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Aggregation stability of natural rubber latex with low dry rubber content (DRC) in acidic medium

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Summary

Natural rubber latex was diluted from its original *ca.* 61% DRC (Dry Rubber Contend) to 10% and the resulting material was studied with respect to its aggregation stability. Two non-ionic surfactants with distinct HLB (hydrophilic - lypophilic balance) and cloud point values were used to stabilize the dilute latex. The stability of the obtained materials was evaluated through the addition of acetic acid solutions of different concentrations, and measurement of the pH and coagulation times of the resulting mixtures. Independently of the nature and concentration of the surfactants, the same behavior was observed for all the systems. All the latex solutions were stable after the addition of the acetic acid solutions for at least thirty days.

Introduction

The natural rubber latex extracted from Hevea *brasiliensis* is an important raw material not only from the economic point of view, as development instrument in third world countries[(1)], but also because of the characteristics of the main macromolecule, the poly-cis-1,4-isoprene, that takes part in its composition. The latex utilization in the manufacture of artifacts for the pneumatic industry is largely known. However, its application in the preparation of parts that do not have a relationship with that rubber market segment, depends on the utilization of its chemical potentialities.

It is well known that the latex is basically constituted of a dispersed phase containing the rubber (poly-cis-1,4-isoprene) particles and other non rubber components in minor quantities, and the dispersing agent, water, which contains several other organic substances and mineral salts in solution. The natural rubber latex is vulnerable to degradation and coagulation through chemical or biochemical processes in short time periods. After the concentrated raw material is exuded from the tree it is stabilized through the addition of chemicals. Most of the modifications which can be performed on the latex depend on additional stabilization[(2)]. Such is the case of latices epoxidation reactions, in which the reaction medium becomes extremely acidic through the addition of formic or acetic acids and hydrogen peroxide, for an “in situ” peracid formation, or through the direct peracid addition to the medium[(3-12)].

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The objetive of the present work is to evaluate the aggregation stability of dilute natural rubber latex (DRC=10%) stabilized with different amounts of non-ionic surfactants. The stability was evaluated through the addition to the latex of acetic acid solutions of different concentrations, followed by pH measurements and coagulation time observation of the resulting mixtures.

Experimental

The used natural rubber latex is produced by Agro Industrial Ituberá and was supplied by Látex Lemgruber S. A.. Initially the latex was diluted from 61 % to 10% DRC. To aliquotes of the dilute latex different amounts of a 20% (w/v) water solution of a commercial ethoxylated fatty alcohol surfactant were then added. The surfactants, UO/100 (HLB = 12.4; cloud point = 58^{0}C) and UO/200 (HLB = 15.3; cloud point = 75^{0}C), were supplied by Oxiteno S.A. Indústria e Comércio and were added so as to obtain 1, 3 or 5 phr of them in the dilute latex. Merck's 100% acetic acid and distilled water were employed to prepare the used 5, 10, 30, 50 and 100% v/v acetic acid solutions. After the acid solution addition the pH of each resulting mixture was measured with a pHmeter (Ion-Analisador, Mod. IA 601 of Analion Ind. Com. Ltda) equipped with a V620 glass electrode. The acidic latex solutions were stored at 23^{0}C for at least thirty days, being daily checked for the presence of coagula.

Results and Discussion

We have recently prepared composites of natural rubber from Hevea *brasiliensis* with Malva fiber, a typical brazilian natural fiber, which has already been physically and morphologically characterized by us[(13)]. As a follow up of that work it is our intention to prepare and evaluate the properties of epoxidized natural rubber composites with the above mentioned fiber. It is known that acetic acid, as well as other acids, may be used to coagulate rubber lattices[(14)]. Rubber epoxidation reactions are carried out in acid media and the fiber incorporation is intended to be carried out in a dispersed medium. Thus, it became important to evaluate the aggregation stability of the natural rubber latex previously stabilized with a surfactant, against the addition of acetic acid. The effect of both the amount and the dilution of the acetic acid was investigated. The pH variation of the latex solutions as a function of the amounts of added acetic acid, for different surfactants and their amounts, as well as acetic acid solution concentrations are shown in Figures 1 through 6.

As a general feature it should be noticed that, in all cases, the addition of very small amounts of acetic acid causes a sharp decrease of the pH, from 9.7 to *ca.* 4.5, where the latex isoeletric point is located[(2)]. From that value on, down to about 2.7, the pH decrease is relatively smooth and it represents the accumulation of free acetic acid in the medium.

The lack of coagulation in the neighborhood of the isoelectric point shows that both surfactants are effective in any of the used concentrations, independently of their chemical structures and cloud points. Besides, it is interesting to remark that although the total number of moles of added acetic acid was the same in all the studied cases, the final dilution of the latex solutions was quite different. Even so, no visible effect on the latex stability was detected.

After the total addition of the chosen amount of acetic acid to the stabilized latex solutions they were all kept at 23^{0}C and daily checked for coagulation.

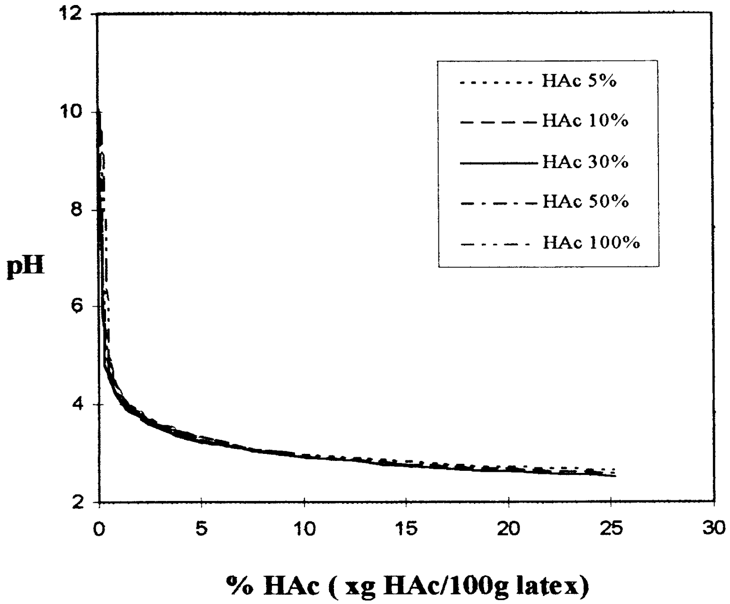

Figure 1. Effect of UO/100 surfactant concentration (1 phr)

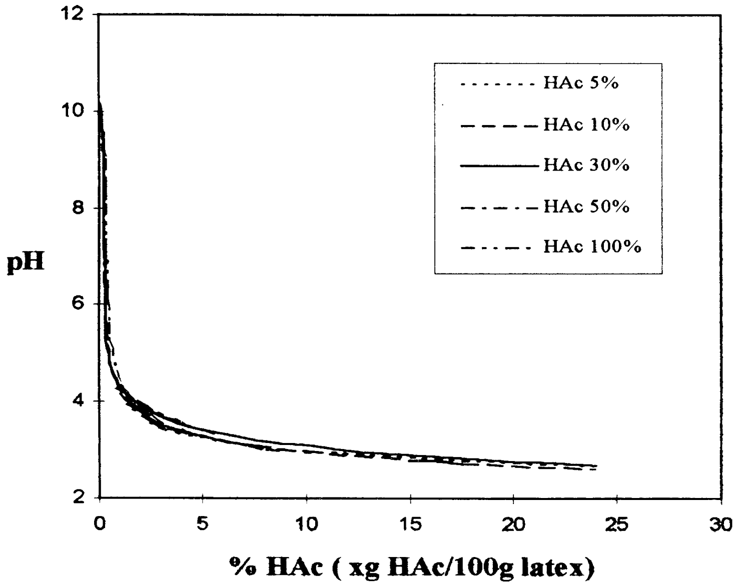

Figure 2. Effect of UO/200 surfactant concentration (1 phr)

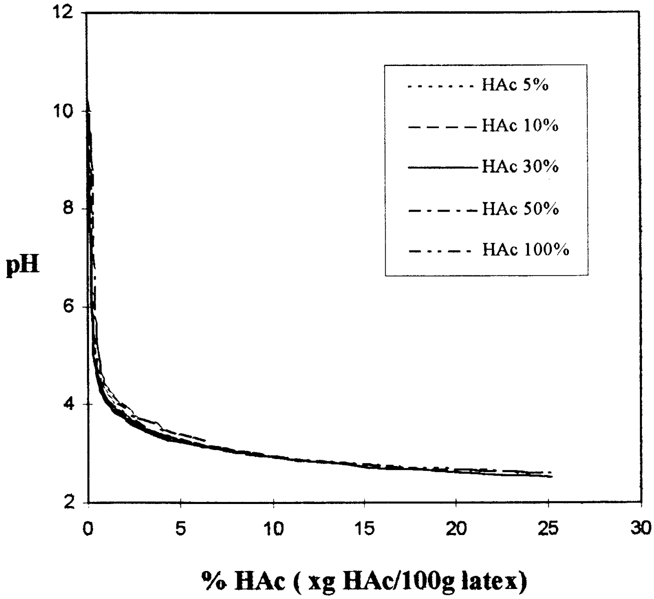

Figure 3. Effect of UO/100 surfactant concentration (3 phr)

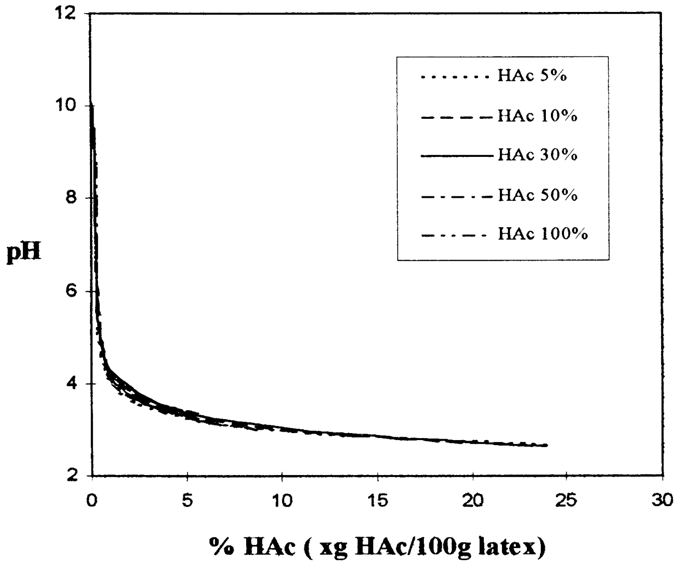

Figure 4. Effect of UO/200 surfactant concentration (3 phr)

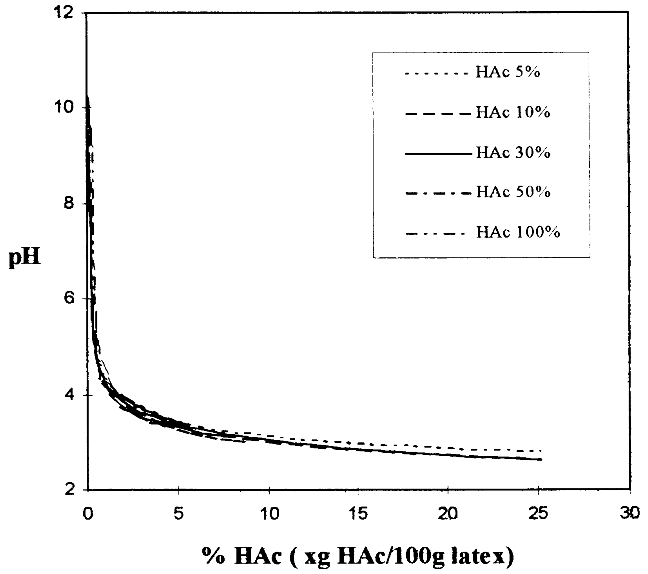

Figure 5. Effect of UO/100 surfactant concentration (5 phr)

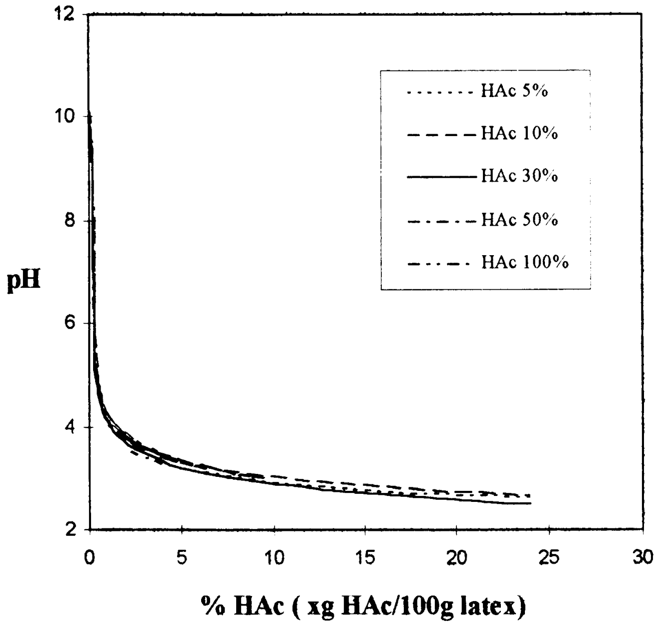

Figure 6. Effect of UO/200 surfactant concentration (5 phr)

All of the acidified surfactant stabilized latex solutions were stable for at least thirty days.

Conclusions

It was shown that it is possible to stabilize low DRC (10%) natural rubber latex against coagulation, through the addition of small quantities of an adequate surfactant, even when pure acetic acid is used as coagulation agent. This is an extremely relevant observation for the production of epoxidized rubber latex. Both of the studied systems showed basically the same behavior, independently of the chemical nature, HLB and cloud point of the surfactants. Acidified latex solutions may be stored for at least thirty days without coagulation ocurrence.

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