



05/2021  
CASE STUDY

**EXPERIMENTAL STUDY  
OF NEW INSULATION PACKAGES  
CONTAINING DRY ICE PELLETS  
FOR FRESH SHIPPING**



FOOD INDUSTRY

# FRESH SHIPPING



Shippers of food products, in most cases, have regulatory responsibility to ensure quality by maintaining product's temperature during transportation. Dry ice may be the best way to keep frozen and refrigerated foods from spoiling in the event of a power outage. At a temperature of -79°C, dry ice can replace the cooling power of refrigerator or freezer.

*Dry ice appears as a translucent white solid. It changes from a solid to a gas (sublimes) at normal temperatures without going through a liquid state. It is a completely natural product.*

## Common applications

- Storage and transportation of frozen or chilled foods
- Storage and transportation of medical, pharmaceutical, research and other temperature-sensitive materials
- Refrigerant for food storage in airline catering
- Freeze-branding
- Reactions coolant in the chemicals, research and pharmaceutical industries

## Benefits of dry ice

- Does not alter the taste of food
- Does not leave behind any residue (it doesn't melt)
- Can be combined with other cooling agents

- Generally inexpensive and more cost-effective in bigger quantities

## Packaging Requirements for Dry Ice

When shipping with this type of refrigerant, it is recommended to keep the dry ice at the top of your cooler. By keeping the dry ice at the top, you are allowing the food at the bottom to stay cool, without freezing.

To slow down the sublimation process, losing product, you should minimize air pockets in your cooler. You can fill this empty space with dry ice pellets.

## Size of Dry Ice

ICS Ice Cleaning Systems manufactures dry ice in-house from liquified CO2. Our dry ice products are available for commercial use and for the general public in three sizes: 1,5 mm, 3 mm and 16 mm.

Dry ice pellets are manufactured every weekday at our facility. Contact us for more information on best pick-up time.





2021 |

## EXPERIMENTAL STUDY OF INSULATION PACKAGE CONTAINING DRY ICE PELLETS

# 02 | TEST

Current research experimentally and numerically explores dry ice sublimation packed in encountered containers made of polystyrene foam.

Keywords: Dry ice sublimation, Insulation, Cold storage

# 01 | DRY ICE

Dry ice is the solid form of CO<sub>2</sub> (carbon dioxide) at a temperature of -79 °C. Dry ice is non-toxic, odourless, inhibits the growth of bacteria, fungi and spores, and reduces biological contamination. It reduces the development of yeast and other bacteria which cause problems in breweries, bakeries and other establishments with environments that have higher temperatures and humidity.



## SUBJECT OF THE TEST

Tests were performed using two isolated boxes made of expanded polystyrene foam (EPS). One box was closed all time during experiment, another one was opened every 30 minutes for 15 seconds and contain 6 cans of soda.



## TEST PARAMETERS

Date: 14.05.2021

Room Temperature: 26,9 °C.

Dry ice pellets: 2 000 g

Box dimensions: 270 mm x 220 mm x 180 mm





# 03 | MEASUREMENT

The cuboid box has an external dimension of 265 mm x 215 mm x 190 mm and a wall thickness of 40 mm.

The experiments were designed with an objective to validate the numerical solutions, namely, the variation of dry ice mass and temperature inside the packages with time. For this purpose, the packages were filled with dry ice pellets and were placed on a weighing scale to measure the mass of remaining dry ice pellets as the gas escaped the box after sublimation.

A dry ice pellet is in the shape of a small cylinder having approximately 3 mm diameter. The temperatures inside the packages were measured using E-type thermocouples. The experimental procedure is similar for both packages and consists of the following steps: (1) Thermocouple tip is attached at their locations using a 1 x 1 cm aluminium tape; (2) Empty package is placed on the weighing scale and dry ice pellets are filled in the package; (3) The package is covered with a lid and the weighing scale is tared to zero; (4) A program measures the mass and temperature every 30 minutes.

Parameters		Temperature at box (°C)	
		box closed all the time	box opened every 30 min.
Time	Weight (g)	Box without grocery	Box with grocery
9:00	4310	22,9	22,6
9:30	4295	20,0	4,7
10:00	4200	-17,1	2,1
10:30	4100	-19,5	3,5
11:00	4030	-24,2	0,5
11:30	4000	-24,6	-1,5
12:00	3865	-24,9	-2,3
12:30	3800	-24,5	0,4
13:00	3710	-24,3	-3,6
13:30	3620	-23,5	-2,6
14:00	3525	-22,7	-4,9
14:30	3450	-21,9	1,2
15:00	3360	-21,5	-3,8
15:30	3150	-21,3	-3,6
16:00	3200	-21,2	-5,7
16:30	3100	-20,1	-3,1
17:00	2905	-18,5	-4,7

## 04| RESULTS

How much dry ice should you include in your shipment? As a rule of thumb, expect approx. 100 grams of dry ice to sublimate every 30 minutes. However, the exact sublimation rate will depend on the density of the expanded polystyrene (EPS) insulating foam container you use. The lower the density, the faster the sublimation. Factor this into your shipping calculation.



## 05| CONCLUSION

**Dry ice is a safe and effective way of shipping goods that need to stay frozen, if used properly and compliantly.** When shipping with dry ice, it's best to choose the shortest route as possible. You should also consider the day and time that you're shipping the package. Use special containers for storing dry ice, and place it inside a cardboard box. Try to keep your contents separate from the dry ice. The only use for the dry ice is to keep your shipment cold.

*You don't want anything touching the dry ice. You just want to let the dry ice do its job, which is to keep the*

*packaging system cold. If you are shipping food with dry ice, pack the food carefully to preserve freshness and avoid damage.*

DO NOT seal your dry ice box airtight—the vapor needs to be able to escape or your package could explode. Do not use containers that are airtight, as the process of sublimation can cause the container to rupture. On the exterior of the shipment packaging with dry ice inside, there should be a note or a sticker stating 'Dry Ice' or 'Carbon Dioxide, Solid' with a note of the weight of the dry ice.

