Milk Tester: Design, Development and Performance Study

Abstract

Milk and its by-products are highly nutritious foods that are consumed, processed and marketed all around the world. However, they are at higher risk of being contaminated in different stages of processing. Milk analyzers should determine the quality of milk by analyzing its purity and quantifying the presence of nutritional components in it. Most of the commercial milk analyzers can measure the percentage of fat, SNF, protein, and lactose content of milk. A very few instruments are available to identify the adulteration in milk along with the fat, SNF, protein components; however, they are expensive and not suitable for the use of the ordinary people. In this context, this thesis aims to develop a 'Milk Tester' that can simultaneously determine the fat content and presence of adulterants in milk and is 40 times cheaper than the existing commercial milk analyzers. The proposed 'Milk Tester' contains a polymethyl methacrylate (PMMA) coated adulteration detecting sensor and a lipase enzyme immobilized PMMA coated fat detecting sensor. The use of low-cost polymer makes the sensors inexpensive. Further, the sensors are bio-compatible, and their fabrication process is simple. The phase angle of the sensor impedance changes when they are dipped in different types of milk. A calibration methodology, along with a reference solution, is proposed. The difference in phase angle between the milk and the solution is utilized to determine the adulteration or fat % in milk. The phase angle difference is converted to a voltage by a suitable signal conditioning circuit, in which, a microcontroller is programmed to display the quality and fat content of milk in LCD. Quality of the milk is shown as 'Adulterated Milk' or 'Pure Milk'; whereas, the fat content is shown as 'LFM (low fat milk)' or 'HFM (high fat milk)' or 'VHFM (very high fat milk)'. The proposed 'Milk Tester' does not involve any external chemical and no prior technical knowledge is required at the time of testing, which makes the instrument user-friendly. A commercial milk analyzer is used for the initial validation of the developed 'Milk Tester'.

Keywords: Milk tester, milk adulteration, milk fat, sensor, PMMA, lipase, signal conditioning circuit, statistical analysis, electrical modeling.