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DETERMINATION OF DRY RUBBER CONTENT IN NATURAL RUBBER LATEX FROM NIR REFLECTANCE MEASUREMENT

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1. Introduction

Natural Rubber Latex is a special form of cytoplasm containing a suspension of rubber and non-rubber particles in an aqueous serum. Natural Rubber Latex has Dry Rubber Content (DRC) varying from about 20% to 40% (Kuriakose, 1992). Besides rubber and water, fresh latex contains 2 - 4% non rubber substances. The estimation of DRC at the latex stage itself is very important from a commercial point of view because it is the DRC value that determines the yield of rubber from the latex. Moreover, the DRC of latex forms the basis of payments to producers/ traders and hence its accurate estimation is very important. The most accurate method for the determination of DRC is by the standard laboratory drying method, the most prominent being the Chee method. Several other methods also have been reported for DRC estimation (Rubber Research Institute of Malaysia, 1973). The shortcomings of these methods are that they are either labor intensive, time consuming, difficult to use or expensive.

In this work we report a totally new method to determine the DRC of rubber latex, which measures the spectral reflectance of near Infrared radiation from latex samples taken in a suitable cuvette with flat sides. This method has many advantages such as simplicity, fastness, reproducibility etc. An outline of the principle of the technique, procedure adopted for measurements, results obtained and a discussion of the results are given in the following sessions.

2. Principle of the Method

In the normal transmission mode of optical absorption, one can apply the Beer- Lambert law to determine the concentration of a specific analyte in a sample at a specific wavelength, and is given by

$$A = \varepsilon IC \qquad (1)$$

where, at a specific wavelength, A is the measured absorbance, ε is the molar absorption or the extinction coefficient ($M^{-1}cm^{-1}$), l is the path length (cm) and C is the analyte concentration. The relationship between the Absorbance and Transmittance T is given by

$$A = log\ T \qquad (2)$$

The Beer–Lambert law describes the linear relationship between absorbance and concentration.

Our experiments have shown that it is very difficult to measure the optical absorption in the through transmission mode due to the heavy absorption in the latex sample. So we decided to follow the optical reflectance measurement to record the optical absorption spectra in the near Infrared region of the electromagnetic spectrum. Reflectance spectrum carries the same information as a normal

transmission spectrum, but is suitable for highly absorbing samples such as rubber latex.

2.1 Experimental Method

Near Infrared absorption spectra of natural rubber latex samples were recorded with a Varian Carry 5000 UV–Vis–NIR spectrophotometer in the reflectance mode utilizing the Internal Diffuse Reflectance attachment model DRA 2500 attached to the instrument. The latex samples were taken in rectangular quartz cuvettes for these measurements. The reflectance spectra were recorded for several fresh latex samples. The spectra of the same samples diluted with different percentage of water were also recorded to understand the effect of dilution on the reflectance intensity.

The DRC values of all the samples were also determined following the conventional drying and weighing method for comparison. These values have been compared with the reflectance values to estimate the sensitivity of the reflectance method.

Latex producers and traders have a tendency to add different adulterants to rubber latex. Comprehensive list of adulterants or treatments which have been used in practice is not available in open literature though several have been postulated by latex buyers. Although adulteration has not been proved in most of the complaints, latex buyers have high level of apprehension about latex adulteration. We wanted to test whether the IR reflectance method is able to sense adulterants present in latex. Systematic measurements with addition of five common adulterants, coconut water, saturated salt solution, rice effluent, rice water and ground water, have been carried out. Latex samples have been mixed with three known concentrations (25 %, 50 %, and 75%) of the adulterant and their reflectance values have been measured following the same procedure as described above.

3. Results and Discussion

Spectral reflectance data have been collected in a series of the measurements on different sets of samples. The variations of the reflectance values for different latex samples as a function of wavelength in the region 1420nm to 1520 nm are shown in Figure 1. It can be noted that the absorbance is maximum or reflectance is minimum at wavelength 1465nm. The variation of the percentage reflectance at 1465 nm for different latex samples with the corresponding DRC values, measured following the gravimetric method, is shown in Figure 2. The results have been analyzed using statistical tool, it is found that reflectance and the % DRC values, as shown in Figure 2, possess a correlation better than 0.95. The estimated uncertainty is $\pm$ 0.06, with a coverage factor of 2 and at a confidence level 95 %.

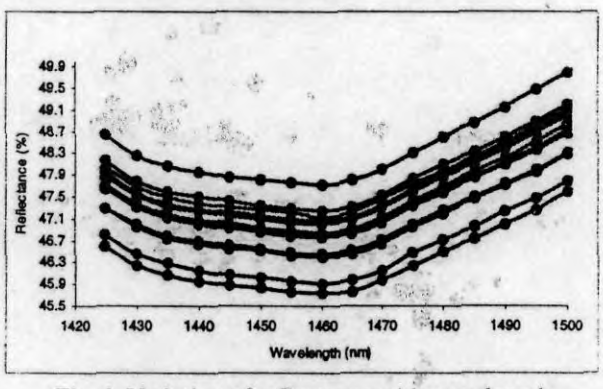

Fig. 1. Variation of reflectance with wavelength for samples with DRC values ranging from 34.5% (bottom curve) to 48.5 % (top curve)

The variations of spectral reflectance with wavelength measured in adulterated samples show that addition of adulterants to latex sample results in a reduced reflectance value. The reflectance value decreases with increase in concentration of the adulterant, which can easily be detected from the measurements.

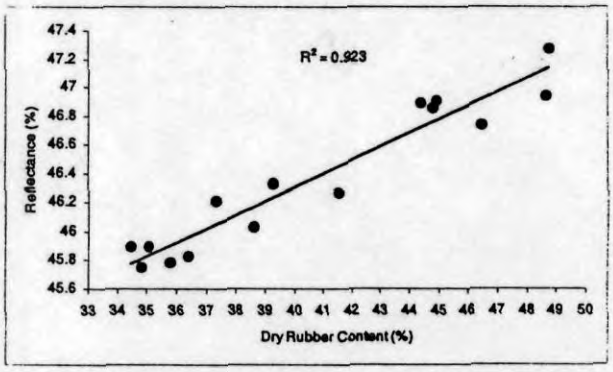

Fig. 2. Variation of NIR reflectance with DRC of rubber latex. R is the correlation coefficient

4. Conclusions

We have been able to establish a good correlation between DRC of natural rubber latex with spectral reflectance in the near infrared region. It is found that water molecules in the latex selectively absorbs near infrared radiation at specific wavelengths, which can be used as a technique to estimate the DRC natural rubber latex. Though we have been able to establish the relationship between DRC and reflectance of latex, we have not attempted to bring out the influence of non rubber constituents in these measurements. Since the major contents of these adulterants are again water, we expect the reflectance values to decrease drastically with the addition of such adulterants.

5. References

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