Project proposal of design and development of an optical system to monitor the qu...

Education, Learning

This document proposes the design and development of an optical based system to monitor the quality of colloidal liquids. The operation of the system is based on the principle that the intensity of light scattered by the suspended particle in a colloidal liquid is proportional to its concentration. There are commercially available instruments to measure the turbidity of a fluid. However, these instruments are relatively bulky and come with a high price tag. The proposed system is compact in size, lightweight and inexpensive as the components used can easily be sourced from the market. The proposed system aims to provide an alternative in quality assurance assessments in manufacturing processes as a non-intruding way to provide continuous record of particles concentration in a colloidal liquid.

A mixture can be categorised into one of the three primary types which are suspension, solution and colloid. Suspensions comprise of particles larger than 1 micrometre, which are relatively large and visible to naked eye. They are turbid, and the suspended particles will settle out after agitation, producing sediments. A solution on the other hand, has relatively much smaller particles dissolved in it no settling will occur. A solution is transparent, the dissolved particles are not visible, and there will not be sediments formed when a solution settle out. Colloids sit between the abovementioned types of mixture. The particles in a colloid are larger than those in a solution, yet small enough that they will not settle upon standing.

A colloidal system can exist in three major forms of matter, which are solid, liquid and gas. The form that will be further discussed is the liquid form, or colloidal liquid. A colloidal liquid is a solution which has microscopic particles

(in the size of 10-5 to 10-7 cm) equally suspended in it, hence sometimes it is known as colloidal suspension. The term colloid was first developed by Scottish scientist Thomas Graham (1861, p. 183), which was derived from the Greek words kolla, meaning “ glue,” and eidos, meaning “ like”, to classify mixtures such as gelatine, starch in water, paint and latex. There are multiple methods to measure the quality of colloidal liquids and one of them is the measurement of mechanical stability. A colloidal liquid is said to be stable if its particles are able to remain suspended in the medium, overcoming the colloidal destabilization effects when mechanical influences such as shearing and agitation are applied.

A very well-known colloid is rubber latex concentrate, which is essentially a colloidal dispersion of rubber particles in an aqueous medium usually containing between 20% to 60%w/w of rubber solids. In other words, it consists of particles dispersed throughout another substance which are too small for resolution with an ordinary light microscope and at the same time, incapable of passing through a semi permeable membrane. For latex concentrates, the Mechanical Stability Time (MST) test (Dawson, 1949) is determined as the time to the onset of flocculation when it is subjected to the stirring action of a flat circular plate rotating at speeds of 14, 000 rev/min. The common approach to do this relies on the experience and analytical skills of the operator on duty in determining this on the extracted sample taken at regular time intervals (Akmal, Othman and Mansor, 2013). It is vital in the transportation and processing of latex, at which the latex must have sufficient mechanical stability to withstand the shearing forces incurred

under mechanical influences in handling and processing without suffering from destabilization.

The current method used by the industry to measure the mechanical stability time of colloidal liquids particularly latex haven proven to be inefficient and inaccurate. The mechanical stability time of latex is mostly tested manually which is laborious, time consuming and vulnerable to human error. Besides, the process requires the operator to introduce toxic chemicals i. e. ammonia to the test sample which poses potential health issues to the operator. Moreover, the outcome of the test is subjective, as it is judged by the operator, and has poor repeatability and reproducibility.