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Artisan Gelato and ice cream machinery — Performance characteristics and energy consumption

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National foreword

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Machines à glace artisanale et crème glacée - Caractéristiques de performance et consommation d'énergie

Maschinen für handwerklich hergestelltes Eis und Speiseeis - Bestimmung von Leistungsmerkmalen und Energieaufnahme

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European foreword

This document (EN 16754:2016) has been prepared by Technical Committee CEN/TC 44 “Commercial refrigerated cabinets, Commercial and Professional Refrigerating Appliances and Systems, Performance and Energy Consumption”, the secretariat of which is held by UNI.

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1 Scope

This European Standard specifies requirements and test conditions of machines for processing Artisan Gelato, ice cream and similar frozen desserts.

It defines machines performance characteristics and energy consumption, measured under specified conditions and test methods, using a reference test mix.

This European Standard applies to professional machines having a maximum capacity of 400 l, for thermal-treatment of Artisan Gelato, ice cream and similar frozen desserts listed as follows:

— pasteurizers;

— ageing vats;

— cream cookers;

— batch freezers;

— combined machines.

The machine can be factory assembled or field connected to a remote condensing unit.

The machine can include separate remote refrigeration systems for the frozen product and fresh mix and can be either air-cooled or water-cooled.

2 Normative references

Not applicable.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
compression type machines
machines where the cooling is performed by means of a refrigerant liquid at low pressure in a heat exchanger (evaporator), the steam thus formed becomes a liquid by a mechanical compression higher pressure and cooling in another heat exchanger (condenser)

3.2
condenser
heat exchanger in which after compression, the vaporized refrigerant is liquefied, giving off heat to external cooling system

3.3
evaporator
heat exchanger in which, after the reduction of pressure, the refrigerant is vaporized by absorbing heat from the medium which is cooled

3.4
condensing unit
system assembled in factory to run part of the refrigeration cycle (compression and condensation), including one or more refrigerant compressors, condensers, liquid tanks, piping systems and ancillary equipment assembled on a common basis

3.5
pasteurization cycle
cycle during which test mix is heated for a time fixed to different type of pasteurization and then immediately cooled to conservation temperature, to avoid the bacteria's development

3.6
conservation temperature
temperature below which the text mixture shall be kept

3.7
product temperature/extrusion temperature
temperature of the frozen product immediately after extrusion

3.8
normal load
load obtained when the machine is operating at ambient temperature at climate class declared by the manufacturer using the test mixture in the quantity and at the temperature specified by this standard

3.9
overrun
percentage increase in volume due to the addition of air to frozen product whose calculation is the ratio between the liquid mix and the drawn frozen product

3.10
reference test mix
mix specifically prepared for testing

3.11
frozen product
product obtained after freezing test cycle of the reference test mix

3.12
climate class
range of ambient temperature in which the machines are intended to be used

3.13
time of cycle
time required by the machine to complete the foreseen cycle

3.14
artisan gelato
self-made frozen dessert

3.15
pasteurizer
machine used for mixing, heating, cooling ingredients in order to produce and store the mix for artisan gelato

3.16
ageing vat
machine used for the storage and ageing the mix for artisan gelato

3.17
cream cooker
pasteurizer intended for use with liquid and thick products

3.18
batch freezer
non continuous operating machine used to freeze the mix incorporating air to produce artisan gelato

3.19
combined machine
machine combining two or more functions of pasteurizer, ageing vat, cream cooker, batch freezer

4 Performance characteristics

4.1 Loading of pasteurizer and cream cooker

The machines shall operate at ambient temperature (see 5.3). The pasteurization tank of the machines shall be loaded with the maximum amount, expressed in kilogramme, indicated by the manufacturer with the reference test mix (see Clause 6) at 20 °C ± 1 °C. The machines shall be operated as long as necessary so that the reference test mix reaches the heating temperature expected (5.5.1) and shall then proceed to the cooling cycle to the storage temperature ≤ 5 °C.

4.2 Loading of batch freezer

The machine shall operate at ambient temperature (see 5.3). The machine shall be loaded with the 75 % of the maximum amount, expressed in kilogramme, indicated by the manufacturer or with the average of the values min and max declared by the manufacturer with the reference test mix at a temperature of 5 °C ± 1 °C . The machine shall work the time required for the reference test mix reaches the temperature < −9° C.

The product obtained is discharged and the machine is turned off.

The final product characteristics shall be the following:

— temperature < −9 °C

— overrun > 20 %

— discharged Quantity > 80 % of the Total Load

4.3 Loading of combined machine

The machine shall operate at ambient temperature (see 5.3). The machine shall be loaded with the 75 % of the maximum amount, expressed in kilogramme, indicated by the manufacturer of the reference test mix (see Clause 6) at 20 °C ± 1 °C. The machines shall be operated as long as necessary so that the reference test mix reaches the heating temperature expected (5.5.4). The machine shall work the time required for the reference test mix reaches the temperature < −9 °C.

The product obtained is discharged and the machine is turned off.

The final product characteristics shall be the following:

— temperature < –9 °C

— overrun > 20 %

— discharged Quantity > 80 % of the Total Load

4.4 Product temperature/Extrusion temperature

The extrusion temperature of the reference frozen mix (Clause 6) depends on the adjusting and setting of the freezing equipment and is directly related to the characteristics of the final product.

The extrusion temperature of the reference frozen mix (Clause 6) affects the energy consumption of the batch freezer and combined machines.

4.5 Overrun

Generally, during the freezing, the test product (Clause 6) and air enter in the freezing chamber, where a beater assemblies scrapes ice crystals from the chamber walls and blends the air into the test mix.

The overrun of the reference frozen mix (Clause 6) depends on the adjusting and setting of the freezing equipment and is directly related to the characteristics of the final product. The overrun of the product obtained with the reference mix (Clause 6) affects the energy consumption of the batch freezer and combined machines.

5 Energy consumption test

5.1 Test room

5.1.1 General design, walls, floor and radiant heat

The test room shall be a parallelepiped space in which two of the opposite side walls, referred to as the *discharge technical side wall* and the *return technical side wall*, are designed to create an even, horizontal air flow within the test room. By convention, the distance separating these two technical side walls is referred to as the “length” of the test room.

The minimum useful dimensions (length, width, height) of the test room shall be dependent on the overall dimensions (length, depth, height) of the machine to be tested.

The ceiling and the two non-technical side walls of the room shall be thermally insulated and shall be equipped with an inner metal skin.

A minimum insulation level equivalent to 60 mm of rigid polyurethane foam $\lambda = 0{,}03$ W/(m K) should be used for the building of a new test room.

The floor shall be made of concrete or of thermally equivalent material and/or shall be sufficiently insulated to ensure that external climatic conditions do not affect the floor temperature.

5.1.2 Thermal characteristics

An experimental evaluation of the test-room performances shall be carried out minimum once per year.

Air temperature measured at different points shall not deviate from the rated temperature of the test-room by more than ± 2 K.

The test room shall be capable of maintaining values of humidity within ± 5 units of the relative humidity percentage figures of the rated humidity of the test room temperature class at the specified measuring points.

The surface temperatures of the walls shall remain within a tolerance of ± 2 K in relation to the air temperature measured in the test room.

The point for measurement of ambient temperature and relative humidity shall be midway along the length of the machine.

5.2 Apparatus

All the following test apparatus shall be calibrated at least once every two years.

5.2.1 Balance, with a resolution of at least 2 g

5.2.2 Stop watch, with a 1 s resolution

5.2.3 Thermometer probe, capable of immersion with a resolution at least of 0,5 °C

5.2.4 Watt-hour meter, for measuring the electrical energy consumption, having a resolution of at least 10 Wh and a maximum uncertainty no greater than 1,5 % of the measured value for any demand greater than 100 W. For any demand less than 100 W, the meter shall have a resolution of at least 1 Wh and a maximum uncertainly no greater than 10 %.

5.2.5 Water meter having a resolution of 1 l.

5.2.6 Water pressure gauge having a resolution of 10 kPa.

5.3 Ambient temperature and humidity

The ambient temperature in the test room shall be 22 °C.

Ambient temperatures shall be kept constant within ± 3 K both during the periods required for obtaining stable operating conditions and during the tests. Unless otherwise specified, relative humidity shall not exceed 75 %.

5.4 Installation

Install the machine in test room according to the manufacturer's instructions. Machine placement from the walls of the test room shall be indicated in the test report.

Connect the machine to a calibrated energy test meter. A voltage regulator may be required during tests if the voltage supply is not within ± 2,5 % of the manufacturer's nameplate voltage.

Confirm (while the machine compressor(s) are energized) that the supply voltage is within ± 2,5 % of the operating voltage specified by the manufacturer. Record the test voltage for each test and indicate the value in the test report.

5.5 Test cycle

5.5.1 Pasteurizing Test Cycle

The pasteurization cycles of the reference test mix is the following:

— start from "Stop" without the reference test mix;

— add the reference test mix at 20 °C ± 1 K;

— power up;

— record the initial time;

— heating cycle maintaining the temperature ≥ 85 °C for at least 30 s;

— cooling down to a temperature ≤ 5 °C;

— record the final time.

5.5.2 Freezing Test Cycle

Start the first freezing process, in order to lead the machine to the freezing temperature.

Test with the machine at ambient temperature of 20 °C ± 1 K. Fill it with the reference test mix (Clause 6) at the temperature of 5 °C ± 1 K. Start the freezing process, recording the initial time. When the reference test mix (Clause 6) reaches the product characteristics as in 4.2, stop the freezing process and discharge at least 80 % in weight of the frozen product. Record the final time. The test cycle shall be repeated six times. Discharge the remaining frozen product from the machine and weigh it. The average of the last five time cycle, temperature and overrun values of the final product shall be declared.

5.5.3 Combined machine test cycle

The combined machine cycle of the reference test mix (Clause 6) is the following:

— start from “Stop” with no reference test mix in the machine;

— add the reference test mix at 20 °C ± 1 K;

— record the initial time for each cycle;

— carry out the heating cycle maintaining the temperature ≥ 85 °C for at least 30 s.

Start the freezing process. When the reference test mix (Clause 6) reaches the product characteristics as in 4.3, stop the freezing process and discharge at least 80 % in weight of the frozen product. Record the final time of each cycle. The test cycle shall be repeated five times. Discharge the remaining frozen product from the machine. The average of the five times cycle, temperature and overrun values of the final product shall be declared. In case the combined machines is composed of two tanks, it is possible to carry out the pasteurizing cycle at the same time of the freezing cycle.

5.5.4 Ageing Test Cycle

The ageing cycles of the reference test mix (Clause 6) is the following:

— start from “Stop” with no reference test mix;

— add the reference test mix (Clause 6) at 5 °C ± 1 K;

— record the initial time;

— keep the reference test mix at ≤ 5 °C for 6 h.

5.5.5 Product temperature/Extrusion temperature

Discharge in a tank at least 80 % in weight of the frozen product from the batch freezer. Insert immediately the probe of the thermometer in the frozen product placing the tip of the probe in the middle of the content of the tank.

The temperature of the frozen product shall be within the range from −9 °C to −11 °C, otherwise the test shall be repeated. Record the temperature of the frozen product when the display of the thermometer does not change for 5 s, with a tolerance of ± 1 K.

5.5.6 Overrun determination

Fill a transparent cup of at least 200 ml with the liquid reference test mix at a temperature ≤ 5 °C. The liquid reference test mix is filled to the upper rim of the transparent cup with a spatula. Determine the net weight of the liquid reference test mix in the transparent cup (weight A).

From the 80 % in weight of the frozen product discharged in a tank (see 5.5.5), fill again the transparent cup with the frozen product, minimizing the presence of air bubbles in the transparent cup.

The frozen product is made even with a spatula at the upper rim of the transparent cup. Determine the net weight of the frozen product in the transparent cup (weight B). The overrun obtained shall be ≥ 30 %.

The overrun is calculated with the following formula:

$$\%overrun = \left[\left(\frac{weightA}{weightB} \right) - 1 \right] \bullet 100$$

5.6 Determination of energy consumption

The ambient temperature shall be in accordance with 5.3.

The machinery shall be installed in accordance with 5.4.

The values of temperature and voltage supply measured during the test period giving the lowest energy consumption shall be recorded.

The energy consumption of the machine is the arithmetic mean of the tests cycle of the obtained values.

The energy consumption of the machine is expressed in kWh/kg of the freezing product.

5.7 Water consumption test

To test a water-cooled type machine, the condenser water flow shall be maintained at 25 °C inlet and 35 °C outlet. If 35 °C outlet water cannot be kept, the machine shall be tested at 25 °C inlet water and 250 kPa ± 50 kPa nominal pressure. The outlet temperature shall be declared in the test report (Clause 7).

5.8 Operating time calculation

The operating time of the machine is the arithmetic mean of the tests cycle of the obtained values.

6 Reference test mix

The reference test mix used for the tests shall have the composition indicated in Table 1. Preparation of the mix shall be carried out slowly and manually. The use of electric mixers might alter tests since air would be absorbed in the mix.

Table 1 — Reference test mix

Ingredients	Quantity to be prepared kg			
	1	10	60	120
Milk	0,745	7,45	44,7	89,4
Saccarose	0,250	2,50	15,0	30,0
Stabilizer and emulsifier	0,005	0,05	0,3	0,6
TOTAL	1,000	10,00	60,0	120,0

The composition of the stabilizer and emulsifier is indicated in Table 2.

Table 2 — Stabilizer mix

Ingredients	Quantity to be prepared kg
	1
E410 Locust Bean Gum	0,100
E412 Guar Gum	0,200
E466 Carboxymethyl cellulose (CMC) or cellulose gum (viscosity 2000 cP)	0,100
E471 Mono and diglycerides of fatty acids (MDG 90)	0,600
TOTAL	1,000

The reference mix shall be pasteurized before use.

7 Test report

The test report shall contain at least the following information:

a) the manufacturer's name or trademark;

b) type and serial number of the machine;

c) hourly production (kg/h);

d) overrun (%);

e) product temperature (°C);

f) total energy consumption (kWh/kg);

g) water waste (dm^3);

h) operating time (s);

i) remaining frozen product (kg) (see 5.5.2 and 5.5.3).

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