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A REVIEW

Development of PLC-based automatic Grape dryer

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ABSTRACT

Grape is a seasonal crop and gets spoiled fast. Therefore, all the grapes of a season must be utilized within short span of 4-5 days. Present natural process of grapes (Kishmish making) requires 12-15 days. Hence, the investment of space and infrastructure are large and cannot be afforded by Indian farmers. To overcome this problem, an experimental drying chamber has been designed and fabricated which simulate the climatic condition. Also a PLC based system is developed to provide flexibility in varying conditions to produce all varieties of raisins (brown, golden, green).

KEY WORDS : Grape, Resins, Kishmish, Programmable logic controller (PLC), Dryer

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INTRODUCTION

Science of grapes cultivation is called Viticulture. The grape have natural life period of only 2 to 4 days. In general, around 3000 acres of area is under grape cultivation in Maharashtra. The grape production in Maharashtra is now increasing due to the high earnings. India produces grapes on commercial scale. in subtropical region of Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh in subtropical regions of Maharastra, Tamil Nadu, Karnataka, Andhra Pradesh, Punjab and Haryana. Maharastra is leading producer of grapes. Raisins are produced in California, Turkey, Greece, Iran, South-Africa and Spain.

Raisins have large market worldwide and can boost the economy of farmer as returns are much higher than those obtained by marketing of fresh grapes. Thus the production of good quality raisin can be a boon to the Indian farmers, in the form of profitability and avoiding their possible exploitation by traders. About 50 per cent of raisins production of world comes from California. Raisins have large market worldwide, and can boost economy of Indian farmers. Increased production of grape raisins can also save country‘s valuable foreign exchange as raisins worth 200 million rupees are imported every year. The traditional process of raisins worth 200 million rupees is imported every year [1-8].

The traditional process of raisins making has following disadvantages :

– The process is carried out manually and do not have any control.
– Drying time is more about 15-20 days.
– The drying process is unhygienic.
– Quality of raisins is not uniform and acceptable for export.
– Drying is not possible in humid conditions.
– The exposure of the product to open surrounding leads to losses due to birds eating and dust from external environment.

Objectives of the research paper :

– To dry the grapes without losing the nutrient contents and natural colour with optimized artificial dehydration system.
– To identify and optimize various parameters affecting the quality of raisin.

– To design the process equipment.
– To identify the control and manipulation variables.
– To develop PIC microcontroller based system to conrol the process.

Hardware details of Grape dryer system :

The drying system consist of following major parts

Fig. 1 shows following discrete components :
– Drying chamber
– Power supply unit
– Load cell
– Heater
– IR led bank
– Temperature sensor
– Humidity sensor
– Exhaust fan

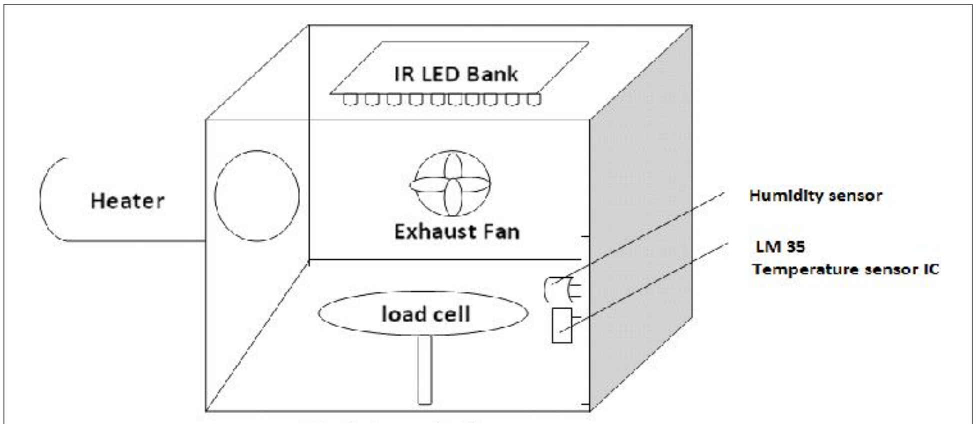

Fig. 1 : **Schematic diagram showing all components**

Drying chamber :

Fig. 2 shows drying chamber and its internal components
– Material of construction : Wood
– Input power : 230 V, 1 PHASE, 50 Hz Supply.
– Capacity : 1 kg of grapes.

Fig. 2 : **Internal setup of drying chamber**

– Range of temperature : Ambient to 70°C .
– Humidity : 20 per cent RH.
– Power : 336 W.

Load cell :

Load cells utilize strain gages that are configured in a Wheatstone bridge as their primary sensing element. The resistance value of the strain gauges changes when load is applied to the sensing structure and consequently, any voltage through the Bridge circuit will be varied. The Wheatstone bridge requires a regulated DC voltage excitation that is commonly provided by a strain gauge signal conditioner. The resultant output signal from the load cell is typically expressed in units of millivolt per volt of excitation. This millivolt signal then varies proportionately to the force applied to the load cell. The strain gauge signal conditioner provides zero and span adjustments to scale its 0 to 5 VDC analog output to be proportional to any desired input range. Additional features of the signal conditioner may include a digital display and alarm set point limits. Fig. 3, SYCON 5 Kg load cell is used.

The four-arm Wheatstone bridge configuration shown in Fig. 4.

Fig. 3 : Load cell

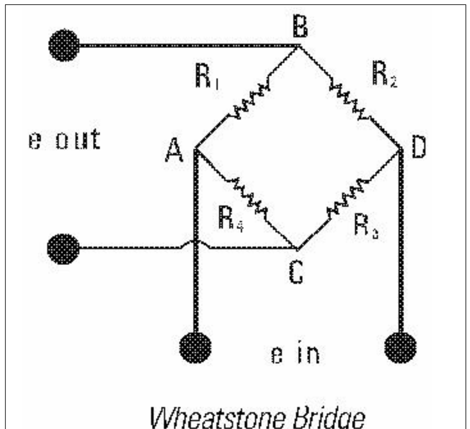

Fig. 4 : Four arms of wheastone bridge

Signal conditioning circuit for load cell :

The electrical signal output of load cell is typically in the order of a few millivolts and requires amplification by a differential amplifier before it is used. So for the purpose a differential amplifier is used in inverting mode with feedback gain of 1000. The different values of resistors used are Rf=200K, Ri=200 ohm. The ckt diagram is shown in Fig. 5.

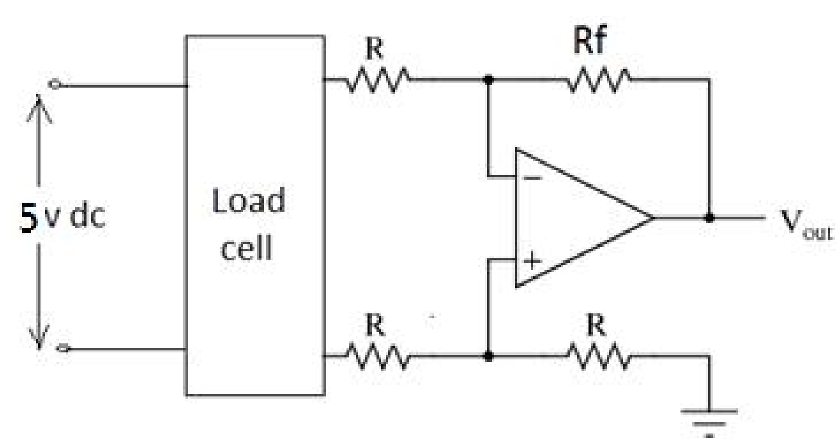

Fig. 5 : Circuit diagram for signal conditioning of load cell

Power supply :

– +5 V –Supply for operation of LM35,Humidity Sensor, Load cell, IR lamp circuit.
– +12 V and -12 V-signal conditioning circuits of Temperature sensor, Load cell.
– +12 –For operation of exhaust fan.
– Heater :

Fig. 6 shows the heater. It is used for generation of heated air *i.e.* totally dry air. The dry air does not have any content of moisture. With the help of fan this heated dry air is blown into the chamber and it is uniformly distributed in chamber.

Fig. 6 : Heater and LM 35 temperature sensor

IR LED Bank :

An IR LED, also known as IR transmitter, is a special purpose LED that transmits infrared rays in the range of 760 nm wavelength. Fig. 7 shows bank of LEDs. Such LEDs are usually made of gallium arsenide or aluminum gallium arsenide. They, along with IR receivers, are commonly used as sensors.

The appearance is same as a common LED. Electrically-heated infrared heaters radiate up to 86 per cent of their input as radiant energy. Nearly all the electrical energy input is converted into infrared radiant heat in the filament and directed onto the product by reflectors. Some energy is lost due to conduction or convection.

For practical applications, the efficiency of the infrared heater depends on matching the emitted wavelength and the absorption spectrum of the material to be heated. For example, the absorption spectrum for water has its peak at around 3,000 nm. This means that emission from medium-wave or carbon infrared heaters is much better absorbed by water and water-based coatings than NIR or short-wave infrared radiation. The same is true for many plastics like PVC or polyethylene. Their peak absorption is around 3,500 nm. On the other hand, some metals absorb only in the short-wave range and show a strong reflectivity in the medium and far infrared. This makes a careful selection of the right infrared heater type important for energy efficiency in the heating process.

Thus, for the practical purpose, we use 50 LEDs as a LED bank. Instead of using lamp, we use LEDs because LED are unidirectional. They have high penetrating action. The LED bank is placed 8inch above the grapes. The connection diagram is as shown in Fig. 7.

Fig. 7 : LED bank

LM-35 (Temperature sensor) :

Fig. 8 shows LM 35 Temperature Sensor. For temperature sensing, voltage source sensor LM35 has been used. It has a resolution of 33mv/^{o}C. The millivolt output of sensor is the amplified by using OP-AMP 741, to get the output value in 0V to 10V. This voltage output is given to the PLC input card for further processing.

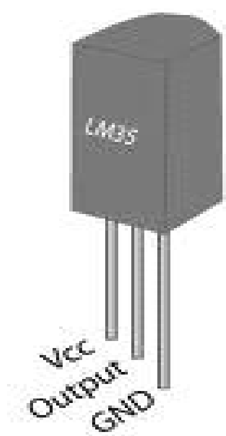

Fig. 8 : LM 35 temperature sensor

Features :

- Calibrated directly in °Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guarantee able (at +25°C)
- Rated for full -55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±1/4°C typical
- Low impedance output, 0.1 W for 1 mA load.

Signal conditioning of LM35 :

The electrical signal output of LM35 is typically in the order of a few millivolts and requires amplification by a differential amplifier before it is used. So for the purpose a differential amplifier is used in inverting mode with feedback gain of 1000. The different values of resistors used are Rf=200K, Ri=200 ohm. The ckt diagram is shown in Fig. 9.

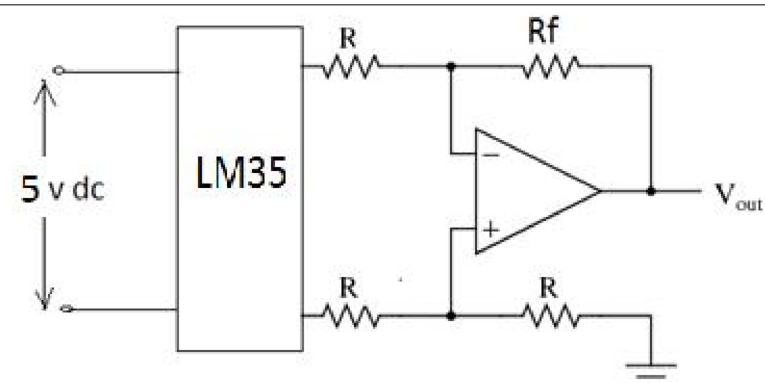

Fig. 9 : Circuit diagram for signal conditioning temperature sensor LM 35

SY-HS-220 (Humidity sensor) :

We are using polymer humidity sensor SY-HS-220 which has a resolution of 33 mv/ per centRH for a supply voltage of 5V. The output is amplified for increasing the resolution and is fed to the PLC input card.

Fig. 10 : SY-HS-220 Humidity sensor

Signal conditioning of SY-HS-220 :

The signal conditioning of humidity sensor is as shown in Fig. 11.

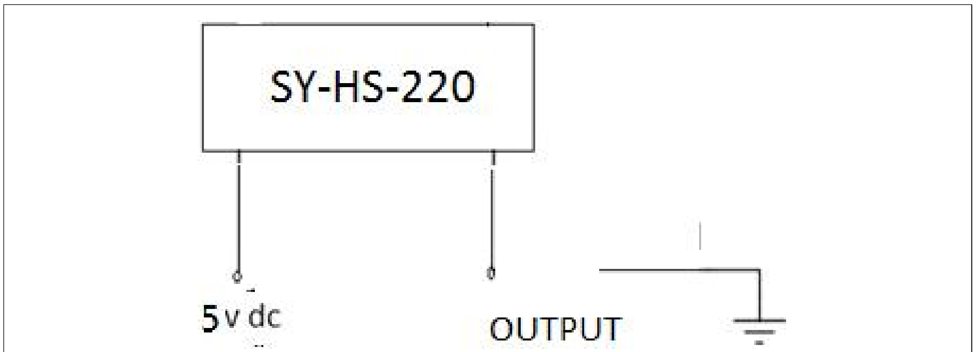

Fig. 11: Circuit diagram for signal conditioning of humidity sensor

Exhaust fan :

The temperature in the drying chamber maintained with the help of the exhaust fan. It removes extra heat and saturated air from the drying chamber. The fan requires 12V dc supply.

Construction :

The setup of Grape dryer unit is shown in Fig. 2.

Material : Wooden

Size : 14inch ×14inch×14inch.

Weight : 5Kg.

Sensed parameters : Temperature, humidity and weight.

Life of unit : 10 year.

When high temperature of chamber is between 38 to 45 degree centigrade yellow colour of grapes becomes brown. Green grape raisins obtained from this drying unit are of grade A an export quality.

Fig. 12 photograph shows grapes before placing into drying chamber. While Fig. 13 shows raisins after being undergone drying process.

Conclusion :

– When high temperature of chamber is between 38 to 45 degree centigrade yellow colour of grapes becomes brown.
– High temperature of IR source destroys chlorophyll in green grapes resins.
– IR LED source is used to get required green raisin profile.
– Green grapes raisins obtained from this drying unit are of grade A an export Quality.

Fig. 12 : Photograph shows grapes

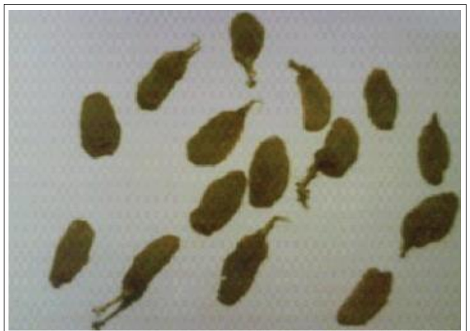

Fig. 13 : Photograph shows raisins

- This drying unit has more flexibility for other fruits and vegetables like tomatoes, potatoes, etc.
- In traditional drying of grapes duration of drying is 4 to 5 days, with others losses and drying time in this drying unit is 7 to 8 hours with no loss.
- Because of penetrating power of IR rays moisture removal rate from inside grapes was high *i.e.* IR is more effective in removing moisture from thick cuticle in the second phase of drying process.
- Because of IR rays do not heat the air, Change in humidity was very less.

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