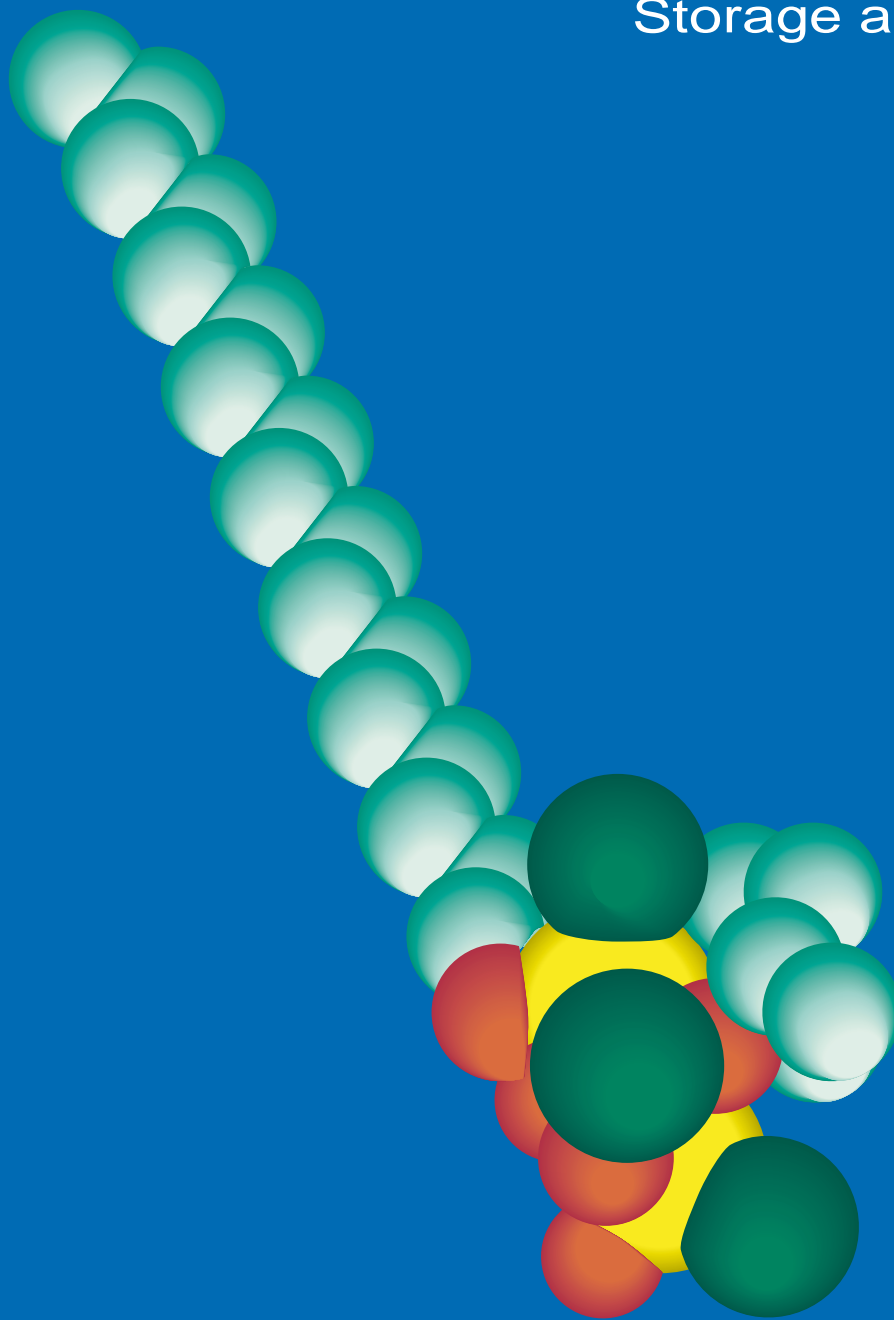


QUILON®

CHROME COMPLEXES

For Release and
Surface Treatment

Properties, Uses,
Storage and Handling



PRODUCT OVERVIEW

Quilon® is a solution, largely in isopropanol, of a dark green, chemically reactive complex in which a C₁₄–C₁₈ fatty acid is coordinated with trivalent chromium. Seven grades are available: Quilon® C, M, and S; higher-strength Quilon® H, L, and C-9; and Quilon® L-11, which is our highest-strength grade.

Quilon® reacts with polar groups on paper, leather, nonwovens, woven fabrics, polymers, and other negatively charged surfaces. When cured, Quilon® forms an insoluble layer of polymerized complex that is chemically bonded through chromium to the available polar groups on the substrate surface. The hydrophobic fatty acid chains are oriented away from the surface. When mixed into aqueous polymer systems such as starch, polyvinyl alcohol (PVA), and polyvinyl acetate, the chromium reacts with active groups on the polymer chains, effectively insolubilizing polymer films upon drying.

The most noticeable characteristics of treated surfaces are release property and water repellency. Other properties include increased chemical resistance, and resistance to water-borne stains. The wet strength of a paper surface may be slightly increased, but properties of the dry substrate, such as appearance, are not affected. When used with aqueous polymer systems, there is improved grease resistance.^a

Quilon® is completely soluble in water. It can be easily applied to many materials as a water solution. Quilon® is also completely soluble in short-chain aliphatic alcohols and many polar solvents. Application from solvent systems is preferred for substrates that are adversely affected by contact with water or high cure temperatures.

Quilon® is easy to apply at the size press and calender stack on paper machines at normal machine speeds. Its use rate is low: 1–3 lb (0.5–2 lb of high strength) Quilon®/10,000 ft² of paper is normally adequate. Retention of approximately 0.5% commodity on weight of paper forms a hydrophobic surface with high size.

* Reg. U.S. Pat. & Tm. Off., DuPont Company. Quilon® Chrome Complexes are made only by DuPont.

^a DuPont also offers a complete line of polyvinyl alcohol and fluorochemical finishes for excellent oil and grease repellency.

Quilon® has the sanction of the Food and Drug Administration (FDA) and of the Meat and Poultry Inspection Program of the United States Department of Agriculture (USDA) (See FDA Status on page 12). It also has similar approval by corresponding organizations in many foreign countries.

Table 1 below lists the Chemical Abstracts Index Names and CAS Registry Numbers for the major ingredient in each product.

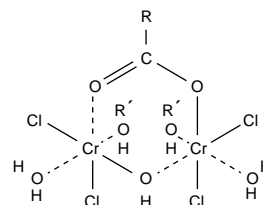
TABLE 1
CAS Names and Registry Numbers
for Quilon® Products

CAS Name	Registry No.
Quilon® C and C-9: Chromium, pentahydroxy(tetradecanoato)di-	65229-24-5
Quilon® M: Tetradecanoato chromic chloride hydroxide (1:2:4:1)	15659-56-0
Quilon® S: Octadecanoato chromic chloride hydroxide (1:2:4:1)	15242-96-3
Quilon® L, L-11 and H: Mixtures	15659-56-0 15242-96-3

CHEMICAL AND PHYSICAL PROPERTIES

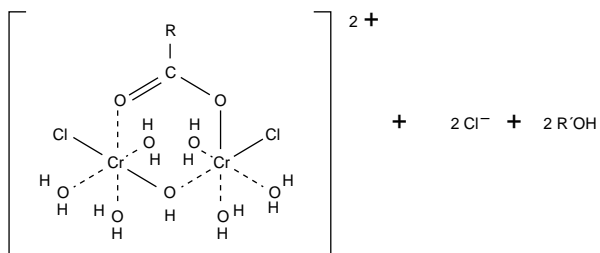
CHEMICAL STRUCTURE

Quilon® chrome complexes have not been isolated from solution, and their structures can only be inferred. The following is likely:

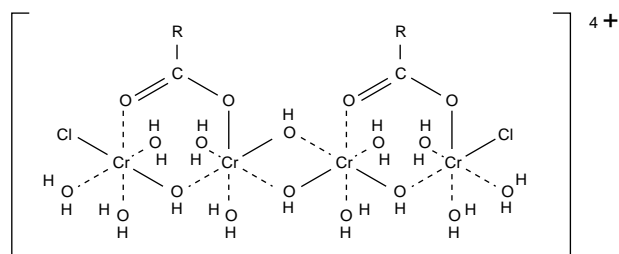


in which R represents the fatty acid radical (C₁₃–C₁₇) and R' the alkyl group (C₃) of the isopropanol.

When Quilon® is diluted with water, aquo groups replace the coordinated alcohol groups and some of the chlorine atoms. These latter enter solution as chloride ions and the molecules of Quilon® acquire a positive charge.



Subsequent hydrolysis or neutralization with a weak base frees more chloride ions; the aquo groups lose protons and the molecules polymerize as hydroxyl bridges form.

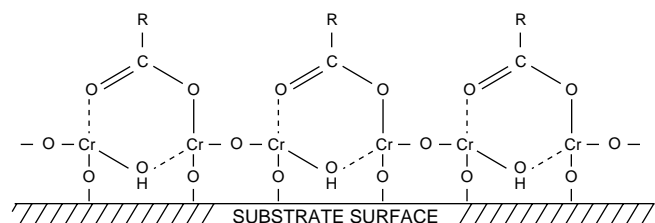


Increasing temperature also promotes polymerization. Thus, the stability of Quilon® solutions depends on the concentration, temperature, amount of neutralization, and age of the solution. Solutions become more acidic on standing, as protons are produced during the polymerization process. With proper control, the molecules grow to a low colloidal size, as evidenced by the Tyndall effect,^b without precipitating.

Quilon® solutions are most effective when the chromium polymer is at the colloidal or sub-colloidal size, just prior to precipitation. Excessive base, improperly added base, high temperature, and prolonged standing of the solution should be avoided to preclude precipitation of the Quilon® polymer. Precipitation diminishes the effectiveness of the treatment solution and introduces particles which may be detrimental to the end-use.

^b If a beam of light is passed through the solution, light scattering from the colloidal particles appears as a turbid cone (Tyndall effect) when viewed from the side.

Many surfaces such as paper, textiles, and glass fibers contain polar groups such as $-\text{OH}$, $-\text{COOH}$, $-\text{CONH}_2$, $-\text{SO}_3\text{H}$, etc., and are negatively charged. The high positive charge that builds up on the molecules of Quilon® causes the chromium portion of the molecules to strongly bond to the negatively charged surface. As a result, the fatty acid groups are oriented outward from the surface of the substrate. Drying and curing irreversibly eliminate the water molecules and the chrome complex becomes permanently bonded to the substrate.



A substrate surface treated with Quilon® chrome complex has durable water-repellency and release. The polymeric complex is not a continuous film over the surface; the substrate retains its natural porosity, flexibility and appearance. It should be noted that Quilon® deposits are not coatings in the classical sense, but rather surface treatments that are ideally only one molecule thick.

GRADES

DuPont offers seven grades of Quilon® chrome complex to meet the needs of specific industries and their different processing conditions. The properties of the grades are shown in *Table 2*, while the principal applications are listed in *Table 3*.

Quilon® H, L and C-9 are about 60% more concentrated than C, M and S, and Quilon® L-11 is 90% more concentrated. The more concentrated grades provide both economic and storage advantages. Freight, and storage area needed for equivalent quantities of active ingredient are lower than for Quilon® C, M, and S.

The Quilon® molecule probably includes water and isopropyl alcohol as part of the Werner complex, as indicated by the structure proposed on page 2, and the percentage of active ingredient may in principle be calculated from the chromium analysis based on this structure. The percentage of solids obtained by measurement, however, varies considerably depending on the method used (*Table 5*). We therefore do not use percentage of solids as a criterion; the percentage of chromium is a much more reliable indicator of the concentration of the solution.

Quilon® S and L usually provide the best treatment results. Quilon® C and C-9 are almost as good and do not require the extra step of partial neutralization that must be used with the other grades. Furthermore, whereas all other grades need fairly high drying temperatures, typically 100°C or higher, Quilon® C will develop good properties when dried at any temperature. It can therefore be used on a paper machine, where the drying cans seldom heat the web to higher than about 80°C (180°F).

Regardless of any of the above considerations, it is possible to develop good release and water resistance on most substrates with any grade of Quilon®.

Quilon® C, H, M, L and L-11 have excellent storage stability. Quilon® S and C-9 can develop sludge during storage, especially under warm conditions. S should be used only if the release desired cannot be achieved with

any other grade. A good replacement for S is L, which provides almost the same degree of release without any sludging.

The reactivity of the chromium portion of the complex, determined by its degree of hydrolysis and polymerization, is an important criterion in selecting the grade of Quilon® to use. Quilon® H, L, M, and S are monomeric and their chromium portions will react readily with negatively charged materials, such as polyvinyl alcohol or the protein in leather or feathers, to cross-link or insolubilize the material. The chromium portion of Quilon® C is more polymerized. Its main advantage is its ability to cure at lower temperatures to produce excellent water repellency or release. Quilon® C is also the preferred grade for application from isopropanol or similar organic solvents. Quilon® L and S are normally used on tight paper substrates, such as greaseproof or parchment paper, when optimal release properties are required.

TABLE 2
Typical Analyses and Properties* of Quilon® Chrome Complexes, Technical

	Grade						
	C	C-9	H	L	L-11	M	S
Appearance	blue-green liquid	blue-green liquid	dark-green liquid	dark-green liquid	blue-green liquid	dark-green liquid	dark-green liquid
Odor	alcoholic	alcoholic	alcoholic	alcoholic	alcoholic	alcoholic	alcoholic
Chromium as Cr, wt. %	5.7	9.2	9.2	9.2	11.0	5.7	5.7
Chloride as Cl, wt. %	7.8	12.7	12.6	12.7	15.2	7.8	7.8
Fatty Acid (C ₁₄₋₁₈), wt. %	11.8	21.2	19.0	21.2	25.2	11.7	14.8
Boiling point, approx. °C	82	—	82	82	—	82	82
°F	180	—	180	180	—	180	180
Freezing Point, °C	-47	—	2	4	—	-50	-35
°F	-53	—	36	39	—	-58	-31
Flash point, (TOC) °C	4	—	-3	-2	—	1	2
°F	39	—	27	29	—	34	36
Density at 20°C (68°F), g/mL (Mg/m ³)	0.953	1.050	1.015	1.025	1.125	0.922	0.924
lb/gal	8.1	8.7	8.7	8.6	9.3	7.8	7.9
Solubility in Water	complete	complete	complete	complete	complete	complete	complete
Commodity stability at storage temperatures below 32°C (90°F) and above freezing point	indefinite	negligible sludging	indefinite	indefinite	indefinite	indefinite	may sludge after 5 months

* This table gives typical properties based on historical production performance. DuPont does not make any express or implied warranty that these products will continue to have these typical properties.

TABLE 3
Principal Applications of Quilon® Chrome Complexes

Typical End-Uses	Products	Substrate	Grade
<ul style="list-style-type: none"> • Release sheets for the manufacture of plastic laminates. • Food separators and pan liners for frozen foods, meats, pastries, candy. • Separator sheets for pressure-sensitive tapes and labels. 	<ul style="list-style-type: none"> • Release and grease-crawl-resistant paper. 	<ul style="list-style-type: none"> • Greaseproof paper • Glassine • Parchment paper 	S, L, L-11
<ul style="list-style-type: none"> • Wet-strength bags and cartons for fresh or frozen foods—vegetables, meats, seafoods, dairy products, baked goods. • Low-cost, tough, disposable, refuse bags; ice bags; grocery sacks. • Weather resistant wraps for shingles, vinyl tiles, and similar building materials; shipping containers for polished and painted metal and furniture. • Paper cover sheets for gypsum wallboard. • Release papers for high pressure laminate manufacturing. • Release papers for vinyl plastisol. 	<ul style="list-style-type: none"> • Water repellent packaging materials. • Grease-resistant and release paper when applied with PVA. • Release sheets. 	<ul style="list-style-type: none"> • Paper • Paperboard • Liners for corrugated sheets 	C, C-9, H, L, L-11, S
<ul style="list-style-type: none"> • Surgical drapes and gowns. 	<ul style="list-style-type: none"> • Water-repellent nonwoven fabrics 	<ul style="list-style-type: none"> • Nonwoven fabrics 	C, C-9
<ul style="list-style-type: none"> • Strippable backings for pressure-sensitive labels and tapes. • Release sheets. 	<ul style="list-style-type: none"> • Adhesive tapes • Release films 	<ul style="list-style-type: none"> • Films 	C, C-9
<ul style="list-style-type: none"> • Insolubilization of adhesives, films, protein binders, and inks. 	<ul style="list-style-type: none"> • Water-repellent coatings and adhesives. 	<ul style="list-style-type: none"> • Resin emulsions and solutions 	H, M, S, L, L-11
<ul style="list-style-type: none"> • Shoes, golf bags, luggage, gloves. 	<ul style="list-style-type: none"> • Water- and stain-resistant leather 	<ul style="list-style-type: none"> • Side leather 	H, M
<ul style="list-style-type: none"> • Drycleanable suede garments. 	<ul style="list-style-type: none"> • Colorfast, water-repellent suede 	<ul style="list-style-type: none"> • Suede leather 	H, M
<ul style="list-style-type: none"> • Pillows, sleeping bags, jackets. 	<ul style="list-style-type: none"> • Water-repellent, odorless feather fillers. 	<ul style="list-style-type: none"> • Feathers 	M

USES

SOLUTION PREPARATION

Quilon® mixes readily with water. The usual method for preparation of solutions consists of adding water at approximately 20–30°C (70–90°F) to the mix tank, and adding the required amount of Quilon® while stirring, to ensure uniform distribution. A common formulation consists of 5–10 gallons of Quilon® in 90–95 gallons of water (or 3–6 gallons of high-strength grades in 94–97 gallons of water). This degree of dilution is determined from two inputs: the amount of Quilon®, as shipped, needed to provide the desired properties, and the amount of solution deposited by the type of applicator to be used. The resulting dilution can vary from 1 to 20% or even more. It depends considerably on the porosity of the substrate and the application method used. The solutions are acidic—a 1% solution in distilled water has a pH of 2.6–2.7.

The performance of Quilon® can often be improved by neutralization with a weak base. Neutralization is not required for Quilon® C and C-9. Normally, the amount of weak base used is a fixed ratio to the amount of Quilon® used in the solution, as indicated below:

TABLE 4

Neutralizing Agent	Approximate lb/100 lb		
	Quilon® M, S	H, L	L-11
Granular technical grade Hexamethylenetetramine (See FDA Status, page 12)	1.5–2.7	2.4–4.2	3–5
Technical grade urea	1.9–3.3	3.0–5.4	4–6.5
Urea-formate solution*	50–100	80–160	100–200

* A solution of 16.5 lb urea, 5.0 lb sodium formate, 0.2 lb formic acid (90%), in 78.3 lb water.

Hexamethylenetetramine (HMT) or urea can be added directly or in water solution to the well-stirred solution of Quilon®. The resulting pH will be in the 3.0–4.0 range

depending on the solution concentration and the amount of neutralizer added. After the neutralizer is added and the pH is increased, hydrolysis of the complex will cause a gradual decrease in pH. Additional neutralizer should *not* be added; further neutralization will cause the complex polymer to become too large and precipitate. Once the Quilon® solution has been neutralized, it should not be further diluted.

The higher neutralizer levels may be used only if the Quilon® solution is kept below about 30°C (45°F). If the treated substance will be used in contact with food or if a solution with stability at temperature up to 65°C (150°F) is required, use of urea as a neutralizer is recommended. However, urea will not give the water repellency obtainable with HMT neutralization.

SOLUTION STABILITY

The stability of a solution of Quilon® depends on the grade of Quilon®, temperature, other ingredients, and impurities. Solution stability decreases as the concentration, pH, or temperature is increased.

Although aqueous solutions of Quilon® are sensitive to polyvalent anions such as sulfate and phosphate, amounts normally present in hard water can be tolerated. The salts of hydrochloric, formic and acetic acids have little effect on solution stability. Water softeners, alkaline salts or similar materials may raise the pH; poor solution stability results if the pH is much higher than 4. It should be kept in mind that recycle from a size press to the feed trough can contaminate the Quilon® solution with paper ingredients such as alum.

Water solutions of Quilon® become more acidic on standing because the chrome complex hydrolyzes, polymerizes and liberates protons, as described previously. The rate of polymerization increases with increasing concentration, pH, and temperature of the solution. The solution will become bluer; this is not a sign of deterioration, but further polymerization results in cloudiness or sludge formation, indicating a loss in solution stability. Sludging increases with pH and is instantaneous above approximately 6.0. Solutions of Quilon® should be clear blue-green with not more than a slight amount of Tyndall effect to ensure good performance throughout the application. If the solution is consumed in a short period, a more polymerized solution is occasionally used.

Aqueous solutions of Quilon® prepared at room temperature remain stable more than 24 hours below approximately 30°C (80°F). Higher temperatures shorten the working life. For instance, at approximately 40°C (110°F), 8 hours is most likely a more typical pot-life. External cooling should be provided whenever solution temperatures exceed approximately 40°C (110°F).

For further details on solution stability, see item 5, under Additional Information, page 14.

TREATMENT OF PAPER PRODUCTS

The partly neutralized solutions of Quilon® can be applied by any coating device. On a paper machine they are normally applied at the size press, on the calender stack or with a Champion coater or similar device. The application station should precede the drying section of the paper machine, the temperature of which largely determines the grade of Quilon® to be used—drying can often result in a web temperature of less than 80°C (180°F), dictating the use of Quilon® C or C-9. Spraying, followed by doctoring and drying, is particularly convenient when application is to be intermittent. Flooding the sheet with the solution of Quilon® and removing the excess ensures uniformity of application. When the excess Quilon® is recycled, e.g., from a size press, the recycle tank should be as small as possible, to reduce contamination of the feed by components of the paper.

In providing release or water resistance, Quilon® is changing the surface of the substrate; any Quilon® that is absorbed below the surface does not contribute to this effect. The use-rate of Quilon® therefore depends on the porosity of the substrate.

On smooth, low-porosity paper the amount of Quilon® needed is typically between 1 and 3 lb (0.5–2 lb of high strength) per 10,000 ft² (i.e., less than 1 lb per ream, or very roughly 1 kg per 1,000 m²). Tight, dense papers such as glassine or parchment can be treated in the low end of this range. More porous substrates such as paperboard, corrugated liners, etc., will require more Quilon®, typically 3 to 5 lb per 10,000 ft², e.g., 1.5 lb per ream or 2 kg per 1,000 m².

The usual reason for treating the tighter papers is to provide release; the bond between the Quilon® and the paper is so durable that migration of the Quilon® to an adhesive, a foodstuff or other material in contact with the release paper is very unlikely. A more common reason for using Quilon® with paperboard is to provide resistance to liquid water, for products such as paper plates, shipping containers for fresh or frozen foods, etc. (See FDA Status, page 12).

On porous substrates the usage of Quilon® may be reduced either by thickening the treatment solution by blending with polyvinyl alcohol (see page 11) or by pre-coating the paper with a sealer. The latter could be polyvinyl alcohol, sodium alginate or other resin. Starch is not recommended, since the fatty-acid groups of the Quilon® do not orient properly on it.

The paper should be cool and damp as the solution is applied. Solution temperatures should not exceed about 35°C (90°F).

Neutralized 5–10% solutions of Quilon® are preferred for application on the calender stack or at the corrugator.

TABLE 5
Percent Solids Content of Quilon® Chrome Complexes

	GRADE				
	C	H	L	M	S
Calculated % Active Ingredient based on chrome analysis and pure fatty acids	34	60	61	37	39
Air drying, ambient conditions	44	79	74	45	50
Oven drying of air dried samples for 20 minutes at 110°C in a forced draft oven	44	78	72	45	51
ASTM Method D-2369-81	34	62	66	36	37

On the calender stack, it may be necessary to rapidly circulate the solution through one or more water boxes to keep it cool. The first water box should have a spreader to prewet the paper. Water boxes should be positioned so the solution surface is as close to nip level as possible (*Figure 1*).

Heat accelerates the reaction of Quilon® with paper. Drying the paper at 60–107°C (140–225°F) promotes insolubilization and anchoring of the complex. Quilon® C does not require an elevated cure temperature to achieve performance.

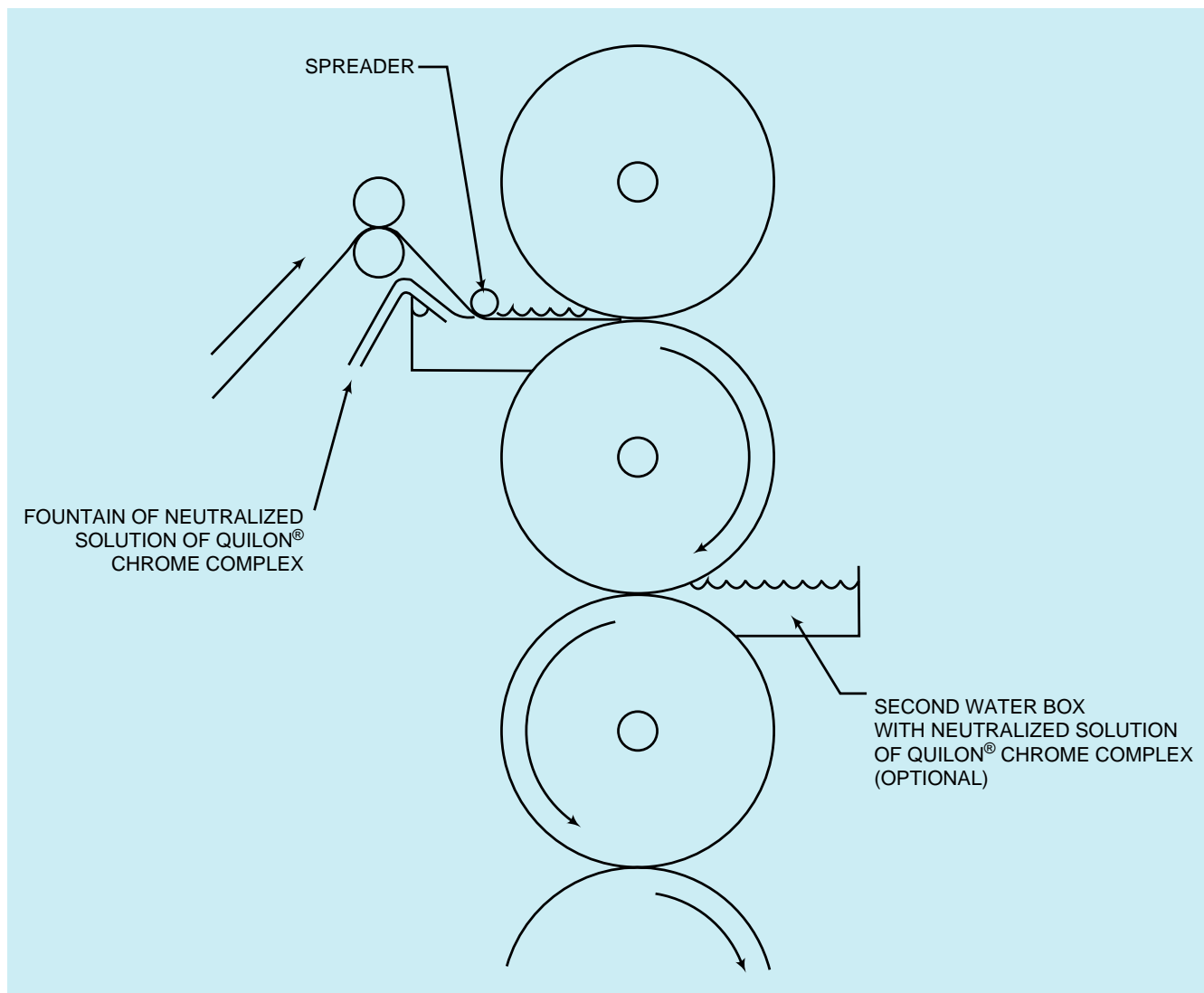
A transfer roll followed by a metering rod can be used on the corrugator to apply neutralized solutions of Quilon®. The applicator station should be just before the preheater on the single facer or double backer station. A transfer roll should preferably rotate counter to the direction of the paper (*Figure 2*). The roll should rotate fast enough to apply an excess of solution to the liner. The liner should then pass over a metering rod or a doctor rod.

Converters apply Quilon® solutions on a variety of devices; flexographic, rotogravure and other forms of transfer equipment are common.

Regardless of the method of application it is advisable to check the uniformity of the treatment. Many companies do this merely by applying the water roll-off test (see *Table 6*) immediately before wind-up, though this is not a certain test for release. The use of a traveling X-ray device, which measures the amount of chromium deposited, is more reliable.

Under some conditions, such as when a roll is rapidly rotating in a Quilon® solution, it will be necessary to use an antifoam agent. The recommended antifoam agent is “Antifoam” FD-82, sold by HODAG Chemical Corporation, 7427 North Central Park Avenue, Skokie, Illinois, 60076. This product has FDA approval for direct food contact and as an indirect food additive. “Antifoam” FD-82 is a 30% silicone emulsion. The recommended use

Figure 1. Preferred Position of Water Box on Calender Stack



level is 25–200 mL (1–7 fluid ounces) per 100 gallons of solution. Adjustment from this level can be made to obtain the desired foam depression.

“Antifoam” AF emulsion sold by Dow Corning appears to be a similar product and has been used successfully, as has “LE-45”, also made by Dow Corning. In general, it appears that any of the nonionic silicone antifoam emulsions will perform well.

TREATMENT OF CORRUGATED BOARD LINERS

Quilon® chrome complexes are excellent sizing materials for treating the liners of corrugated paper products. The treated liners may be used in contact with dry or wet foodstuffs (including frozen or fresh seafood, vegetables, fruits, butchered meats, etc.), fresh flowers and other produce.

Corrugated boxboard with an exterior treated with Quilon® is ideal for cartons for refrigerated storage, since the release imparted by the Quilon® permits easy separation of the individual packages. Furthermore, when the pack-

ages are removed from the refrigerator or freezer, the water repellency prevents absorption of water that condenses on the outside of the package. The usual application is 3–5 lb of Quilon® (2–3 lb high strength) per 10,000 ft², e.g., 1.5 lb per ream, or 2 kg per 1,000 m², but this may be reduced if the liner has a tight prior coating.

Prior to treatment the liner should be cool and preferably damp, and the temperature of the treatment solution should not exceed about 40°C (100°F). If rotation of the transfer roll causes foaming, an antifoam may be added to the Quilon® solution as previously described.

Another DuPont product, Ludox® colloidal silica, can be used by corrugators to impart frictionizing properties. Quilon® and Ludox® can be co-applied from the same finishing bath to obtain water repellency, grease resistance, and frictionizing properties. The mixture is usually applied in a size press application.

Water repellency of the dry treated board may be tested as described in *Table 6*; the uniformity of the treatment may be judged by repeating the test at several points along and across the board. If the treatment is uniformly poor it may be improved by adding more Quilon® to the

Figure 2. Application Station on Corrugator

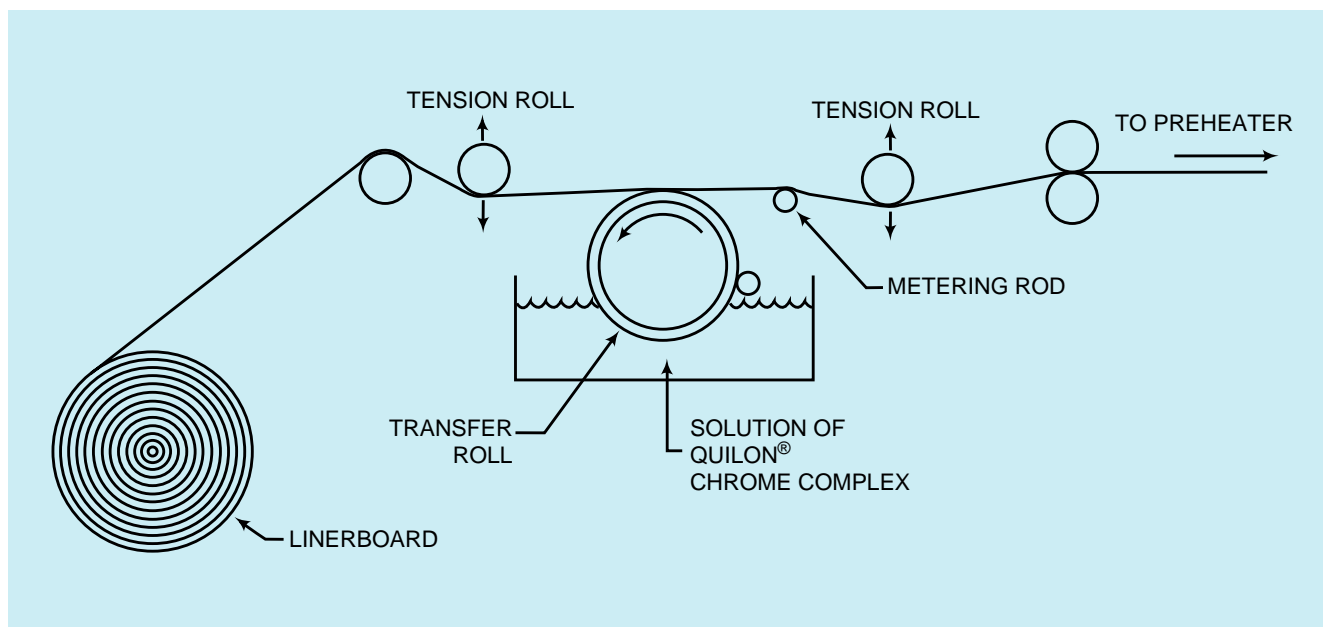
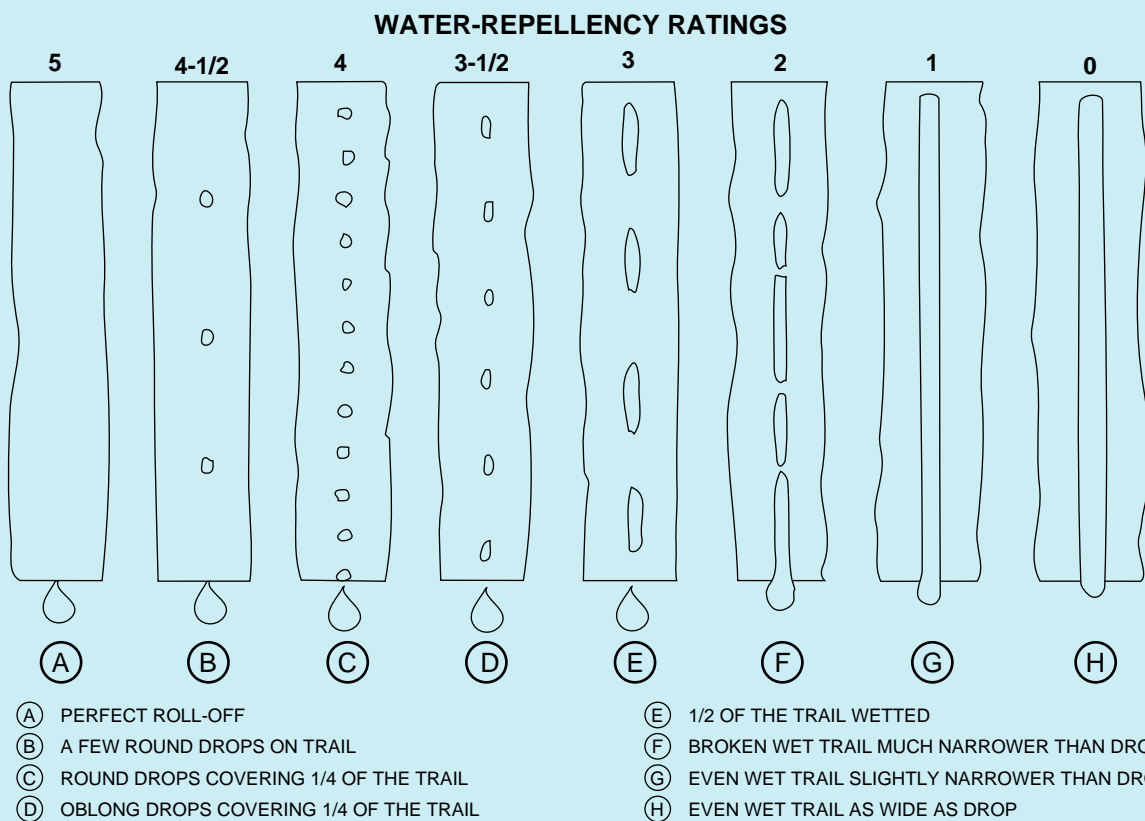


TABLE 6
Water Repellency Test for Linerboard Treated with Quilon® Chrome Complex
 (cf. TAPPI Routine Control Method RC-212)

Equipment: (1) Rack capable of holding length-wise an 8-1/2 × 11-inch sheet of liner-board at a 45° angle.
 (1) Eyedropper containing water.

Method: (a) Place 8-1/2 × 11-inch sheet of liner-board on rack.
 (b) Let a drop of water fall from the eyedropper onto the uppermost area of the linerboard.
 (c) Compare the trail made by the drop, as it rolls down the inclined board, with those depicted below to evaluate the water repellency of the board.



solution. If the treatment is not uniform, however, the problem may stem from uneven doctoring of the solution, poor contact between the transfer roll and the liner board, or foaming. Treatment of starch-sized boards is also likely to give poor results.

The water repellency and release of substrates treated with Quilon® chrome complex necessitate careful consideration of the adhesive needed to achieve good

bonding. Adhesives based on sodium silicate, and sometimes those based on starch, may not bond board treated with Quilon®. Those based on polyvinyl acetate or polyvinyl alcohol, however, can give excellent bonds.

The area to be glued should preferably be sprayed or sponged with water before the adhesive is applied, and the formulation should be high in resin content. If a treated surface is bonded to one not treated with Quilon®, the adhesive should be applied to the treated surface.

APPLICATION WITH POLYVINYL ALCOHOL (PVA)

Quilon® is used in conjunction with PVA in two ways and for three reasons: The two materials may be applied separately (Quilon® over PVA) or in the same solution; and the purpose may be to add grease resistance to the other properties of the Quilon®, to cross-link the PVA, or to retain the Quilon® on the surface of a porous substrate that would otherwise absorb it.

On a porous substrate good grease-resistant and release coatings may be obtained by applying a solution containing both Quilon® and a fully-hydrolyzed grade of PVA such as DuPont's Elvano® polyvinyl alcohol. The PVA increases the viscosity of the solution, coats the surface fibers and provides grease resistance, and the Quilon® provides release and water resistance.

The coating may be accomplished by any standard method, on- or off-machine. Loadings of 3 lb of Quilon® S or C with 2.5 lb of Elvano® 71-30 per 10,000 ft² give excellent results.

A popular combination is 6% Quilon® and 4% Elvano® 71-30. A PVA solution is prepared first, by sifting Elvano® into the vortex of rapidly stirred cold water (room temperature or below) to form an 8% slurry. This is heated at about 90°C (200°F) for 20–30 minutes while continuously agitating. When the Elvano® has dissolved, the solution is cooled to about 50°C (120°F), and cold water is added to result in a 4% solution. The temperature should fall to no higher than 40°C (100°F) before enough Quilon® is added, with good stirring, to make a final concentration of 5%. A defoamer may also be added. See page 9.

Alternatively, the PVA—or other non-starch size—may be coated on the paper and dried before coating it with Quilon®.

The cross-linking of PVA with Quilon® is irreversible. Equipment should therefore be washed immediately after use in order to avoid building up deposits of insoluble polymer.

TREATMENT OF POLYMERIC FILMS AND FOILS

Surfaces that are not readily wetted by water, such as DuPont's Mylar® polyester film, polyolefins and aluminum foil may be treated with Quilon® by several methods. Films can be corona treated, after which they may be coated with Quilon® exactly as for paper products.

Any substrate that is difficult to wet by water can probably be treated quite readily by dissolving the Quilon® (C is recommended, without neutralization) in isopropanol instead of in water. The treated substrate should be dried at temperatures up to about 120°C (250°F) if the substrate can tolerate it.

A third method of improving the treatment is to add a surfactant to the Quilon® solution. DuPont offers a broad line of hydrocarbon and fluorochemical agents for this purpose. The surfactant should not be anionic.

It should be noted that, although the FDA approval for the use of Quilon® on paper products (see page 12) is broad, there is no such coverage for its use on films and foil. FDA approval on these substrates is limited to the adhesively bonded area of a package.

INSOLUBILIZATION OF POLYMERIC SYSTEMS

This subject was alluded to in the section above on PVA, but insolubilization is not limited to that resin. Many water-soluble resins, including acrylics, glues and proteins may be cross-linked with Quilon®, improving the water-resistance of the resulting dye films. A typical loading is 5 parts of Quilon® per 100 parts of solution. Uses include the insolubilization of adhesives, vinyl coatings, protein binders and inks.

TREATMENT OF LEATHER

Tanned side-leather or suede treated with Quilon® H or M chrome complex has improved lubricity, dimensional stability, and resistance to water and stains. Appearance and durability are also enhanced. For instance, shoes and boots are treated with Quilon® to improve resistance to water, perspiration and farm chemicals. Suede garments treated with Quilon® retain their color and softness through repeated drycleanings; redyeing and refinishing are not necessary.

Chrome-tanned leather that has been retanned with a vegetable extract to a 10% level (based on the split/shaved weight of the leather) is a suitable side-leather for Quilon® M treatment^c. When applied during the fatliquoring operation, the formulation typically contains 10–40% Quilon® M. If the treatment follows the fatliquoring step, the Quilon® M concentration is 6–10% (again based on the weight of the leather).

In either method the pH of the treatment composition is adjusted to 3–4 and the temperature to 30–40°C (80–100°F). A drumming time of about an hour exhausts Quilon® onto the leather, as evidenced by fading of the typical blue-green color of Quilon®.

Colored suede can be similarly treated with Quilon® to make it drycleanable. The crusted suede is normally dyed at about pH 4. After a water wash at about 40°C (100°F), and treatment with a normal float at the same temperature, the pH of the float is adjusted to 3–3.5, and Quilon® is added to give a solution concentration of 10–20% (based on dry- or crust-weight). The reaction of Quilon® with the leather protein molecules is complete when the float has turned colorless.

^c U.S. 3,102,772, issued Sept. 3, 1963, DuPont Company.

TREATMENT OF FEATHERS

Prolonged exposure to moisture causes feathers to decay and lose their filling power. The “Tan-O-Quil QM” process^d combines a tanning operation and a water-repellent treatment, e.g., Quilon[®]M, that makes feathers decay-resistant, improving their filling power.

PROCEDURE

1. Immerse cleaned feathers in 25–35 times their weight of water in a digester tank equipped with paddles.
2. Add salt to give a 0.6–0.8 wt. % solution.
3. Adjust the pH to 3.4–3.6 with sulfuric acid.
4. Add a 4.6 wt. % solution of Tanolin[®] R basic chromium sulfate in water to give 10 wt. % concentration (based on the weight of the feathers).
5. Add Quilon[®] M to give 5% by weight of the feathers.

Exhaustion of the chrome composition is complete in about an hour. The feathers are rinsed, drained, centrifuged, and then dried at temperatures below 60°C (140°F).

FDA STATUS

U.S. REGULATIONS

The use of Quilon[®] in the manufacture of paper and paperboard products for use in contact with aqueous or fatty foods has prior sanction and is covered in FDA Regulation 21 CFR 181.22 and 181.30 (Substances employed in the manufacture of paper and paperboard products used in food packaging).^f The use of Quilon[®] in the manufacture of paper and paperboard products for use in contact with dry foods is covered in FDA Regulation 21 CFR 176.180 (Components of paper and paperboard in contact with dry food.)

Hexamethylenetetramine (HMT) must not be used to neutralize treating solutions if the treated surface will come in contact with aqueous or fatty foods. HMT may be used where contact is with dry foods only (21 CFR 176.180, Components of paper and paperboard in contact with dry food.)

Quilon[®] is cleared for use in adhesives under 21 CFR 175.105 (Adhesives), subject to an extraction limit.

The Meat and Poultry Inspection Program of the U.S. Department of Agriculture has no objection to paper treated with Quilon[®] for use in contact with meat or poultry.

FOREIGN REGULATIONS

Quilon[®] products have been approved for use in Canada and most European and Asian countries for applications similar to those approved by the U.S. FDA. Both myristic and stearic acid chromium chloride compounds are listed in the “Handbook of Existing Chemical Substances,” Second Edition, issued in February, 1981 by the Chemical Products Safety Division, Basic Industries Bureau, Ministry of International Trade and Industry (Japan). These compounds are approved for use in Korea, Hong Kong, Singapore, New Zealand, Australia, Philippines and Taiwan.

In Europe, Quilon[®] products are approved under certain conditions in Austria, Republic of Ireland, Belgium, France, Germany, United Kingdom, Italy, Netherlands, Switzerland, Scandinavia, Luxemburg and Israel. Customers should consult specific regulatory agencies to determine detailed clearances in each country.

STORAGE AND HANDLING

STORAGE

Quilon[®] chrome complexes are Class 1B flammable liquids. Keep them away from heat, sparks and open flames. OSHA regulations for “Flammable and Combustible Liquids” are contained in Title 29 of the Code of Federal Regulations (CFR) Section 1910.106 and must be followed when handling Quilon[®]. Positive ventilation is required in areas where containers of Quilon[®] are stored or solutions of Quilon[®] are prepared and used.

Containers should be grounded and all electrical equipment in the area should be explosion-proof. The recommendations of the National Electrical Code for Class 1 Hazardous Locations should be followed. Only non-sparking tools should be used. In case of fire, use water, dry chemical or carbon dioxide fire extinguishers.

^d U.S. 2,975,018, issued March 14, 1961, to the U.S. Army Quartermaster Corps.

^e Reg. U.S. Pat. & Tm. Off., Hamblet & Hayes Co.

^f Due to changing governmental regulations, such as those of the Department of Transportation, Department of Labor, U.S. Environmental Protection Agency, and the Food and Drug Administration, references herein to governmental requirements may be superseded. You should consult and follow the current governmental regulations, such as Hazard Classification, Labeling, Food Use Clearances, Worker Exposure Limitations, and Waste Disposal Procedures for the up-to-date requirements for the products described in this literature.

Keep drum closures up to prevent leakage. Never use pressure to empty drums of Quilon®. Do not store or mix with oxidizing agents.

Containers of Quilon® chrome complex should be stored in cool, shaded areas to avoid the possibility of degradation, as evidenced by sludging. Containers should be used in the order in which they are received.

Quilon® may be stored at ambient winter temperatures, except for C-9, H, L and L-11 in severely cold climates. (See freezing points in *Table 2*). All grades should be permitted to warm to the workplace temperature before use. If a small amount of sludge has formed it may redissolve as the material warms. If it does not, the solution may be decanted off. Large amounts of sludge are an indication that the product has deteriorated.

SPILL OR LEAK

Evacuate personnel and thoroughly ventilate the area. Remove sources of heat, sparks, and flame.

Wear a full chemical-proof suit with hood and breathing air supply. Dike the spill and soak up with sand, earth, or other non-combustible absorbent material. Transfer the material to a covered metal container. Prevent liquid from entering sewers, waterways or low areas. After removal, flush the spill area with plenty of water. Obey Federal, State and local regulations for reporting releases. The CERCLA reportable quantity for generic ignitables is 100 lb.

WASTE DISPOSAL

Waste from Quilon® may be a RCRA Hazardous Waste due to its generic ignitable and toxicity characteristics. It may be disposed of by a licensed incinerator or in a licensed landfill (dry material). Treatment, storage, transportation and disposal must be in accordance with applicable Federal, State/provincial, and local regulations. More information is available (item 6, page 14).

MATERIALS OF CONSTRUCTION

Acid- and chloride-resistant materials—Hastelloy^g C nickel-base alloy, Monel^h nickel-copper alloy or a construction metal or plastic protected by Lithcoteⁱ LC-34 resin coating, polyvinyl chloride, properly compounded neoprene, polyethylene, or glass—give optimal service in contact with Quilon® chrome complex and its solutions. Common construction materials such as mild steel, iron, and brass may be slowly corroded by solutions of Quilon®, but are nevertheless frequently used. Galvanized iron and tin may be noticeably attacked.

Rollers used to apply solutions of Quilon® to flat surfaces, such as paper, should be hard rubber or chilled cast iron. The pressure roll should be covered with resilient rubber. Chromium-plated rolls are also used, but are sometimes blistered by solutions of Quilon®. The problem may sometimes be overcome by discussing the environment with the plater, who may be able to reformulate his solutions.

SHIPPING CONTAINERS

All Quilon® chrome complexes are available in 15-gallon plastic-lined steel drums, 55-gallon plastic-lined steel drums, and 300-gallon semi-bulk tanks and tank trailer.

Department of Transportation (DOT) information:

Proper Shipping Name—Flammable Liquid, Corrosive, N.O.S.^j (Chrome III Complex in Isopropanol and Acetone)

DOT Placard—Flammable

Hazard Classification—Flammable Liquid, UN 2924

Drums carry the Department of Transportation (DOT) labels for flammable liquids and corrosives

PERSONAL SAFETY AND FIRST AID

HEALTH HAZARDS

Users of DuPont Quilon® should be thoroughly familiar with the DuPont MSDS.

The chromium in all Quilon® products is completely in the trivalent state. Unlike the hexavalent form, Cr (VI), which can be toxic, the trivalent form, Cr (III), is an essential trace mineral.

On contact, Quilon® chrome complexes cause eye burns and may cause skin irritation. When dried on a substrate, Quilon® is less hazardous. In patch tests on 200 human subjects, samples of wool gabardine that had been treated with Quilon® to a level of 2 wt. % caused neither skin irritation nor sensitization.

Quilon® solvent contains isopropyl alcohol, isopropyl chloride, acetone, and minor amounts of chloroacetone and other organic chemicals. Exposure to the vapors of Quilon® may cause eye irritation or tearing, and irritation of the respiratory system.

^g Reg. U.S. Pat. & Tm. Off., Cabot Corporation.

^h Reg. U.S. Pat. & Tm. Off., The International Nickel Co., Huntington Alloy Products Div.

ⁱ Reg. U.S. Pat. & Tm. Off., Lithcote Corporation.

^j Regulated as a Reportable Quantity material only when shipped in tank cars and tank trucks.

SAFETY PRECAUTIONS

Do not get Quilon® in eyes. Avoid contact with skin. Avoid breathing vapors or mist. Sufficient ventilation should be provided to keep vapor concentrations below established exposure limits; see the MSDS. Self-contained breathing apparatus or full-face air line respirators and a full chemical-proof suit should be available for use in emergencies. Wash hands thoroughly after handling. Wash contaminated clothing before reuse.

SITE FACILITIES

The following safety facilities should be readily accessible in all areas where Quilon® chrome complexes are handled or stored:

Fire Extinguishers—Carbon dioxide or dry chemical for small fires; alcohol-resistant foam plus water spray or fog for large fires.

Safety Showers—With quick opening valves which stay open.

Eye Wash Fountain—Or other means of washing the eyes with a gentle flow of tepid tap water.

PERSONAL PROTECTIVE EQUIPMENT

The following personal protective equipment should be made available and worn.

As routine:

- Safety spectacles with side shields
- Neoprene, PVC, or nitrile gloves
- Chemical splash goggles

As appropriate:

- Hard hat with brim
- Full length face shield
- Rubber apron
- Rubber safety shoes or rubber boots over leather shoes
- Complete chemical-proof suit
- Self-contained breathing apparatus or full-face air line respirator

In emergencies or in performing work where there is a possibility of direct or repeated contact, a complete chemical-proof suit with hood and breathing air supply should be worn.

FIRST AID

In case of contact with eyes, immediately flush with plenty of water for at least 15 minutes. Call a physician. In case of contact with skin, flush with water. Remove contaminated clothing and wash before reuse.

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

If swallowed, do not induce vomiting. Give two glasses of water or activated charcoal slurry. Call a physician.

ADDITIONAL INFORMATION

Further information on Quilon® or any other DuPont product may be obtained by calling (800) 441-9442 or (302) 774-2099. The following papers are internal DuPont publications and are supplemental to the information in this brochure:

1. "Chromium Complex Treatments for Paper," by Louis B. Fournier, Proceedings of the Technical Association of the Pulp and Paper Industry, 1984 Papermakers Conference, TAPPI Press. Reprint.
2. "Detection of Quilon® on Paper."
3. "Chrome Complex on Paper, Glass, Cloth or Film—Determination of Chromium by Atomic Absorption."
4. "Quilon® Chrome Complexes for Improved Performance of Polyvinyl Alcohol Paper Coatings, Films, and Adhesives."
5. "Factors Affecting Quilon® Chrome Complexes Solution Stability."
6. "Disposal of Wastes—Quilon® Chrome Complexes and Volan® Bonding Agents."
7. "Quilon® Chrome Complexes—MSDS."