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Process Bulletin

Latex

Description

Natural latex is a milky liquid secreted by a variety of plants that grow in the tropics. It is not a sap, and its function in the plant is not well understood. The latex produced by the rubber tree contains about 30 to 40% rubber hydrocarbon (polyisoprene) suspended in water. Today, the term latex applies not only to the natural suspensions but also to suspensions of synthetic rubber and synthetic elastomers. Some of these synthetic materials are: styrene-butadiene copolymers, acrylonitrile-butadiene (nitrile) rubbers, chloroprene rubbers, acrylic copolymers, synthetic cis-polyisoprene, vinyl acetate co-polymers, vinyl chloride copolymers and butyl rubber.

All latices, both natural and synthetic, are shear-sensitive to varying degrees. This means that under shear these materials can coagulate. Raw natural latex is matured with time to produce a more stable product. If raw latex is not allowed to mature, processing becomes very difficult because of agglomeration. Raw latex may contain soaps and ammonium hydroxide to maintain stability. This shear instability makes it difficult to process latices with high shear equipment such as mixers or colloid mills. However, the homogenizer has been extremely successful in this operation. The success of the homogenizer is due to the fact that the instability of latex is a function of the degree of shear and the time to which it is exposed to this shear. In the homogenizing valve the degree of energy input is high, but the time is essentially zero, thus permitting the processing of the most shear-sensitive latices with the minimum of coagulation. However, even in the best processing conditions, latex may agglomerate inside the homogenizer pump requiring routine cleaning of the machine to maintain good pumping action.

The homogenizer has a number of applications in the processing of latex. The following list indicates the diversity of its usage in the field.

1. Dispersion of compounding ingredients in latex.
2. Agglomerating or growing of latex particles.
3. Manufacture of latex thread or filaments.
4. Master-batching of latex prior to coagulation. (Carbon black or other reinforcing agents.)
5. Pigmenting of latices.
6. Incorporation of extending oils to latices.
7. Plasticizing of latices.
8. Reduction of agglomerates in synthetic latices.

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Objectives

The objectives for these various latex applications cover a range of goals that sometime seem contradictory. For example, a latex particle can be either increased or decreased in size by the same piece of equipment; i.e., the APV homogenizer, depending upon the conditions of operation and the type and percentage of surfactant present in the formulation. A brief summary of the objectives for each application follows.

Compounding of Latex

Latex to be used for dipping, coating, and rug-backing must be mixed with compounding agents which include (a) stabilizers including surfactants, (b) vulcanizing agents, (c) vulcanization accelerators, (d) antioxidants, (e) fillers, (f) viscosity modifiers (thickeners) and (g) gel sensitizers. These ingredients provide the physical characteristics required in the final product. This requires a uniform, fine dispersion of these chemicals in the latex, which can be accomplished with the homogenizer.

Growing of Latex Particles

In the manufacture of foam rubber, it is desirable to have a latex solids content of 60 to 65% and still have a workable viscosity of not over 2000 cP, prior to foaming. Lower solids content will result in cells of insufficient wall thickness, causing collapse of the foam with light loads.

There are a number of methods of preparing the latex, so that it may be concentrated without acquiring an excessive viscosity. These methods are (a) solvent addition, (b) soap neutralization, (c) electrolyte addition, (d) freeze agglomeration, (e) chemical agglomeration and (f) pressure agglomeration by homogenization. Only the latter three are used commercially, and homogenization is the preferred method. Various parameters will affect the extent of agglomeration: pH, solids content, temperature, soap-to-rubber ratio and homogenizing pressure. To increase agglomeration one must make one or more of the following changes: decrease pH, increase solids, decrease temperature, decrease soap-to-rubber ratio and increase homogenizing pressure. The use of the homogenizer for agglomeration is covered by a number of patents.

Thread

Thread is usually made from natural latex, although there is an increasing use of some of the synthetics in this application. Thread is manufactured by dispersing into this latex: vulcanizing agents, antioxidants, fillers, opacifiers, etc. Frequently, when these materials have been incorporated in latex, the viscosity of the latex is increased. Since the latex thread is manufactured by gravity flow of latex through a spinnerette and into a coagulating bath, any change in viscosity will result in a change in the thread diameter or, in extreme cases, breakage of the thread. It has been found that passing the latex through the homogenizer stabilizes the viscosity and ensures a uniform compound.

Master-Batching

In normal master-batching, a latex is coagulated, washed, dried and then mixed in a rubber mill with carbon black or other reinforcing agents to provide a fine, uniform dispersion of the reinforcing agent to obtain maximum strength in the elastomer. There are processes for mixing carbon black dispersions with liquid latex prior to coagulation, but these methods do not achieve the same tensile strength as the dry mixing method. By mixing a crude carbon black aqueous dispersion with a latex and homogenizing the mixture, it is possible to obtain an intimate combination of the carbon black and the latex, which results in a rubber having higher tensile strength than rubber made by the normal methods of master-batching.

Pigmenting of Latex

Latex is usually pigmented by preparing a pigment dispersion and then mixing this with the latex to provide the final colored product. By using the same procedure as in master-batching; i.e., taking a crude dispersion of the pigment, adding this slurry to the latex and homogenizing the two materials, a phase transfer can be achieved in which the pigment is removed from the aqueous phase and deposited inside the latex particles. This provides a more intense color, improves washability and fade resistance and, generally, improves the physical characteristics of the paint. This process has made possible the use of the acrylic artists' watercolors. Without homogenization it would not be possible to achieve the brilliance and depth of color.

Oil Extending Latex

The use of mineral oils in the compounding of rubber has been standard for many years to improve the working characteristics of the rubber and reduce the cost of the final compound. Oil can be introduced into the latex as an emulsion and mixed with the latex emulsions or, simply, as oil mixed with the latex emulsion, but none of these provide a true, uniform, stable mixture of oil and latex. Mixing oil and latex together and then homogenizing will produce a uniform product having superior physical characteristics.

Plasticizing of Latices

Many of the synthetic resin latices are extremely hard and brittle, but for a number of applications they must be modified to have greater flexibility and improved adhesion. Plasticizers normally used with these synthetic resins are commonly mixed with the latices under continuous agitation, heat, and pressure in an autoclave for one and one-half hours or longer to cause the plasticizer to migrate into the latex particle. By use of the homogenizer both the time and temperature may be materially reduced in this operation.

Reduction of Agglomerates

In the emulsion polymerization of latices, many of the small polymer particles tend to loosely join together forming agglomerates. In some polymerization reactions the total quantity of agglomerates can reach 10% of the batch. If the latex is to be used for paint or fine-coating applications, these must be filtered out prior to use. By homogenizing, 90% of this agglomerated material can be separated back to the original particle size, reducing the load on the filter to 1% and saving up to 9% of the latex that would formerly have been lost.

EQUIPMENT AND PROCESS

For latex processing the APV homogenizers are operated in the pressure range of 2000 psig (13.8 MPa) to 8000 psig (55.2 MPa). These machines should have special wearing parts, when they are used to disperse solids or pigments.

TESTING

The methods and type of equipment used cover approximately everything used in the paint and rubber fields. The microscope, however, is extremely useful to analyze solid dispersions, and a viscometer would be used for thread or for growing of latex particle operations.

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