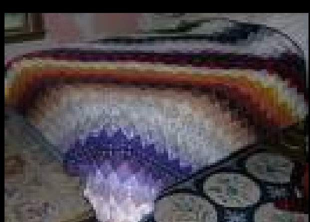
Fabric Conditioners

Agenda

- Introduction
  - Basic Features
  - The Softening Effect
  - Fabric Softener History
  - Consumer Requirements

- Fabric Softeners
  - Basic Tech Aspects
  - Components by Function
  - Manufacturing Process
  - Formulas
  - The Future
  - Main issues in formulations and process
  - Conclusions

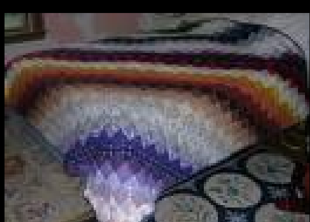
Introduction:
The Softening Effect



→ How does the FS work?

- It deposits lubricating chemicals on the fabric.
- Fiber negative charge interacting with Softening chemicals. Static charge neutralization.
- These chemicals help in the fiber separation giving volume to the fabrics.
- Between softener molecules water molecules can be interchanged between the fabric and the media.

Introduction:
The Softening Effect



- Why was a need?
  - The first fabric softeners were developed by the textile industry during the early twentieth century.
  - The process to dye cotton fibers left them feeling harsh. In the early 1900s, preparations known as cotton softeners were developed to improve the feel of these fibers after dyeing.

Introduction:
More History

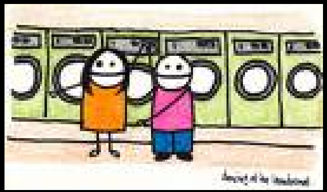
→ How was the evolution?

- By the 1960s many major marketers, including P&G, begun to sell liquid fabric softeners for home use.
- The popularity increased over the next decade due to new formulations that provided improved softness and more appealing fragrances.
- The major disadvantage: softener chemicals not compatible with detergents and can not be added to the washer until all the detergent has been removed in the rinse cycle.
- In the late 1970s it was found a way to deliver some fabric softening benefits in a dryer sheet format.
- In the 1990s, eco-minded manufacturers began test ultra-concentrated formulations. One-quarter as much product has to be used and they can be packaged in smaller containers but success remains to be seen.
- By the end of the 1990s, US liquid fabric softeners sales reached ~ $700 million/year. About $400 million worth of dryer sheets are sold per year.
- P&G (Downy) and Lever Brothers (Snuggle) dominate about 90% of the market share while private label brands account for the remaining 10%.

Introduction:
customer requirements

- Viscous and creamy product aspect.
- Fragrance as important as the softening effect itself in all stages
  - POP
  - Service Area
  - Damp and dry cloth.
- No yellowing effect on clothes.
- No greasy but soft fiber.
- No softener materials floating on liquor surface.

Fabric Softeners
The Basic Tech Aspects



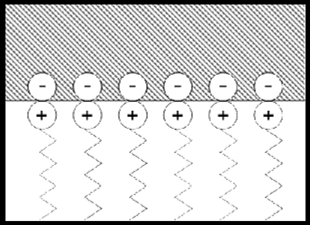
- Fabric Softeners
  - Formula
    - Active chemical ingredients
    - Other Raw Materials Involved in formulation
  - Process
  - Typical formulas
  - The future
  - Main technical issues
  - Conclusions

Fabric Softeners
Active Components

→ Conditioning agents

Function

They provide fiber softening and Substantivity effect providing pleasing touch sensation, perfume fixation. It also provide stability to the formulations. No build-up effect on fibers and not fabric properties modifications like water absorption.

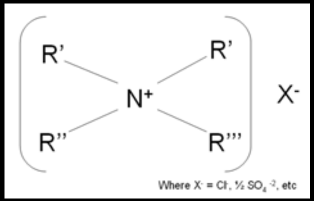


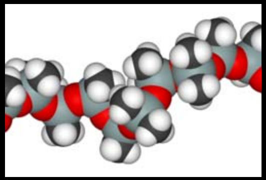
- Early FS formulas were simple dispersions of fatty materials like dihydrogenated tallow dimethyl ammonium chloride (DHTDMAC), better known as quaternary ammonium compound, or quats.
- Part of the molecule has a positive charge that attracts and binds it to negatively charged fabric fibers.
- This charge interaction helps disperse the electrical forces that are responsible for static cling.
- The other part of the molecule is fatty in nature and it provides the slip and lubricity that makes the fabric feel soft.

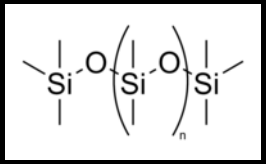
Fabric Softeners Components

→ Conditioning agents (cont)

Quats pros and cons and quats alternatives







- Quats do soften fabrics but also can make them less absorbent.
- Modern formulations use quats in combination with other ingredients that lower substantivity but less likely to interfere with water absorption (critical for towels and diapers)
- One of the new classes of materials is polydimethylsiloxane (PDMS). A silicone based fluid that lubricate fibers to give improved softening and ease of ironing.
- Other silicones used include amine- and amide-functional silicones and silicone gums.
- Silicone derivatives are modified to be more substantive to fabric, dramatically improving its feel.

Fabric Softeners Components

→ Emulsifiers

- Conditioning ingredients are not soluble in water due to their oily nature so emulsifier must be added to form a stable mixture.
- Without emulsifiers the softener liquid would separate into two phases
- The types of emulsifiers used in FS formulations:
  - Micro-emulsions: it creates oil particles that are so small that light will pass around them. So it is characterized by its clarity and transparency as opposed to being milky white. The silicone particles are so tiny that they will actually penetrate into the fibers, while macro-emulsions only deposit on the fiber's surface.
  - Macro-emulsions: creamy dispersions of oil and water similar to hand lotions or hair conditioners. The emulsifier molecules surround the hydrophobic oil or silicone droplets and allow them to be dispersed in water.
  - Emulsion polymers: create dispersions that look similar to a macro-emulsion but just create a stabilized web of molecules that suspend the tiny silicone droplets like fish caught in a net.

Fabric Softeners Components

→ Emulsifiers (cont)

- Emulsifying system must be chosen carefully to ensure the appropriate level of deposition on the fabric.
- A blend of non-ionic emulsifiers (those that have no charge) and cationic emulsifiers (those that have a positive charge) are typically used.
- Anionic surfactants (which have a negative charge) are rarely used. The fabric conditioning agents have a positive charge which would tend to destabilize an anionic emulsion.

Fabric Softeners Components

→ Others ingredients

- In addition to conditioning agents and emulsifiers, FS's contain other ingredients to improve their aesthetic appeal and to ensure the product will be shelf stable.

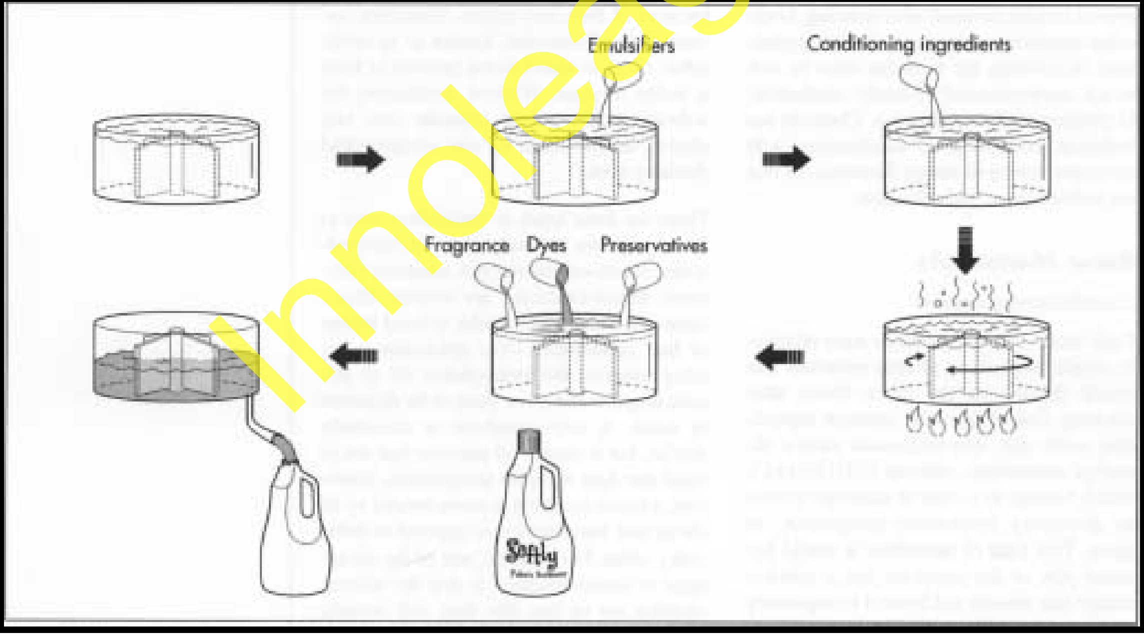
  - Fragrance
  - Color
  - Emulsion stabilizers
  - Preservatives

Both are added to make the product more pleasing to consumers.

are used to ensure the product quality.

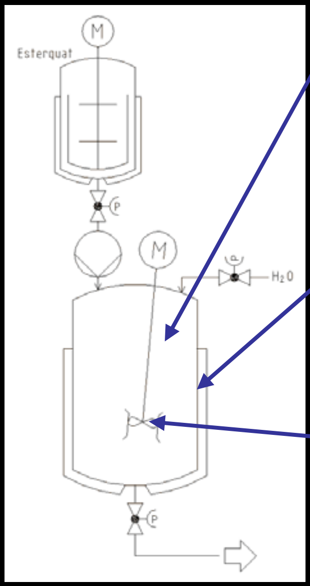
Fabric Softeners Components

- Other ingredients (cont.)
  - The emulsifiers and then conditioning ingredients are added to water. The batch is heated and mixed. Then the other ingredients are added.



Fabric Softener Manufacturing process

→ Process



- The preferred method involves heating the ingredients together in one large mixing vessel.
- Mixing tanks should be constructed from high grade stainless steel to prevent attack from the corrosive agents in the formula.
- The tank is typically equipped with a jacketed shell that allows steam and cold water to be circulated, so the temperature of the batch can be easily controlled.
- The tank is fitted with a propeller type mixer that is driven by a large electric motor. This kind of mixing blade provides the high shear that is needed to properly disperse the ingredients.

Fabric Softener Manufacturing process

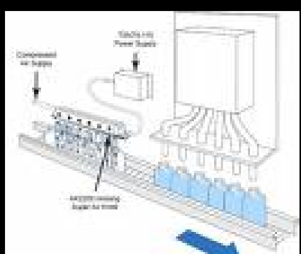
→ Process (cont)

- 1. To fill the tank with the specified amount of water, the carrier for all the other ingredients. Deionized water is used because it is free from metal ions that can affect the performance of the batch.
    - – Conventional formulations can contain as much as 80-90% water.
- 2.After water addition heating and mixing is initiated.
- 3. When the water has reached the appropriate temperature, the emulsifiers are added.
    - These chemicals tend to be waxy solid materials, they are added at relatively high temperatures (between 70-80°C). It usually more effective to disperse the emulsifiers prior to adding the less water-soluble materials.
        - – Emulsifiers are used between 1-10%.
- 4. The conditioning ingredients are added to after the emulsifiers.
    - – For a typical strength formulation about 5% is used. For more concentrated formulations, levels of 10% are more common. When blends of quats and silicones are used, the silicones are used at levels as low as 0.5-1.5%.
    - – When pre-emulsified silicones are used in the formula they are added late in the process when the temperature is lower and there is less mechanical agitation in the batch. If higher molecular weight silicones are used that have not been pre-emulsified they must be added to the batch at high temperatures with a high level of agitation to ensure the silicone oil is dispersed.

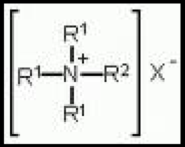
Fabric Softener Manufacturing process

→ Process (cont)

- 5. Heating and mixing continues until the batch is homogeneous. At this point cool water is circulated around the tank to lower the temperature.
- 6. Then the remaining ingredients (preservatives, dyes, and fragrance) are added.
  - These ingredients are used at much lower concentrations, typically around 0.5% percent for fragrance and less than 1% for preservatives and dyes.
- 7. When the batch is complete, a sample is sent to the analytical chemistry lab to ensure it meets quality control standards
  - Solids, pH, and viscosity.
- 8. The completed batch may be pumped to a filling line or stored in tanks until it is ready to be filled.
  - When it is transferred to an automated filling line: Plastic bottles are fed onto a conveyor belt that carries them under a filling nozzle. At the filling head there is a large hopper that holds the formulation and discharges a controlled amount into the bottle. The filled package continues down the conveyor line to a capping machine that applies the closure and tightens it. Finally, the filled bottles are packed in cartons and stacked pallets for shipping.



Fabric Softener
Typical Formula



Ingredients	Examples	%
Emulsifiers		
	Alcohol Ether Sulfate (SLES)	
	Alkylsulfonate	5.0 - 15
	Alcohol Ethoxylated	
Conditioning agents		
	DHTDMAC (di-hard tallow dimethylammonium chloride)	
	DHTIMS – imidazolinium methosulfate	
	PDMS	1.0-10.0
	Silicone (polydimethylsiloxane polymers) and its organo-modifications (include amine- and amide-functional silicones and silicone gums)	0.1- 1.0
Co-softeners		
	Glyceril monoestearate	
	Stearic Acid	0.5-5.0
	Tallow alcohol	
	Lanolin derivatives	
Preservatives		
	Formol	0.0-0.5
Fragrance		0.2-0.8
Water		85-95.0

Fabric Softener
Case Study Formulation

TABLE 4 Fabric Softener Formulation Used for Case Study

Material	% wt/wt
DHTDMAC	13.20
Tallow Amine 15:1 EO	1.91
Stearic Acid	0.59
Perfume	0.30
Calcium Chloride (2H2O)	0.7-0.9
Dyes	0.005
	(0.25% of a 2% stock)
Preservative	0.05
Water	Balance

Source: Ref. 54.

Fabric Softener
Antibacterial Formulation

Anti-bacterial Fabric Softener based on conventional Quat

Composition				
	Trade Name	**INCI-Name / Chemical-Name**	**Supplier**	**% w/w (as supplied)**
Part A	TINOSAN® HP 100	Hydoxydichlorodiphenyl Ether	Ciba Specialty Chemicals	0.30
Part B	Neodol 25-7 E	C12-15 Pareth-7	Shell Chemicals	0.50
	Arquad 2HT-75	Quaternium 18 (and) Isopropyl Alcohol	Akzo Nobel	4.00
Part D	Water	Water		qs to 100
	Perfume and Preservative			qs

Technical Data	
Appearance	Turbid
pH value	5,0
Viscosity (Brookfield DVIII+, LV)	250 m.Pas

Manufacturing instruction

Part A is dissolved in the part B and 10% of the calculated amount water by stirring and heating up to about 35°C.
Complete to 100% with part C.

Bacteriostatic activity on treated cotton (CG147e)	**Inhibition zone**
Staphylococcus aureus ATCC 9144	14 mm
Escherichia coli NCTC 8196	8 mm

Fabric Softener
Latin American Formulation

TABLE 3 Latin America Fabric Softener Formulation

Material	% wt/wt
DHTDMAC	3.50
Glyceril Monoestearate	3.00
Perfume	0.60
Blue Dye	0.002 (0.10% of a 2% stock SN.)
Preservative	0.10
Water	Balance

Source: IFF Database

Fabric Softener
Latin American Formulation

TABLE 2 Latin America Fabric Softener Formulation 2

Material	% wt/wt
Ester Quat	3.00
Stearilic Alcohol	1.50
Perfume	0.50
Blue Dye	0.004 (0.20% of a 2% stock SN.)
Preservative	0.12
Water	Balance

Source: IFF Database

Fabric Softener
The future

- **Formula areas**
- Two formula related areas will affect the future of fabric softeners.
  - The impact the ultra-concentrates on the market. It is too soon to tell if they will be accepted by consumers.
  - The role that multi-functionality will play in the future. As chemists develop new more efficacious ingredients there is more potential for additional consumer-perceivable benefits. Multifunctional fabric softener formulations are the latest trend. These products soften clothes,improve the ease of ironing, reduce wrinkling in the dryer and provide stain protection. Both UL and P&G have capitalized on this trend with new formulations that deliver multiple fabric care benefits.

- **New forms to make softeners easier to use.**
- One new method introduced by P&G in the late 1990s is the "Downy Ball."
  - A reusable plastic tennis ball sized sphere that is filled with liquid Downy and added to the washer at the beginning of the cycle. The ball stays sealed during washing but the spinning of the rinse cycle triggers it to open and release the softener. For consumer who do not have an automatic softener dispenser on their washing machines, the "Downy Ball" saves them from the trouble of adding the liquid in a separate step.

Main Tech Issues

→ Foaming

- Can appear due to
  - Non-ionic presence
  - Low-Molecular-weigh fatty acid presence
    - coconut fatty acids
  - Alcohol addition
    - Quat cutting
  - Amido-amines
    - contaminated with fatty acids
  - Equipment contamination
    - With Anionic surfactant

Main Tech Issues

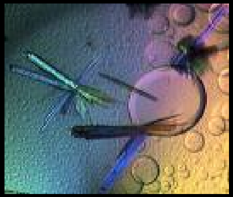
→ Viscosity Control

- Viscosity can drop out due to the presence of electrolytes
  - Water used
  - Quat used
- Non-ionic surfactants
  - Can be part of the perfume solubilizers
- Poor or improperly Dispersion

Main FS Tech Issues

- Viscosity Control (cont)
  - Viscosity of the packed product can increase
    - Thickening on standing
      - High shear during mixing
      - Electrolyte presence in water
        - Particularly during the hot process phase

Main Tech Issues



- Phase Separation
  - Normally has to do with:
    - Bad procedures during dispersion
    - Low quality quats
    - Free Amines content
    - Use of thickeners
    - Use of Fatty acids
- Lumps and greasy stains have the same reason why's.

Main Tech Issues

→ Fragrance modification

- The perfume is attached to the fabric fiber thanks to the Quats hydrophobic chains
- The main reasons for perfume modifications are:
  - Poor quality Quat usage
  - Non saturated molecules.
  - Quat hydrolysis
  - Builders
  - Contaminations that oxide the perfume ingredients or catalyse the perfume oxidation.

Main Tech Issues

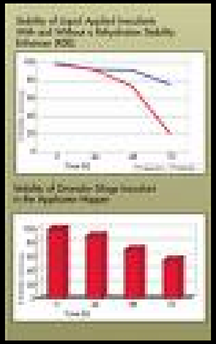
- Product Stability

It is necessary to ensure the product is of acceptable quality throughout its entire storage period.

- New and existing products raise many new technical challenges.
- One of the most important is how long will the product keep and at what temperature and conditions?
- How can shelf-life be extended and by how long?

- Shelf-life testing are connected to consumer acceptability.
  - Often shelf-life can be extended through addition of antioxidants, stabilizers, superior packaging or temperature control.

Main Tech Issues



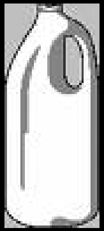
→ Product Stability

- During storage relevant chemical and physical properties of the product are monitored under defined conditions using methods capable of detecting changes, deterioration or degradation
- Those aspect to be checked are:
  - Active ingredients and/or components content:
  - Product aspect:
    - Color
    - Viscosity
    - Phase separation
  - Perfume modification:
    - Note
    - Intensity
    - Color

Main Tech Issues

→ Product Stability

- Typical conditions are:
  - 4°C, RT (room temperature from 20 to 30°C), 37°C and 45°C.



Humidity conditions are not considered critical as product is generally stored in closed bottles

Storage stability of all submissions presented/recommended should continue till 12 weeks.

- Others:
  - Thaw cycles or freeze, 4°C, RT, 37°C, 43°C, 50°C and sunlight (photo stability)

Conclusions

→ Care in Fabric Softener formulation is crucial.

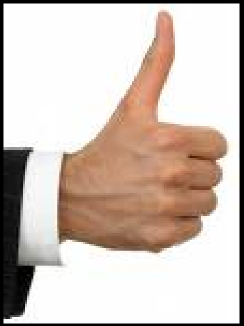
- The softener contains a dispersion of a solid conditioning ingredients insoluble in water
  – The system is unstable *per se*
- Quat and water quality are critical to avoid problems in formulations.
- The simpler the formula, the better and more stable the fabric softener.

Conclusions

→ Perfume

- For most consumers, the perfume is as important as the softening effect.
- Active ingredients having low or poor quality endanger the fragrance pleasantness and stability.
  - Interference in POP, providing malodour to the base.
  - Interference in fragrance ingredients fixation, fabrics are not well scented.

Conclusions



→ Quality

- The consumer is being more demanding.
- Softening requirements will be greater
  - Laundry bar soaps in decadence
  - Washing machine usage is growing.
- People strongly reject products that turn yellow or stain clothes.