# The eCube

## Using the eCube (food simulant) to operate refrigeration plant rather than relying on the air-temperature.

**The eCube is specifically designed to ensure that refrigeration keeps food at the correct temperature when fitted to its thermostat sensor/sensors. It changes the refrigeration from operating on the air temperature to that of the food.**

**This is in fact a logical step, the government tell us we should monitor refrigerated food temperatures rather than circulating air - so why not have the refrigeration plant operating on the same basis. The eCube has undergone numerous tests to confirm what effect this has had on refrigeration, and these are our conclusions from these tests:-**

- **Changing to a food temperature based system results in a far more efficient system, with a drastic reduction in refrigeration cycles, the compressor works longer and is also idle for longer. This results in significantly lower electricity consumption as it is during the compressor start ups that electricity consumption is at its highest. The analogy is that of a car's fuel consumption… high during short stop/start journeys, and low during long journeys.**
- **With the compressor on-cycles being longer the effect is a colder food storage area. We typically see refrigeration plant at 2-3C colder with the eCube fitted, and re-adjusting the thermostat to account for this results in lower electricity consumption (typically 10% for every 1C adjusted). Importantly food safety and quality is not compromised.**
- **With these longer on and off cycles wear and tear of the plant is also reduced leading to less breakdowns and longer equipment life.**
- **Noise pollution is reduced which is an increasingly important consideration especially on sites with compressors housed on the outside on non industrial sites (retail, fast food, petrol outlets etc)**

## Quotes from independent trialists:

- **CCFRA; (Campden & Chorleywood Food Research Association) has verified energy savings of 26% and confirmed that food safety & quality was not compromised. CCFRA is the UK's largest independent food research association.**

# eCube
# Background and Technical Advantages

## Background

The eCube was designed to fulfil two specific areas relating to refrigeration and food storage temperatures. It is a food simulant contained in an enclosure designed to be retrofitted to either a thermostat or thermometer sensor. The food simulant in the eCube will mimic food parcel temperature at around 10mm below the surface and in the event of a refrigeration breakdown it will warm up slightly quicker than the food itself, but will be within 2C of the food as verified by the US NSF P235 standard. The eCube has been granted a full Patent . Although there are no UK/EU standards for Food Simulants it is the only one that has achieved the US NSF P235 Food Mimicking Device Standard. It has been extensively tested both in-house and by independent organisations, all confirming significant reduction in electricity consumption without compromising food safety.

## The two areas of use for the eCube are:

a) Fitted to the Temperature sensor, the fridge/freezer will display the actual food temperature, not the circulating air temperature. If fitted to the temperature probe of a monitoring system the recorded temperature will be that of the food as per the: Food Safety (Temperature Control) Guidelines 1995

b) Fitted to the Thermostat sensor, which controls the compressor, will significantly reduce the frequency of the refrigeration cycles as the fridge/freezer will cycle based on the food temperature rather than the fluctuating air temperature. This leads to a colder storage area as the plant operates more efficiently, and by re-adjusting the thermostat back to its normal temperature settings significant electricity savings will be made without compromising food safety and quality. A knock-on effect of this is lengthening the life expectancy of the equipment and also less noise pollution.

The importance and advantages of food temperature control and monitoring (not air temperature) is now not only an accepted principal but forms a vital part of HACCP procedures. We believe it is logical that if we are to rely and record actual food temperature we should have the refrigeration plant operate by the same method, especially as this leads to significant financial and environmental advantages.

## Technical Advantages:

## Energy Saving Advantages of the eCube

By using the eCube as a device to control food storage temperatures, a more efficient refrigeration cycle is attained. At the moment air cycles (on/off) typically produce a minimum of 12 cycles per hour, and in some open display cases 20 cycles per hour. By using the cube as a cycle control mechanism a reduction of refrigerated cycles can be lowered by as much as 80%. (Example: Dairy Case: air cycles 3 minutes on, 2 minutes off = 12 cycles per hour. With the cube fitted it changes its cycles to 8 minutes on and 7 minutes off = 4 cycles per hour. This example equates to a 66% reduction in starts).

As the start up of a refrigerator compressor uses 3 times more power (i.e. start up amp is 12 amps, run amps is 4 amps) this will result in a power consumption reduction of 16% to 22% (refrigeration is effectively switched on when the food demands it, and switched off when the food does not need it to operate!). This is further explained by the start period which, although very short, nevertheless produces excessive heat into the start winding, and because of the refrigeration process i.e. winding suction, this then has to be cooled by the refrigerant gases (i.e. the heat removed), affecting the efficiency of the compressor, and its energy consumption.

**Below are the details of the advantages of having the eCube fitted to the thermostat probe.**.

## 1. Reasons for the benefit of longer on cycles on the food

Normal air cycles will operate as the air temperature attains the set point of the thermostat. This will generate several on/off-cycles, without having very much effect on the food temperature. i.e. several 3 min on-cycles. However with cube fitted, this changes to 8 min on-cycles, resulting in a positive food temperature reduction by cooling the food quicker, leading in turn to a safer food. It also leads to a cooler storage compartment allowing the operator to readjust the thermostat, resulting in an additional energy saving.

Thus installing the ecube leads to a more efficient use of the refrigerator system combined with a lower energy consumption and safer food.

The longer on-cycle will create a higher efficiency of the refrigeration cycle i.e. longer runs at a maximum advantage (compare it to fuel consumption and efficiency in a car on a stop start urban road, or a long stretch of motorway driving at a steady 70 miles an hour).

## 2. Advantages of longer Off-Cycle

A longer off-cycle will allow a pressure equalisation between the high and low pressure parts of the refrigerant within the refrigeration system, allowing a softer start from a cooler system, thus avoiding compressor trip caused by high pressure or an unbalanced system. i.e. lower amperage clean start obtains a maximum efficiency far quicker (with a further energy saving).

The electrical starting component and devices used on refrigeration equipment have an engineered life span, so the less maximum power use of these components will extend the reliability of the components, reducing refrigeration failure pro-rata. Thus using eCube technology will extend the life of the starting devices and in turn the refrigeration equipment, with fewer breakdowns and engineer call outs.

## 3. Lower temperatures achieved without heat induced defrost cycles

Due to the low evaporating temperatures of refrigerants, to maintain a refrigerating temperature within a refrigerated space, the evaporator temperature will have to be below freezing (i.e. chiller evaporating temp -10degC to maintain a storage temp of +4degC, and freezer evaporating temp -30degC to maintain a temp of -20degC). In all cases a frost will form on all evaporating surfaces.

We will deal with fresh meat/fish temperature storage (-1 to +1 degC) to highlight the advantages of natural defrost for fish keepers, seafood storage and fresh meat conditioning (hanging) by using the eCube as against heat introduced defrost which is presently the only way to achieve defrost.

As already established evaporating temperatures are at least 10 degC below storage temperatures thus creating frost on the evaporator surfaces (fins), so a periodical application of heat has to be applied to the evaporator surfaces to melt the frost to condensation. This is done by pre-set defrost intervals, applying heat by electric heater or reverse cycle hotgas defrost. i.e. 4 defrost per 24 hr period at 20 min duration; terminate by termination klixon or thermostat. The introduction of this heat has to be removed after the termination of the defrost cycle, when the refrigeration cycle is re-instated. This format produces heat that has to be removed from within the refrigerated space (fridge). The conclusion is that heat is introduced into the defrost cycle, which the refrigeration cycle has then to remove to return to set refrigeration storage temperatures, a process which is, to say the least, very uneconomical.

The installation of the cube with the advantage of longer on-cycle and extended off-cycle will allow temperatures to rise just above freezing to allow the evaporator frost to blow clear without the introduction of enforced heat (as no frost has then to be removed this leads to a large reduction in the use of enforced defrost heaters with a

subsequent reduction in energy usage), so a natural defrost cycle on the normal off-cycle by use of the eCube allows safe fresh meat and fish storage without the introduction of enforced heat defrost.

## 4. Reduction of noise nuisance on remote (situated on the outside of the building) condensing units

The following points deal with noise nuisance from commercial establishments in high density rural and urban areas generated by remote refrigeration equipment sited outside the premises, i.e. refrigeration and air-conditioning condensing units mounted outside of commercial premises: convenience stores, restaurants, hotels, etc.
As has been described the reduction of refrigeration cycles provide closer and more efficient food storage and energy saving. A further advantage in fewer starts is a great reduction in noise pollution which is caused when refrigeration and air-conditioning condensors are located outside commercial premises. The stopping and starting of refrigeration equipment causes great annoyance in areas where commercial premises are mixed with residential dwellings. It is apparent that a softer and quieter start up reduced from 12 to 20 starts per hour to perhaps 4 starts per hour will reduce conflict in this situation.

## 5. Frequently asked questions:

### A few frequently asked questions and answers that you may find useful:-

**Q. How can the eCube react to different sizes and densities of food?**

**A. It does not react differently and neither does the fridge/freezer if it is operating based on the air temperature. All food parcels will eventually reach the same temperature, some may take a bit longer than others whether you use an eCube or not. This has been verified by the US NSF P235 standard which the eCube has passed.**

**Q. If the fridge is 'on' for longer, will this not result in freezing of certain types of susceptible foods?**

**A. All fridges and freezers work to a set differential and temperatures within the food storage area are different in different locations (hot and cold spots) when operated by the air temperature, with the eCube this is still the same, however with the eCube fitted the on-cycles are longer leading to a colder storage area and it is important to account for this by simply re-adjusting the thermostat to maintain the correct temperature.**

**Q.** **I've noticed that with the eCube fitted the air temperature which I monitor varies much more, is that normal?**

**A.** **Yes, because you now have a fridge/freezer operating based on the actual food temperature, and you will find that the food temperature will be kept within the set parameters. Generally speaking the guidelines relating to temperature control are all about food temperature and that is logical as it is the food temperature that is important, not the air temperature.**

**eCube**

Description

eCube is an inner enclosure containing a high-grade food safe substitute inside an outer enclosure that forms an air barrier within. This construction will simulate an average small food sample in a pre-packed condition.

**eCube consists of:-**

- eCube and bayonet fixing (male)
- two-part cable trap (termination)
- bayonet fixing plate (female)
- locking ring

Composition

1. Blend 2241
2. Grade 3154 FP (Food Packaging Grade)

Dimensions:-

- Length: 4.5 cm – 7.5 cm with bayonet and 2 part cable trap
- Width: 4.5 cm

**SHELL MICRCRYSTALLINE**

| Properties | | | | LMP | Test method |
|---|---|---|---|---|---|
| | | | | | |
| Congelating point | | | degC | 62-66 | ASTM-D 938 |
| Penetration at 25 degC | | | mm | (a) | ASTM-D1321 |
| Penetration at 43 degC | | | mm | 70-160 | ASTM-1321 |
| Colour lovibond (6 inch cell) | | | max | 1.5 | IP17B |
| Odour | | | max | 1 | ASTM-D1833 |
| Oil content | % | m/m | max | 1 | ASTM-D 721 |
| U.S. Food & Drug Administration<br>- paragraph 172.886<br>- paragraph 178.3710 | | | | <br>Pass<br>Pass | |
| Statutory instruments 1966/1073 | | | | Pass | |
| Statutory instruments 1978/1927 | | | | Pass | |
| German Federal Law Gazette 1972<br>Amended: 24-12-1977 | | | | <br>Pass | |
| German Health Authorities Regulation, Art. XXV, 1975 modified by | | | | | |

| | | |
|---|---|---|
| communication 38 of 29-7-1976 | Pass | |

(a) Typrical range 20-30

Plastic properties

Magnum 3154FP is a low gloss extrusion/thermoforming grade especially designed for food packaging applications.

3 belongs to the Magnum 3000 series
1 has a charpy impact value of between 5-7 kj/$m^2$
5 has a melt flow rate between 18-21 g/10min
4 has a VICAT value between 99-102 degC
FP is classified as Food Packaging grade

| TEST METHOD | | | | | MAGNUM 3154 FP |
|---|---|---|---|---|---|
| | Unit | ISO | DIN | ASTM | |
| **Physical properties** | | | | | |
| Density | KG/m3 | 1183BR | 53749-B | D-792-B | 1050 |
| Bulk Density | KG/m3 | 60 | 53466 | D-1895 | 650 |
| Melt flow rate (230 degC, 3.8Kg) | g/10min | 1133 | 5375-N | D-1238 | 5 |
| (220 degC, 98N) | g/10min | 1133 | 5375-U | | 20 |
| **Thermal properties** | | | | | |
| Vicat (49 N, 50 degC/h) | degC | 306B | | D-1525-A | 99 |
| (9.5 N,120 degC/h) | degC | 306A | | D-1525-B | 108 |
| Heat distortion temperature annealed (1.8 Mpa) | degC | 75/A | 53461-A | D-648 | 100 |
| **Mechanical properties**[(2)] | | | | | |
| Charpy (notched) (23 degC) | KJ/m2 | 179/2C | 53452 | | 7 |
| (0 degC) | KJ/m2 | 179/2C | 53453 | | 7 |
| (-20 degC) | KJ/m2 | 179/2C | 53453 | | 6 |
| (-40 degC) | KJ/m2 | 179/2C | 53453 | | 6 |
| Charpy (unnotched) (23 degC) | KJ/m2 | 179/2C | 53453 | | No break |
| (-40 degC) | KJ/m2 | 179/2C | 53453 | | No break |
| Izod (notched) (23 degC) | KJ/m2 | 180/1A | | | 10 |
| Tenalie yield (100mm/min) | MPa | DIS 527/D | 53455-6-3 | D-638-M | 37 |
| Tensile elongation (1mm/min) | % | DIS 527/D | 53455-6-3 | D-638-M | 20 |
| Tensile modulus (1mm/min) | MPa | DIS 527/D | 53457-1-3 | | 2000 |
| Flexural strength (1mm/min) | MPa | 178 | 53452 | D-790-D | 60 |
| Flexural modulus (3-point) | MPa | 178 | 53457-B3 | D-790-M | 2000 |
| (4-point) | MPa | | 53457-B4 | D-780-M-B | 2300 |
| Shear modulus (23 degC) | MPa | 537 | 53445 | D-4065 | 865 |
| Rockwell hardness, R-scale | | 2039/2 | | D-785 | 78 |
| Ball indentation | MPa | 2039 | 53456 | | 98 |
| **Flammability** | | | | | |
| UL flame class rating [(4)] | UL 94 | 1.57 mm | | | HB |
| | UL 94 | 2.00 mm | | | |
| | UL 94 | 3.17 mm | | | |