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Drying of Niagara grapes aiming at generating information for processing, supervision and control

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ABSTRACT

The data acquisition and process control is one of the main problems faced by engineers and researchers responsible for automation and analysis equipment and agricultural processes in real time. For a decision about the characteristics of the process are carried out with a greater chance of success, it is important to know and monitor the parameters related to its performance. Thus, the aim of this work was to develop a computer program in order to register and display real time information about the process and the dynamics of weight loss product. The system was implemented using the LabVIEW software. Developed Virtual Instruments (VI) for the following types of sensors: load cell, PT 100, Transducer of electrical, air humidity and frequency inverters. Obtained the application DRYING OF GRAPES for monitoring and controlling the process of partial dehydration of grapes developed, which was observed during the tests, ease of operation of the system, allowing the rapid acquisition of data, and the ability to combine the system implemented to meet the demands of several studies, and can be used in different types of agricultural products.

Keywords: Decision support system; real time; mathematical model.

1. INTRODUCTION

For the monitoring and analysis of drying are done in real time is essential to use technology and mechanisms to assess quickly and accurately the information that is inherent to the treatment, providing support to the operator for decision making regarding process change is made, considering the response of the product hygroscopic (KARIM and HAWLADER, 2006; NGUYEN and PRICE, 2007).

For the acquisition of information is guaranteed with high precision measurement systems and control should be associated with sensitive instruments and stable, and able to make data acquisition at any time (BERGEIJK et al., 2001

ADAMCHUK et al., 2004; GONZÁLEZ and HERRADOR, 2007; ANURAG et al., 2008).

The purpose of this work was through the instrumentation of a structure drying, develop and validate a computer application in order to register and display real time information about the process and the dynamics of weight loss product.

2. MATERIAL AND METHODS

Part of an experimental prototype at the Laboratory of Thermodynamics, Faculty of Agricultural Engineering of the State University of Campinas, the structure consists of a drying chamber cooled (cooling capacity of 4,400 kcal.h-1 to -10 oC) fitted with a tunnel forced air (air flow rate of 2,900 m3. h-1) and resistance (2400 W) that enable drying of fruits and vegetables in low and high temperatures.

From previous work (Silva and TERUEL, 2011; SANTIAGO et al., 2012), the computer application for monitoring and controlling the drying considered signals from five temperature sensors Pt 100 (FM = 0 to 100 º C; model TR106 , 4 to 20 mA, accuracy = ± 0.2%), a sensor for relative humidity RHT-WM/Novus with compact electronics module and transmitter of values (FM = 0 to 100% RH; 4-20 mA, precision = ± 1.5%), a system comprising a weighing load cell, model PW12C3 - IMB (50 C - 50 kgf, a sensitivity of ± 0.1% 2-mV.V 1), two transducers of electrical Min f K-05, Kron (accuracy 0.2%; voltage of 220 V; communication interface RS485 type; speed 9600, 19200, 38400 configured 57600bps or; data format 8N1, 8N2, 8E1, 801configurável , address 1 to 247, configurable; Modbus - RTU and coding of information floating point, IEEE-754), a block of space heaters air comprises four finned RTDs with nominal voltage of 220 V and 600 W power each and two frequency inverters CFW09 - WEG (supply voltage 220-230 V three phase; isolated input with resolution of 8 bits, linearity error less than 0.25%), one to control air flow tunnel forced and others to control power to the game system's thermal chamber.

The information related to sensing instruments are integrated into a central processing unit and data acquisition according to the diagram in Figure 1.

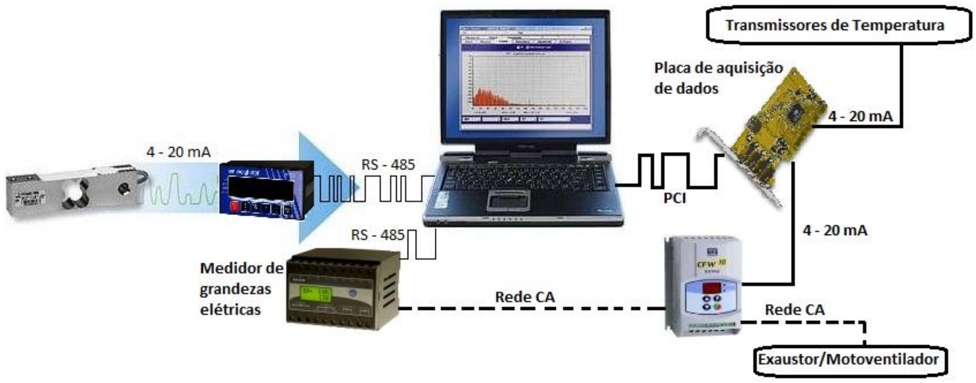


Figure 1. Scheme of the data acquisition process.

The data acquisition of temperature and relative humidity was carried out by data acquisition board (PCI-NIDAQ 6229) coupled to the connector block (CB-68LP) both from National Instruments. This board has as inputs the analog values of temperature and relative humidity expressed between 4-20 mA and outputs a voltage which acts on the frequency inverter compressor and exhaust, and can vary between 0 and 10 V as the cooling efficiency and speed desired air. The digital data of electrical meters and weighing system are transmitted to the microcomputer systems via Modbus protocol via the RS485 serial port, enabling data to be read and stored.

All signals obtained with the instrumentation system, after processed by the computer are displayed in real time on the application of supervision and available as a source of information and aid to decision making related to changes in the parameters governing the kinetics of the process, such as temperature and velocity of the drying air. The data are structured from sample means every minute and stored in spreadsheets for further analysis.

2.1 Computer application

The computer application was developed in the graphical environment of the programming software LabVIEW ® (National Instruments). The Labview has its operation based on two interfaces. A graphic intended for contact with the user, allowing monitoring of the process in real time, as control of the characteristics of interest by changing the process environment. The second interface enables the realization of interaction of the hardware and signal processing. The main feature is the possibility of Labview development and implementation of control applications in a graphical format friendly. With the calibrated parameters, the response signals of drying are analyzed and processed, generating new information to the operator.

To validate the ability of the application in real-time monitoring of the drying process, tests were performed partially dried grapes.

2.1.1 Feedstock

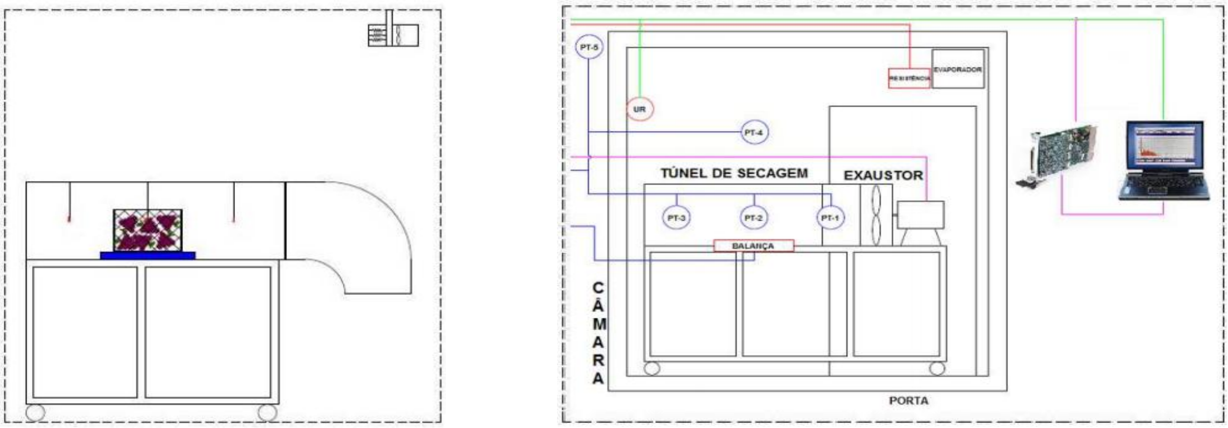
We used to cultivate Niagara Rosada grapes (*Vitis labrusca*), the harvest from July to November 2011 collected in the city of Jales, northwest of São Paulo. The grapes were packed in cardboard boxes with a capacity of 7 kg and transported to the Laboratory of Thermodynamics and Energy, Faculty of Agricultural Engineering of the State University of Campinas (LTE - UNICAMP).

After completion of the pre-cleaning of the cluster to remove the stems and berries damaged or compromised by the presence of fungi, we performed the sample distribution.

2.1.2 Partially dried grapes

Tests of partial dehydration resulted from the combination of the parameters temperature and air velocity. The effect of different combinations of product quality was assessed by Santiago et al. (2012a) and Santiago et al. (2012B).

The fruits were packaged in plastic, 25% effective opening area, dimensions 50 x 30 x 25 cm, containing 25 bunches of grapes, longitudinally arranged. The package was placed inside the drying frame (Figure 2a). With the air flow perpendicular to the position of the bunches are increased rates of heat and mass transfer, allowing the dehydration process occurs in a shorter period without forced air.



(a) (b)

Figure 2. (a) Schematic structure forced-air drying, (b) Schematic instrumentation system.

Given the chemical and physical characteristics of grapes adn purpose of carrying out partial dehydration and not complete, the logic is designed so that the supervisory system to achieve weight loss of reference, ie a percentage of the initial mass of the product the system turns off automatically.

3. RESULTS AND DISCUSSIONS

The program resulted in the development of application called DRYING OF GRAPES, which has the purpose of collecting, processing and storing data from the sensors installed in the drying chamber, in addition to providing for the operator to take decisions on possible changes in the process.

The application SECAGEM DE UVAS (DRYING OF GRAPES) available to the user in graphical and numerical form through the computer screen the data in real time. It also allows the user to control and determine the performances of some system equipment experimental physicist. Figure 3 shows part of human machine interface (HMI), which can be seen the control icons and indicators of system equipment such as compressor motors and exhaust, control of data storage and numerical indicators and led the operation and level operation of these devices.

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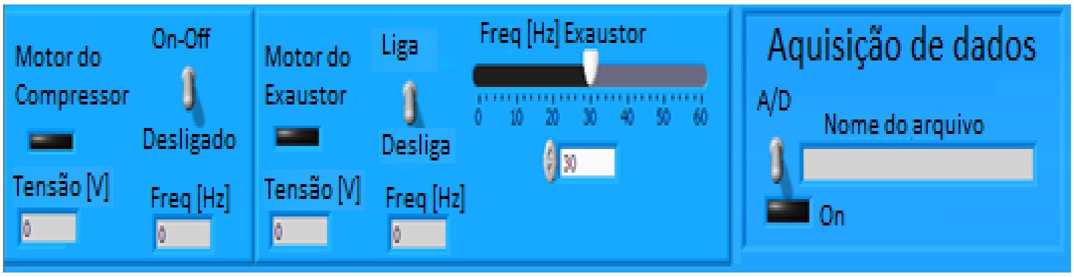

Figure 3. User Interface Part 1.

The HMI also includes monitoring of the internal conditions of the drying chamber, where through numerical and graphical indicators parameters temperature, relative humidity are exposed and monitored in real time by the operator (Figure 4). In this window are present the numerical indicator of the mass sampled by weighing system, the graphic indicator of mass loss during the course of the drying time and control icon in the end of the process, ie, setpoint mass loss.

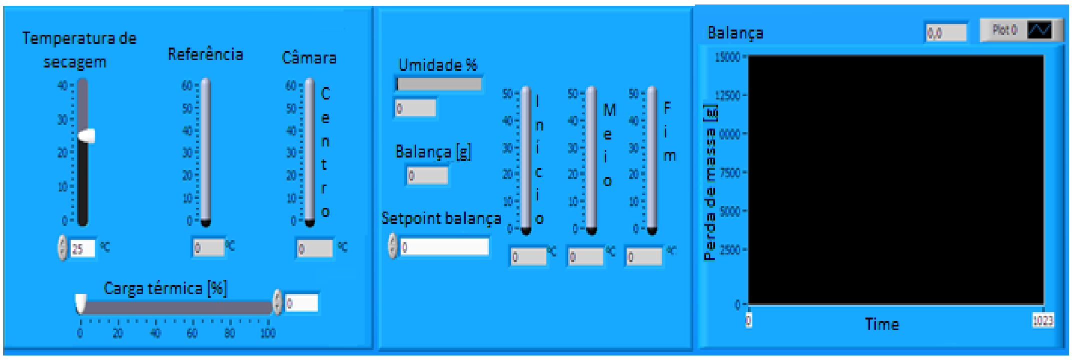

Figure 4. User Interface Part 2.

Figure 5 shows the box HMI where the signals from the transducers of electrical process are presented through numerical indicators.

Figure 5. User Interface Part 3.

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The MMI overall supervisory system is shown in Figure 6. As described above, this system is programmed to read the signs of the temperature sensors, relative humidity, weight and power consumption, in addition to acting on the operation of the compressor motors and exhaust, the operating frequency of the hood and level of heat load dissipated by the resistances. The application collects the signals from the load cell at a rate of approximately 120 samples per second, forming an average result every 1 minute for the other sensors is the rate of 100 samples per second, also forming an average result for each 1 minute.

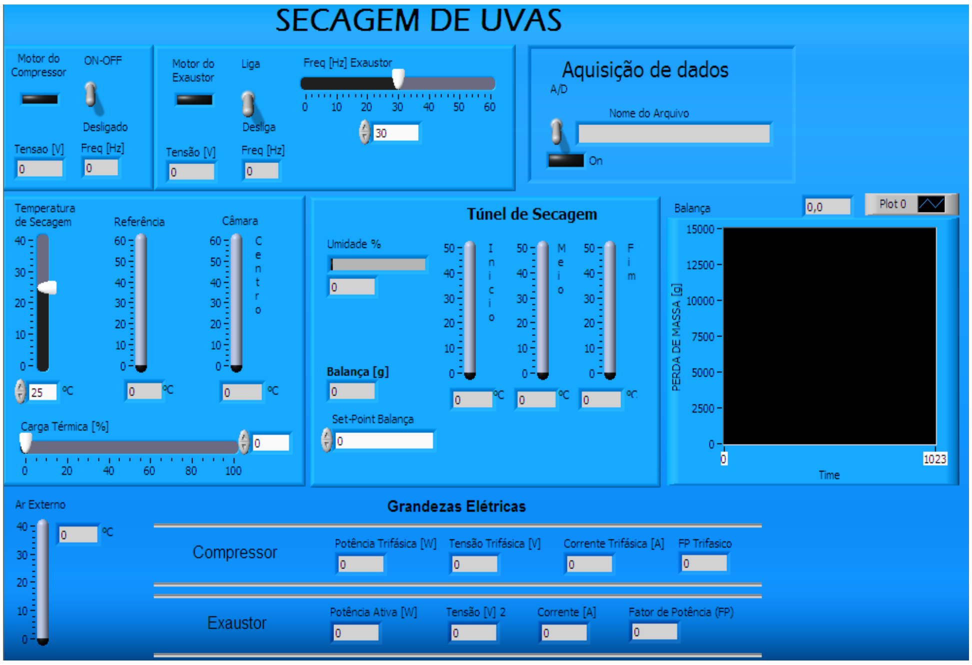

Figure 6. Screen for supervisory system implemented.

Once launched, the application performs its routine transmission and reception of signals until internal system error occurs, the setpoint range of mass loss or purposeful interruption made by the operator.

4. CONCLUSIONS

1 - The application program developed for the purpose of monitoring and decision support showed satisfactory performance during the partial drying of grapes, being able to measure and present the operator with real-time information about the process.

2 - The application interface DRYING OF GRAPES was characterized as friendly, featuring ease of interaction between the user and the application.

3 - The control logic inserted to the end of the process from the maximum rate of mass loss function properly, although the thermal load of the internal structure has not been disrupted, causing the process to continue development.

4 - For the application can perform the function of controlling the end of the process, new routines must be inserted into your schedule, allowing the source to be disconnected heating the thermal load of the internal structure is dissipated.

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