Wi－Free Technical Information

What is Wi-Free?

Provides a stable high electric field environment
⇒ High voltage / low current IMPROVES “freshness,” “maturation,” and “defrosting” effect

Conventional refrigeration technology　High voltage / low current　Freshness, maturation, and defrosting effect

List of effects

1. Chilled temperature (near 0°C) effect optimal for food preservation is achieved without freezing!
   ① Suppress microbial activity ② Suppress some enzymatic actions ③ Suppress chemical changes such as oxidation
   ④ Suppress physical changes such as drying ⑤Suppress respiratory activities and the like of agricultural products

2. High electric field environment suppresses cause of quality degradation
   ① Suppress microbial activity ② Suppress oxidation, etc. ③ Reduce drip by uniform thawing

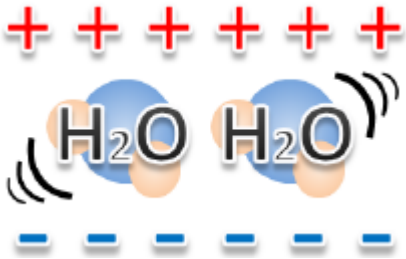
3. Voltage processing! Static electric field environment provides new added value!
   ① Acceleration of decomposition into amino acids and sugars ② Increase in water penetration ③ Changes in taste (mellow), etc...

Although the effects of low temperatures and electrostatic fields are currently under research, there have been announcements and publications made by research institutions.

Theory / Structure

Mechanism - high electric fields wobble water -

From a chemical perspective and tests conducted by public research institutions, etc., it is suggested that water molecules, amino acids, etc. are receiving an electric effect by high electric field alternating currents.
(Fig. 1)



Wobbles the water molecules, etc. that are affected by electricity. Fig. 1

Basic structure - the evolving refrigerator -

Refrigeration technology + Wi-Free technology

The conventional refrigerator is provided with a high voltage generating core (control part / transformer) and a mount and shelf for applying high voltage and prepared with current leakage countermeasures.
In addition to new storage facilities use, retrofitting the technology to current facilities is also possible.

Safety

Electricity - voltage (electric field) and current (electromagnetic wave)

Is high voltage dangerous?

Electric shocks are caused by the current. Wi-FREE uses high voltage / low current, so there should not be any serious accidents. (Fig. 4)

Wi-FREE Voltage: Generally 3,500 v (with regulator: 1,500 ~ 5,000 v)
Current: ~6 mA

Static electricity in winter (clothes, doorknobs, etc.)
Voltage: Approx. 3,000 v ~ 10,000 v
Current: Several mA

[Impact of electric shock]
The severity of the impact changes by: "size of current flowing," "duration of flow," and "path of flow (body part)."

Symptoms by current size is as follows:

1 mA	:	Feels something
5 mA	:	Feels pain
10 mA	:	Intolerable
20 mA	:	Seizures, cannot move
50 mA	:	Very dangerous
100 mA	:	Deadly

Fig. 4

[Wi-Free] Multiple safety measures

1. Current flowing from the voltage generating transformer is controlled to less than 6 mA
2. Sensors are installed at the door opening and shutting part, so when the door opens, the system will stop
3. Insulating structure using ABS resin and rack system
4. Overcurrent detector*1 is installed, so if too much current flows, the system will stop

Q&A (Non-freezing)

Q. Why does it not freeze?

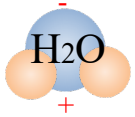
A. Freezing means a liquid has changed to solid. In food products, what freezes is the moisture (liquid inside and outside cells). Water is still a mysterious substance to mankind, so we cannot say anything specific, but it is thought that electrostatic energy is directly or indirectly reacting with moisture to inhibit freezing.

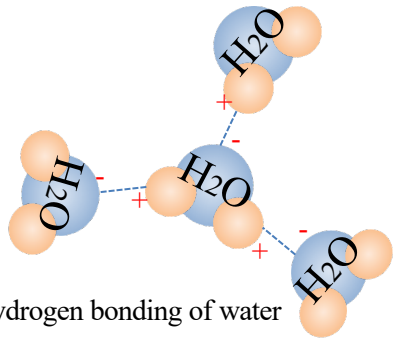
*) As for low temperature non-freezing, there are topics related to antifreeze protein and antifreeze polysaccharide that are research areas still in progress.

Water freezing means water molecules bonding (water molecules are hydrogen bonding). Water molecules are polar molecules that are electrically biased, so an electrostatic field may inhibit the bonding. This is very likely as we can produce a stable supercooled state. (Physical effect)

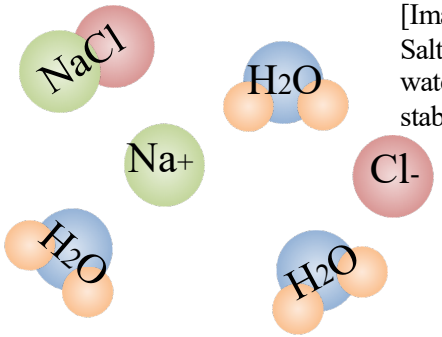
One way of suppressing freezing is additives (salt, sugar, alcohol, etc.). The reason salt water is hard to freeze is because the salt melted in water becomes sodium ion and chloride ion particles which inhibits water molecules from bonding. This is why they don't freeze under 0°C. (Used as antifreezing agent) Food products also have these constituents (0.9% of bodily fluid in mammals are salt water) and as you may have done in science experiments, by having electric current flow through, a portion of these may have been ionized. Sugar does not get ionized, but sugar molecules can lower the freezing point. It is unknown if starch is saccharified by electricity, but it is possible that the lowered temperature changes starch into sugar (cold acclimation), so it is possible that the freezing point of the food product is lowered by these effects. (Scientific effect)

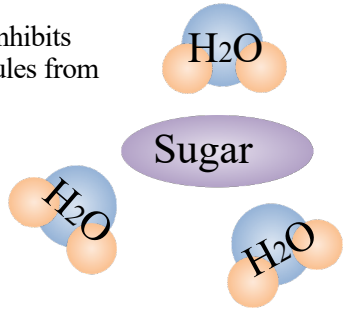
[Image]
Electrical bias of water molecules.
Freezing means the water molecules stabilize.





[Image]
Salt / sugar inhibits water molecules from stabilizing.





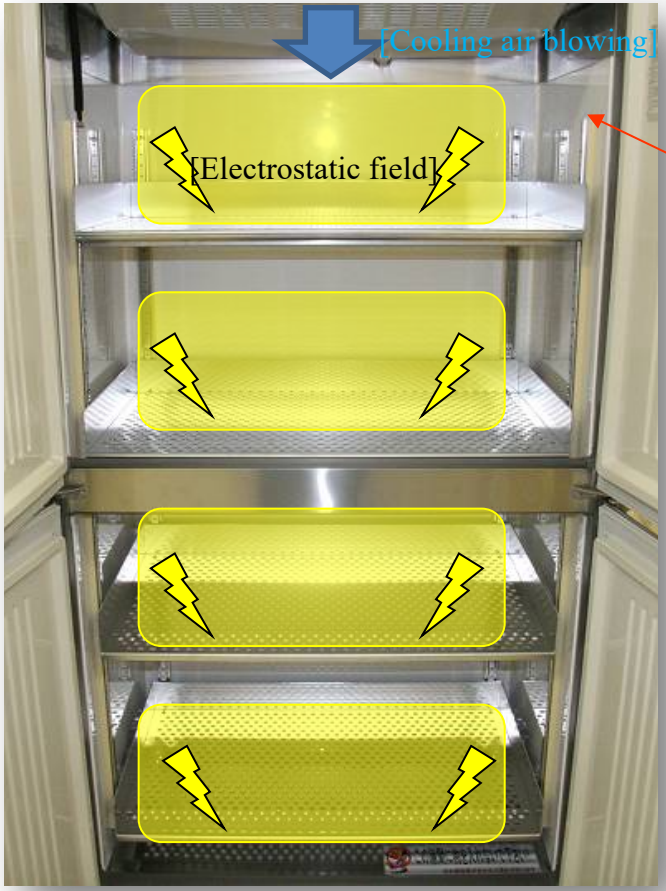
Q&A (structure / type)

Q. What is the structure like? What type?

A. The structure of Wi-Free is adding a system to apply high voltage / low current into a conventional refrigeration facility. A structure related to electricity is added to use an electrostatic field.

It can be manufactured for almost any refrigeration facilities such as industrial refrigerators, prefabricated types, container types, and vehicles. In addition, we have achieved great cost reduction by our patent pending relay system (see next page) compared to conventional similar technology.

[Example: Industrial refrigerator]



By applying insulating plates (resin type) or performing space insulation on the interior walls of the fridge, the structure inhibits current from leaking outside the shelves where voltage is applied.

[20 ft container for railway]

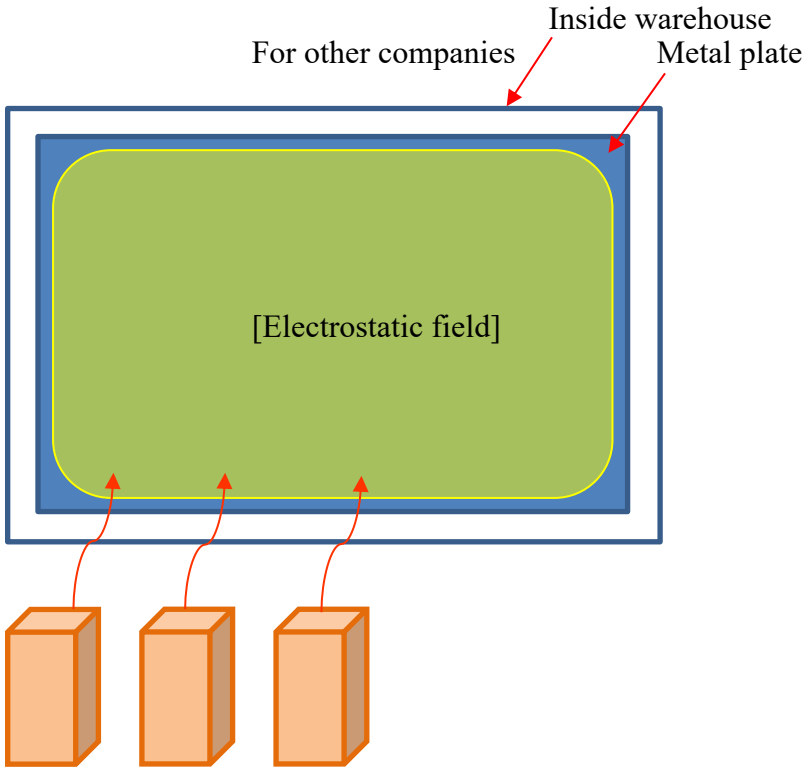
[20 ft container for sea]

Q&A (Unique technology: Relay System)

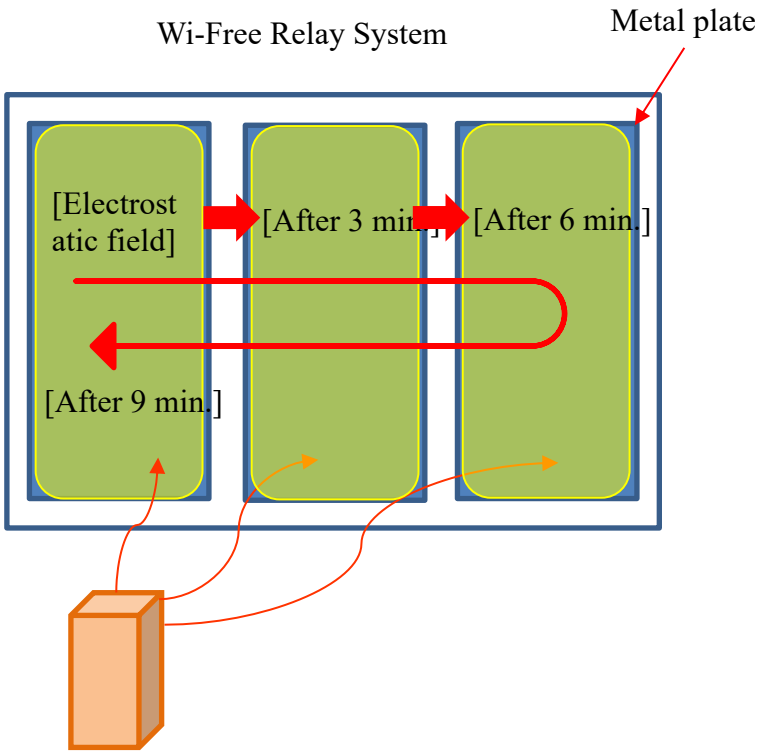
Q. What is the relay system?

A. Other competitors with similar technology must add more voltage generators or increase the size depending on the area the voltage needs to be applied, so cost increases by size. However, with our unique relay system, we control where we apply voltage by time, so we can reduce the cost for installing the system in large facilities.

[Example: Large refrigeration warehouse]



We need 3 high voltage generators to create an electrostatic field



By applying voltage every 3 minutes using 1 Wi-Free, we can cover a wide area using a small number of units

Q&A (Safety)

Q. What is the impact of electromagnetic waves? I hear ozone is generated, but is that ok?

A. The wavelength used in Wi-Free is the same as that used in households: 50 / 60 Hz. The World Health Organization (WHO) and the US National Institutes of Health state that there are no scientific evidence that there are health risks at low wavelength electric fields (50 /60 Hz). (Research still ongoing for health risks)

Currently, health risks are acknowledged for electromagnetic fields with wavelengths around 100 kHz or greater, and in such cases there would be notable energy absorption and temperature increase.

In addition, health risks may occur due to magnetic fields for electromagnetic waves. The magnetic field is determined by the size of the current, but since the current is 6 mA or less in the fridge, the magnetic field would be very weak.

(If you place a compass in the fridge, it would not react. Regular household appliances (TV, electric carpet, fluorescent light, etc.) has 5 mA or greater current flowing, so only the same level of current used for charging portable phones is flowing.)

The wavelength and strength of magnetic field is lower than the official standard.

Ozone is a gas having high corrosiveness and a unique pungent smell. Ozone has a high oxidation capability, with effects such as sterilization, deodorization, and bleaching. Ozone is gathering much attention as a next generation sterilization method.

Due to its high oxidization capability, it is very unstable and easy to bond with other materials, so it is not persistent.

(It is used for piped water sterilization and acknowledged as a food additive.)

The ozone concentration inside the fridge is low: 0.02 ~ 0.08 ppm. This is about the same as in sea shores and forests.

(There is the difference of an open space and closed space)

The concentration is below the approved concentration of 0.1 ppm for working environments.

(The concentration decreases based on the existence of ethylene generated from stored products in the fridge.)

[Impact of ozone on people]

0.01 ~ 0.02 ppm	Can smell some odor (will get accustomed)
0.1 ppm	Odor is notable, and there is irritation in nose and throat
0.2 ~ 0.5 ppm	Eyesight deteriorates after 3 to 6 hours exposure.
0.5 ppm	Clear irritation in upper air passage.
1 ~ 2 ppm	After 2 hours exposure, head ache, chest pain,
upper	air passage drying and coughing occurs and if exposure is repeatd, chronic intoxication occurs.
5 ~ 10ppm	Increased pulse, body pain, anesthesia symptoms, and continued exposure will result in pulmonary edema.
15 ~ 20 ppm	Small animals will die within 2 hours.
50 ppm	People will be in danger of life in 1 hour.

Q&A (difference with refrigeration and freezing)

Q. What is the difference with refrigeration and freezing?

A. Refrigeration and freezing are categorized by the storage temperature, freezing, and non-freezing of the food. Also, there are various methods for freezing and thawing.

Wi-Free technology uses electrostatic fields, so it cannot be categorized by temperature, but we can say it can be categorized as refrigeration from the standpoint of freezing / non-freezing.

Name	Temperature	Description
Ordinary temperature	Above 10°C	For storing things that may have low-temperature damage. Vulnerable to bacteria, decomposing enzymes, oxidation, etc. and has shorter storing period.
Refrigeration	0°C ~ 10°C	Storage temperature used in general. It suppresses bacteria and oxidation, but it is not perfect, so it has a limited shelf life. This is a basic technology and is used in combination with other technologies (humidity, constant temperature, vacuum, etc.).
Chilled	5°C ~ -5°C	Due to the reduction in temperature unevenness during cooling with the evolution of refrigeration technology, this method is becoming more popular. By storing the object at a low temperature without freezing, it is possible to extend the storage period compared to refrigeration.
Partial freezing	-3°C Partial freezing	A portion of the object is being frozen. When storing for a long time, it will be completely frozen. It is used for high freshness in a short period.
Freezing	-15°C and below	Temperature that does not get affected by bacteria, decomposing enzymes, and oxidation. Problems such as the effects (drip) of cell destruction during freezing, freezerburn, and changes in proteins, oils, and fats also occur. In addition, there is more labor and operation cost such as freezing and thawing compared to refrigeration.

Q&A (freshness, maturation, and defrosting)

Q. How can you maintain freshness? Why does it become more tasty?
A. Cold environments generally work better for preservation. In addition, it is not 100% well understood, but effects particular to high voltage have been reported by research institutions.

These elements together intertwine to create a positive effect.
Some vegetables and fish changes itself by increasing amino acid and sugar levels in low temperature to resist freezing.
This phenomenon is used in snow carrots and snow cabbages in northern Japan for increased sweetness.
(Low temperature saccharification is still under research, but there are research published for antifreeze protein and antifreeze polysaccharide, so it should be resolved in the future)

Various tests has revealed that Wi-Free tends not to allow food constituents (drip) from leaking compared to conventional refrigerators.

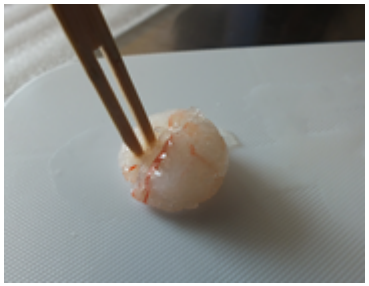
*Effects of electrostatic fields is a field where new discoveries and research is yet to come.

Q. Why can you defrost with less drip and better taste?
A. Usually, thawing would defrost from the outside due to heat exchange at the outer part. In addition, refreezing and the like would occur during defrosting, and as a result the cell membrane is damaged and the constituents inside leaks outside. The voltage penetrates the food in Wi-FREE, so the defrosting effect (antifreezing ability) takes place in the whole food. Defrosting takes place from the inside while reducing food contamination risk, and leaking (drip) of tasty constituents can be reduced. Restaurants that spend about 1 day to thaw imported meat are happy with our product due to less drip.

*There are three freezing methods: (1) slow freezing, (2) quick freezing, and (3) instant freezing. Damage at time of freezing (nutrients leak) cannot be restored. Due to this, better defrosting is possible with better quality freezing.

[Phenomena under low temperature environment]
① Inhibits the activity of microorganisms (fungi, mold, etc.)
② Suppress or stop the activity of enzymes
③ Slow down chemical changes such as oxidation
④ Accelerate physical changes such as drying and freezing

[Phenomena under electric field environment]
① Generating ozone
Sterilization and control of microorganisms and removal of ethylene
② Preventing growth of microorganisms
③ Suppress outflow of food constituents / maintenance of cells
④ Breaking up oils and fats
⑤ Improve water absorption of food
⑥ Improved defrosting ability
*) ② ~ ⑥ are under verification



The outside is frozen, but the inside can be penetrated using a bamboo skewer.

Q&A (how to think of storing period ①)

Q. How long can XX be stored?

A. No clear answer can be given even for the same food, because it depends on the origin, variety, cultivation method, year, time of receipt, etc. Due to the above reasons, we cannot store all food (XX) for the same period.

*General components of food include moisture, protein (amino acids), lipids, carbohydrates, ash (minerals, vitamins, and fatty acids), dietary fiber (water-soluble, insoluble), and the like which appear as individual differences. Living organisms can change body tissues from their activities, so we cannot guarantee a shelf life.

Q. Is there an appropriate voltage / appropriate temperature for each food?

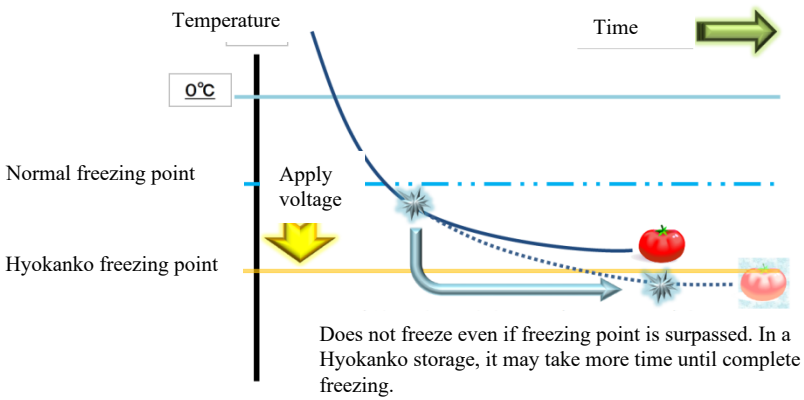
A. If you want to be precise, yes. (Especially for temperature) However, if you try to divide food too strictly, then the equipment would become tedious to use, so if you can set the temperature to around 0℃ ~ -2℃ and the voltage to 3500 v, there should not be any problem.

Q. Can all foods be preserved without freezing when the temperature is below 0℃?

A. The temperature for freezing differs by food. When you tell others, please explain as such: “Meat, Fish = -2 ~ 3℃ and Vegetables, Fruits = -1℃ ~ +2℃.”

*Depending on the individual material, some can be stored without freezing at very low temperatures. In addition, some foods are weak against low temperature such as summer vegetables, so please be careful.

*When the food is just entered in the fridge, it may not freeze due to not being cooled enough, but after some time it may freeze. (If the temperature is lower than the freezing point of the food material)



How to prevent freezing:

*Increase temperature.
1℃ increase can make a difference.

*Increase voltage.
It may not be suitable depending on the food.

*Weaken the chillness.
Lower the cool wind from the cooler. Use packing material, etc.

Q&A (how to think of storing period ②)

Q. If you take out water from the storage and shake it, it would freeze, so won't meat and vegetables freeze too?
A. They won't freeze. Water is 100% liquid, so the supercooling phenomenon is noticeable. However, food have various constituents which means more factors that inhibit ice crystals from forming, and we have not confirmed any cases of freezing. (Solid does not freeze)

Q. Will it freeze if you add vibration while it is inside the storage?
A. Liquids will freeze, but other solids are hard to freeze. *We did a vibration test using a vehicle, but it did not freeze

Q. What should we do if want a consolidated cargo?
A. The storage period for each food material may be shortened compared to setting the temperature for one material, but it is possible to have a consolidated cargo. In addition, you can also use the property of a refrigerator to your advantage (the lower shelf have lower temperature than the temperature set).