Disperser/Mixer Improves Plastisol Production

The Emigsville, Pa., plant of Herculite Protective Fabrics Corp. has improved production of plastisol adhesives with installation of a disperser/mixer from Day Mixing, Cincinnati, Ohio. The Daymax unit turns out a better dispersion and more uniform product in less than half the time of the previous system.

Herculite produces custom vinyl laminates for applications ranging from tarps to hospital mattress ticking. Prior to installing the Daymax disperser, Herculite was using a conventional shear-type mixer, which required about an hour to produce a one-drum (55-gallon) batch of plastisol. And the company's laminating line was being delayed by the plastisol-producing part of the operation.

With the Daymax disperser, a five-drum batch is prepared in two hours, providing a constant supply of plastisol to the laminator and allowing the operator to help out in other areas of the plant. According to Bill Stegner, plant quality control supervisor, "We needed a bigger disperser and we got a good one. It turns out 255 gallons in two hours. The speed and larger quantities we can produce on the disperser really helped us, and we get a better dispersion and more uniform product."

Production Process

Herculite installed the 330-gallon (maximum capacity) Daymax about a year ago. The installation included a pumping system for adding liquid ingredients to the mix, an access stand for operator loading of other ingredients through the top opening, and a dust control hood over the top opening where powdered resin is added to the mix.

The disperser unit, which handles 2,500- to 3,000-cP plastisol adhesives, is equipped with a jacket for chilled water. Herculite uses 40° cold water circulating in the jacket to offset the heat generated in the mix.

Precise temperature control is important, according to Stegner; without the coolant, the temperature of the mix could rise about 30°F within five to seven minutes, spoiling a batch worth $2,000. The plastisol is heat-sensitive and excess heat cures it. Another potential problem is that overmixing causes the plastisol to jell, and great care is taken to avoid this.

Presently, Herculite has 17 different formulations in the same viscosity range. Since installing the disperser, the company has been improving these formulations by varying the loading sequence for plasticizer, resin, fillers, wetting agents, and other ingredients. The sequence and rate of addition is very critical for better dispersion and control of heat. In some formulations, all the plasticizer is put in first,

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Table II — Typical Solution Properties

pH	Product solids, %	Approximate viscosity,* cP		
		Acrysol ASE-60	Acrysol ASE-75	Acrysol ASE-95
7.0	0.5	200	65	400
	2.0	3270	270	2800
8.0	0.5	215	70	280
	2.0	3600	200	4500
9.0	0.5	220	60	90
	2.0	3500	140	5400

*Measured at 25°C on a Brookfield LVF viscometer at 60 rpm; various spindles. These viscosities are given simply to illustrate relative molecular sizes. In each case, neutralization was done with concentrated ammonium hydroxide.

Table III — Thickening Efficiency of Acrysol ASE-60 vs. Acrysol ASE-75 for Typical Aqueous Dispersions

System	Total solids, %	Thickener[1]	% thickener on total solids — giving Brookfield viscosity (12 rpm) of:		
			2,000 cP	6,000 cP	10,000 cP
Nitrile latex[2]	20	Acrysol ASE-60	4.0	5.4	6.7
		Acrysol ASE-75	6.2	8.0	8.0
Styrene copolymer[3]	20	Acrysol ASE-60	4.2	6.4	7.5
		Acrysol ASE-75	9.0	>10.0	>10.0
Natural latex[4]	50	Acrysol ASE-60	0.8	1.3	1.6
		Acrysol ASE-75	0.6	2.2	3.5
Acrylic latex (Rhoplex B-60A)	20	Acrysol ASE-60	2.5	4.1	5.8
		Acrysol ASE-75	> 6.0	> 6.0	> 6.0
Paper coating (Rhoplex B-15)	35	Acrysol ASE-75	3.2	5.0	—
Rutile TiO_2 dispersed with 0.25% Tamol 731	10	Acrysol ASE-60	8.3	12.0	15.0
		Acrysol ASE-75	>30.0	>30.0	>30.0
	60	Acrysol ASE-60	0.3	0.5	0.6
		Acrysol ASE-75	0.5	1.2	1.7

[1]Solution of sodium salt of polymer indicated.
[2]Nitrex 2614 — supplied by Naugatuck Chemical Div. of U.S. Rubber Co.
[3]Kralac 2733 — supplied by Naugatuck Chemical Div. of U.S. Rubber Co.
[4]NC-400 — a centrifuged natural rubber latex supplied by U.S. Rubber Co.

Acrysol ASE-75 are also of interest as temporary binders in ceramics and as dispersants and suspending agents for pigments or abrasives.

Films formed from Acrysol ASE-75 or a solution of the polymer salt are hard and somewhat brittle. Unless the carboxyl groups of the polymer are crosslinked during film formation with a zinc-ammonia complex, these films are water-sensitive and may be redissolved in dilute alkali solutions or some organic solvents.

Acrysol ASE-95

Acrysol ASE-95 is also an acid-containing, acrylic emulsion copolymer. When diluted with water and neutralized with a base, each particle dissolves. The emulsion clarifies under these conditions and becomes a highly effective thickener. In comparison to Acrysol ASE-60 and Acrysol ASE-75, Acrysol ASE-95 imparts a very leggy consistency to adhesive compounds.

Solutions of this emulsion are particularly useful for thickening pigment suspensions, surfactant solutions, polar solvents, and compounded latex adhesive systems.

Conclusion

These acrylic emulsion copolymers can be incorporated directly into compositions to be thickened without any necessity for slow preliminary preparation of separate thickener solutions. This *in-situ* thickening is a marked advantage over procedures usually employed with natural thickeners (e.g., alginates) or with semisynthetic polymers (e.g., methyl cellulose or carboxymethyl cellulose). It is usually desirable to predilute an Acrysol ASE emulsion with equal parts of water and to keep the pH at as low a value as possible until the emulsion has been thoroughly stirred in. Adjustment of pH to dissolve or swell the thickener then brings the formulation to the desired viscosity smoothly and rapidly.

The thickeners offer the following primary advantages: viscosity control, ease of mixing, *in-situ* thickening, and high solids content. They may be used in the formulation of a wide variety of adhesives.

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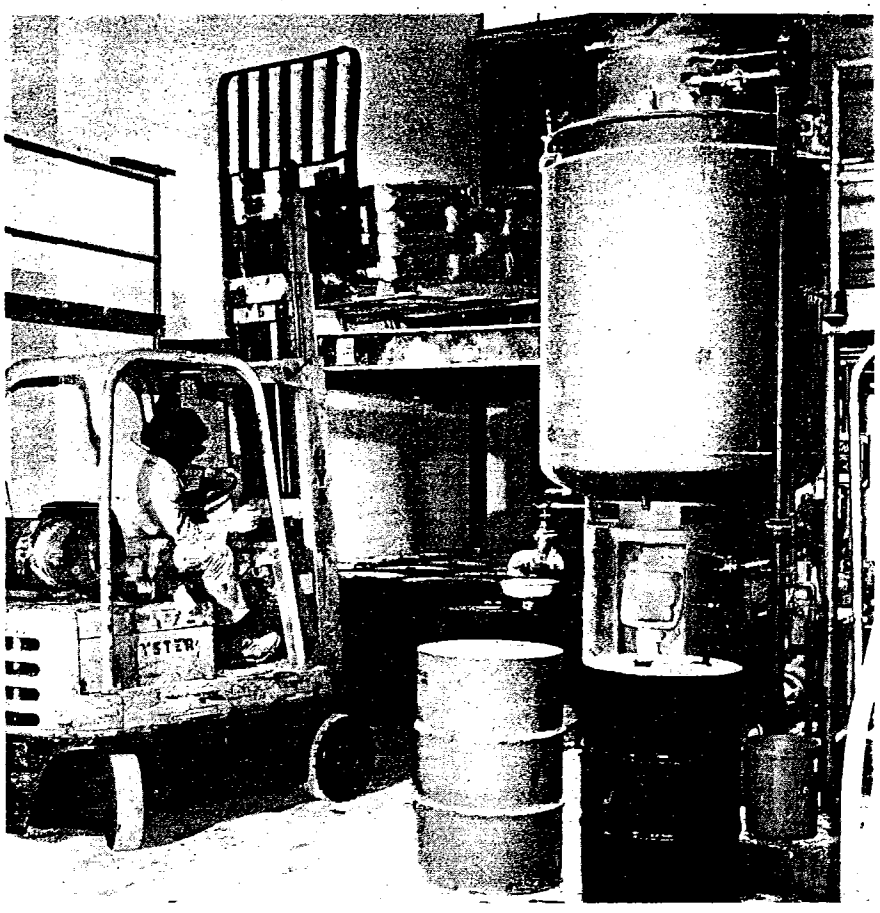

Lifting PVC resins in 40- and 50-lb bags to top of platform in preparation for mixing. Disperser is at right.

followed by resin and then filler; in others, a portion of the plasticizer will be held off until after all the antimony oxide has been added.

It takes approximately seven minutes for the addition of all ingredients, and the final mix is prepared after about three more minutes.

Quality control is stringent; before any batch is emptied from the equipment, the dispersion is checked carefully for lumps and viscosity.

The plastisol from the disperser is cured between vinyl sheets in a laminator for 15 to 18 seconds. The vinyl laminate is then trimmed, tested, inspected, and packaged for shipment.

The Daymax disperser is used four hours a day, five days a week to make 500 mixes or batches per month. No special cleaning is necessary and, according to Stegner, no maintenance has been required to date.



Here, operator adds wetting agent to the mixer. Dry solids are added at the top through the funnel-shaped opening. A dust shield has been provided by Herculite on this machine to create a cleaner environment.

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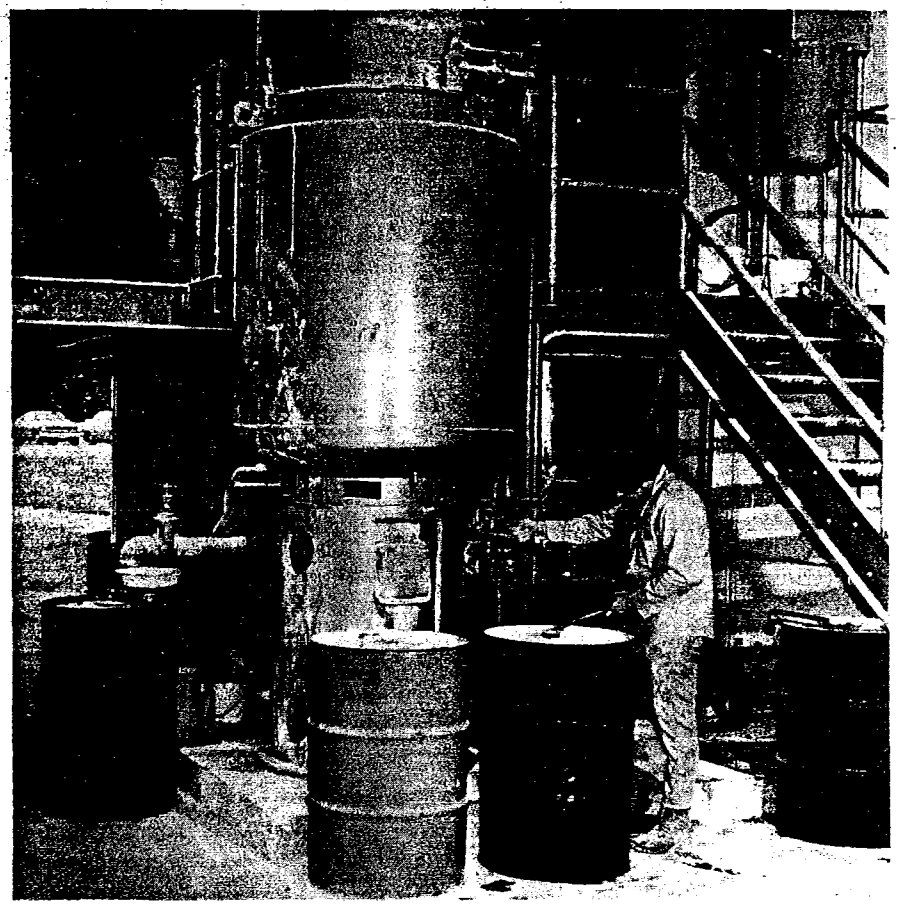
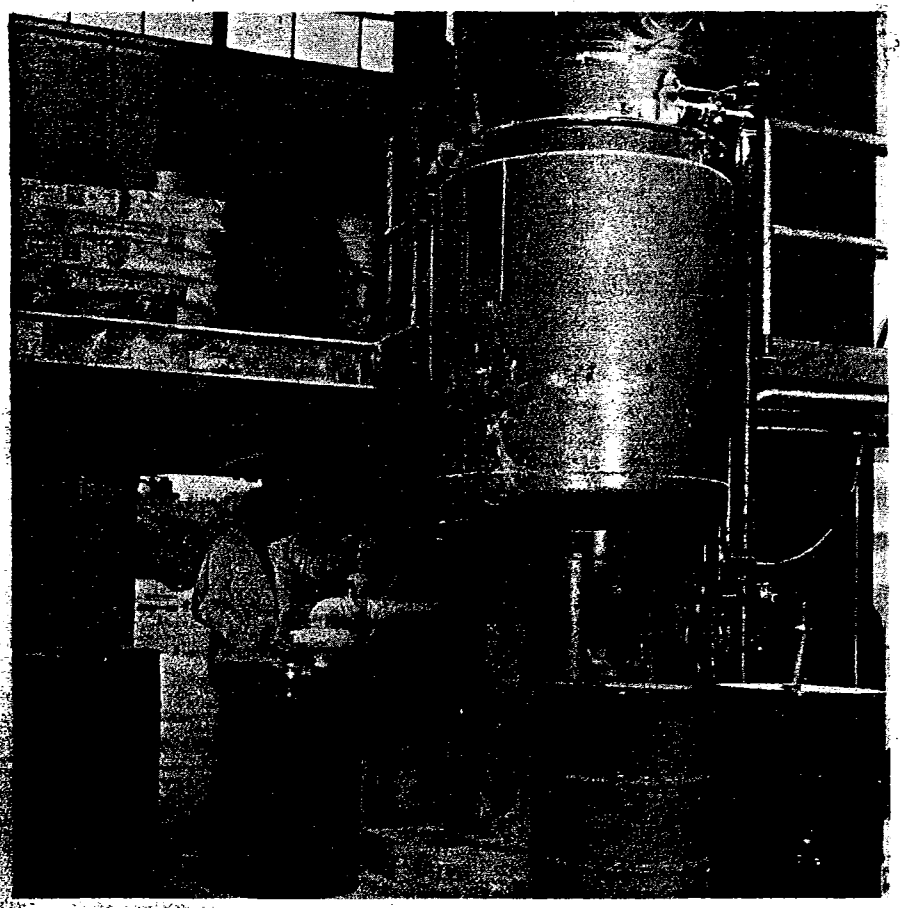


The disperser, with a 330-gal maximum capacity and a 300-gal working capacity, is being charged with liquid plasticizer from 55-gal drum.



Finished product is being emptied into drums for storage through the discharge valve at bottom left of machine.

Disperser Features

The Daymax disperser consists of a vertical tub-shaped tank with a built-in water jacket for product heating or cooling, a cover with a central loading funnel, a gate valve for product emptying, a support base, and a six-blade rotating knife-edged impeller that operates at 1,800 rpm. The action of the blades and the tank bottom configuration create impacts of varying pressure as well as friction actions, which account for the low mix time required for dispersion.

Rotation of the impeller produces pressure in the liquid next to the cutting edge of the blade, followed by friction action and a low pressure at the trailing edge of the blade, which is compressed by the leading edge of the next blade. This succession of compressions and depressions at an impeller tip speed of 9,000 fpm allows dispersion — with homogeneity and particle sizes as small as one or two microns — in as little as two or three minutes.

The disperser can be operated under a vacuum to remove air from the mix. At Herculite, Stegner says it has not been necessary to use the vacuum cover because 1) with the drive shaft passing through the bottom of the tank to support the dispersion impeller from beneath the surface of the mix, there is no possibility of air being introduced into the mix and 2) a system of large, adjustable, and removable baffles (from one to three as required by the application) prevents horizontal rotation of the liquid and prevents formation of a vortex and the introduction of air.

According to Day, the unit requires essentially no maintenance, except for monitoring the mechanical seal for the impeller drive shaft. "The seal in our Daymax has been in for almost a year," said Stegner, "and we have not had to replace it yet." And cleaning the unit — for example, before long shutdowns — consists of adding solvent, running the machine, and rinsing.

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