Sustainability through Chemical Selection along Footwear and Apparel Value Chain

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The "Environmental Targets" within Sustainability

Product life cycle view:

- Raw materials
- Factory operations
- Transportation
- Use and disposal

All impacts from chemicals use

- Air, water, soil
- CO2 emissions
- Waste
- Health

Important aspects for the assessment of sustainable chemistry

- Selection of appropriate assessment baseline metrics
  - Environmental impact in g chemical/kg product
  - Energy consumption in MJ/kg product
  - Specific consumption in g or l/kg product
- Balance between collecting data and data set use
- Transparent reporting of results
- Application to all products (needed update)
- Must set priorities and cut-off criteria
- IT tool to calculate accumulated numbers

Possible instruments to build up sustainable products and related processes

Å RSL concept for consumer safety

ï Provides clear instructions for product requirements

ï Implementation challenges

ï Poor consideration of factory related aspects

Å Life cycle analysis ï time consuming, expensive, internally challenging

Å Regulations such as REACh ï complex and slow

Basic Elements for Process and Product Assessments

- Factory environmental impact (chemical and textile)
  - **Emissions**
    - Air = g carbon or substance/kg product
    - Wastewater = g TOC or substance/kg product
    - Energy and CO2 emission factors in MJ/kg or g/kg product
  - **Consumption and waste**
    - Consumption factors for water, energy and chemicals
    - Generation of waste per kg of product
- Consumer and associated environmental impact
  - **Residual/releasable chemicals in mg/kg product**

Two Successful Examples:

Resulting in reduced impact to environment and consumer

Å Synthetic Leather Manufacturing

Å Oil and water repellent fabric and garment manufacturing

Synthetic Leather – Prior Situation

Å PVC based ï chlorine chemistry, energy, waste

Å Solvent based PU´s ï reproductive toxic solvents

Å Toxic catalysts and additives (plasticizers)

Å Partly instable PU´s and crosslinkers decompose during any heat application

Å These chemicals and materials pose potential risks to factory workers, environment and consumer

Synthetic Leather – New Situation

Å Enhanced knowledge on chemical risks
Å Problematic organic solvents replaced by water
Å Organotin catalysts replaced by harmless substitutes
Å Remove lead and cadmium based pigments
Å Plasticizers avoided through smart PU backbone design
Å APEO as emulsifier replaced by biodegradable substitute

Major advantages for manufacturing and consumer

- Minimized occupational health issues for factory workers from solvents
- Reduced process emissions to ambient air and avoidance of cost intensive off gas treatment
- Improved waste water quality
- Minimized residual solvents in synthetic leather avoiding RSL conflicts
- Eliminated risks from thermal decomposition of any PU coated materials
- Significantly reduced risks from sensitizing additives

Oil and water repellent fabrics – prior situation

- Use of emulsifiers such as PFOS and PFOA
- High residual fluorinated telomers and monomers from polymerization
- Organotin catalysts
- High solvents content
- Crosslinkers not fully reacted may release toxic decomposition products during ironing
- Residuals from these chemicals pose potential risks to factory workers, environment and consumer

Oil and water repellent fabrics – new situation

Å Enhanced fluorochemicals products due to improved synthesis knowledge and care ï C6 technology

Å PFOS and PFOA replaced or minimized as impurity

Å Residual fluorotelomers significantly reduced

Å Organic solvents predominantly replaced by water with biodegradable emulsifiers

Å Substitution of organotin catalysts

Major advantages for manufacturing and consumer

- Minimized occupational exposures for factory workers
- Minimized process emissions to ambient air
- Eliminate PFOA or PFOS release to factory and consumer environment
- Reduced wastewater loading from non biodegradable ingredients and heavy metals
- Minimized residual solvents, telomers and other impurities in apparel avoiding RSL conflicts
- Contribution to lower energy, water and detergent consumption from reduced laundry cycles

Further examples for sustainable chemistry minimizing costs and risks in whole value chain

- Elimination of carcinogenic azodyes and sensitizing disperse dyes ï workers and consumer
- Environment and consumer friendly carrier dyeing
- Thermostable and biodegradable synthetics manufacturing lubricants (global release to air and water around 500,000 t/a of mainly hydrocarbons)
- Low emission textile auxiliaries and colorants (- 90 % to air)
- APEO free detergents, textile auxiliaries and colorants
- Formaldehyde low resins and gas heated stenters
- Phthalates alternatives for screen prints and polymers

Thank You

Together we can enhance sustainable chemistry through technology

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