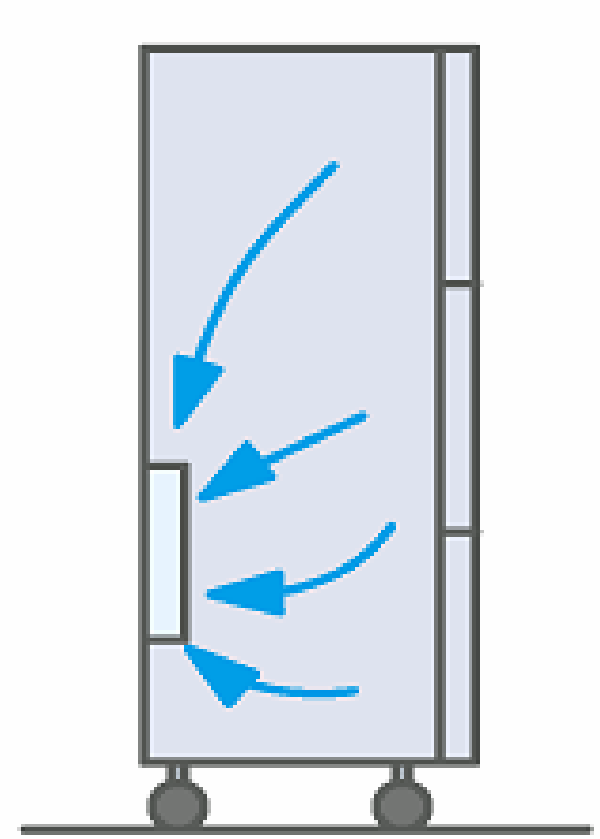
Totech dry cabinet

Functional Principle



To ensure a minimal inflow of outside ambient air the interlocked fan is stopped automatically when a door is opened

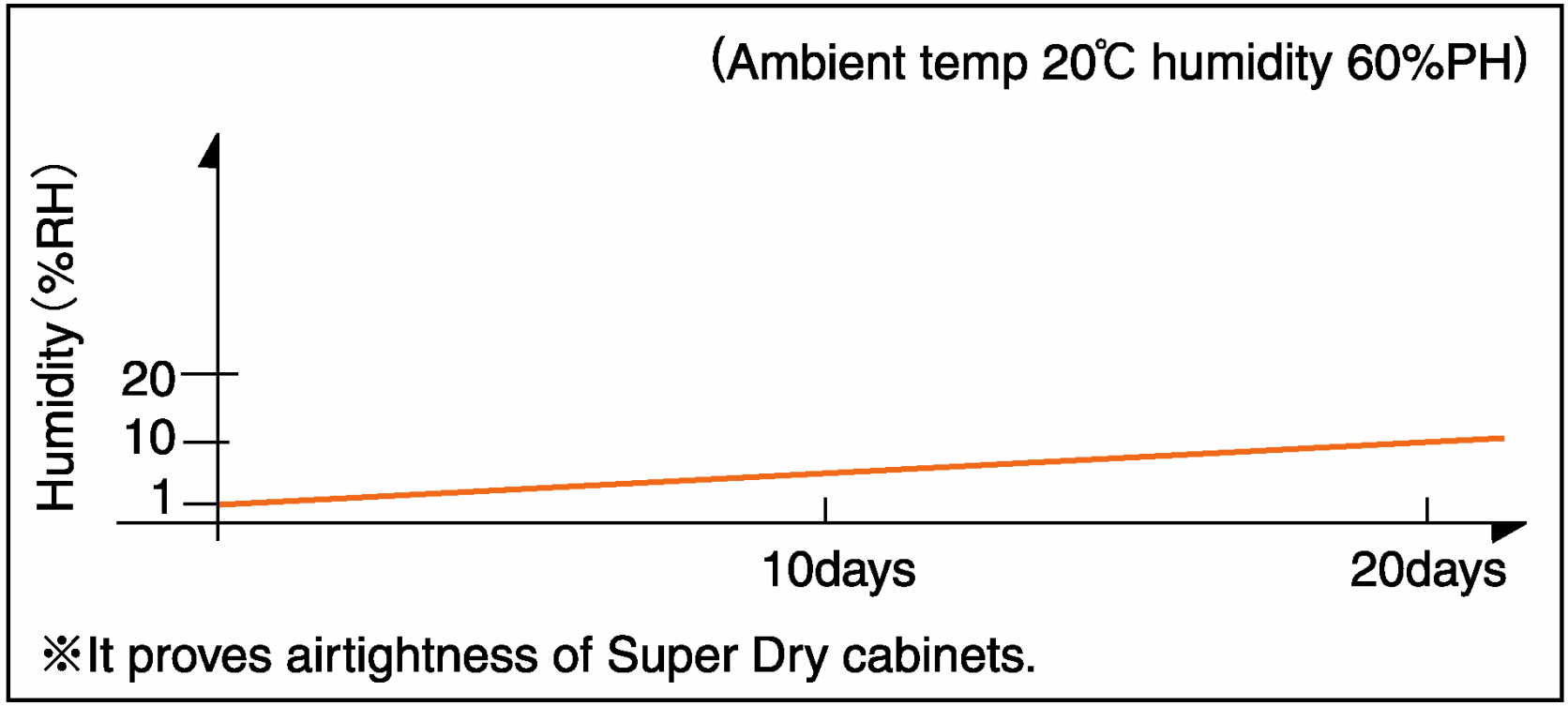
Functional Principle



After the doors are closed, the fan beginsoperating again to accelerate the moisture absorption inside the air tight Drying Cabinet

Increase of Humidity during Blackout

＜Humidity changes when blackout SD-1104-02＞



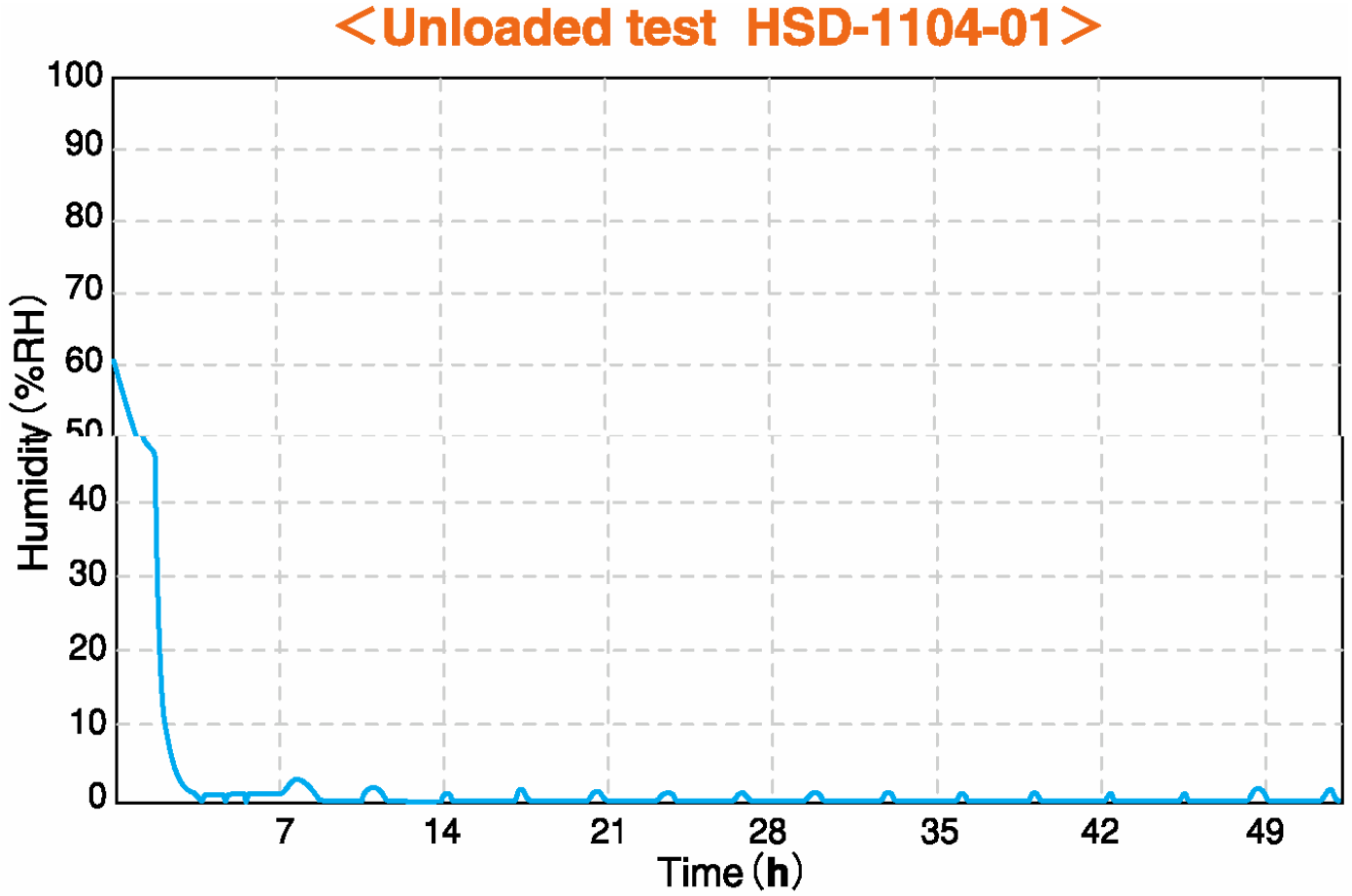
01 and 02 series

Totech dry cabinet

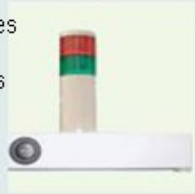
Features of 01 and 02 series

- Convenient Digital Control Panel
- ON/OFF calliper on front side
- Infinitely variable humidity setting
- Automatic resetting temperature display
- Alarm function when doors are left open
- Delayed humidity alarm with LED
- Key Lock Function for the Digital Control prevent unintended changes of setting

Humidity Appearance



Options

1. Shelf  Greatly increase the usable space inside Super Dry	**2. Reel Rack** Suitable for storage of components on tap eand reel 	**3. Divider** Better organization of inner space 	**4. L shape Metal Fitting** Anti tip stablizer 
5. Humidity Alarm Light Alarm light flashes when its internal humidity exceeds unit set point 	**6. Humidity Alarm Buzzer** Alarm buzzer sounds when its internal humidity exceeds unit set point 	**7. Door Alarm Buzzer** Alarm buzzer sounds when door open time exceeds unit set point 	**8. Wrist Strap Connection** Allows grounding while handling ESD sensitive materials 
9. Castors  Available as an option for Super Dry not installed as standard	**10. Adjustable Legs** Available for Effective stablization 	**11. N2 Auto-Purge System** Effective usage of N2 combined with Super Dry 	**12. Data Logger** Data Logging humidity and temperature 

Totech dry cabinet

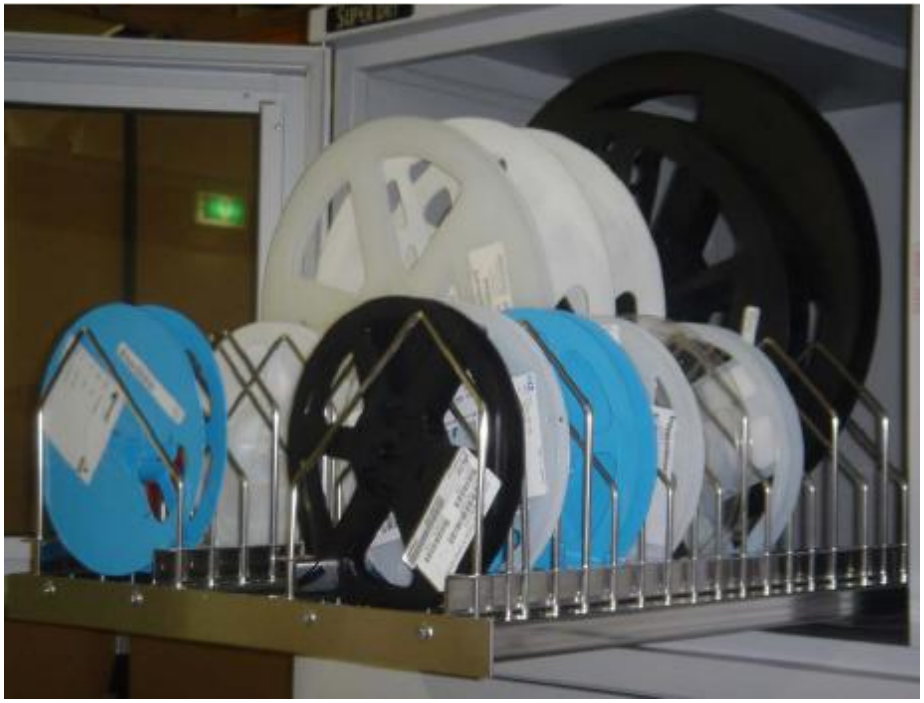
Option: N2 purge system

- Continuous stand-by of 0 -25l/min
- Automatic initiation to purge the cabinet (max 25 l/min) after closing the doors

Totech dry cabinet

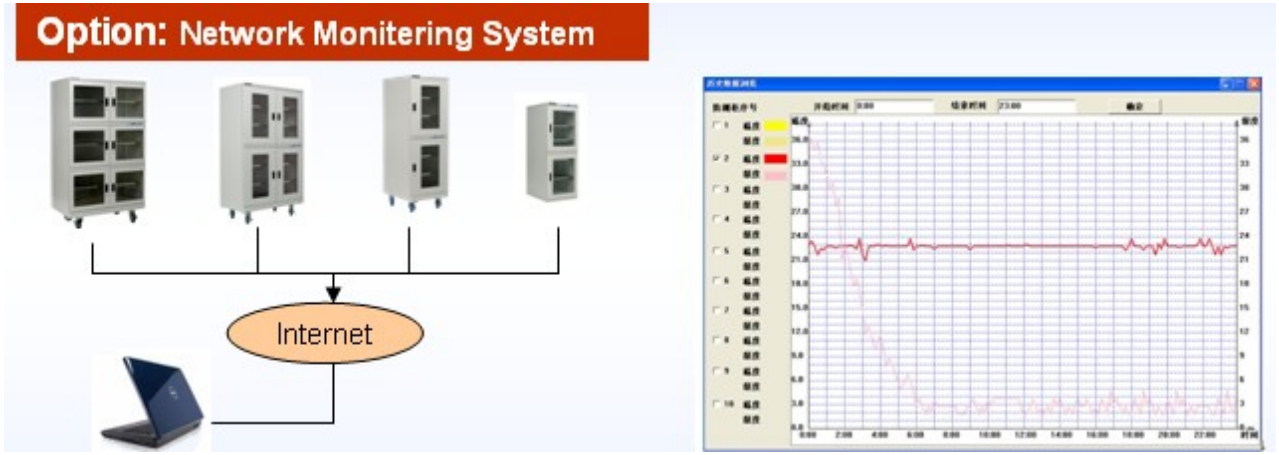
Option: Reel Rack

- **Single or Dubble Reel-Rack on rail move out**



Totech dry cabinet

Option- Humidity&temperature monitoring system



Multi-point sampling of temperature and humidity, carried out at 24hrs.
The monitored data is transmited directly to thenetworked computers.
The temperature and humidity is displayed and stored simultaneously.
The data can be checked and printed at any time.
Automatic alarm in case of overrun.
Software also has the function of calculating the floor life.
Multiple languages available (Chinese, English, Japanese)

Summary

It is important to provide

- Comprehensive ESD protection
- A closed loop feedback from the sensor
- Forced air circulation
- Use of a good dessicant(zeolites with open surface structure)

Totech dry cabinet

Thank you!