This work was suporteed by a grant of the Romanian Ministery of Research and Inovation CCCDI – UEFISCDI, project 12 PCCDI / 2018 within PNCDI III

RECENT DEVELOPMENTS CONCERNING THE METHODS FOR DRYING AND DEHYDRATION OF ORGANIC FRUITS

Lucian I. DUMITRESCU, Mariana SINGH, Marian VINTILĂ, Angela MOHORA

Research and Development Institute for Processing and Marketing of the Horticultural Products,

5N Drumul Gilaului , Bucharest Sector 4, Romania

- The quality of agro-industrial products, in general, is one of the main objectives of development strategies of the food-producers.
- Quality can only be achieved by a continuous improvement of production technologies, high productivity equipment and a high level of specialization for workers, which can consider the quality as an innovative culture.
- The strategy of the research activities is oriented to development agro-food production technologies with an practical echo for the economic operators.
- Fruits and vegetables are important sources of essential dietary nutrients such as vitamins, minerals and fibers.
- Because the moisture content of fresh fruits and vegetables is more than 80%, they are classified as highly perishable food products.
- Given the improvement in the quality of dehydrated foods, along with the increased focus on instant and convenience foods, the potential of dehydrated fruits is bigger than ever.

T R I A D of COMPETITIVE STRATEGIES :

PRODUCT

MARKET

TECHNOLOGY

- One of the oldest methods of preserving fruits is Drying (Dehydration).
- Drying can be an alternative to canning or freezing, or compliment these methods.
- With modern dehydrators, fruits can be dried all the year round .

The Benefits of Drying Fruits are :

- Inhibits bacteria, yeast & mold growth
- Prevents food spoilage
- Slowing down enzymatic activity
- Reduction of transportation and storage costs
- Saving packaging costs

Drying versus Dehydration

- Drying

  - Concentration of a liquid product to a liquid product

  - Involves partial removal of water from fruits by conventional energy sources like sunlight and wind under natural conditions.

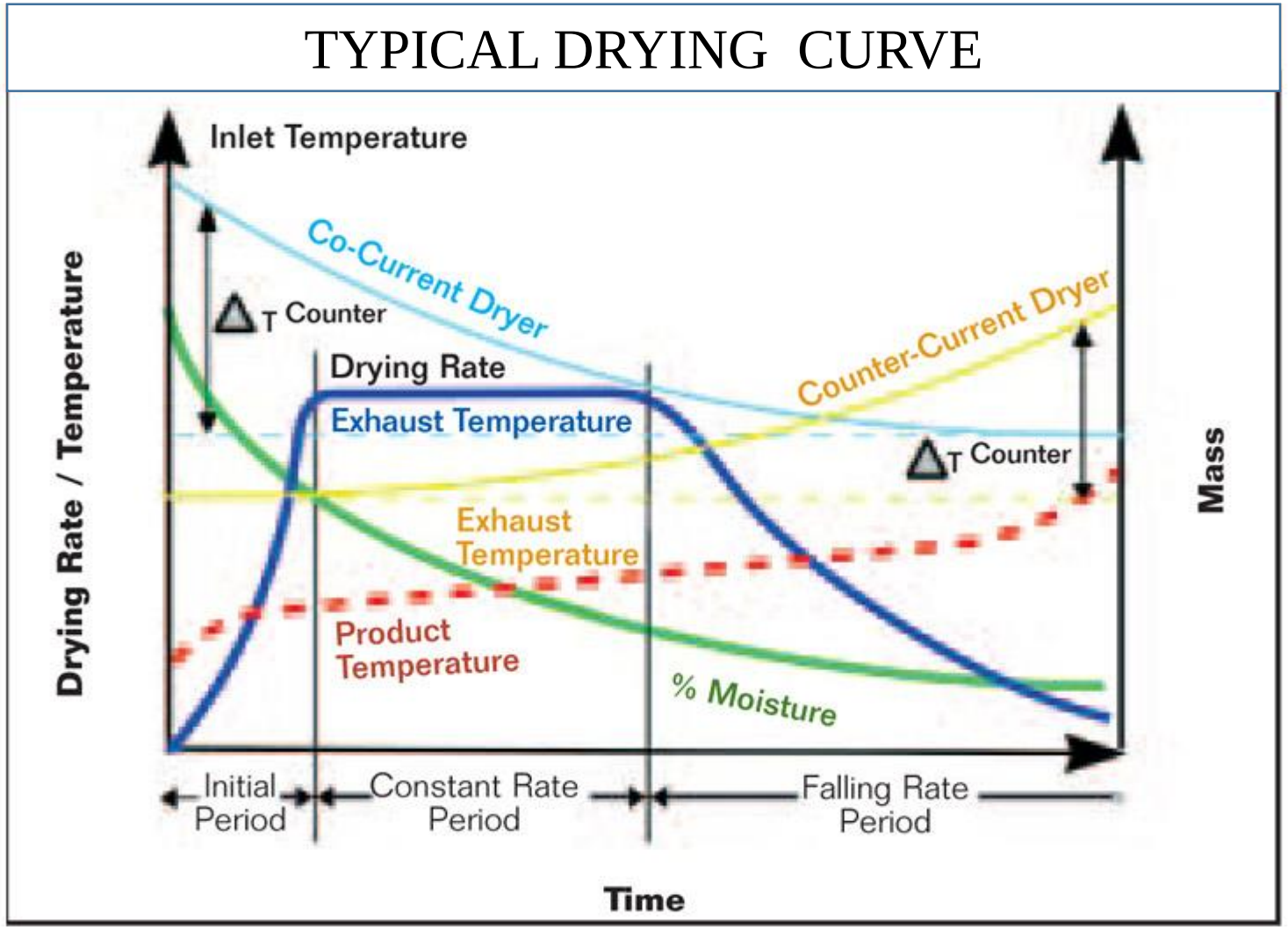
- Dehydration

  - Conversion of a liquid product to a dry (solid) product

  - Involves (almost) complete removal of water under controlled conditions like temperature, relative humidity and air flow

Drying / Dehydration Techniques

- Sun or solar drying
- Freeze drying
- Drum drying
- Spray drying
- Foam mat and vacuum belt
- Convection air & Superheated steam (tray, tunnel)
- Osmotic drying
- Microwave
- Combination of different techniques
- Vacuum- osmotic
- Osmotic – microwave
- Ultrasound pre-treatment followed by drying
- Fluidized bed
- Pulse combustion
- Jet zone or impingement



Drying Curve | Source – www.process-heating.com

Three phases of drying :

1.Initial rate period – initial heating of equipment and the product to be dried occurs.

2.Constant rate period – Free moisture is removed easily and unbound moisture will come-off at constant rate

3.Falling rate period – Rate of moisture removal decreases with time

Factors that can affect the drying / dehydration process

- Temperature
- Humidity
- Air velocity
- Direction of air flow
- Type of dryer
- Type and size of food

(very difficult to remove last 2% of moisture)

FLOW CHART OF DRYING

Hirehal, (2007)

Types of Dryers

• Based on design or process used
– Tray, cabinet, drum, spray, tunnel, fluidized bed, vacuum-freeze, atmospheric-freeze, filtermat, dielectric, ultrasonic, flash, through, vacuum, paddle, rotary, air impingement, spouted, contactsorption, heat pump, pulse combustion, plasma torch, CarverGreenfield process, organic solvent vapor, slush, shock wave

• Based on medium
– Air, superheated steam, flue gases

• Based on mode of operation
– Batch, continuous

• Based on number of stages
– Single, multiple

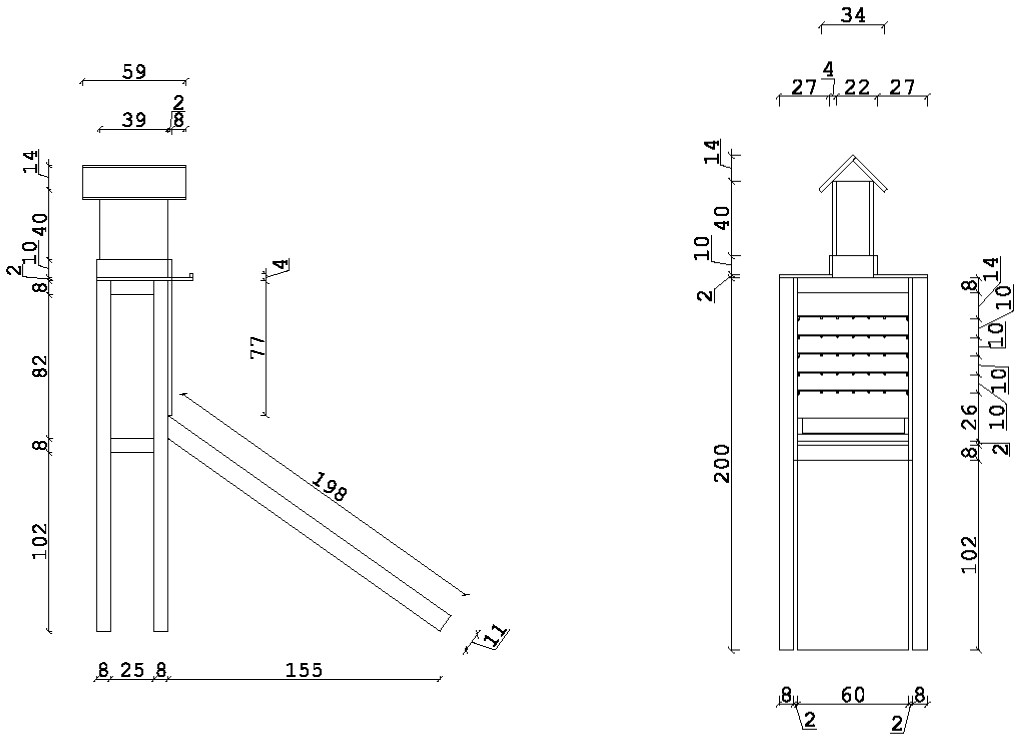
Until 1990, HORTING was the only research institute in Romania specializing in the preservation of horticultural products by dehydration. HORTING's research programs covered the six subdomains of horticultural dehydration:

- the quality of the rouch material;
- dehydration technology;
- equipment and installations for dehydration;
- the quality of the final product,
- condition and storage of the finished product;
- designing production plants.

These programs solved specific problems of the industrialization of horticultural products and ensured a continuous process of development and technological innovation in this field. At the same time, it has led to the creation of a consistent database that allows for the development of knowledge in this field.

SOLAR DRYING – An solar dryer was designed and developed at ICDIMPH –Horting. These dryer can be accessed as an investment in small farms, in terms of the costs of execution (about 2,500 lei) but also its utility for increasing the added value and diversification of the range of products.

The dryer have two components, an indirect heater (solar collector) having 1.6 square meters and a separate drying chamber with a volume of 216 liters which have 5 trays of 0.24 square meters each, designed to be detachable for easy maintenance and mobility as needed. The chimney above the drying room is equipped with a shutter which can be opened or closed according to the air flow wanted to pass through the dryer. The dimensions of the dryer are given in Fig. 1 and an overview in Fig. 2.



a. **b.**

Fig. 1. Physical dimensions of the dryer:
a) side view; b) back view

a. **b.**

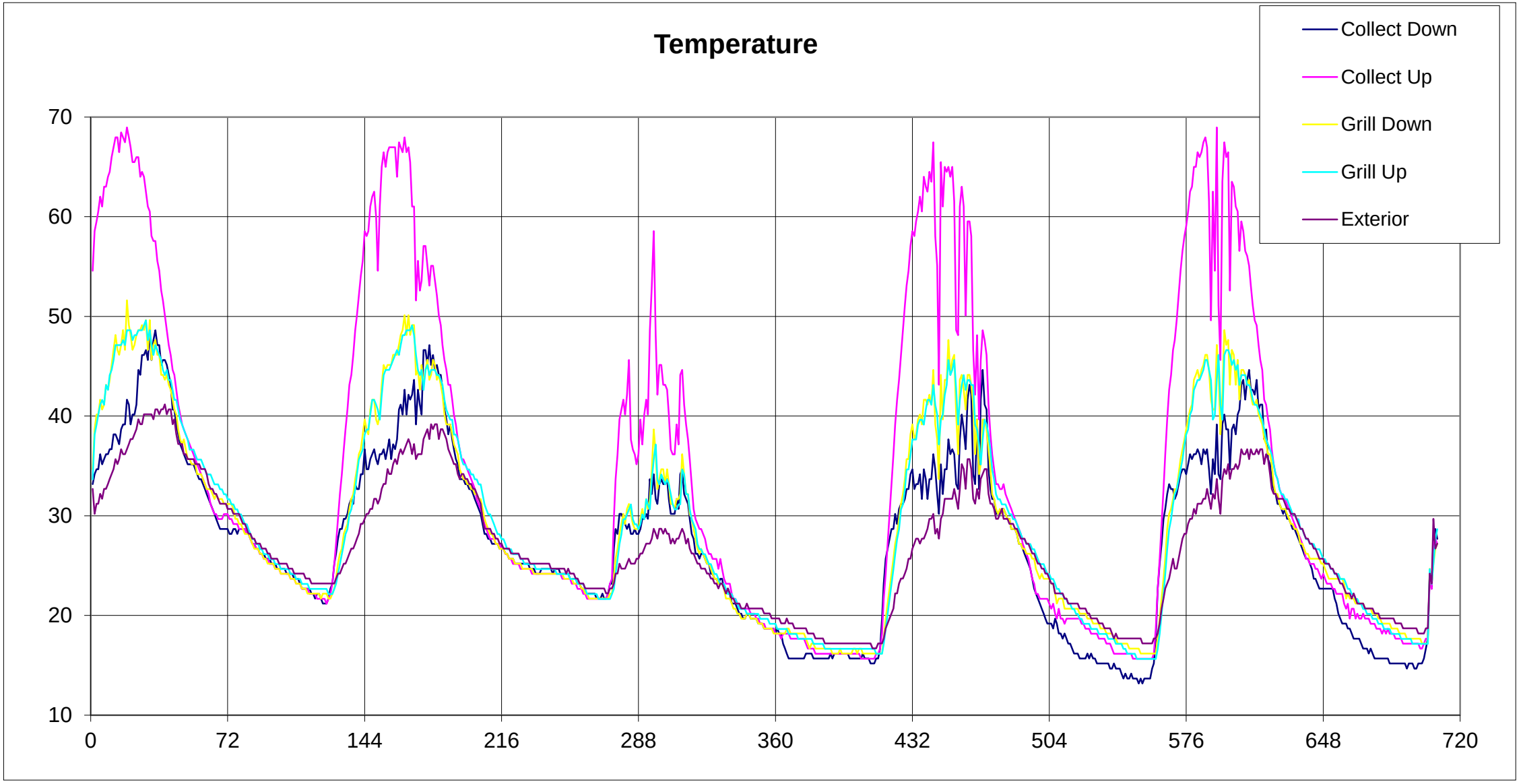
Fig. 2. Overview of the dryer:
a) side view; b) back view

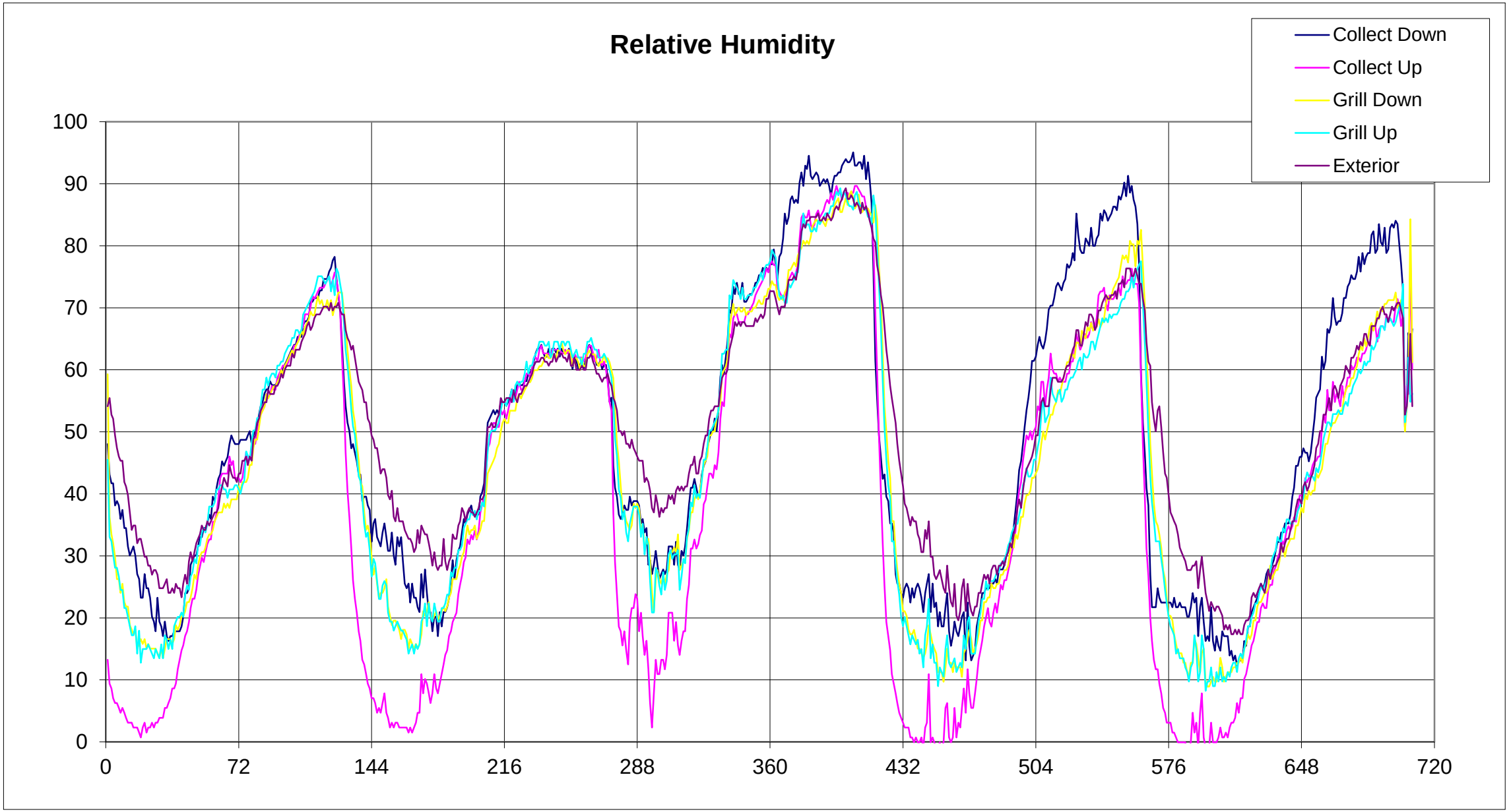
Sensor for temperature and humidity measurement

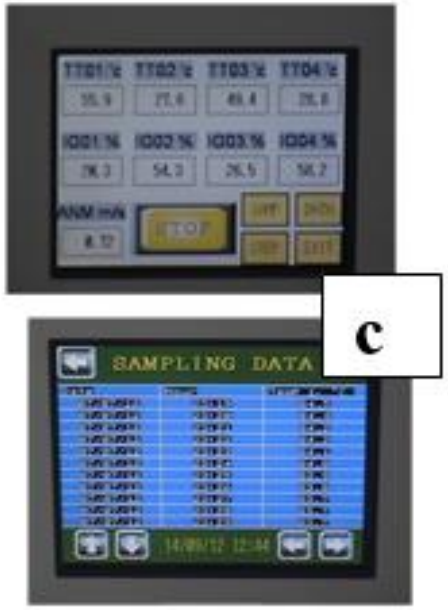
During the experiments the temperature and relative humidity were measured in different points of dryer :

- on the bottom side of the collector
- on the top side of the collector
- on the down grid from the drying chamber
- on the up grid from the drying chamber
- on the outside

HORTING

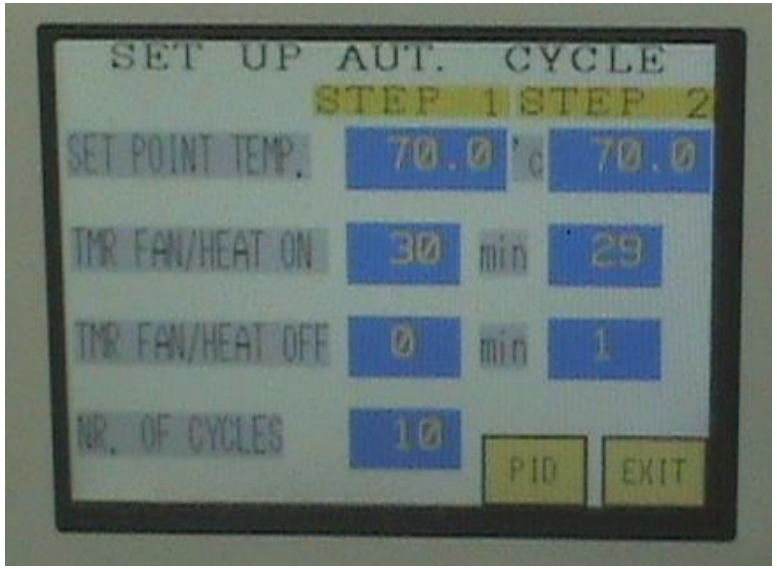

Temperature
Collect Down
Collect Up
Grill Down
Grill Up
Exterior
70
60
50
40
30
20
10
0
72
144
216
288
360
432
504
576
648
720

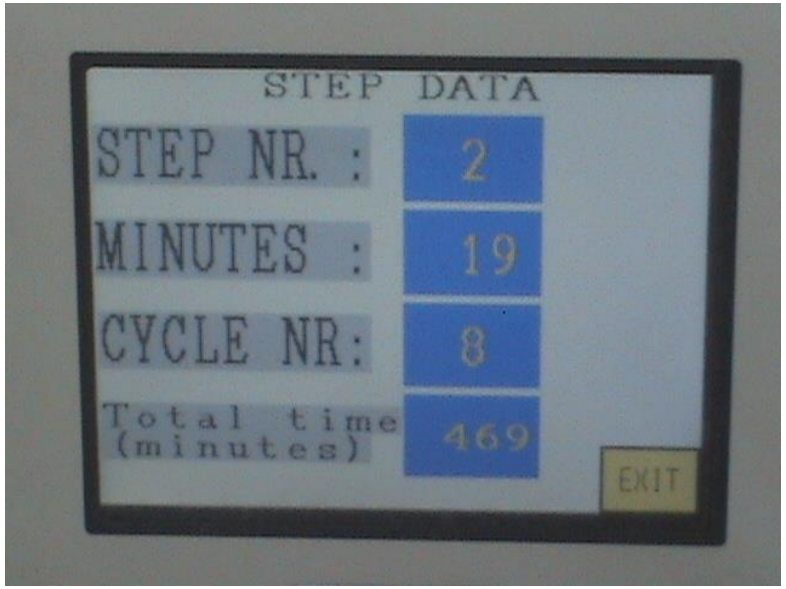

Relative Humidity
Collect Down
Collect Up
Grill Down
Grill Up
Exterior
100
90
80
70
60
50
40
30
20
10
0
0
72
144
216
288
360
432
504
576
648
720



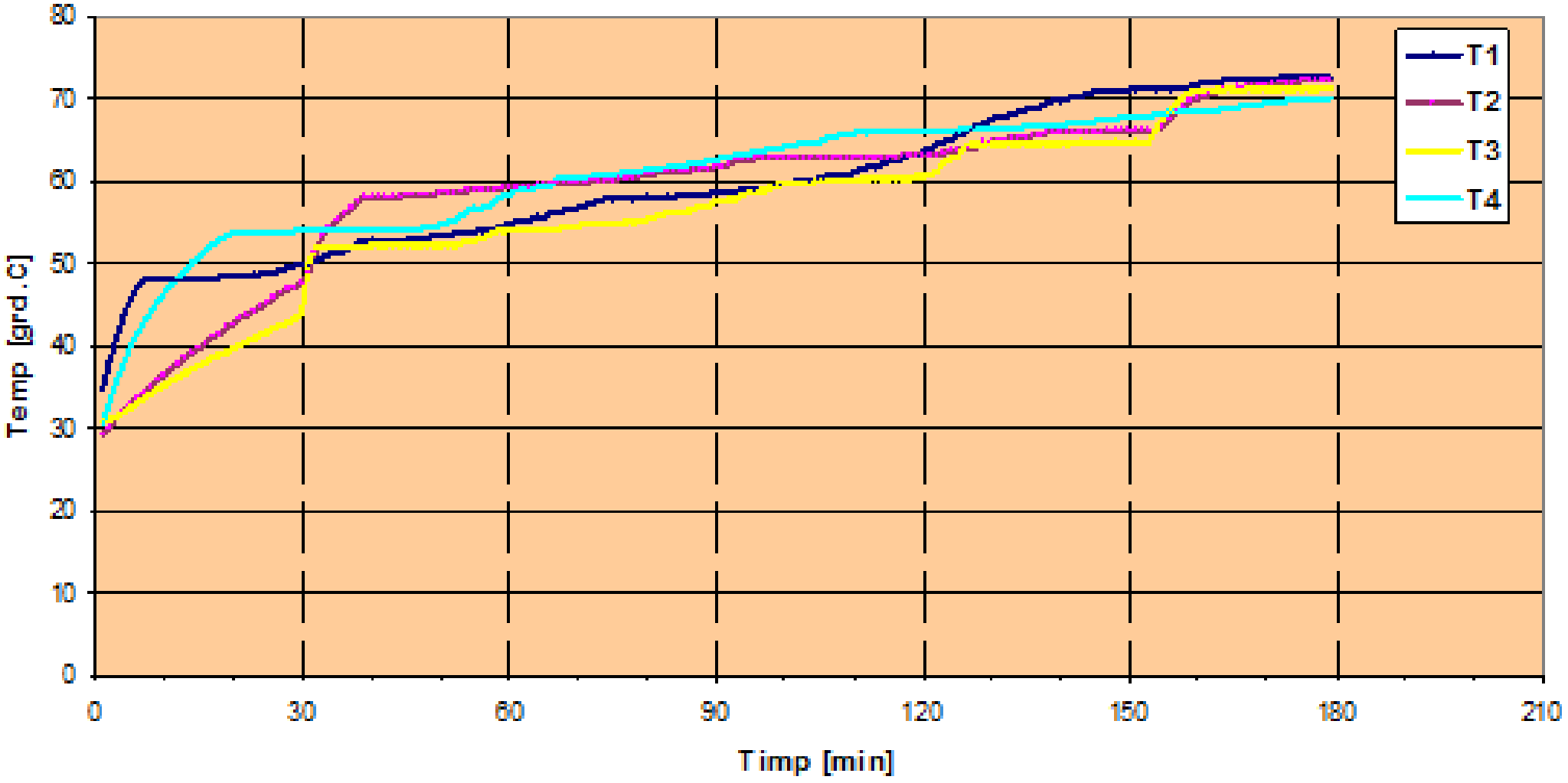
Equipment for dehydrating fruits and vegetables
a. general view
b. driving panel
c. processor interface
d. systems for temperature and velocity measurement


4 2,61
1 2,68

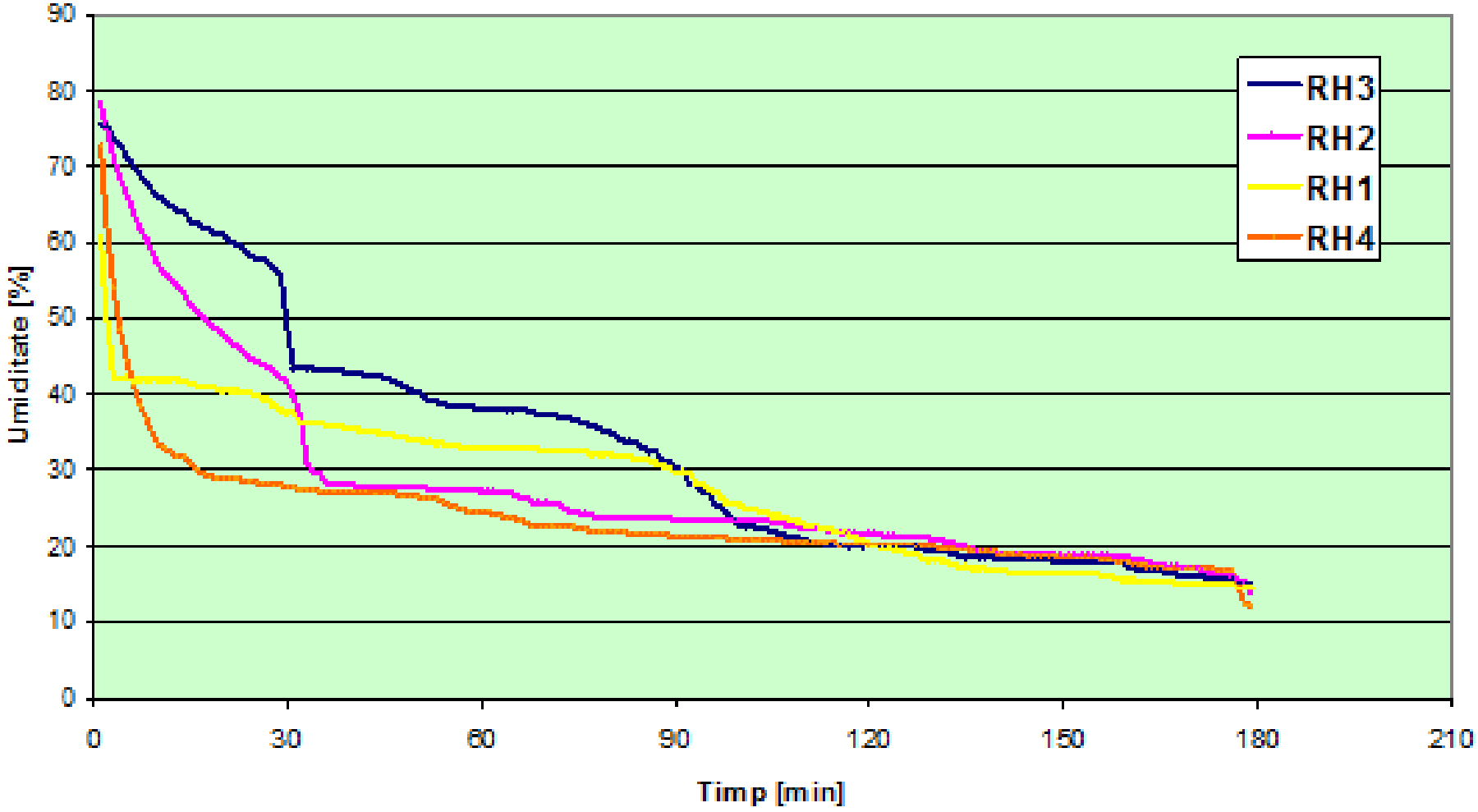

SET UP AUT. CYCLE
STEP 1 STEP 2
SET POINT TEMP. 70.0 °C 70.0
TMR FAN/HEAT ON 30 min 29
TMR FAN/HEAT OFF 0 min 1
NR. OF CYCLES 10
PID
EXIT

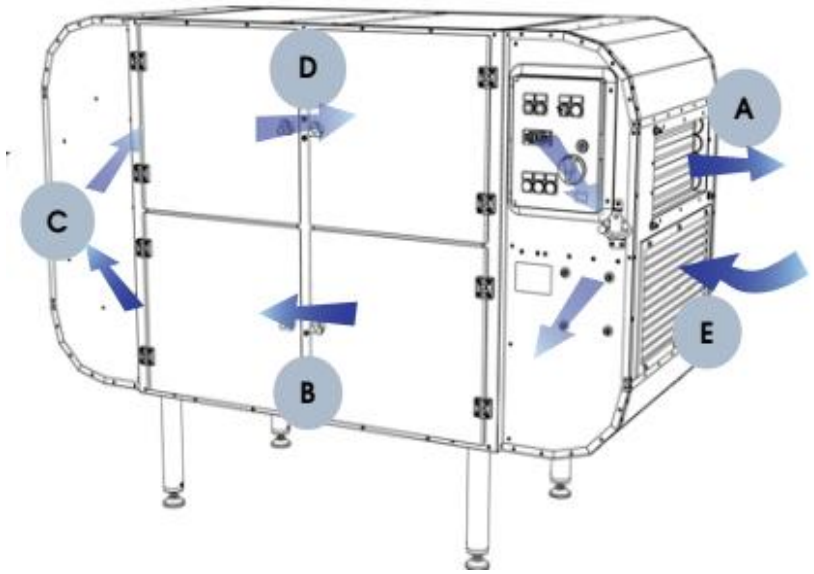

STEP DATA
STEP NR. : 2
MINUTES : 19
CYCLE NR: 8
Total time (minutes) 469
EXIT

Variation of air temperature in the drier chamber until reaching the operating temperature



Variation of air humidity inside dryer





The BM40 dehydrator recently acquired by HORTING is a low-temperature dehumidifier.

It has a construction that allows the air to circulate inside the drying chamber and to be evacuate only when certain relative humidity values are reached.

On the shutter (A) is mounted an automated monitoring of humidity levels. It can open or close the shutter, function of the relative humidity pre-seted.

At the same time, air from the outside environment is drawn in through the grille (E). The heating elements fitted in this point heat it, drying it and making it suitable for dehydration purposes.

The air will pass through the trays in the bottom half of the dehydrator (B), and will then be conveyed to the upper trays (D) around the return curve (C).

Fruits ready to be fed into the dehydrator

Trays with dehydrated apple slices

Dried plums in laboratory dehydrator

Thank you for your attention !

HORTING