Adhesives and Sealants Raw Materials

Cable Filling/Flooding
Hot-Melt Adhesives
Laminating
Liquid Adhesives
Pressure-Sensitive Adhesives
Roofing
Sealants and Caulks
Urethane Adhesives and Sealants
Wax Blending

Epolene became a trademark of Westlake Chemical Corporation as of December 1, 2006.

Repulping of Hot Melt Adhesives and Hot Melt Coatings

Approximately 30% of paper products produced in the United States is being recycled, and total world demand for recovered paper is expected to grow to 84 million tons by the year 2000.[1] As a result, there is a growing need for raw materials for hot melt adhesives and hot melt coatings that are more compatible with repulping processes. This calls for raw materials and finished adhesives and coatings that are chemically or physically separable from paper and aqueous repulping media.

Due to the diversity of repulping mill configurations, emerging environmental legislation, and specific recycled product requirements, several definitions of repulpability must be addressed. While chemical dispersion of hot melt components into repulping solution streams and/or recycled paper products are worthy of discussion, this publication will address physical removal of hot melt contaminants. Physical removal of hot melt material early in the repulping process is presently the most immediate solution to the complications caused by "stickies."

The literature[2] reports that hot melt formulations with specific gravity values outside the range of 0.98 to 1.05 have improved compatibility with repulping processes which make use of centrifugal cleaners. Typical hot melt formulations with specific gravity values below 0.98 are reported to be separable by reverse centrifugal cleaners at 90% efficiency in a single pass.

In reverse centrifugal cleaning, small particles, which are not removed by screening and which have densities less than water or saturated paper fibers, are rejected from the repulp stream as they are thrown toward the center of a hydrocyclone. A basic diagram of a reverse centrifugal cleaner is given in Figure 1. Most state-of-the-art repulping mills have centrifugal cleaning systems.

[1]*Edwards, J. R.*, "Future Trends in the Secondary Fibers Industry," *Progress in Paper Recycling: 1991, 1 (1), 24–30.*

[2]*Arnold, J. M., and Wise, E. M. (Jefferson Smurfit Corporation),* "The Role of Specific Gravity on Removal of Hot Melt Adhesives in Recyclable Grades," *TAPPI Hot Melt Symposium Notes: 1992, 131–141.*

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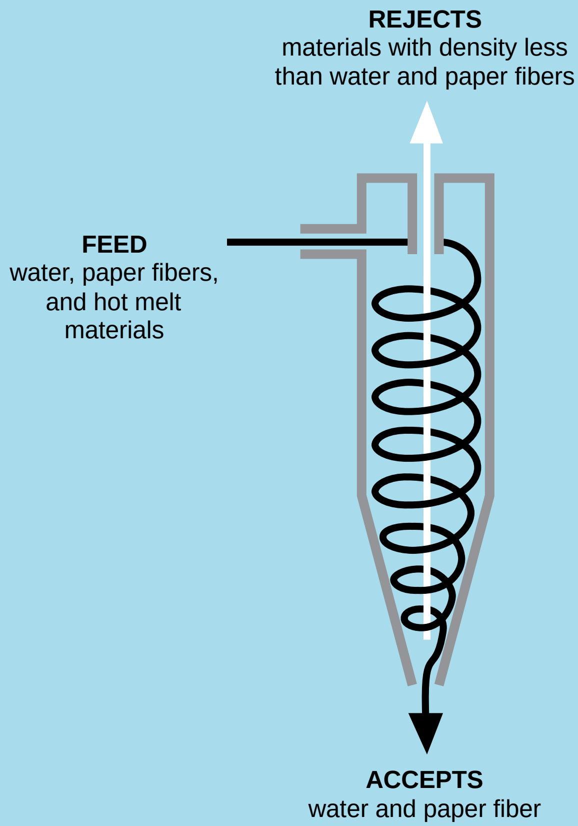
Figure 1 — Basic Diagram of a Reverse Centrifugal Cleaner



Laboratory Procedure

Eastman Chemical Company offers several raw materials for hot melt adhesives and coatings which have density values below the critical 0.98 g/cc level. These raw materials may be formulated to produce hot melt adhesives for packaging applications with density values well below 0.98 g/cc.

A simple laboratory test method has been devised to approximate the degree of separation which might be seen using reverse centrifugal cleaners to separate low-density materials from the repulping solution and paper fibers.

- Add 2–3 drops of a liquid organic dye to 5 grams of molten hot melt material and mix thoroughly on a hot plate.
- Coat molten, dyed hot melt material onto white bond copier paper to a thickness of 1.5 to 3.0 mil with an appropriate wire-wound rod. Any uncoated edges should be trimmed away.
- Cut a piece of coated paper to weigh 0.6 gram and determine the coat weight by weight difference of coated and uncoated paper.
- Tear weighed, coated paper into pieces approximately 1" × 1" and place into 250 mL of appropriate repulping solution (water, alkaline solution, etc.) to obtain a solids to liquid consistency of ~0.25%.
- Allow coated paper to soak in solution for 1 hour then transfer to the bowl of a kitchen blender and agitate for 2 minutes at the lowest possible speed.
- Following agitation, quantitatively transfer the contents of the blender bowl to a preweighed centrifuge jar and cap.
- Centrifuge the sample at 2,000 rpm for at least 10 minutes and no longer than 15 minutes.
- Following centrifugation, carefully remove sample jar from centrifuge and place on level surface until all particles are motionless.
- Carefully transfer any material floating in the sample jar with approximately one-half of the repulping solution by decanting into a preweighed beaker. **Minimize disturbance of the paper fibers at the bottom of the jar.**
- Label all jars and beakers appropriately and place them in a forced draft oven at 250°F. Dry to constant weight, cooling in a desiccator.
- The degree of separation of hot melt material from paper fibers is determined by weight difference as follows:

$$\frac{(DB\text{-}EB)}{ICW} \times 100 = \%\ \text{Separation}$$

ICW = Initial coating weight
DB = Weight of beaker containing decanted material after drying
EB = Weight of empty beaker before decantant added

Results

This method was designed to simulate one pass through a reverse centrifugal cleaner. In a typical repulping mill employing this method, several cleaners are used in series to optimize contaminant removal. Using this method, a density value of 0.95 g/cc was established as the upper limit for optimal separation of hot melt material from paper fibers and water. The usefulness of this method was tested on three families of hot melt packaging adhesives. Hot melt adhesives based on *Eastoflex* amorphous polyolefins, *Epolene* polyethylene polymers, and three commercially available formulations based on ethylene-vinyl acetate (EVA) were compared. Data obtained for the separability of formulations based on *Eastoflex* amorphous polyolefins is given in Figure 2. Similar information for formulations based on *Epolene* polyethylene polymers is given in Figure 3. Comparison of the separability of all three families of hot melt adhesives is given in Figure 4. This data correlates well to that published in the literature. Analysis over a density range of 0.89–1.02 g/cc revealed a nearly inverse linear relationship between density and percent separation with a correlation coefficient of −0.963.

Figure 2 Separation vs. Density—Starting Point Formulations Based on *Eastoflex* Amorphous Polyolefin

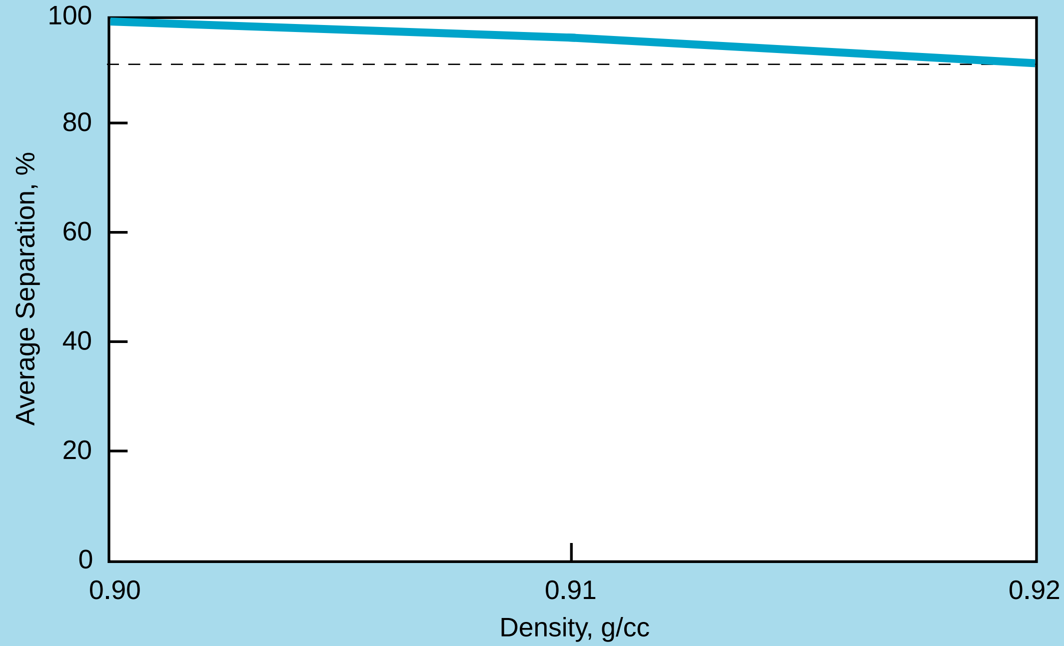


Figure 3 Separation vs. Density—Starting Point Formulations Based on *Epolene* Polymer

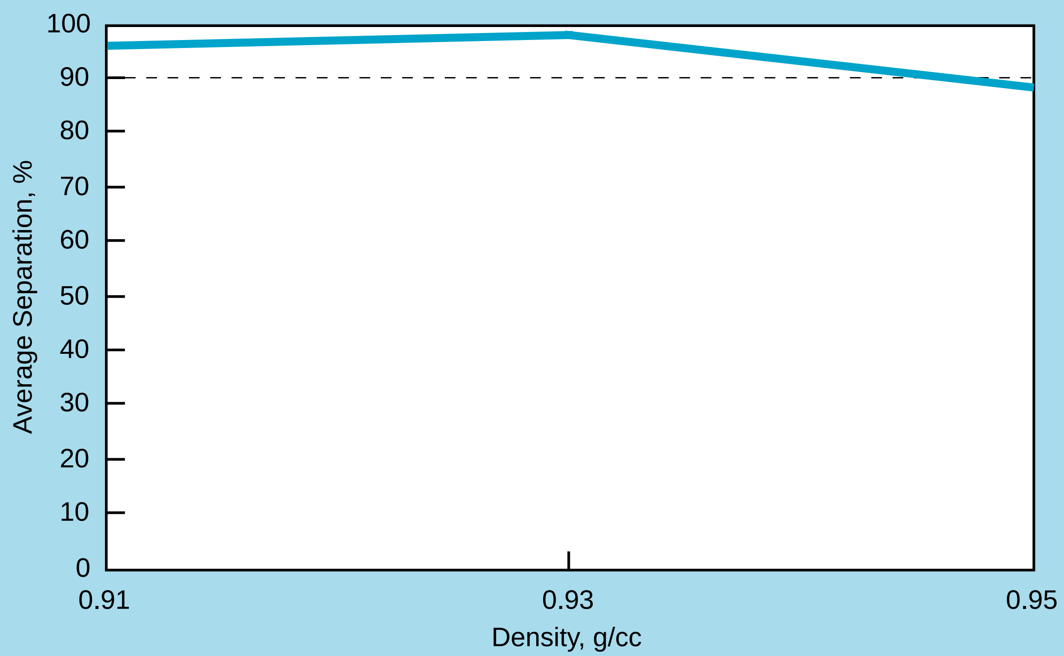
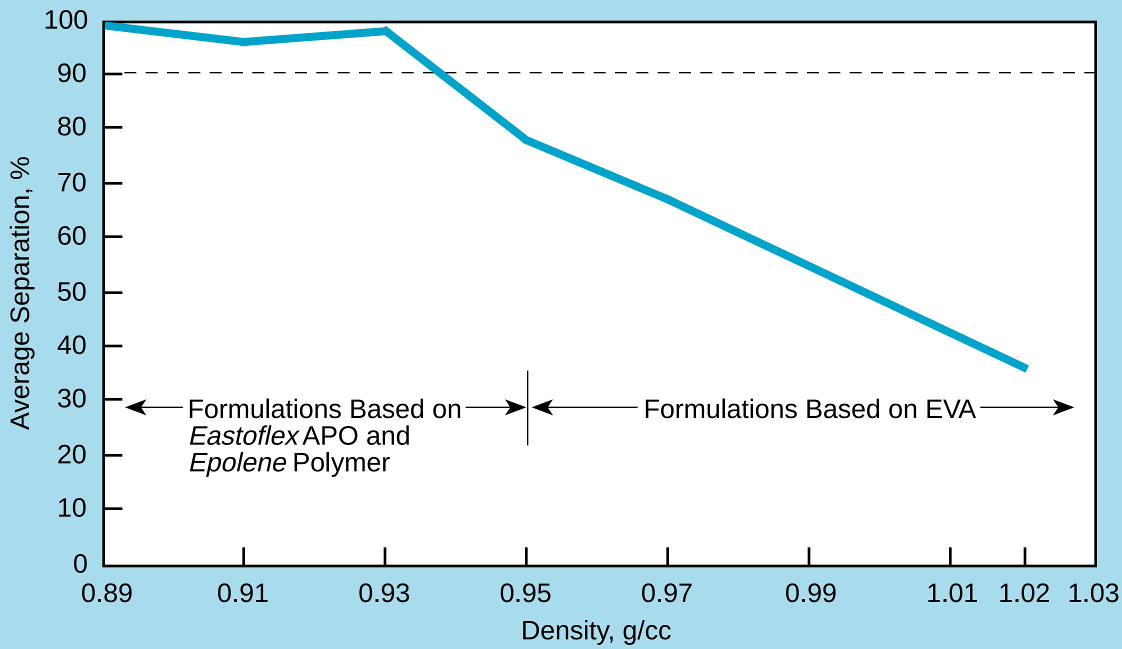


Figure 4 **Separation vs. Density—Starting Point Formulations Based on *Eastoflex* APO, *Epolene* Polymer, and EVA**



Conclusions

From these results, it is concluded that hot melt packaging formulations based on *Eastoflex* amorphous polyolefins and *Epolene* polyethylene polymers may be more compatible with repulping processes that make use of reverse centrifugal cleaners than formulations based on EVA. It is also concluded that separability might improve as formulation density falls below 0.95 g/cc. Starting point formulations for hot melt adhesives based on *Eastoflex* amorphous polyolefins and *Epolene* polyethylene polymers are given in Tables 1 and 2.

Table 1 Starting Point Formulations Based on *Eastoflex* APOs

Formulation	1	2	3
Eastoflex P1023, %	62	30	25
Eastoflex E1060, %	—	30	—
Eastoflex D-167, %	—	—	25
Epolene C-13, %	—	—	10
Eastotac H-130, %	23	25	25
Paraflint H-1, %	15	15	15

Typical Properties			
Brookfield Thermosel Viscosity, cP @ 350°F	800	1,200	3,000
Ring and Ball Softening Point, °C	136	130	128
Needle Penetration, 0.1 mm	8	12	6
Waldorf Set Time, sec	3	5	7
Peel Strength on Kraft, gm			
0.1 in./min	950	820	1,000
20 in./min	1,050	1,050	1,000
Peel Strength on Foil, gm			
0.1 in./min	700	1,000	800
20 in./min	600	750	600
Peel Strength on *Mylar* Film, gm			
0.1 in./min	650	600	1,000
20 in./min	10	50	300
Density, g/cc	0.91	0.92	0.92
Average Separation, %	100	90	95

Table 2 Starting Point Formulations Based on *Epolene* Polymers

Formulation	1	2	3	4	5	6	7
Epolene C-18, %	90	80	60	72	69	—	—
Epolene C-15, %	—	—	—	—	—	72	69
Eastotac H-130, %	10	20	28	22	19	22	19
Epolene N-21, %	—	—	12	6	12	6	12
Typical Properties							
Brookfield Thermosel Viscosity, cP							
@375ºF	1,300	1,000	700	900	900	850	800
350ºF	1,800	1,500	900	1,200	1,100	1,200	1,000
Ring and Ball Softening Point, ºC	97	99	111	107	111	106	111
Waldorf Set Time, sec	9	8	2	4	3	4	3
Peel Strength on Kraft, gm							
0.1 in./min	750	850	950	850	600	750	600
20 in./min	1,000	1,050	750	700	600	900	800
Peel Strength on Foil, gm							
0.1 in./min	600	500	550	550	600	400	400
20 in./min	700	650	500	450	700	550	800
Peel Strength on *Mylar* Film, gm							
0.1 in./min	30	20	20	40	45	20	10
20 in./min	700	700	30	150	180	100	40
Density, g/cc	0.91	0.92	0.94	0.93	0.93	0.93	0.93
Average Separation, %	95	95	90	100	100	100	95

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