# Production of Tubes by Heat Sensitized Extrusion of Natural Rubber Latex

K. MARIAMMA GEORGE, N. R. PEETHAMBARAN and E. V. THOMAS

*Rubber Research Institute of India, Kottayam-686 009*

## INTRODUCTION

Tubes produced from latex have advantages over those based on solid rubbers with respect to their elasticity, smoothness and purity. Several workers have made attempts to produce tubes from latex specially compounded for gelation induced by higher temperature[1]. In this method, in addition to the vulcanizing chemicals, heat sensitizing agents are also added to the latex. Some of the heat sensitizing agents used in rubber latex industry are ammonium salts-zinc oxide mixture, polyvinyl methyl ether (PVME) and polypropylene glycol (PPG)[2]. A production process of tubes using polyvinyl methyl ether as heat sensitizing agent has already been studied[1]. In the present study, use of ammonium salt and zinc oxide system for tube extrusion from latex compound is investigated. The optimum concentration of heat sensitizer system, temperature of gelation, compound formulation and other factors influencing the extrusion process were also studied.

## EXPERIMENTAL

Rubber latex required for this study was collected from the experiment station of Rubber Research Institute of India. The latex was concentrated by the creaming method using tamarind seed powder. The properties of the creamed latex so obtained are given in Table 1. The formulation used for preparing the base compound is given in Table 2. Dry compound-

TABLE 1. Properties of Creamed Latex

| | | |
|---|---|---|
| Total solids (TS), % | — | 59 |
| Dry rubber content (DRC), % | — | 57 |
| Alkalinity, % | — | 0.8 |
| Mechanical stability time (MST), s | — | 1300 |
| Volatile fatty acid number (VFA) | — | 0.07 |
| KOH number | — | 0.8 |

TABLE 2. Compound Formulation (base compound)

| Ingredients | | Parts by wt. |
|---|---|---|
| Creamed latex (Dry Rubber Content) | ... | 100.0 |
| Ammonium laurate | ... | 0.02 |
| Vulkastab VL (Poly ethylene oxide condensate) | ... | 0.10 |
| Sulfur | ... | 2.0 |
| Zinc diethyldithio carbamate | ... | 1.0 |
| Zinc mercaptobenzthiazole | ... | 0.5 |
| Zinc oxide | ... | 0.25 |
| Polymerized 1, 2 dihydro 2, 2, 4 tri methyl quinoline | ... | 0.25 |

J. Polym. Mater. 2 (1985) 189-193

ing ingredients were added to latex as dispersions prepared in a laboratory ball mill. The latex compounds were matured for 48 hours.

### Heat Sensitizing System and Its Effect on the Stability of Latex Compound

Ammonium acetate and zinc oxide system was used as heat sensitizing agent[2-5]. Earlier investigators had used organic heat-gelling agents for extrusion of tubes from latex compound. In the present experiment inorganic heat sensitizing agents were used for the rapid gelation of the latex compound for its continuous extrusion. Different dosages of zinc oxide and ammonium acetate were mixed with the latex compound, keeping its pH at different levels. The gelling time and temperature in each case were determined[6] and the results are given in Fig. 2. a, b, c.

The stability of the latex compound after adding the optimum concentration of gelling agent was investigated[4]. The effect of a non-ionic surfactant (Vulkastab VL or polyethylene oxide condensate) on compound stability was also examined[4]. The results are given in Fig. 3.

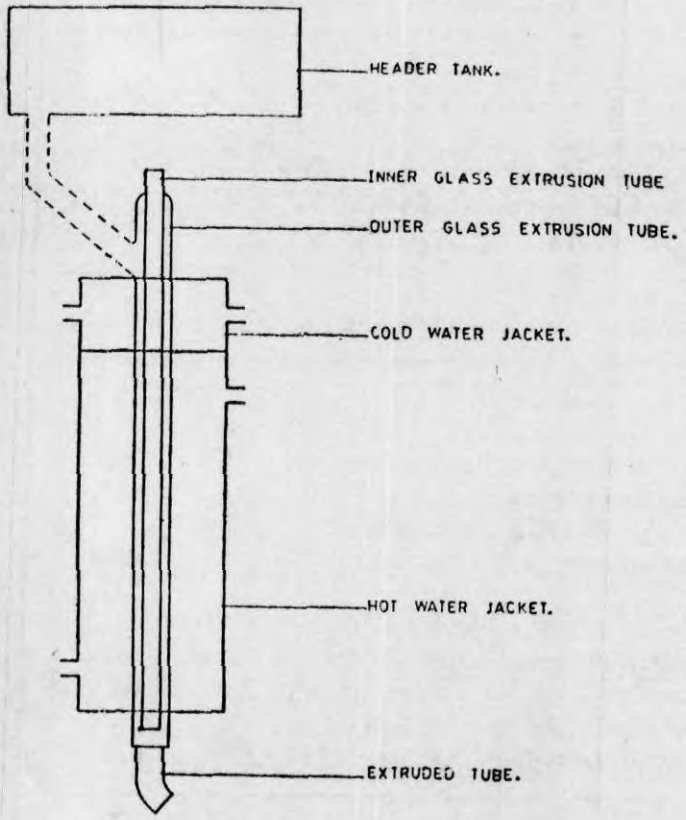


Fig. 1. Apparatus for latex extrusion

### Extrusion of Tubes

**Apparatus.** The apparatus used for extrusion was fabricated in glass. It consisted of two glass tubes of different diameter arranged concentrically and the outer diameter of the inner tube and the inner diameter of the outer tube determined the final dimensions of the extrudate. It was fitted with cold and hot water jackets. As the latex compound flowed through the apparatus, it passed through cold to hot area where it formed a solid gel and the solid tube continued to extrude from the apparatus under gravity force and pressure of latex column. (Fig. 1)

**Production of tubes.** The latex compound was mixed with surface active agent, fillers and heat sensitizer as shown in Table 3, and each compound was extruded separately through the apparatus. In all the cases the total solid content of the latex compound was kept at 45 percent. The rate of extrusion was determined in each experiment and the results are given in Fig. 4a. The length of the hot water jacket was increased to 10 cm and again the experiment was repeated. The results are given in Fig 4b.

## RESULTS AND DISCUSSION

The results of the trials for selection of the heat sensitive system are given in Fig. 2 a, b, c. It may be seen from the figures that the pH of the latex compound was very critical in determining the gelation time and temperature. The ideal pH was found to be 10. As the zinc oxide content was increased the gelation time decreased as may be seen from Fig. 2 b. But zinc oxide content above 5 phr had adverse effect on the stability of latex compound. The gelation time decreased as the ammonium

TABLE 3. Latex Compounds for Extrusion Trials

| Ingredients | Latex compound | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Latex compound (Dry rubber content) | 100 | 100 | 100 | 100 |
| Vulkastab VL ... | 0.5 | 0.5 | 0.5 | 0.5 |
| Zinc oxide ... | 5 | 5 | 5 | 5 |
| Ammonium acetate ... | 4 | 4 | 4 | 4 |
| China clay (Filler) ... | 5 | 10 | 15 | 20 |

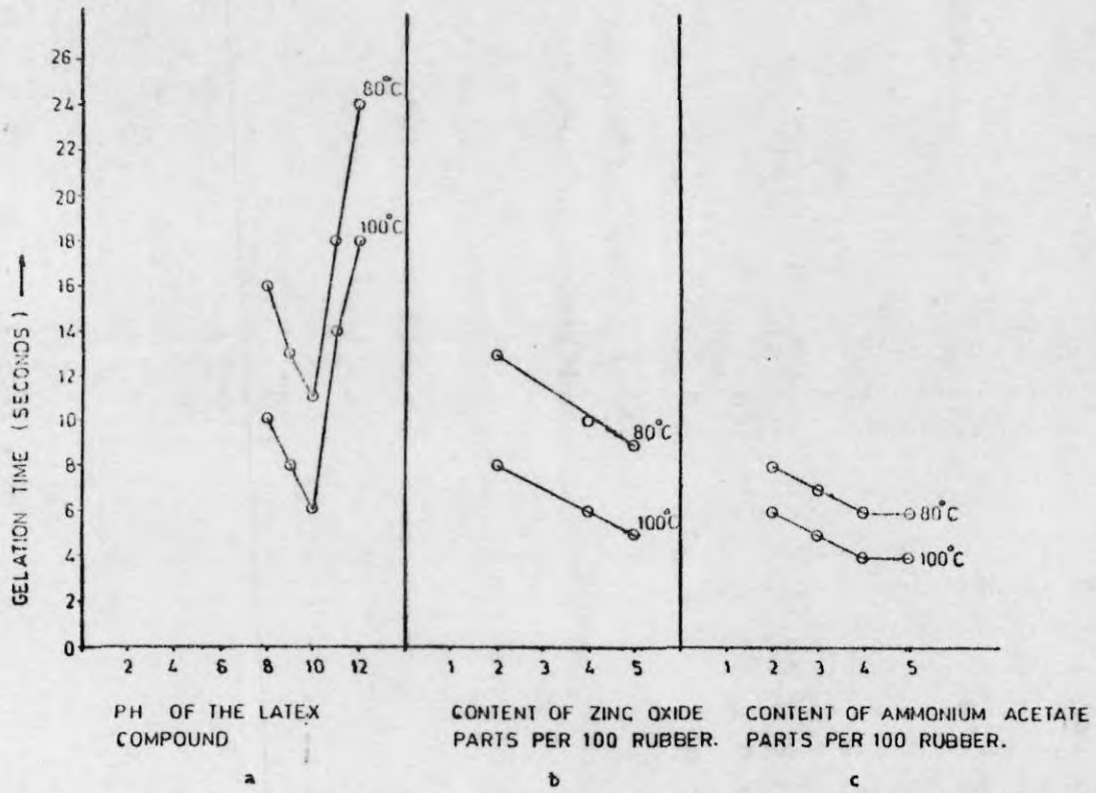


Fig. 2. Effect of (a) pH of the latex compound, (b) the content of zinc oxide and (c) the content of ammonium acetate on gelation time at different temperatures

acetate content was increased. This effect was seen upto an ammonium acetate concentration of 4 phr, and above this there was no effect as may be seen from Fig. 2c. It was also observed that as the temperature was increased the gelation time decreased markedly. In this experiment, 100°C was selected as the gelation temperature as this is the maximum temperature attainable with steam at atmospheric pressure. After the addition of the optimum dosage of the heat sensitizing system (zinc oxide 5 phr, ammonium acetate 4 phr) the stability of the latex compound was very low at room temperature. But addition of the non-ionic surface active agent improved the compound stability. It can be seen from

Fig. 3 that addition of more than 0.75 phr of Vulkastab VL to latex compound maintained its stability upto 8 h. Valkastab VL looses its activity at 80°C and so it has no effect as a latex stabilizer at the gelation temperature.

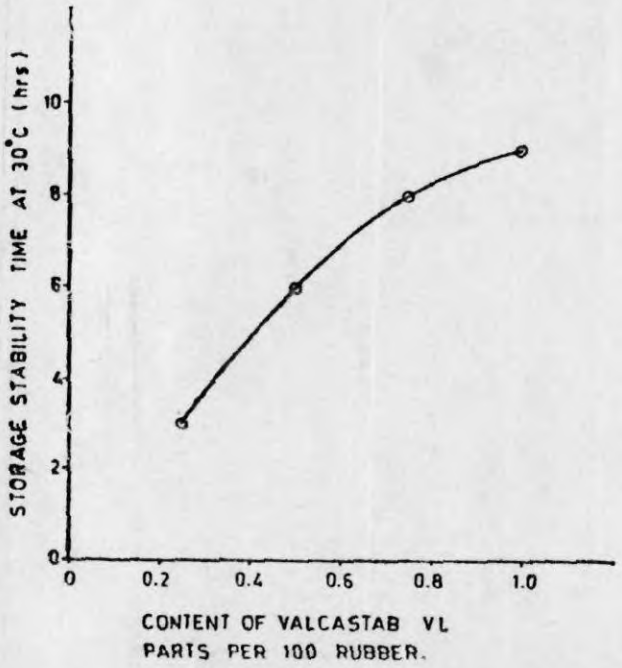


Fig. 3. Effect of vulkastab VL content on storage stability of latex compound at 30°C

Fig. 4 a, b showed that the rate of extrusion increased upto a filler content (China clay) of 15 phr. This may be due to the acceleration of synersis of the gel, and the effect of fillers on shrinkage of the gel accompanied by loss of friction between the gel and the walls of the extruder. It can also be seen that the rate of extrusion decreased as the length of the hot water jacket is increased. This may also be attributed to the friction effect. The tube obtained by latex extrusion had smooth surface and the shrinkage in diameter and length was around 23% after vulcanization.

## CONCLUSION

Ammonium acetate and zinc oxide system as heat sensitizing agent can successfully be used for the extrusion of latex tubes. The rate of extrusion is related to the compound formulation, length of the hot water jacket and the rapid gelation temperature.

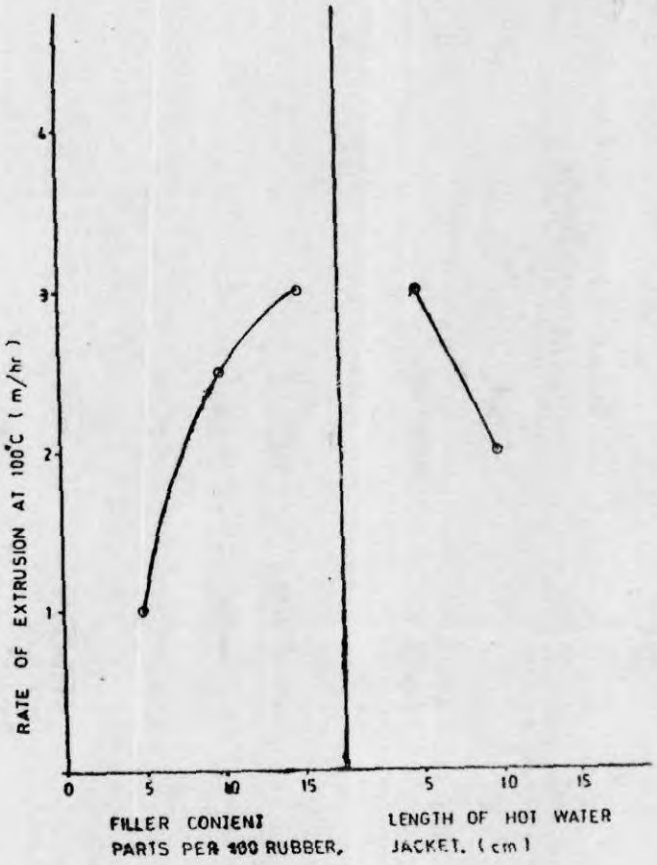


Fig. 4. Effect of (a) filler (china clay) content and (b) length of hot water jacket on rate of extrusion at 100°C

*Acknowledgement.* The authors are thankful to Dr. M. R. Sethuraj, Director, Rubber Research Institute of India, Kottayam for his keen interest in this work. Thanks are also due to Shri. C. Madheswaran, glass blower, for fabricating the extrusion apparatus. The help and suggestions rendered by our colleagues in the Chemistry Division are also gratefully acknowledged.

## REFERENCES

1. T. N. Kamenshchikova, T. N. Ryabikina, I. M. Rashke and B. A. Maizelis, *Int. Polym. Sci and Technol.* **8** (1981) 5

2. A. D. T. Gorton and T. D. Pendle, *NR Technol.* **11** (1980) 1

3. A. D. T. Gorton, *Plast. and Rubb. Processing*, March (1976) 3

4. D. C. Blackley, *High Polymer Latices*, Applied Science Publishers, London (1966)

5. J. L. M. Newnham, *Rubb. Chem. and Technol.* **27** (1954) 286

6. A. W. Campbell, *Rubb. Chem. and Technol* **16** (1943) 215

Received 8 October 1985
Accepted 28 January 1986