Design and Analysis of a Sensor for Measurement of Fat content in Milk using optical technique

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***Abstract*— Today's world is become faster & faster. So we are making a system which will be going to change the lifestyle of Indian farmer and milk collection system. The dairy farming is important business of Indian farmer. Dairies collect milk from farmer everyday & payments for this milk are done according to the rates per liter. This rate depends on various factors like FAT, CLR & SNF of the milk. We have developed a system that will measure these parameters. In recent years the National Dairy Development Board-initiated cooperative movement has led to a substantial increase in milk production in India. The two main reasons for this increase are the efficient collection of milk and higher profit for the milk producers, both of which have to some degree been influenced by latest technology. This is only recently that automation has been introduced into agriculture. In many dairy farms, computer aided control are used lead to increase productivity. Embedded Technology is gives speedy results. An embedded system used as a control system or computer system designed to perform a specific task. Embedded systems are playing important roles in our day today life. This paper describes one of the applications of embedded system or optical system. It is Small compact, embedded in a single unit, requires less power and measure milk parameters like FAT, CLR SNF (Solid but Not FAT) with less cost.**

***Index Terms*—FAT, CLR -Corrected lactometer reading, SNF-Solid but not fat, Embedded system**

I. INTRODUCTION

In Today's World all daily requirements goods are become more luxurious. According to time, there is a need to change milk collection and dairy operating system. There are some reasons to change existing system. Firstly the process of testing of milk by measuring FAT, density and quantity is time consuming. Hence, farmers have to stay in line. Secondly, some milk collections in small villages do not have costly milk analyzing equipment's. In this situation milk sample can be tested after milk collection process which can take two or more hours. During this time collected milk stored in plastic bags or bottles which can lead to unhygienic conditions. Another reason is all measurement done noted and calculated manually which can lead to error or mistake during calculation. To reduce manual work and for faster milk collection there is a need to replace existing system to system using the system where milk collection parameters can be measured automatically and in low cost. The Dairy industry in India is generally co-operative .The primary milk provided to the dairy are farmers who do not process their milk and give it in the raw form to the co-operative dairy. Since more number of farmer are depositing their milk in the dairy, it is a daily task of the dairy to assess the quality of milk from each farmer, verify it & meets the quality norms specified and make payments based on quality and quantity of milk. Though several tests are available for quality assessment of milk like the content of protein, water, detergent, lactose, etc, most dairies use only the FAT content test and CLR (Corrected Lactometer Reading) to judge milk quality.
Standard ranges of FAT content and CLR of milk are specified by the government and it is necessary for the milk to satisfy this quality norms. In measuring fat content we have used the principle of optical scattering of light by fat globules present in the homogenized milk thus diverting totally from the usual method of separating the fat by burning it with acid, centrifuging it and measuring on a calibrated scale, measuring the specific gravity of the milk or the CLR.

III. PRESENT METHODS OF MILK ANALYZING

As payment for the milk to farmers are based on the quality of the milk which they delivered to the dairy & the quality is decided on Fat, CLR, SNF & Weight of milk. Hence there are various methods existing to measure Fat, CLR & SNF and some of them are described below.

A. FAT measurement

Gerber method

In this test H_2SO_4 is used to increase specific gravity of milk serum which makes greater difference between milk serum and fat globules. It also destroys stickiness of milk by dissolving all the SNF. The free fat globules rise to the surface by subsequent application of centrifugal force to this mixture and heat produced due to mixing of acid and milk, causing melting of fat. It facilitates the fat particles to come to the surface freely. The specific gravity of fat is 0.9 and that of acid milk mixtures is 1.43. This situation promotes complete separation of fat when proper centrifugal force is applied. Due to application of centrifugal force lighter substances (Butter fat) are thrown towards centre and rest of serum portion that is heavier is

thrown towards the periphery. Addition of amyl alcohol helps for separation of fat from the milk acid mixture and also prevents the charging of fat and sugar by the H2SO4.

Procedure

1. Put the clean and dry butyrometer in a butyrometer stand with open mouth upwards.
2. Run 10 ml of sulphuric acid with the tilt measure in the butyrometer.
3. Pipette out 10.75 ml of milk sample gently by the side of butyrometer, whose temperature is about 60-70 F.
4.Pour 1 ml. of amyl alcohol with tilt measure.
5. Stopper the butyrometer with the help of lock stopper using regulating pin/guiding pin.
6. The tube is well (mixed) shaken till mahogany red colour is obtained. Keep the butyrometer in hot water bath till it attains 60-70 0 F and the butyrometer are placed in the centrifuged machine that is revolved at 1100 rpm for 4 minutes.
7. Take out the butyrometer in an upright position with the stopper end down wards.
8. Keep the butyrometer in hot water bath a 149 0 F (600 C) for some time.
9. Adjust the fat column which will appear clear and yellowish within the graduation with the help of key.
10. Note the reading. Reading should be taken from bottom of the fat column to lower border of meniscus on the scale.

E-Milk Tester (for Fat Measurement)

The instrument used to measure fat content instantaneously on a digital readout. It does not involve the use of corrosive chemicals.

Working Principle:

E-Milk tester as shown in Figure 1 is based on the principal of photometric measurement of light scattered by the milk sample. The light is scattered by the fat globules present in the milk. The amount of light scattered by the milk sample is a measure of the fat content in the milk. Sensor is a device that detects the quantities required and provides a corresponding output generally as electrical or optical signal. A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors or photo resistors. They are made up of semiconductor materials having high resistance. A light dependent resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the materials conductivity (Hence resistivity) reduces when light is absorbed by the material. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. When light having enough energy is incident on the device more & more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing and hence it is said that the resistance of the device has decreased. Thus the change in the resistance of LDR is indication of the fat content .The circuit is calibrated using standards with sample of known fat values. For cow's milk fat must be 3.5 to 4.5 percent and for buffalo's it is 6-7 percent. If milk fat does not fall in acceptable ranges then milk sample will be rejected.

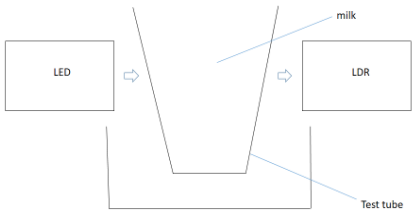


Fig.1 Block diagram of Sensor Module (Optical)

Key Features of E-Milk tester

- Auto zero facility
- Easy to read digital LCD display
- No acid or other chemicals are used.
- Measures up to 10% fat
- Easy to operate.
- Accepts small sample volume
- Performs 120-150 test per hour
- cheapest method of milk testing
- Low power consumption.
- Fast analysis-Allows a large number of measurement to be done
- Simple and light weight design
- Low cost and less time required.

B. CLR measurement

Lactometers are used for rapid determination of specific gravity. The method is based on law of floatation which states that when a solid is immersed in a liquid. It is subject to upward thrust equal to the weight of the liquid displaced by the body and acting in upward direction. Pure milk has a specific gravity of 1.026 to 1.032 grams per ml

Procedure

1. Adjust the temperature of milk sample at 50-80F
2. Fill the clean, dry glass jar about 2/3rd volume

of it with milk, pour the milk down along the sides of the jar to avoid the incorporation of air.
3. Lower the lactometer gently in the milk making sure that the lactometer floats freely without touching the sides of the jar.
4. Add milk to brim of the jar.
5. Read the lactometer reading at the top of the meniscus within one minute.

Manual method

In this method 70ml milk is taken in a measuring cylinder & the density of milk is found by dipping a lactometer in a milk sample. Because of this the lactometer displaces in milk & by observing the calibrated scale marked on its stem the density of milk is known. These readings are noted manually in farmer's membership card.

IV. BASIC COMPONENTS

To overcome the obstacles of present methods of milk analysis explained in previous chapter, a "Design and Analysis of a Sensor for Measurement of Fat content in Milk using optical technique" is developed which is simple in construction, easy to operate & which measures the parameters such as Fat, CLR & SNF of the milk and displays it on LCD display. The data displayed on the LCD display is simultaneously written on this card.
We can use PC interface also to maintain the year-by-year record.
The Figure 2 shows block diagram of Milk collection centre& it mainly consist of following component.
1) Sensor (optical)
2) Power supply
3) Microcontroller
4) LCD

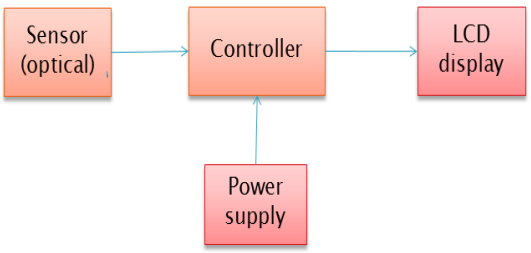


Fig.2 Block diagram of Milk Analyser

Block diagram description

1) Sensor block: The sensor block contains sensor assembly, which includes sensor for measuring Fat and CLR of the milk.

2) Micro controller: All the processing of the signal, storage, billing, and display is done by the microcontroller. The microcontroller used is AVR16, which is having RISC architecture.
3) LCD: LCD is connected to the microcontroller to display the result.

V. EQUATION

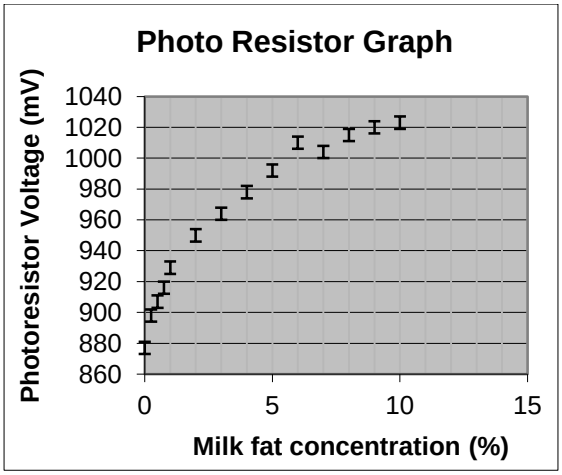
SNF measurement
1) Determine the fat percentage of milk sample by Gerber's method.
2) Take out the lactometer reading.
3) Place the figures of FAT and CLR in the following formula for calculating solids not fat.
SNF %= (CLR reading / 4) + (FAT × 0.21) + 0.36

VI. RESULTS

The reading obtained from milk analyser device that gives milk parameter as SNF, FAT and CLR is given below.

Milk/Method	Buffalo Milk	Cow Milk
GERBER Method	6.98%	5.00%
Dairy Machine	6.95%	4.96%
E-TESTER Method	7.00%	4.99%

Fig.3 E-Milk Tester



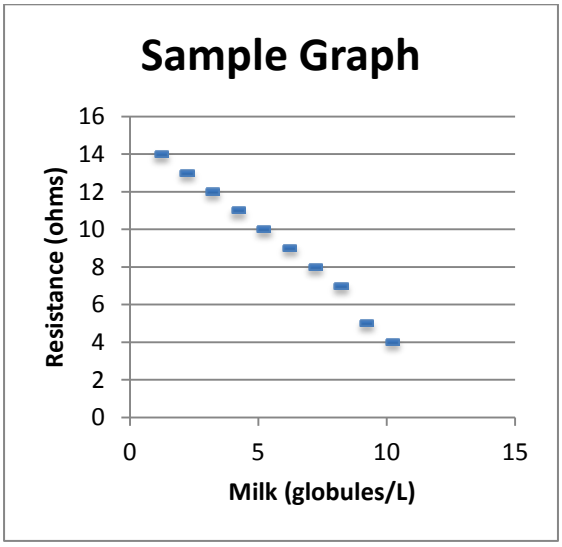


Fig.4

VII. CONCLUSION

With the help of this system we are able to judge quality of milk accurately. The accurate information about FAT, SNF &CLR content is displayed on LCD screen. Also farmers get the proper benefit according to quality of milk and customer get the good quality milk. The economical and credible technology implemented in this dissertation improves the delivery system by ensuring prompt payment to the farmers, instilling their confidence in the dairy industry, and also minimizing the problem of adverse selection and defeating corruption.

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