CONCENTRATION OF NATURAL RUBBER LATEX BY ULTRAFILTRATION

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DECLARATION

I hereby declare that this thesis is based on the research results found by myself. Materials of work found by other researchers are mentioned in the references. This thesis neither in whole nor in part has been previously submitted for any degree.

Signature

DEVARAJ VEERASAMY

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ABSTRACT

Centrifugation is a common process used in the concentration of natural rubber field latex. The process transforms field latex with about 30% dry rubber content (DRC) to about 60% dry rubber content latex concentrate. The concentrated latex is subsequently used in the manufacturing of latex products. During centrifugation. a skim latex by-product with a dry rubber content of 4-5% is produced which is then coagulated using spent acid. usually a cheap grade of sulphuric acid to generate skim rubber. The use of sulphuric acid. for the coagulation of skim latex at latex concentrate factories throughout the country causes environment-related problems. This study presents an alternative method of concentrating field latex that produces latex concentrate and serum as a by-product. The serum is a clear solution which contains no latex but known to contain bio-chemicals. The serum obtained can be utilized for useful biochemical extractions thus attaining zero discharge at latex concentrate factories.

A tubular cross flow ultrafiltration system was assembled using a polyvinylidene fluoride polymeric membrane with an apparent retention character of 100kD MWCO and an effective membrane area of 0.024 m^2. In this study ultrafiltration experiments of natural rubber latex were carried out to identify a suitable composite preservation system between two available options: [ammonia. ammonium laurate. tetra methyl thiuram di sulphite (TMTD) and zinc oxide (Option 1): ammonia and Terric^{R} (Option 2)]. and to study the effects of feed velocity and transmembrane pressure on permeate flux. Attempts were also made to identify the optimum transmembrane pressure for the concentration process and the degree of concentration achievable was also determined.

Fouling of membrane was reduced by carrying out cleaning-in-place (CIP) technique and also by adopting suitable cleaning protocol. Membrane cleaning protocol includes draining the latex from the feed tank, followed by removing remnant latex trapped in the system by opening piping joints at various places. Flushing out the system from any remnant latex was carried out using deionised water (DI) after closing the piping joints. This process was repeated with fresh supply of DI water until the discharged water was free of latex and milky appearance. As a final cleaning process 0.2% of sodium hydroxide solution was circulated into the system followed by a rinse with DI water. This DI water was trapped in the membrane system to maintain it wet and protected to facilitate further experiments the following day.

Results showed that NR field latex with a composite preservation system consisting of ammonia: tetra methyl thiuram disulphide (TMTD), zinc oxide (ZnO) and ammonium laurate system was successfully concentrated from a DRC of 30% to 46%, with a transmembrane pressure (TMP) of 2.75 barg. Concentration reaching DRC value of 46% falls short of the targeted 60% value. This study shows that increased membrane area could possibly achieve 60% concentration in a shorter period of time if a cooling system was incorporated as well as to arrest the increase in temperature because if not checked it could affect the stability of the feed.

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NOMENCLATURE

A_w	cross sectional tubular membrane area (m^2)
dVp	volume of permeate (L)
dt	filtration time (h)
P_T	applied transmembrane pressure (Pa)
P_p	back-pressure on the permeate side (Pa)
P_1	retentate inlet pressure (Pa)
P_2	retentate outlet pressure (Pa)
Δx	length of the channel (m)
J	permeate flux (L/m^2. h)
J_s	convective transport at a rate (L/m^2. h)
C_b	bulk concentration of the rejected solute (g/L)
D	diffusion coefficient (m^2/h)
C_g	gel layer thickness (m)
C_b	bulk concentration of the rejected solute (g/L)
k	mass transfer coefficient (L/m^2. h)
δ	thickness of the boundary layer (m)
R_m	intrinsic membrane resistance (Pa. s. m^{-1})
R_c	resistance due to fouling and cake layer formation (Pa. s. m^{-1})

Greek symbols

μ	viscosity of permeate (cP)
ρ	density of permeate (kg/m^3)