PRODUCTION OF HOLLOW TOY PRODUCT FROM RADIATION PREVULCANIZED NATURAL RUBBER LATEX (RVNRL) BY USING CASTING AND MOULDING TECHNIQUE

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Abstract

Hollow toy products are very synonym to the child from the age of months since it able to stimulating each of their sense such as sight, hearing, taste, touch and smell. Most of hollow toy products are made from natural rubber latex by using moulding and casting technique. The moulding and casting technique is a manufacturing process by pored liquid latex into a mould, which contain cavity of the desired shape. The mould made from plaster of Paris able to absorbs water from latex meanwhile the presence of calcium ions from plaster of Paris will tend to diffuse into latex thus promote formation of deposit on surface of cavity mould. To improve the quality and safety of hollow toy product made from latex, Radiation Pre vulcanized Natural Rubber Latex (RVNRL) has been identified to be used because it can fulfill the standard requirement for latex and also due to its special abilities such as lower modulus (soft latex products), nitrosamines free, low in nitrosatables, free from chemical accelerators induced allergies and better biodegradability. This paper identify the problem appears from the process of making hollow toy products from RVNRL by using moulding and casting technique.

Abstrak

Produk mainan berongga adalah sangat sinonim di kalangan kanak-kanak dari usia bulanan lagi bagi merangsang setiap deria seperti penglihatan,pendengaran,rasa, sentuhan dan juga bau. Kebanyakan produk mainan berongga dibuat daripada lateks menggunakan teknik acuan dan tuangan. Teknik acuan dan tuangan adalah proses menuang lateks kedalam acuan yang mempunyai bentuk rongga yang dihendaki. Acuan yang diperbuat dari plaster paris mampu menyerap air dari lateks manakala kehadiran ion kalsium dalam plaster paris akan cenderung untuk meresap ke dalam lateks lalu mengalakan pembekuan pada permukaan rongga acuan. Bagi meningkatkan kualiti dan keselamatan produk mainan berongga yang dibuat daripada lateks, Lateks Getah Asli Pemvalkunan Sinaran (LGAPS) telah dikenalpasti untuk digunakan kerana ianya menepati kehendak piawaian lateks dan juga kerana beberapa keistimewaannya seperti mempunyai modulas yang rendah (menghasilkan produk lateks yang lembut), bebas dari nitrosamines, rendah tahap nitrosatables, bebas dari bahan-bahan pemecut kimia yang mengakibatkan masalah alergik dan sifat biodegradasinya yang baik. Kertas kerja ini mengenal pasti masalah-masalah yang muncul dari proses penghasilkan produk mainan berongga daripada RVNRL mengunakan teknik acuan dan tuangan.

INTRODUCTION

Basically, the hollow rubber products are produce by using moulding technique. The production process of molding can be categories according to types of molds material used and the way of mold used.

The first of 2 types mould material is *Plaster of Paris Mould* or chemically named as calcium sulphate dihydrate where the latex gelled into two distinct aspects. On the one hand, the plaster with porous surface adsorbs water from latex which encouraging gelation in the surrounding of the mold surface. Meanwhile, the presence of calcium ions in

plaster of paris tend to diffuse in latex thus lowering the latex stability in the surrounding mould surface. These two aspects of gelation mechanism lead to gradual formation of a deposit, which develops from the mould surface inwards. At the same time, the mould surface tends to be slightly eroded especially at sharp edges. The second types of mould material comprises various alloys based aluminium or magnesium. Using this type mould, the rate of build-up of deposit inside the mould depends on the temperature to which the mould heated and also the degree of heat sensitivity of the latex compound.

In term of the way mold is used, there are two types mode of use by slush moulding and rotational moulding technique. The slush molding technique required latex to fill completely into mould and allow certain thickness of deposit to build up. The latex which remains liquid is then poured out, leaving behind the mould a hollow deposit. The second method of using rotational moulding, the latex poured into mould at sufficient amount of latex compound to form article and then rotating the mould about several axes simultaneously. In this condition, the latex flows all around the mould cavity and gels in a layer of uniform thickness.

Most of rubber toy products produced by this technique, it is reasonable to use RVNRL to hollow toy product by this technique due to following advantages over the conventional vulcanization (Makuchi 1996).

1. Absence of N-nitrosamine
2. Very low cytotoxicity
3. Less protein allergy response
4. Degradability
5. Transparency and softness
6. Low emission of SO_2 and less formation of ashes when burned.

MATERIALS

In this experiment, the high ammonia natural rubber latex was obtained from Getahindus (M) Sdn. Bhd, Potassium Laurate,n-BA as sensitizer supplied by Hexachem (M) Sdn Bhd, Aquanox Lp as anti-oxidant produced and supplied by Aquapersion (M) Sdn Bhd, plaster of paris and water.

METHODS

1) Preparation of Plaster of Paris Mould

The hollow rubber products are manufactured by latex casting which requires moulds from plaster of paris. The process of making plaster of paris moulds starts with sculpting a model of the rubber hollow product or master piece to specifications. In this experiment, a box make from cardboard acts as fence is used to contain the plaster of paris for the casting of the first mould and the half part of the master is supported in molding sand or plasticine. The guide pin and poured hole was made on the molding sand as showed in flow chart below. The mixed of plaster of paris and water by weight ratio 1:1 called plaster slurry is then poured on the top of the master and allowed to stand 15 minutes for setting process which involves hydration of calcium sulphate hemihydrate to calcium sulphate dehydrate. The first half of the mold is then inverted and supporting molding sand was removed. The surface of first mould is then lubricated with soap solution in order to prevent adhesion between the two halves of the mold. The second half of the mould is then cast on the top of the first mold. After 15 minutes it has set, thee mould is removed from the box. The two halves are separated and the master removed from the mould. The mould was dried in the oven at temperature 70^oC for 24 hour.

1) A box as fence

2) Molding sand as base and cover half part of masterpiece.

3) The poured hole and guide pin are fabricate on molding

4) The mixed plaster and water poured on molding sand.

5) The first half moulding mold inverted and molding sand removed.

6) The plaster slurry poured on the first mold.

7) The plaster slurry poured to produce second mold.

8) The mold is ready to separate and de-molded.

9) The mold is ready for use.

Figure 1: The Flow Process of Making Plaster of Paris Mould

2) Preparation of Vulcanize Natural Rubber Latex by Gamma Irradiation (RVNRL)

The high ammonia latex of 60% tsc was diluted to 52% tsc using distilled water which was emulsified with the addition of 0.01pphr of LK-2 and 5pphr of n-BA. The emulsified stabilizer and sensitizer with water were added drop by drop with continuous stirring into latex. The stirring process was continued for 3 hours as standing time before irradiation. The latex compound was irradiated at 12 Kgy using y-rays from cobalt-60 source in RAYMINTEX Plant Irradiation Room, Nuclear Malaysia. The Aquanox Lp was added into RVNRL as stabilizer drop by drop after irradiation. The RVNRL was continuously stirred for 12 hours to ensure Aquanox Lp dispersed in RVNRL homogenously.

3) Properties of RVNRL

The RVNRL was analyzed to determine the physical properties such as tsc, viscosity, MST and pH. Mechanical properties were determined on RVNRL film vulcanizes prepared by coagulant dipping method. RVNRL film vulcanizes was cut into 5 dumb bell shaped test pieces and the properties of the film vulcanize were determined as per relevant ASTM standard.

4) Moulding Procedure

The mould was assembled and heated in oven at 100^{o}C for 1 hour, and then the mould filled with RVNRL and allowed to stand for 2 hours. The excess RVNRL was poured out and the mould was inverted to allow small amount of free flowing RVNRL which still remain in the mould can be drain over the inner surface in the region of the pour hole. The mould with deposition of RVNRL was heated in oven at temperature 100^{o}C for 5 hours for drying. The mould was dissembled and the dried deposit of RVNRL was removed or de-moulding. Since the deposition of RVRL not completely dried, the further drying process of rubber product was applied in oven at 100^{o}C for 3 hours.

RESULT AND DISSCUSSION

From observation shows deposition of RVNRL when poured into mould cavity take place fairly rapids, however the deposition rate rapidly decreased as the thick film build up. This is expected due to the pores saturated with water and the initial deposition of thick film build up from the diffusion of water from latex into plaster mould and calcium ions from plaster mould into latex. However the process of thick film builds up decrease since thick film deposition on cavity surface retards diffusion process, thus the thicker RVRL deposition difficult to produce.

In this experiment, the stability of RVRL also influences the thickness of deposition during moulding. As shown in table 1, the pH, MST and viscosity of RVRL are 8.09, 1743s and 47.6cps respectively. These figures indicate RVNRL has high stability. Theoretically, the lower latex stability such as pH, MST and viscosity will produce thicker deposition of RVRL film on cavity mold surface.

Sample	Total Solid Content (%)	pH	MST (s)	Viscosity (cps)	Tensile (MPa)
RVNRL	52.45	8.09	1743	47.6	21.53

Table 1: The Physical and Mechanical Properties of RVNRL

The picture 1 shows the rubber hollow rubber product produced taking precisely the shape of cavity mold with uniform thickness. This result is expected due to low viscosity of RVNRL which easy to flow taking shape of plaster mold cavity. The product produced has yellowish colour, soft and 90% dried. Apart of that the product produced also has high inner surface tackiness effect. This effect will cause problem during production, packaging and to the quality of product itself. Theoretically, the tackiness effect has relation with crosslink concentration where the high

crosslink concentration will reduce surface tackiness. In this experiment, RVNRL has low tensile strength at 21.53 MPa which can be consider the RVNRL has low crosslink concentration.

Picture 1: The hollow rubber product before demoulded

Picture 2: The finish product from RVNRL

CONCLUSION

RVNRL has a potential to produce hollow rubber product using casting and molding technique as its advantages compared to sulfur vulcanization. Several addition of additive is needed in RVNRL before molding to improve the thickness of deposition, inner surface tackiness, hardness and colour of hollow rubber product produced.

RECOMMENDATION

In this experiment, the most important factor is the deposition time of RVNRL where it taken longer time to has thicker deposition of RVNRL. The mold should be dry initially and RVNRL should be partially flocculated to accelerate absorption of water into plaster mold. A controlled degree of flocculation by addition of certain amount of calcium formate, aluminium sulphate or aluminium alum can be considered as long as they are not affecting the advantages of RVNRL.

The incorporation of filler or natural ground whiting is can be take into consideration compared to those chemical since it encourages partial de-flocculation of latex by diffusion of calcium ions and absorption of stabilizer. Apart of that, addition of natural ground whiting may be able to improve tackiness effect and also the hardness of dry deposition.

The addition of anti tack agent into RVNRL can be taking into consideration to improve tackiness effect. Since tackiness effect inside of hollow product, the application of powder as anti tack is not effective. The addition of emulsion such as paraffin oil, wax or oil emulsion can be considered.

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