Radiation vulcanised latex more safe and better

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VULCANISATION is the process of cross linking rubber molecules. It is a chemical reaction which imparts elastic properties to rubber. The rubber products will fail to retain its shape unless they are vulcanised.

Conventional vulcanisation system consists of a variety of chemicals such as sulphur, zinc oxide, dithiocarbonates etc. These chemicals are reported to be carcenogenic and nitrosamine producing and hence unsuitable for the manufacture of articles which may come into contact with human tissue. The use of radiation for vulcanisation of natural rubber latex has been investigated even as early as in 1950's.

Research

However, the dose required was a high as 300 KGy. The discovery in 1961 that carbon tetra chloride can reduce the vulcanisation dose (Dv) required, accelerated the pace of research on processing of radiation vulcanised natural rubber latex (RVNRL). Since then research on RVNRL was carried out in France, USSR, China, Poland, India, Japan and Indonesia. In 1982, the International Atomic Energy Agency with its headquarters at Vienna, implemented a regional project for research into RVNRL as a part of co-operation programme for Asia and Pacific region (RCA programme) funded by UNDP.

In 1983, a pilot plant for RVNRL was established in the Centre for Application of Isotopes and Radiation, the National Atomic Energy Agency, Jakarta, Indonesia. This facility has been used for training and demonstration of RVNRL.

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Simultaneously, the Takasaki Radiation Chemistry Research Establishment, Japan, carried out research into the development of new sensitisers to reduce Dv and to replace toxic carbon tetra chloride.

In 1985 the IAEA convened a meeting of the Expert Advisory Group (EAG) on RVNRL. The meeting chalked out a work plan which consisted of R&D programme, product development programme and cost estimation. Scientists from various countries have been carrying out R&D work at the Japanese Atomic Energy Research Institute (JAERI). The results are presented, reviewed and evaluated at regular EAG meetings. It leads to the development of n-butyl acetate as a promising sensitiser to replace the toxic carbon tetra chloride. Investigation for the development of more potential and effective sensitisers are being carried out by different research establishments all over the world.

Wide-ranging industrial application of RVNRL for major latex products is only a matter of time

Pilot project

India established a pilot project for the processing of radiation vulcanised natural rubber latex in 1992, at Kottayam, Kerala, under the Rubber Board. The plant capacity is 1000 litres per batch. Several batches of RVNRL were processed and supplied to the local latex goods manufacturing industry. The potential of RVNRL as a major raw material for the latex gloves industry has been demonstrated.

Malaysia has commissioned a plant exclusively for RVNRL, in 1996, though it started extensive R&D activities on RVNRL since 1988 only. This plant is the first automatic continuous latex irradiation plant in the world. It is functioning under the control of the Malaysian Institute of Nuclear Technology Research. The throughput capacity of the plant is 6,000 m^3 of latex per annum and the source loading capacity (maximum) is 1,000 kilo curies. The facility is being made use of by the latex good manufacturing industry in Malaysia.

The research and development activities on RVNRL has gathered momentum as evidenced by the increase in the number of scientists, institutes and nations undertaking research into the subject in the recent past. Thanks to the RCA programme, Japan continues to be the fore-runner in the field. The discovery of better and efficient sensitisers has brought RVNRL to the threshold of commercial application.

Consumption pattern

The consumption pattern of latex is undergoing rapid changes. The major area of application visualised for RVNRL is for the latex dipped goods industry which has achieved the distinction of being the largest consumer of latex. Trial production runs for the manufacture of examination gloves, condoms, balloons and a host of other medical and pharmaceutical products have been encouraging. In the field of medical and surgical applications of latex products safety of the patient is the pre-eminent concern. Chemical induced allergy as well as protein induced allergy caused by latex products are major concerns in

developed countries. Lion's share of the consumption of examination gloves is by the USA. Hence the glove manufacturers cannot ignore these concerns. The selection of raw material as well as the manufacturing process should be aimed at minimising the danger perceptions of the consumers. The relevance of the RVNRL for manufacture of gloves has to be assessed in this context.

The production of RVNRL involves mainly three steps:

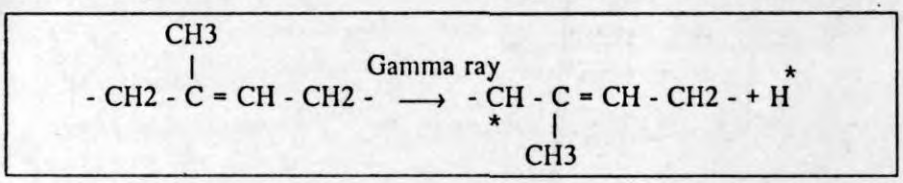
1. Mixing of natural rubber latex with sensitiser.

2. Irradiating with gamma rays or electron beams.

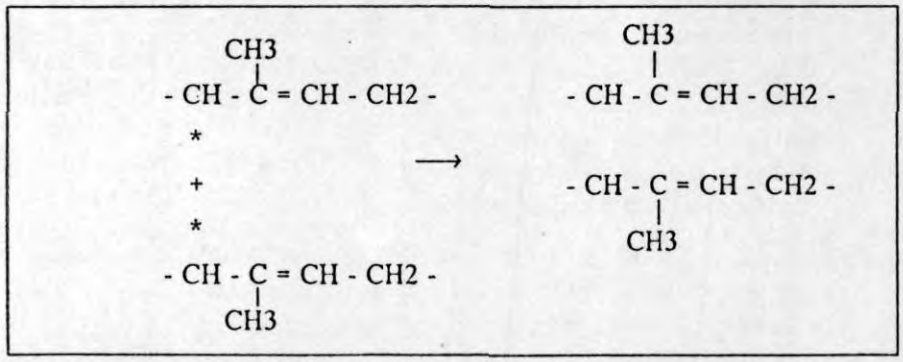
3. Addition of antioxidants.

Other things being equal the quality of RVNRL depends mainly on the strength of the radiation source, the dosage, the nature of sensitiser and the duration of irradiation. The radiation induces free radical formation on the rubber molecule by abstraction of hydrogen, facilitating main chain carbon to carbon linkage. The crosslinking of rubber is achieved through sulphur linkages in the conventional vulcanisation system.

Electromagnetic rays like gamma rays can produce the following effects on rubber hydrocarbon chain.



The free radical thus formed can combine with another free radical forming cross links.



The hydrogen radical can also help in propagating chain reactions.

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H + Polymer ⟶ Polymer radical

The radicals produced from sensitisers also participate in the propagation reaction.

Sensitiser radical + polymer molecule ⟶ + Polymer radical + sensitiser.

The Hydrogen radical produced can also combine with another hydrogen radical to form hydrogen gas.

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H + H ⟶ H_2

The main advantages of RVNRL over conventional SVNRL sulphur vulcanised natural rubber latex) are given below:

Potential area of application for RVNRL

Advantages	Applications
1. Absence of nitrosamine	1. Teats, balloons, gloves, condoms
2. Low cytotoxicity	2. Catheters, medical tubing, gloves
3. Low protein content	3. All latex products
4. Low emission of SO2	4. All medical/surgical products
5. Transparency	5. All unfilled latex products
6. Softness (low modulus)	6. Condoms, teats, gloves

The natural rubber latex processing industry and the latex goods manufacturing industry cannot afford to isolate itself from the rapid changes taking place in the economic scenario world over. The scientists and technologists have a responsibility to society to conserve as much resources as possible. They should devote their efforts to the development of more echo friendly, less energy intensive technology for industrial applications. The RCA programme provides an excellent opportunity for scientists and technologists in the developing and developed countries to pool their resources for the development of cleaner and efficient processes. Wide ranging industrial applications of RVNRL for major latex products is only a matter of time.

Board Scheme

The Rubber Board has evolved a scheme for expansion of its RVNRL facility at Kottayam, India, as a component of the India Rubber Project, being implemented for the integrated development of the rubber plantation industry. The expanded facility will have a source (Cobalt-60) strength of 100 KCi and will employ a batch process for irradiation of the latex. It will be supported by a well equipped laboratory for research and development. The scheme also provides for regular interaction with the latex goods manufacturing industry to identify need based research projects funded wholly or partly by the industry.

The future for RVNRL is very bright in view of the crumbling trade barriers and globalisation of economy. The consumer expectations have to be kept in mind by the industry for its survival. The leaders and visionaries in the industry will be quick to take advantage of the opportunity. Those who do not see the writing on the wall in good time may get themselves sidelined and may not recover at all. The gloves industry in India is expected to make use of the expanded facility established by the Rubber Board to improve the quality of their produce.□