



## PAROIL 54-NR

### FLAME RETARDANT PVC PLASTISOL ADHESIVE PAROIL 54-NR, CHLORINATED ALKANE, AS CO-PLASTICIZER

Alternate methods are available for flame retarding flexible polyvinyl chloride laminates. Conventional techniques are directed toward flame retarding the formulated polyvinyl chloride. The laboratories of Dover Chemical Corporation have developed a method of choice in which the adhesive used in a typical vinyl to nylon scrim laminate is flame retarded by chlorinated alkane, thereby eliminating the use of flame retarded polyvinyl chloride and providing a cost saving to the processor. Flame retardancy of the adhesive can also be achieved with phosphate esters but a considerable formulation cost advantage is obtained by the use of chlorinated alkane and appropriate synergists.

**Paroil 54-NR**, a Dover Chemical product containing 54% chlorine, was evaluated as a flame retarding co-plasticizer for use in plastisols as adhesives. The plasticizer level was higher than that generally used in plastisols, partly due to the thixotropic behavior of the synergists and partly due to the end-use requirement of the product.

The data in Table I establishes that partial replacement of DOP by **Paroil 54-NR**, keeping the same level of  $\text{Sb}_2\text{O}_3$ , (Columns 1 and 4) will give better flame retardancy and equal physical properties at a slightly higher cost. However, by replacing a portion of the DOP with **Paroil 54-NR**, the level of  $\text{Sb}_2\text{O}_3$  can be reduced as shown by Column 3. The level of  $\text{Sb}_2\text{O}_3$  can be lowered from 15 to 10 parts to give a product with improved flame retardancy, better physical properties and at a reduced cost.

Formulation 1 was used as a control in a viscosity study; plastisol viscosities were taken with a Brookfield viscometer using a #4 spindle at 20 rpm and at  $23 \pm 1^\circ\text{C}$ . Viscosities were obtained after 6 hours, 1, 2, 5, 10, 15, 21 and 28 days. Results are reported in Table II and plotted in Graph 1.

TABLE I  
PLASTISOL FORMULATIONS

| Additive                      | 1    | 2    | 3    | 4    |
|-------------------------------|------|------|------|------|
| PVC                           | 125  | 125  | 125  | 125  |
| DOP                           | 125  | 100  | 100  | 100  |
| <b>Paroil 54-NR</b>           | --   | 50   | 50   | 50   |
| Antimony Oxide                | 15   | 5    | 10   | 15   |
| Alumina Trihydrate            | 25   | 25   | 25   | 25   |
| Molybdenum Oxide              | --   | 5    | --   | --   |
| Stabilizer                    | 2    | 2    | 2    | 2    |
| <b>Flame Retardancy</b>       |      |      |      |      |
| UL-94                         | V-O  | V-O  | V-O  | V-O  |
| Oxygen Index (ASTM D-2863-70) | 25.5 | 27.3 | 26.8 | 27.5 |

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| <b>Additive</b>             | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> |
|-----------------------------|----------|----------|----------|----------|
| % Smoke, Arapahoe           | 13.8     | 9.9      | 13.5     | 12.5     |
| <b>Physical Properties*</b> |          |          |          |          |
| Shore A-2 Hardness          | 52       | 47       | 45       | 45       |
| Specific Gravity            | 1.262    | 1.356    | 1.290    | 1.302    |
| Tensile (psi)               | 182      | 622      | 340      | 166      |
| % Elongation (at break)     | 72       | 229      | 138      | 68       |
| Raw Material Cost, \$/lb.   | \$0.394  | \$0.388  | \$0.364  | \$0.387  |
| Pound-Volume Cost           | 0.497    | 0.526    | 0.470    | 0.504    |

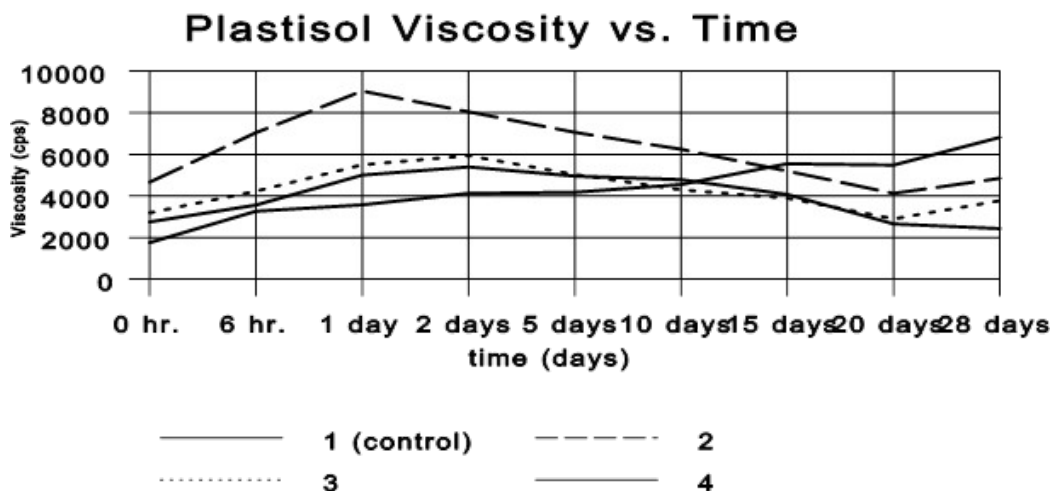
\*The plastisols were molded in a cavity mold at 325°F. for 5 minutes; test bars were cut from the molded plaques. Test plaques were 1/8" thick.

**TABLE II**  
**PLASTISOL VISCOSITIES\* VS. TIME**

| Formula     | 0 hr. | 6 hr. | 1 day | 2 days | 5 days | 10 days | 15 days | 20 days | 28 days |
|-------------|-------|-------|-------|--------|--------|---------|---------|---------|---------|
| 1 (control) | 1750  | 3260  | 3570  | 4120   | 4170   | 4550    | 5550    | 5480    | 6820    |
| 2           | 4660  | 7040  | 9040  | 8050   | 7060   | 6250    | 5200    | 4120    | 4850    |
| 3           | 3190  | 4230  | 5500  | 5940   | 5030   | 4300    | 3900    | 2900    | 3770    |
| 4           | 2750  | 3560  | 5000  | 5390   | 4950   | 4780    | 4070    | 2650    | 2430    |

Brookfield Viscometer, #4 Spindle, 20 rpm at 25°C.  
Plastisols were not mixed after initial formulation.

## GRAPH I



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| <b>Typical Properties</b>               | <b>Paroil 54-NR</b> |
|-----------------------------------------|---------------------|
| Chlorine, Wt. %                         | 54                  |
| Specific Gravity, 25°C/25°C             | 1.28                |
| Viscosity, poise/25°C                   | 20                  |
| Color, Gardner                          | 1                   |
| Thermal Stability, % HCl 4 hrs. @ 175°C | 0.1                 |

| <b>Raw materials</b> | <b>Source</b>                |
|----------------------|------------------------------|
| <b>Paroil 54-NR</b>  | Dover Chemical Corp.         |
| PVC                  | ICC Industries Inc.          |
| DOP                  | Ashland Chemical             |
| Antimony Oxide       | ICC Industries               |
| Alumina Trihydrate   | Akron Chemical Co.           |
| Molybdenum Oxide     | Amax-Climax Molybdenum Corp. |
| Stabilizer           |                              |
| Calcium Stearate     | Fisher Scientific Co.        |

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