What Chemical Finishes You Should Use for Your Fabrics
FINISHING

Definition:

* Any operation (other than preparation or dyeing) in the manufacture of textiles that improves the appearance and/or imparts useful characteristics to the fabric. May give same basic fabric multiple uses to over market versatility.

* Can be broken down into two categories:
  - Chemical Finishing
  - Mechanical Finishing
I. CHEMICAL FINISHING

- Process involves
  Application of finish solution
  Evaporation of solvent or water (drying)
  Heating to activate chemicals (curing)

- Reactors (Drying and/or Curing)
  Spray
  Foam
  Kiss and Engraved Roll Applicators
  Vacuum Extractors
  Padders

- Applicators
  Heating to activate chemicals (curing)
  Evaporation of solvent or water (drying)

Application of finish solution
Process involves

CHEMICAL FINISHING
Chemical Finishing

MA Kiss Roll

Regulator
Triatex MA Kiss Roll Applicator

Engraved Roll
Semi-Stable Foam

Distribution Chamber

Gaston County / Union Carbide FFT Applicator

Stable Foam

UM & M Stable Foam Horizontal Pad Applicator
Chemical Finishing

Foam Application 2 - Side with 2 - Floating Knives

A. Fabric
B. Idler Rolls
C. 1st Floating Knife
D. 2nd Floating Knife
E. Dryer

UM & M - Knife-Over-Roll
UM & M - Horizontal Pad
A. **Easy Care** - Cotton and Polyester/Cotton Fabrics

- Offers "Easy-Care" properties to textiles

  - Wrinkle Resistance
  - Shape Retention
  - No-Iron
  - Low Shrinkage

1. Chemicals

   a. DMDHEU
      (Dimethyloldihydroxyethylene urea)

Properties

- Lower free formaldehyde in bath
- Harder to cure
- Very stable shelf and pot life
- Used in delay cure (long shelf life)
- Lower formaldehyde release
- Good wash durability
- Acceptable chlorine resistance
- Does not affect lightfastness
- No iron
- Low Shrinkage
b. Urea Formaldehyde (DMU)

Properties

- Excellent crease recovery
- Highly reactive
- Stiffen hand by cross-linking

Disadvantages

- Poor wash durability
- Poor chlorine resistance
- Poor shelf life
- Poor pot life
- Affects lightfastness
- Formaldehyde odor
- Fish odor

c. Melamine Formaldehyde

Properties

- Good crease resistance with full stiff hand
- Yellows but does not tender cellulose with chlorine bleach
- Durable
- Used in many applications other than CRF
- Not water soluble but methylation increases water solubility
- Is solvent soluble
d. DMEU (Dimethyolethylene Urea)

Properties

- Good shelf and pot life
- Soft handle
- Cures at low temperatures
- Good DP properties
- Poor wash durability
- Poor chlorine resistance
- Affect lightfastness
- High free aldehyde release

Carbamates

Properties

- High free formaldehyde
- Very good hydrolysis resistance
- Good chlorine resistance
- Lower alkyl carbamates are toxic
- Hard to cure
- Higher losses in physical properties
**f. Catalyst**

*Depends on crosslink*

- Fiber
- Temperature of mix
- Time - Whiteness

- **Strong Acids**
  - Faster cure
  - More sheen change
  - Less stable

- **Latent Acids**
  - Needs heat to develop PH

  - Ammonium and amine salts
  - Affect whiteness
  - Stability - Poor one hour
  - If use with metal ions - hostile

- **Lewis Acids** (weaker salts)

  - Magnesium Chloride
    - Whiteness, Delivered bright

  - Hot Magnesium Chloride

  Aluminum Chloride

  Citric Acid

  Ammonium Chloride

*Used with regenerated cellulose*
g. Buffers and Alkalinity

Buffers are combinations of weak acids mixed with their strong alkali salts. Buffers maintain pH by neutralizing any added acid or alkali.

Citrates, borates and phosphates are deliberately added to resins to overcome yellowing, shade change and to improve lightfastness, eg. "buffered glyoxals"

Alkalinity is the name given to salts of strong base and weak acid which neutralize acids. They act like buffers.

Alkalinity is formed by the preparation process and must be maintained at a consistent level.

Both sources will consume catalyst so they must be controlled. Buffered resins require a greater catalyst-to-resin ratio. Uncontrolled alkalinity will result in widely varying results.
FORMALDEHYDE RELEASE AND CONTROL

1. Definition:

- Formaldehyde release is that emitted from fabric into the atmosphere.

- Free formaldehyde is that found in solutions

2. Test Methods

- AATCC Test Method 112 - Mason Jar measures release

- Titrations measure free formaldehyde

- Japanese methods less vigorous, measure only that which is extracted from fabric.

- Several other less commonly used test that vary in what is measured.
3. Sources of Formaldehyde Released in Jar Test

- **Cellulose Hemiformal** - easily released
  - Reaction of monomeric form with cellulose
  - Atmospheric formaldehyde
  - Free formaldehyde in resin baths
  - Formaldehyde liberated from crosslinking resin breakdown during cure

- **Unfixed or half fixed resins**, pendant \(-\text{N-CH}_2\text{OH}\)
  - A function of curing time, temperature, catalyst and buffers
  - Easily released if fabrics have an alkaline pH

- **Decrossing the Resin by the Test Conditions**
  - Residual acidity in fabric will cause the crosslinks to hydrolyze and revert to starting materials
  - Degree of hydrolysis depends on which reactant was used
  - Best to leave fabric as neutral as possible
4. Methods of Reducing Formaldehyde Release

- After Wash Cured Fabric
  - Costly
  - Can't be done for delay cure items

- Nitrogenous Scavengers
  - Coapply urea, carbohydrazide or ethylene urea with finish formulation

  * Reduction in formaldehyde depends on amount added

  * Additives partake of formaldehyde reactions and compete with the cellulose. Desired properties are impaired.

  * Residual NH groups cause chlorine damage and impair lightfastness of certain dyes

  - Apply the above after the fabric is finished

  * Fog, spray or mist
• Diethylene Glycol

- Coapply with finish. Caps pendant N-CH₂OH during cure.

* Gives good results without too much loss of DP properties. Has the added benefit of improving abrasion resistance.

- Nitroalcohols, sorbitol and propylene glycols also work

- Modified Reactants
ALKYLATED DMDHEU

DMEDHEU is reacted with methanol to form either partially methylated or fully methylated derivatives.

Properties:

- Partially methylated reduce CH$_2$O to 500 PPM
- Fully methylated reduce to 300 PPM
- Both require hot catalyst or longer cures
- DP properties are somewhat diminished

DIETHYLENEGLYCOLATED DMDHEU

Reacted with two moles of diethylene glycol.

Properties:

- Reduce CH$_2$O to 50 PPM
  - DP properties are less impaired than methylated DMDHEU
FABRIC PROPERTIES VS. DEGREE OF CROSSSLINKING

- **Good Properties**
  - No-iron (smoothness)
  - Shrinkage control
  - Shape retention
  - Wrinkle resistance

- **Bad Properties**
  - Tensile and tear losses
  - Loss in abrasion resistance

- **Dependent On:**
  - Reagent concentration
  - Time and temperature of cure
  - Catalyst-to-resin ratio
  - Catalyst type
  - Preparation Dyeing

- **Typical Formulation**
  - Resin \( 10-20\% \)
  - Catalyst \( 20-25\% \) OWR, \(^\text{Resin}\)
  - Wetting Agent \( 0.1\% \)
  - Softener \( 1-3\% \)
  - Other

- **Cotton vs. Blends**
SOFTENERS

• Purpose

- Improve hand
- Improve tear and abrasion
- Improve sewing
- Improve appearance

• Softener Selection Summary

- The physical state of the softener/lubricant will govern the corresponding hand of a fabric. Low viscosity lubricants are responsible for soft, pliable silky feel while solid waxes provide low coefficient of friction without changing the fabric’s hand.

- The softener material’s initial color and/or propensity to develop color when heated or aged must be considered when selecting the class of material to use.

- The softener material’s smoke point may cause processing problems.

- Fabric odors may be caused by certain class of softener materials.

- Softeners can alter the shade of the fabric. Some react with the dye to change it’s lightfastness properties while some will cause the shade to become darker (the same phenomenon that makes wet fabric look darker).

- Softeners can be responsible for poorer crockfastness by dissolving surface dye. Some may migrate onto adjacent light colored yarns causing them to be stained.
• Chemical Types

ANIONICS

- Sulfated Fats and Oils
- Sulfated Alcohols
- Sulfated Ethoxylated Derivatives

Properties of Anionic Softeners

- The anionic softeners impart pliability and flexibility without making the fabric feel silky. They are used extensively on fabrics that are to be mechanically finished such as those that are napped, sheared or sanforized. For mechanical finishing, some lubrication between the fabric and the mechanical device is needed, however the fibers in the yarn need a certain amount of cohesiveness otherwise the fabric will be overly damaged.

- Sulfonated oils (eg. turkey red oil) impart a soft raggy hand.

- Sulfonated tallow impart a full waxy hand.

- Sulfonated fatty esters will impart a smooth waxy hand.
Advantages:

* Most show good stability towards heat and some are resistant to yellowing.

* Anionic softeners do not interfere with finishes to be foamed, in fact some will improve the ability to foam certain finish formulations. Hydrophobic softeners act like defoamers and cause problems when one wants to apply the finish by foam finishing techniques.

* Anionic softeners have good rewetting properties and are preferred for those fabrics that must absorb water such as bath towels.

Disadvantages:

* Anionics are inferior to the softness performance of cationics and some anionics. Generally, more anionic product must be used and even then, the cationics and some nonionics impart a softer, fluffier feel to the fabrics.

* Anionics have limited durability to laundering and drycleaning.

* The anionics will not exhaust from a bath, they must be physically deposited on the fabric. They tend to be sensitive to water hardness and to electrolytes in finish baths.

* Anionics are also incompatible in some finish baths, especially those containing cationically stabilized emulsions.
CATIONIC SOFTENERS

Aminoamides
Imidazolines
Fatty Amines
Quaternary Ammonium Salts

Properties of Cationic Softeners:

Advantages

- Cationic softeners impart very soft, fluffy, silky hand to most all fabrics at very low levels of add-on.

- Cationics will exhaust from dyebaths and laundry rinse baths making them very efficient materials to use.
- Cationics will exhaust from acidic solutions.
- Improve tear resistance, abrasion resistance and fabric sewability.
- Compatible with most resin finishes.
- Good for fabrics to be napped or sueded.

Disadvantages

- Incompatible with anionic auxiliary chemicals
- *Poor yellowing resistance
- May change dye shade or affect lightfastness of some dyes
- *Retain chlorine from bleach baths
- Adversely affects soiling and soil removal
- May impart unwanted water repellency to some fabrics
NONIONIC SOFTENERS

Ethoxylated Hydrophobes

Sorbitan Fatty Esters

Polyethylene Emulsions

Silicone Emulsions

Dimethyl Fluids

Reactive Silicones

Amino Functional Silicones

Properties:

- Silicones are water clear oils that are stable to heat and light.
- They produce a slick silky hand and are preferred for white goods.
- They improve tear and abrasion resistance and are excellent for improving sewing properties of fabrics.
- Amino functional silicones improve DP performance of cotton goods

Disadvantages:

- The silicones are water repellent which make them unsuitable as towel softeners.
- Silicones are expensive compared with fatty softeners.
- Better luster, better crocking
SILICONE WATER REPELLENTS

Advantages-Disadvantages

- Silicone water repellents are durable to washing and drycleaning. Durability is brought about by forming a sheath of finish around the fiber. If the sheath cracks, durability is lost. Absorption of hydrophilic substances found in drycleaning and laundry products also impair water repellency.

- Silicones are more durable than wax repellents but less durable than fluorochemical finishes.

- Silicones are more expensive than wax repellents and less expensive than fluorochemical repellents.

- Silicone finishes resist water borne stains but not oil borne stains.

- Fabric hand can be made soft and pliable.
FLUOROCHEMICAL REPELLENTS

Rainwear Formulation

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Bath Conc. %</th>
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<tbody>
<tr>
<td>Fluorochemical Product</td>
<td>2.0 - 3.0</td>
</tr>
<tr>
<td>Resin Wax Water Repellent</td>
<td>2.0 - 3.0</td>
</tr>
<tr>
<td>DMDHEU</td>
<td>10 - 15</td>
</tr>
<tr>
<td>MgCl₂ Catalyst</td>
<td>2.5-4.0</td>
</tr>
<tr>
<td>Polyethylene Softener</td>
<td>0.5-2.0</td>
</tr>
<tr>
<td>Nonrewetting Surfactant</td>
<td>0.03-0.05</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>0.05-0.1</td>
</tr>
</tbody>
</table>

 Cure  360°F
 20-30 sec. fire

Properties:

- Durable to laundry and dry cleaning
- Resists oils as well as water
- Specially formulated products are used for upholstery as well as carpet antisoil finishes
SOIL RELEASE FINISHES

**Purpose:** Allow soils and stains to be removed by laundering.

**Chemical Principle:** Make fiber surfaces hydrophilic

**Chemical Types:**

- Exhaustible
  - Used on 100% polyester fabrics. Works best on textured.
  - Applied in dye bath.
  - Enhances water wicking, comfortable.
  - Doesn't work well on flat filaments and spun yarns.
  - Improves anti-redeposition.

- Acrylics
  - Used with durable press finishes
  - Good "used-motor" oil release
  - Stiff hand
- Temperamental
- Industrial laundry fabrics

**Dual-Action Fluorochemicals**

- Confers oil repellency with soil release
- Used on durable press items
- Softer hand
- Good soil release
- Expensive

**Flame Retardants**

**Non-Durable Salts**

Ammonium Bromide
Borates
Ammonium Phosphate

**Durable**

Pyrovatex
THPC/NH₃