



Advancements in Cationic Cotton Technologies



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Meet the Presenters



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Sustainability Manager*
Dow



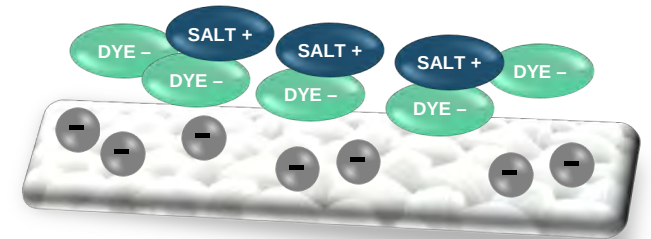
Advancements in Cationic Cotton Technologies

Basics of Cationic Cotton

- Previous Cationic Cotton Webinar: *Subtle to Striped: Sustainable Fashion With Cationic Cotton*, June 26, 2016.
- Cationic cotton refers to cotton that has been chemically modified to possess a permanent cationic (positive) charge
- Concept has been researched for ~50 years
- Ionic attraction of negatively charged dye to cationically charged cotton
- Negates the use of salt, reduces dyestuff, reduces process consumables, and can lead to overall lower costs

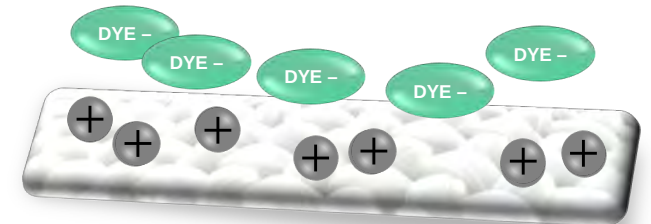
Conventional cotton

Natural negative charge repels dye and requires salt



Cationic cotton

Permanent positive charge attracts dye



Value to the Industry

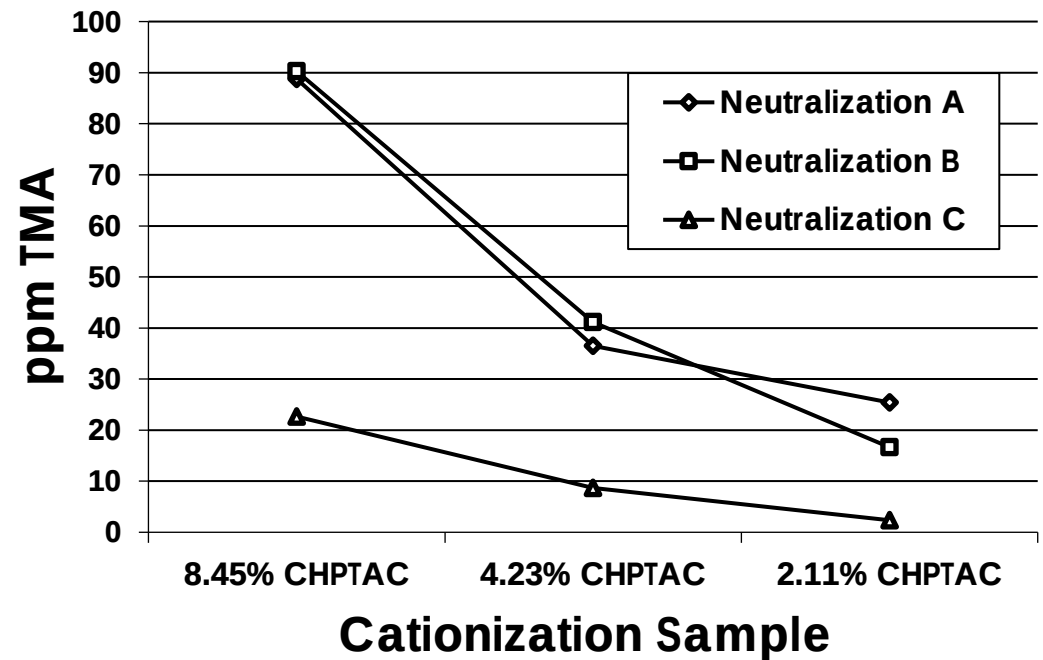
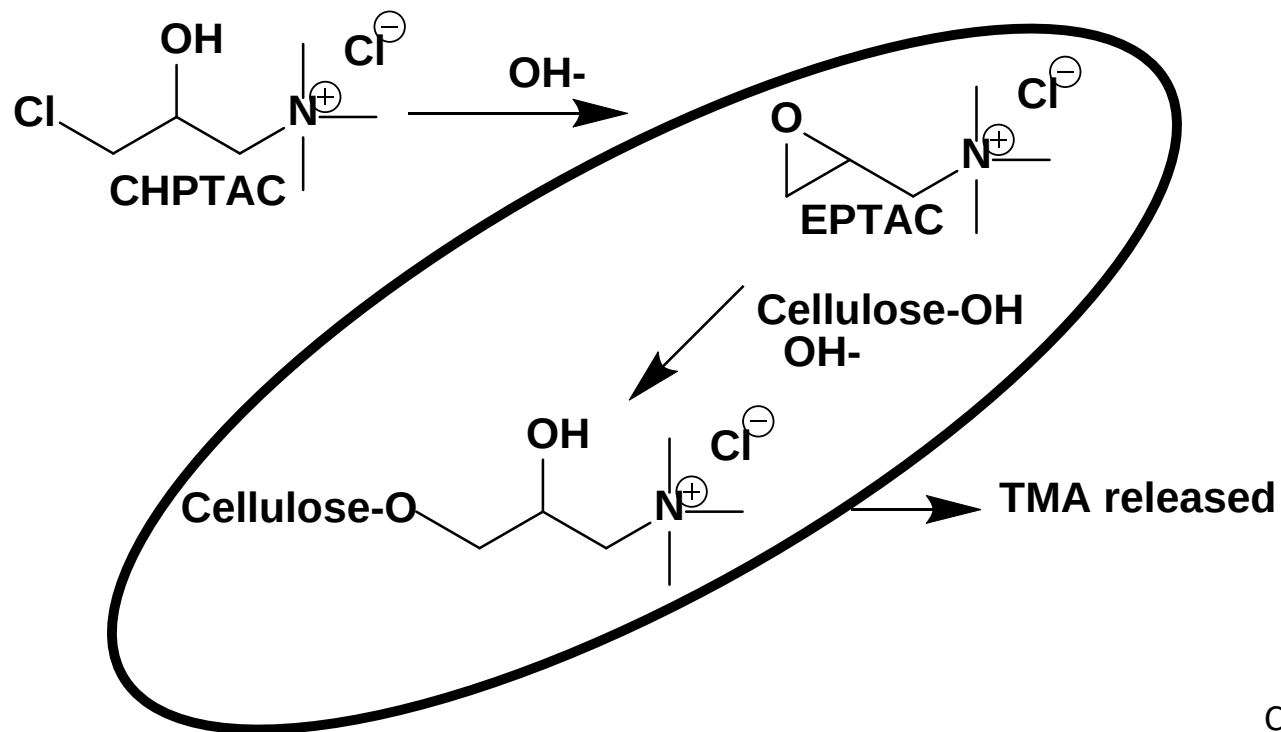
*If consumption trends continue, we'll need **3x as many natural resources** to produce clothing in 2050 compared to 2000.*

Cationic cotton can play a key role in more sustainable textile production.

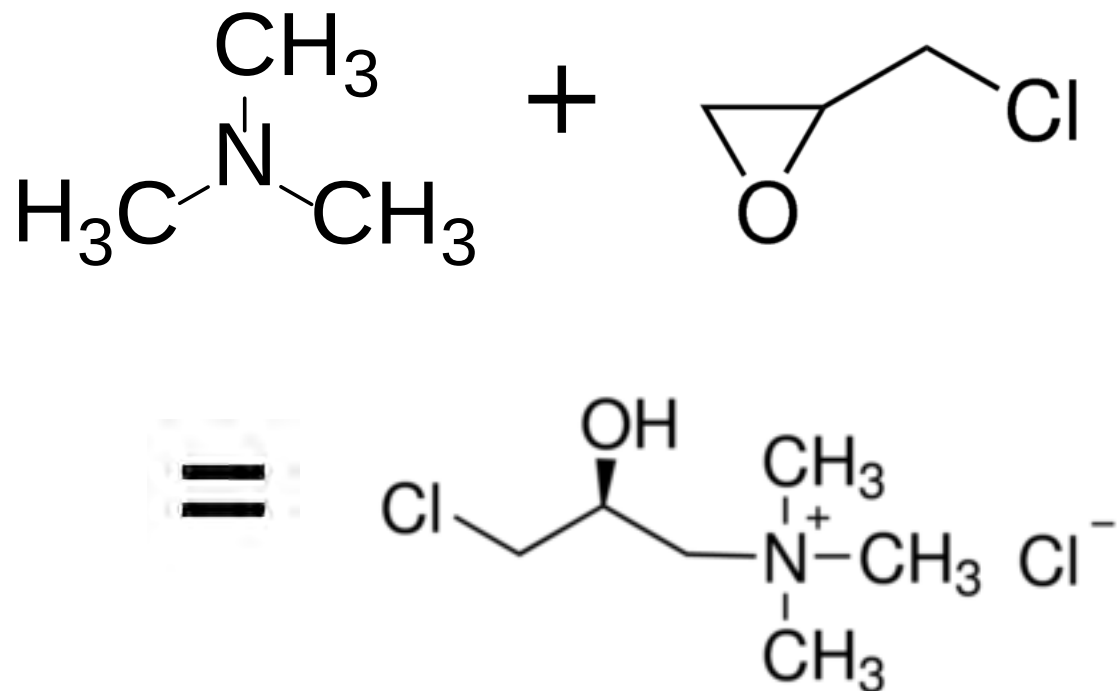


Chemistry of Cationic Cotton

Typical cationization reagent, 3-chloro-2-hydroxypropyltrimethylammonium chloride (CHPTAC)
“Quat 188”

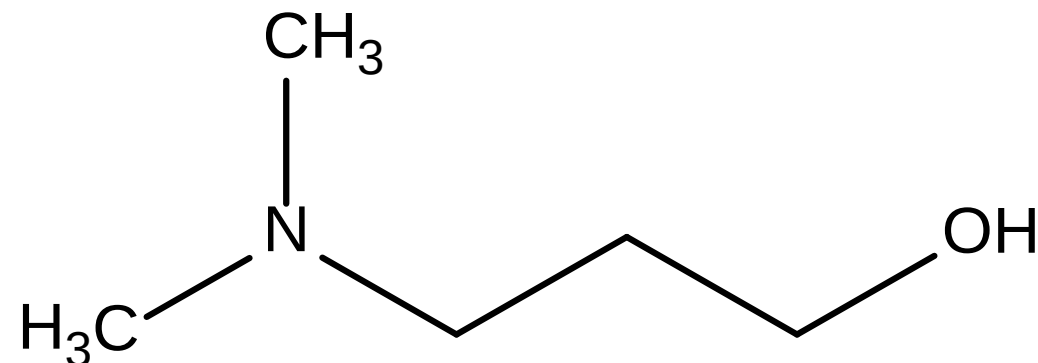


Synthesis of CHPTAC

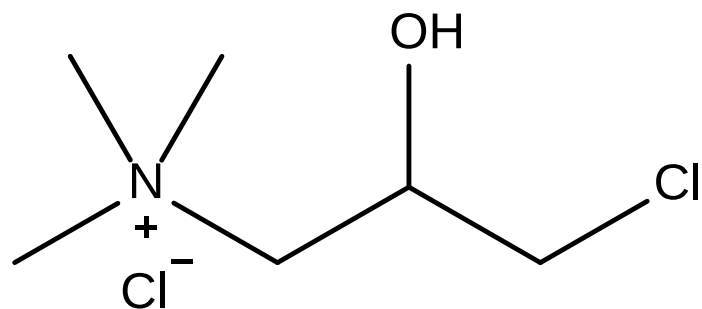


Alternative non-volatile amines

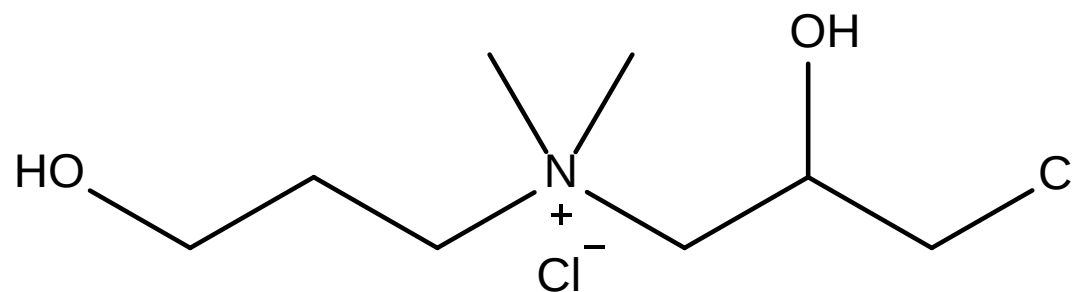
- Low steric hindrance
- Minimal side reactions with EPI
- Economical



Molecule Comparison



CHPTAC
Quat 188



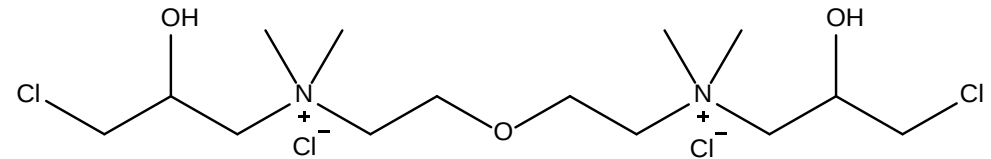
CHPDMAP

ECOFAST™ Pure Textile Treatment

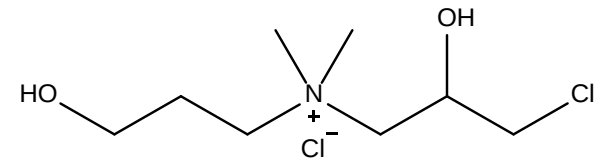
- Dow was approached for interest in producing the new molecule
- Dow shared their newly patented cationization molecule, BEDQ, tradename ECOFAST™ Pure
- Also made from a non-volatile amine, bifunctional in reactivity and cationic sites
- **No odor**



BEDQ
ECOFAST™ Pure



CHPDMAP



Testing Cationic Cotton Treatments

Dyeing Comparison

- Initial applications to confirm product efficacy and no odor
- Presented at 2018 AATCC ICE, ECOFAST™ Pure officially launched

Conventional Dyeing	Black Shade	Reactive Dyes	o.w.g.	Sodium Sulfate	Sodium Carobonate	Sodium Hydroxide
		Black	3.79%	90 g/L	3.0 g/L	3.5 g/L
		Orange	0.74%			
		Red	0.11%			
Cationic Dyeing	Black Shade	Reactive Dyes	o.w.g.	Sodium Sulfate	Sodium Carobonate	Sodium Hydroxide
		Black	2.46%	N/A	1.5 g/L	1.75 g/L
		Orange	0.48%			
		Red	0.07%			

- 33% Less Dye
- No Salt
- 50% Less Alkali
- 20% Time Savings
- 2 less rinses*

Dye bath Comparison

- Improved dye use efficiency and less water use in rinses

Conventional



CHPTAC

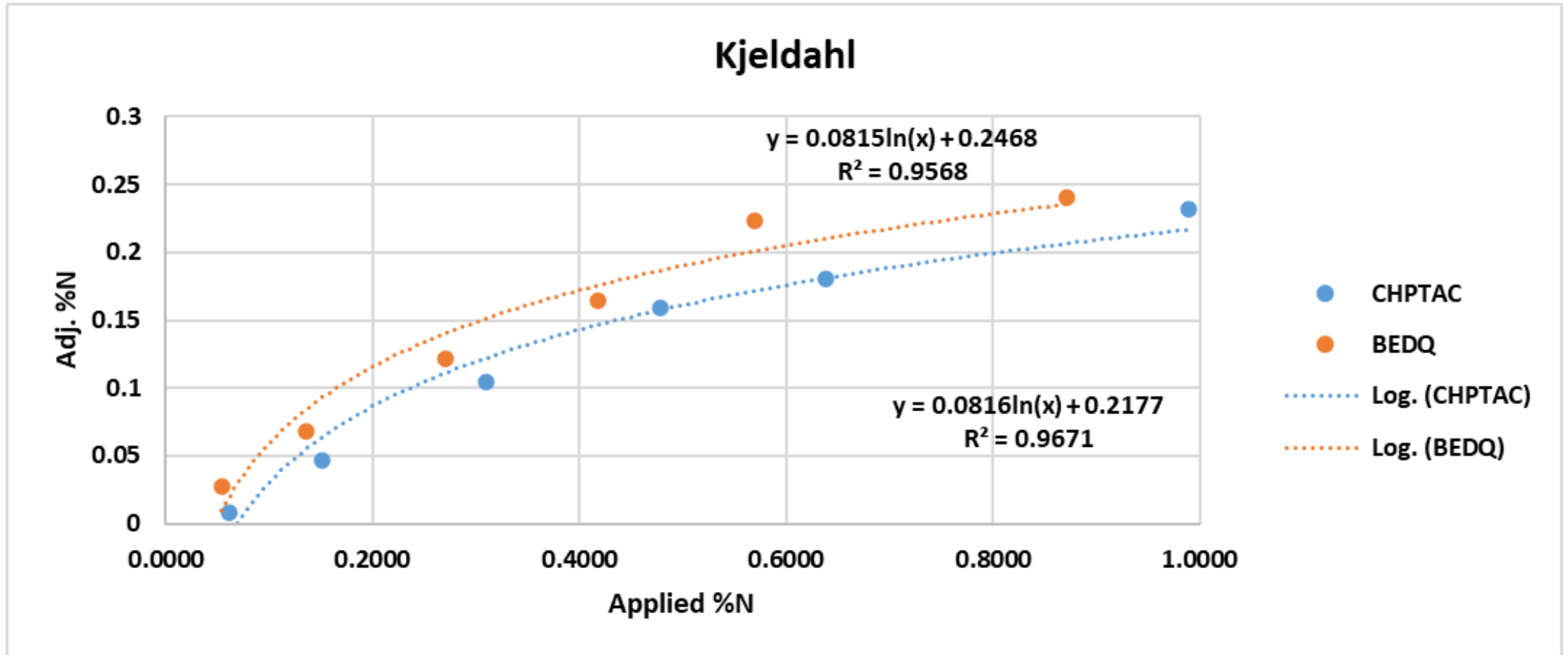


BEDQ
ECOFAST™ Pure

Increased Collaboration for Impact

- Cotton Incorporated and Dow have collaborated to explore and validate ECOFAST™ Pure, including comparison to Quat-188
- Analytically evaluated ECOFAST Pure vs Quat 188 in cold pad batch, pad steam, exhaust, and pad dry cure processes
 - ECOFAST Pure outperforms and improves cationization efficiency in all processes
- Evaluated nitrogen both by Kjeldahl and combustion techniques
- Evaluated effect of wet pick up on cationization efficiency
- Collaborated to build Dow's kinetic calculator

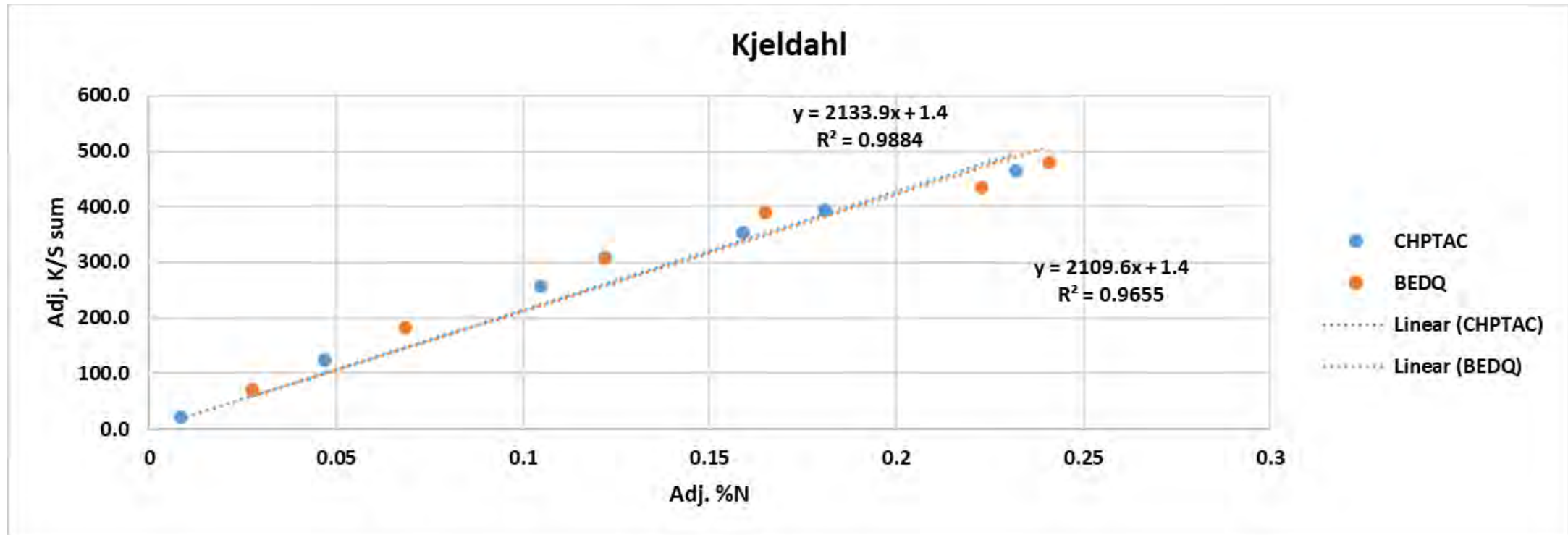
Cold Pad Batch Comparison



Cold Pad Batch Dyeability

Is there a difference in dyeability?

With limited dyes evaluated, have not observed appreciable blocking effects



Validating the Benefits

**ECOFAST™
Pure
enables...**

↓ **90%**
process
chemicals

↓ **50%**
dye

↓ **50%**
water

↓ **40%**
energy

**Key Life Cycle
Assessment
Insight**

↓ **63%**
GHG emissions when
using ECOFAST™ Pure

Other considerations

- Optimized with pad application
- Registered at **ZDHC** Gateway
- Meets **MRSL** standards



Addressing Common Concerns with Cationic Cotton

Challenges Utilizing Pre-Cationized Cotton

- Purchasing pre-cationized fiber can be an attractive alternative to fabric treatment
- Dark shades such as black or navy may only require a simple scour for, bright shades and/or performance requirements may dictate a bleach preparation
 - Typical bleach formulas and process over-activate hydrogen peroxide species causing extensive fiber damage, loss of dyeability, and low whiteness index
- Without the ability to control the treatment levels, and in general, the cationization may work “too well” in attracting dyestuffs
 - Quick strike of dyes onto cationic cotton can cause unlevel dyeings, plotchy appearances, and may impact fastness properties

Investigating the Bleaching of Pre-Cationized Cotton

Table I.
Effect of Bleaching Temperature on Cationized Cotton Fabric

Cotton Fabric	Bleaching Temperature	Bath after Bleaching		Final Fabric Properties		
		% NaOH Consumption	% H ₂ O ₂ Consumption	WI-CIE	Burst (PSI)	% Strength Loss
Uncationized	Greige	—	—	9.5	81.3	—
	100 °C	32	51	82.0	90.0	−10.7
Cationized	Greige	—	—	20.3	63.2	—
	100 °C	82	94	50.5	30.1	52.4
	90 °C	72	90	52.0	30.2	52.2
	80 °C	54	67	53.2	38.4	39.2
	70 °C	42	44	49.2	41.9	33.7
	60 °C	37	31	43.8	50.3	20.4

- Statistical analysis of design of experiments with factors including bleach temperature, time, concentration of caustic and hydrogen peroxide and magnesium sulfate
- Responses included whiteness index, burst strength, and dyeability

Key Considerations for Bleaching Pre-Cationized Cotton

- Direct input of magnesium sulfate (Epsom salt) key in quenching over activation of peroxide system
- Difficult to increase whiteness, burst strength, and dyeability responses at once
- 3-7 g/L of H_2O_2 and 0.5-1 g/L of MgSO_4 are suggested in consideration of all responses
- Other factors including time, temperature, and caustic determined by fabric requirements

Bleaching Visualization

Table III. Effect of MgSO ₄ on Bleaching Cationized Cotton Fabric						
Bleaching Temperature	MgSO ₄ Conc. (g/L)	Bath after Bleaching		Bleached Fabric Properties		
		% NaOH Consumption	% H ₂ O ₂ Consumption	WI-CIE	Burst (PSI)	% K/S _{dyeing}
100 °C	0	82	94	50.5	30.1	81.5
	0.5	46	27	64.4	58.0	90.9
90 °C	0	72	90	52.0	30.2	82.5
	0.5	41	18	59.6	61.8	95.8

Controlling Strike Rate by Process Changes

- The influence of temperature, dye structure, and addition of soda ash on dyeing kinetics and levelness of cationized cotton were evaluated utilizing real-time dyebath monitoring
- For most of the dyes, significantly better dyeing levelness was obtained by lowering the dyeing temperature although the strike rate was minimally slowed
- Addition of soda ash has different effects on dyeing kinetics and levelness for different dyes
 - For VS-MCT dyes, the addition of soda ash has a relatively small influence on the dyeing performance.
 - For MCT-MCT dyes, eliminating soda ash from the initial dyebath significantly reduced the dye strike rate and improved dyeing levelness.

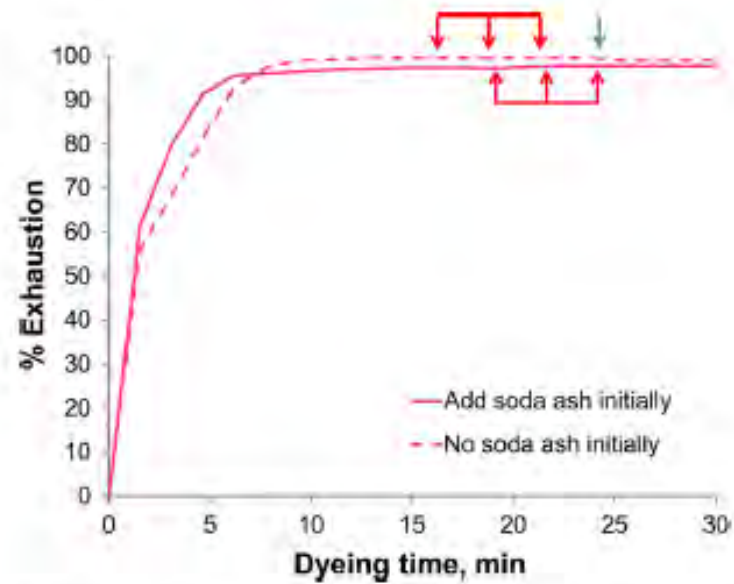
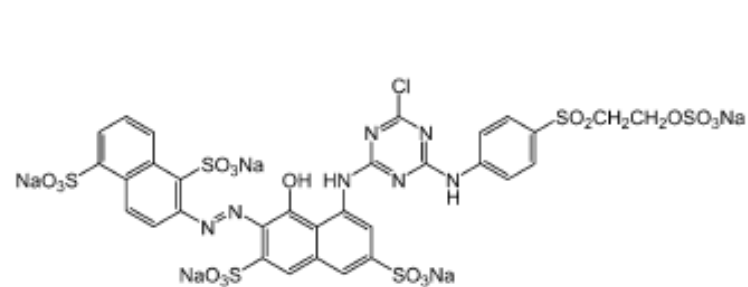
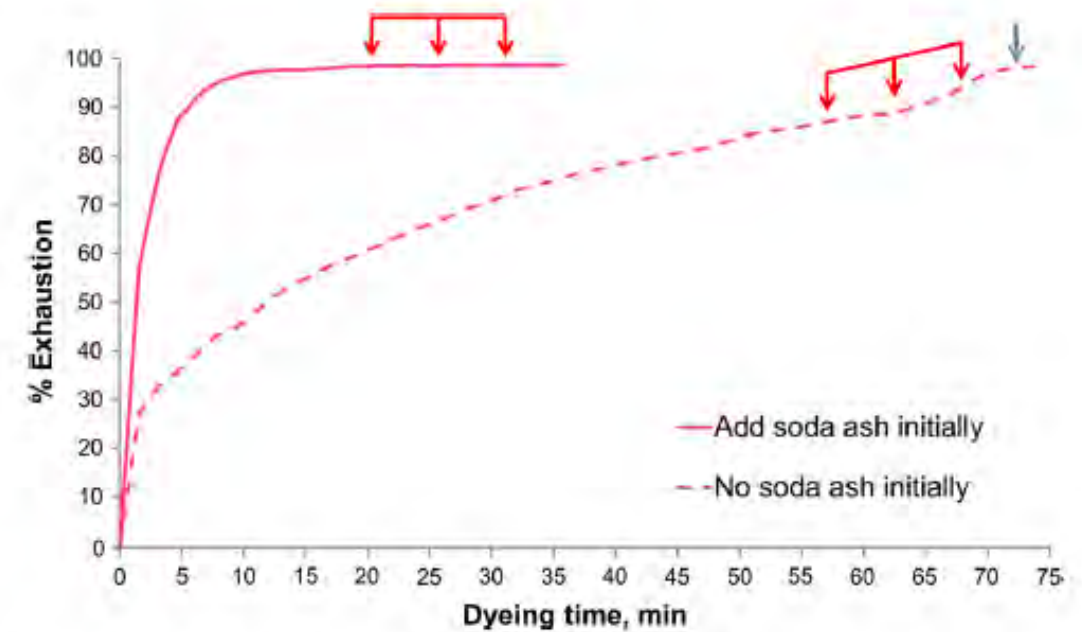
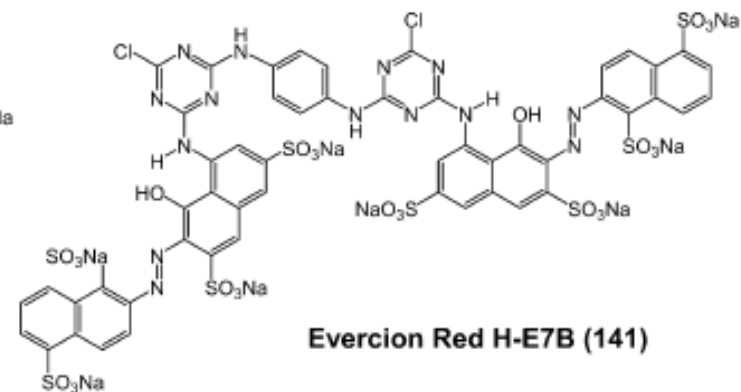


Fig. 9 The influence of soda ash on the exhaustion kinetics of Everzol Red 3BS



Everzol Red 3BS (239)



Evercion Red H-E7B (141)

Controlling Strike Rate by Chemical Means

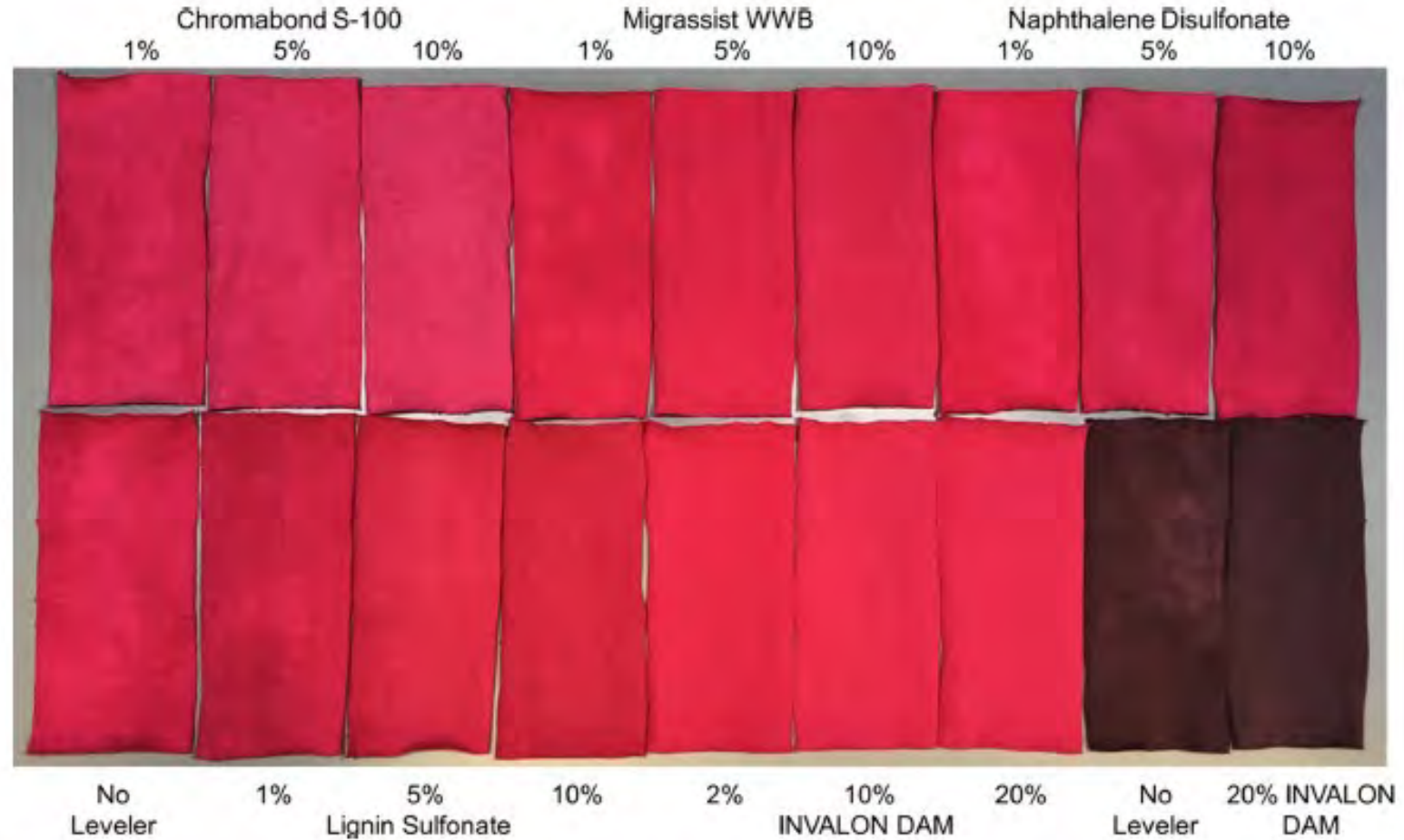
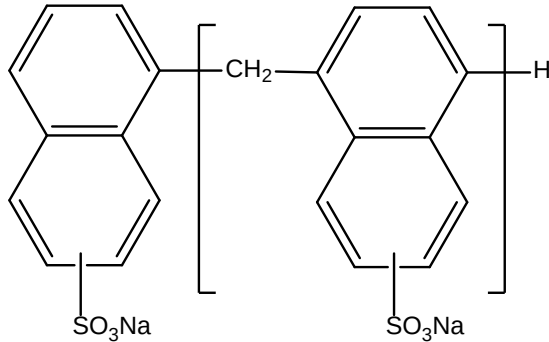


Fig. 12 Cationic cotton fabrics dyed with different leveling agents

Key Recommendations for Strike Rate



- Naphthalene sulfonate formaldehyde condensate is key component to allow dye retardation, obtain levelness, but still obtain near complete exhaustion
- Dye exhaustion temperature as low as possible
- Add soda ash late in process
- Utilize condensate levelling agent
- Add dye in parts or progressively

Fig. 13 The effect of adding dyes in portions on the exhaustion of Reactive Red 239

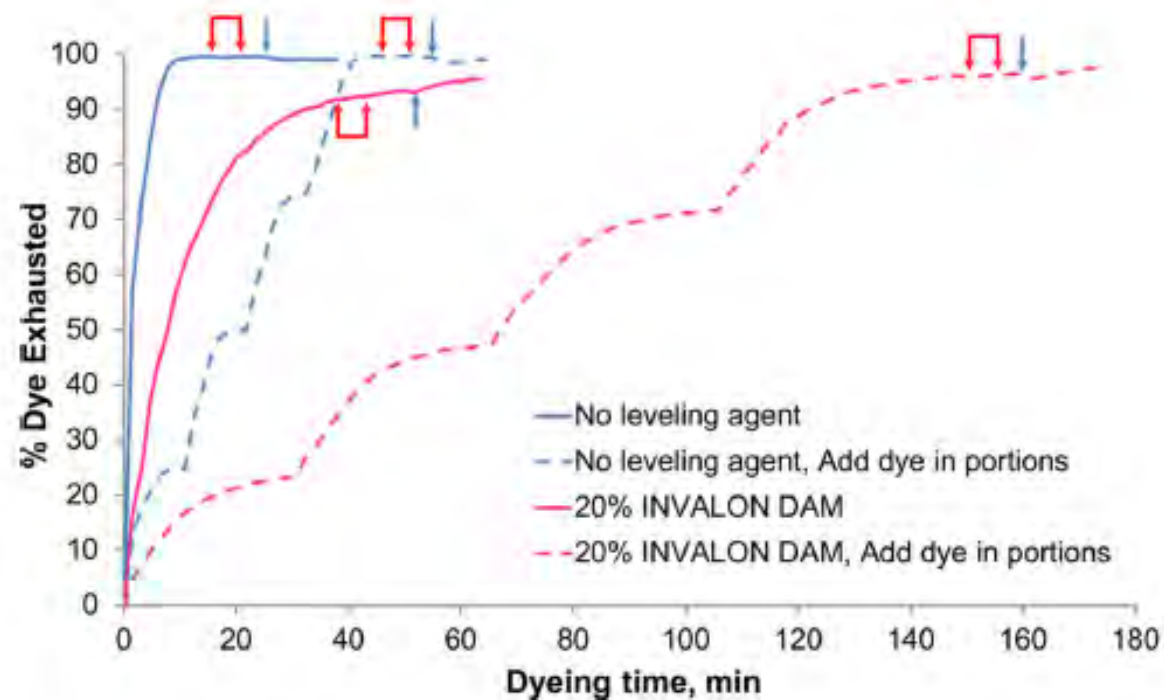


Table 7 The effect of adding dyes in portions on dyeing cationized cotton with Reactive Red 239

Addition of dye	Conc. of INVALIDON DAM	Dye exhaustion monitoring			Dyed cationized cotton		
		Initial rate (%/min)	Max. rate (%/min)	Final exhaustion (%)	L*	K/S	Levelness (σ)
All in	No leveling agent	36.8	11.1	99.0	40.71	13.95	0.678
	20%	15.3	5.8	95.5	42.59	11.14	0.318
Add in 4 portions	No leveling agent	8.1	6.2	98.3	40.31	15.81	0.796
	20%	3.2	2.1	98.3	41.80	12.12	0.217



Advancements in Cationic Cotton Technologies

Cationic Cotton

Topics > Sourcing & Manufacturing > Dyeing

ADD TO LIST ?

COTTON *Picks*

In the textile dyeing process, there are significant challenges related to dye affinity, colorfastness, color flexibility, and quick replenishment to meet consumer demand. The cationization chemistry is REACH registered. The application of cationic reagent chemistry to cotton can transform

Cationic Design Possibilities

Cationic cotton technology prepares the fabric to accept a greater variety of dyes and provides for greater flexibility in the color offerings. Unique designs can be achieved by altering the level of cationization (higher = deeper color) and creating fabrics using both cationized and conventional cotton in the same fabric. Altering the level of cationization can help create tonal effects in the fabric, while blending with non-cationized yarn creates areas that do not take the dye, yielding clean crisp lines. Yarn dye effects can also be created with alternating cationic and noncationic yarns. Cationic cotton can be used for 100% cotton or blended yarns.



What is Cationic Cotton?

Cationic cotton is cotton that has been chemically modified to possess a permanent cationic, or positive, charge. Although the concept of cationic treated cotton has been available for many years, this innovative technology has continued to grow in popularity among companies exploring ways to reduce water, energy and chemical consumption in the development of their products, while also seeking ways to increase responsiveness to consumer fashion demands with more versatile and on-trend fashion offerings.

When immersed in water, cotton naturally possesses a neutral or mildly negative charge. Common dyes used for cotton also possess a negative charge. Like common poles of magnets, the same charges repel each other. Therefore, in typical dyeing of cotton, salt and alkali are used in the dyebath to reverse the charge on cotton so that it has a positive charge, allowing the dyes to react and bond to the cotton. Cationic treated cotton is chemically modified to possess a permanent cationic,

Cationic Cotton

Learn more about cationic cotton on CottonWorks™.

Go to cottonworks.com/cationic-cotton.

FABRICAST™

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If you know what you're looking for, you can search FABRICAST™ directly.

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Fabric Category

- ☐ Wovens (582)
- ☐ Knits (541)
- ☐ 3D Digital Fabrics (139)
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- ☐ FABRICAST™ New Release (75)
- ☐ Natural & Sustainable (53)
- ☐ Trending Fabrics Active (47)
- ☐ Denim Basics & Beyond (34)

Fabric Type

Fiber Content

Fabric Weight

Fabric Technology

Showing 1-32 of 1124 FABRICAST™ Fabrics



6170 ISP
Dobby



6714 A
Herringbone



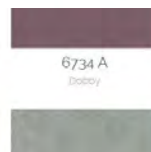
6727 B
Plain



6730 B
Satin - Warp Face



6730 D
Satin - Warp Face



6734 A
Dobby

[View all Knits](#)

Wovens

Many unique woven structures, technologies, and washdowns are featured in the woven FABRICAST™ developments. Woven fabric developments provide structure and durability, and can be featured in many different product applications from denim to outerwear. Explore Cotton Incorporated's one-of-a-kind woven FABRICAST™ selections and learn how to integrate these fabrics into any supply chain.

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Advancements in Cationic Cotton Technologies



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