Advancements in Composite Cover Technology for Calender Applications

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RETHINK PAPER:
Lean and Green

Composite Cover History

- Composite covers introduced in the late 1980's
- Initially had a high failure rate
- Replaced cotton filled rolls
- Improved calender capabilities
  - Higher load
  - Higher temperature

Original Composite Cover Details

- No reinforcement fiber
- Resin did not contain any fillers
- Fillers were eventually added to the resin
- Simple manufacturing processes

Original Composite Cover Issues

- Poor wear resistance
- Poor impact resistance
- Lack of experience
- Poor operator training
- Elementary cover design
- 25-50% of all covers replaced annually

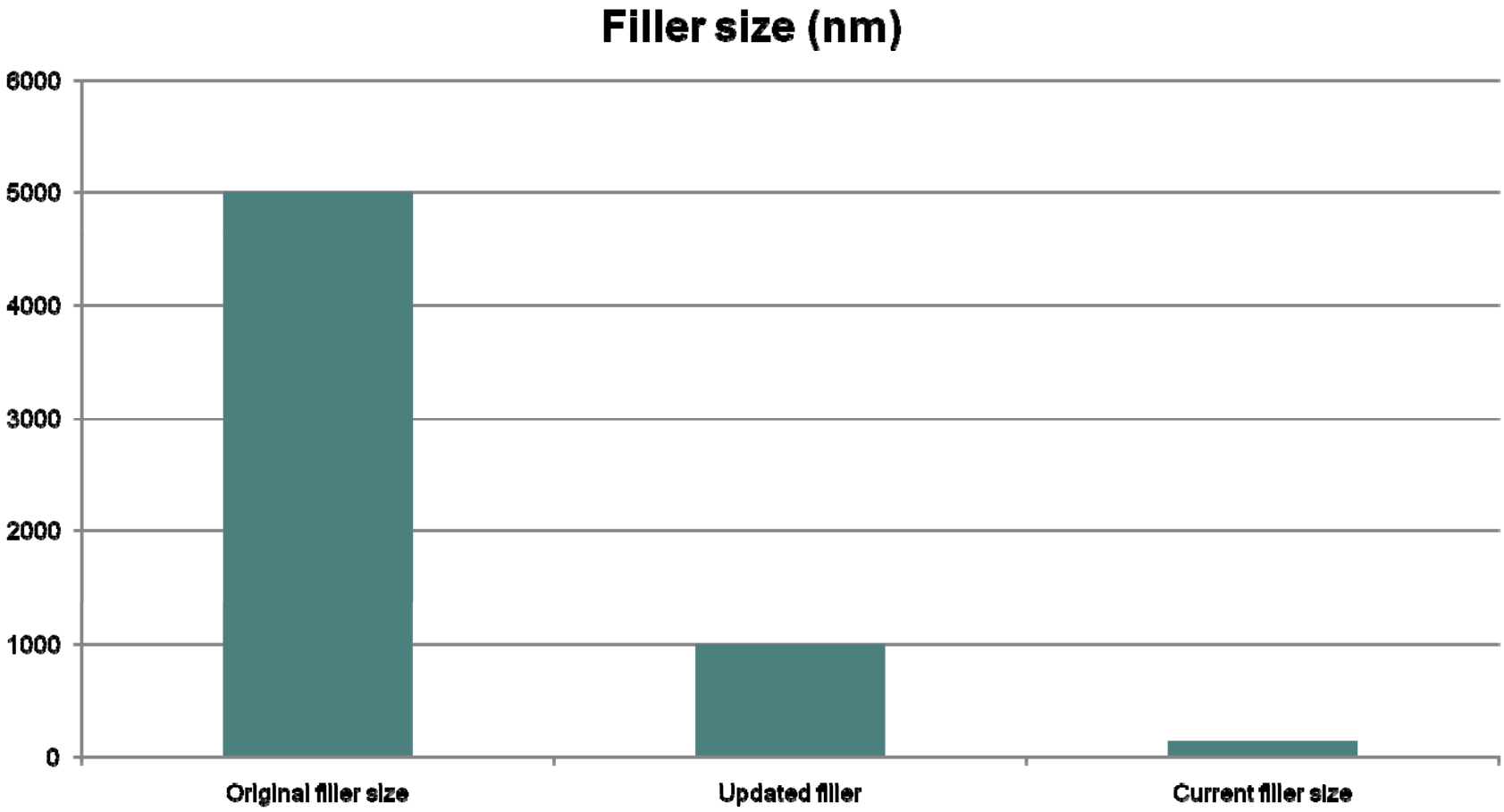
Resin Improvements in Composite Calender Covers

- Filler improvements
  - Improved materials
    - Silicon Carbide
    - Titanium Dioxide
  - Filler shape and size
    - Consistent filler shape
    - Decreased filler size
  - Improved cover ductility

Material Improvements

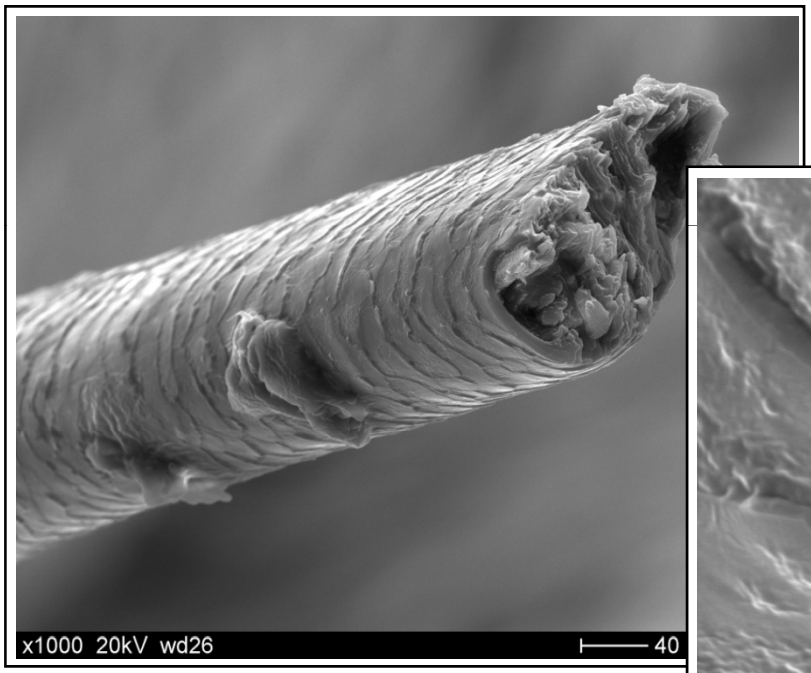
- Silicon Carbide and Titanium Dioxide replace clay based fillers
- These fillers have a Mohs Hardness value of 7-9 and clay has a value of 2-3
- These fillers are also available in smaller sizes

Filler Size Reduction

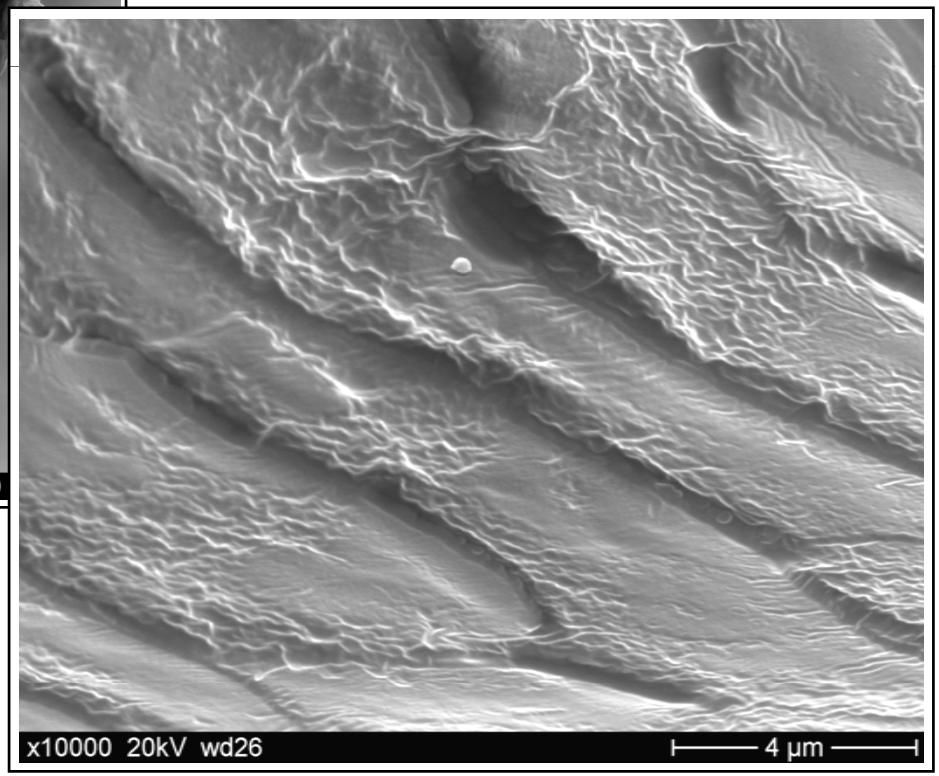


Nano Particle Fillers

DIAMETER OF A HUMAN HAIR: 50µm



Nano -Particle (300nm) on Hair



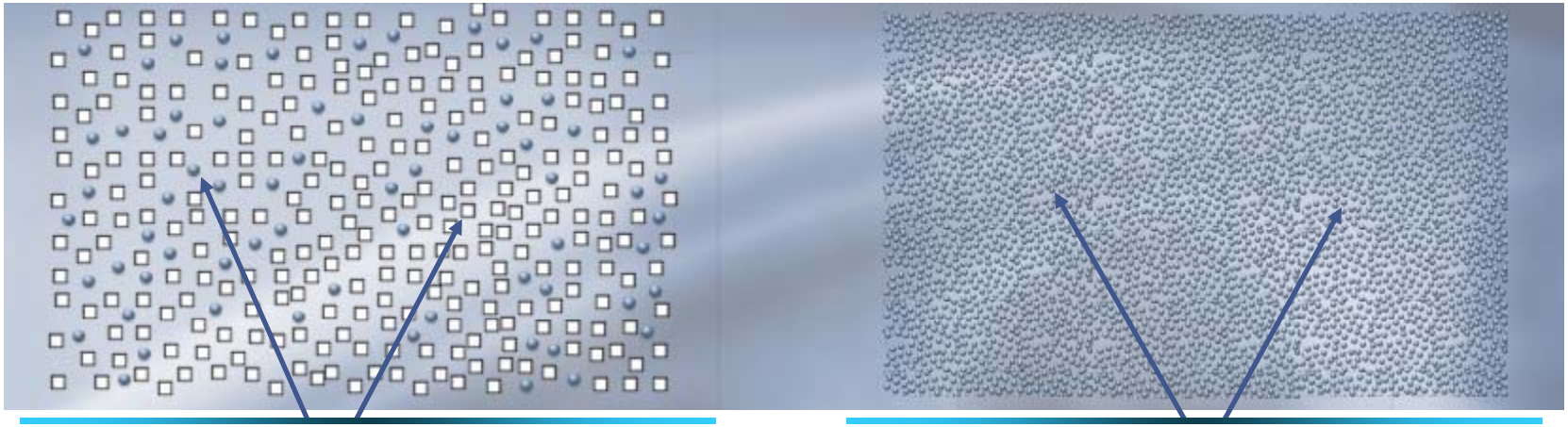
Three major goals:

- **Wear resistance**
- **Fracture toughness**
- **Surface smoothness**

Wear Resistance

Conventional Cover Matrix

Nanotechnology Matrix



Large flake, spherical, and block particles allow more pockets of pure matrix with poor resistance to wear as the matrix wears the filler falls out leaving large voids.

Sub-micron treated particles distributed evenly in matrix yield improved wear resistance.

Fracture Toughness

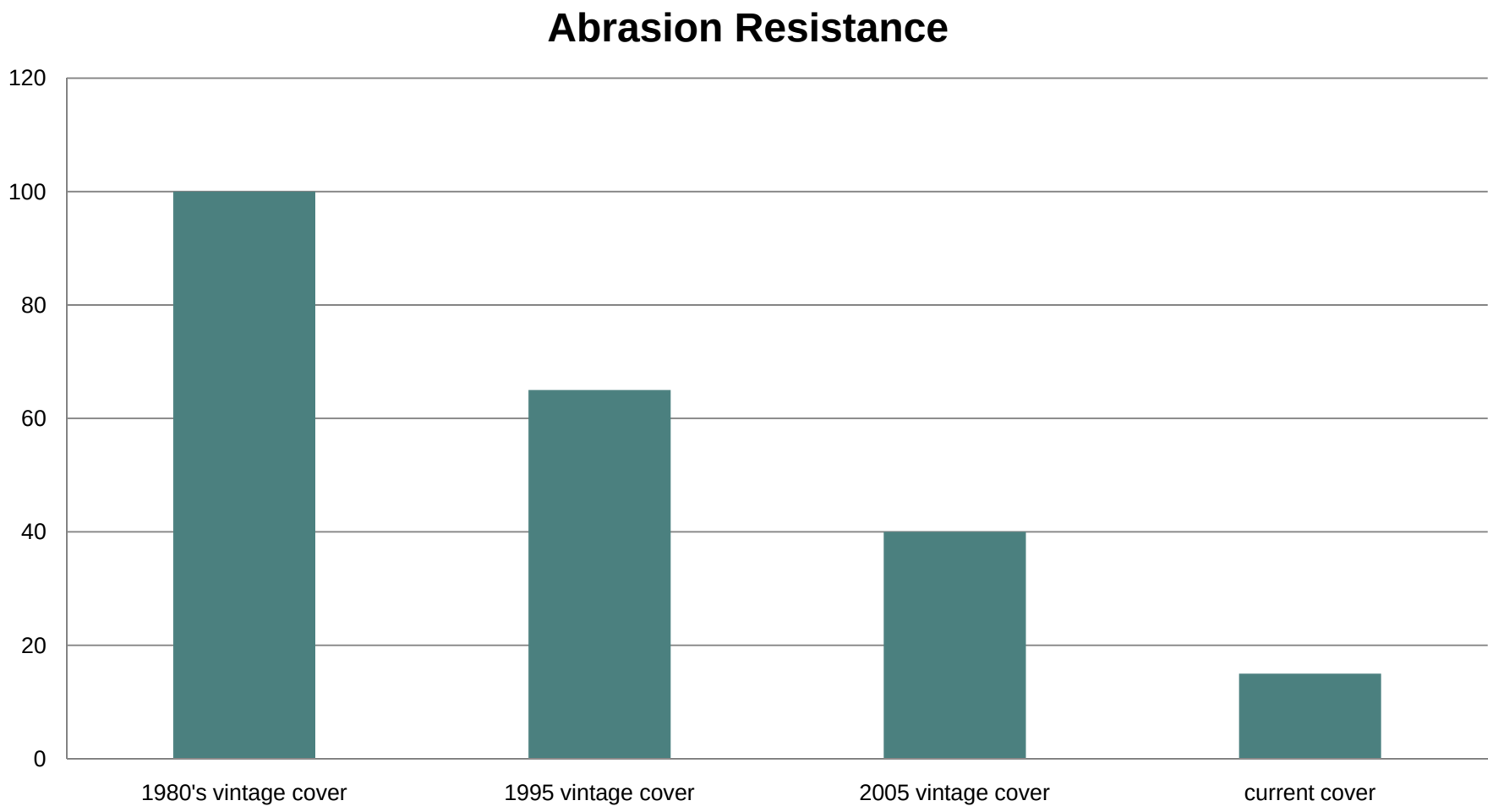
- Free crack propagation
- Lower surface area
- Poor energy absorption

- Impedes crack propagation
- Higher surface area
- Improved energy absorption

Conventional Matrix

Nanoparticle Matrix

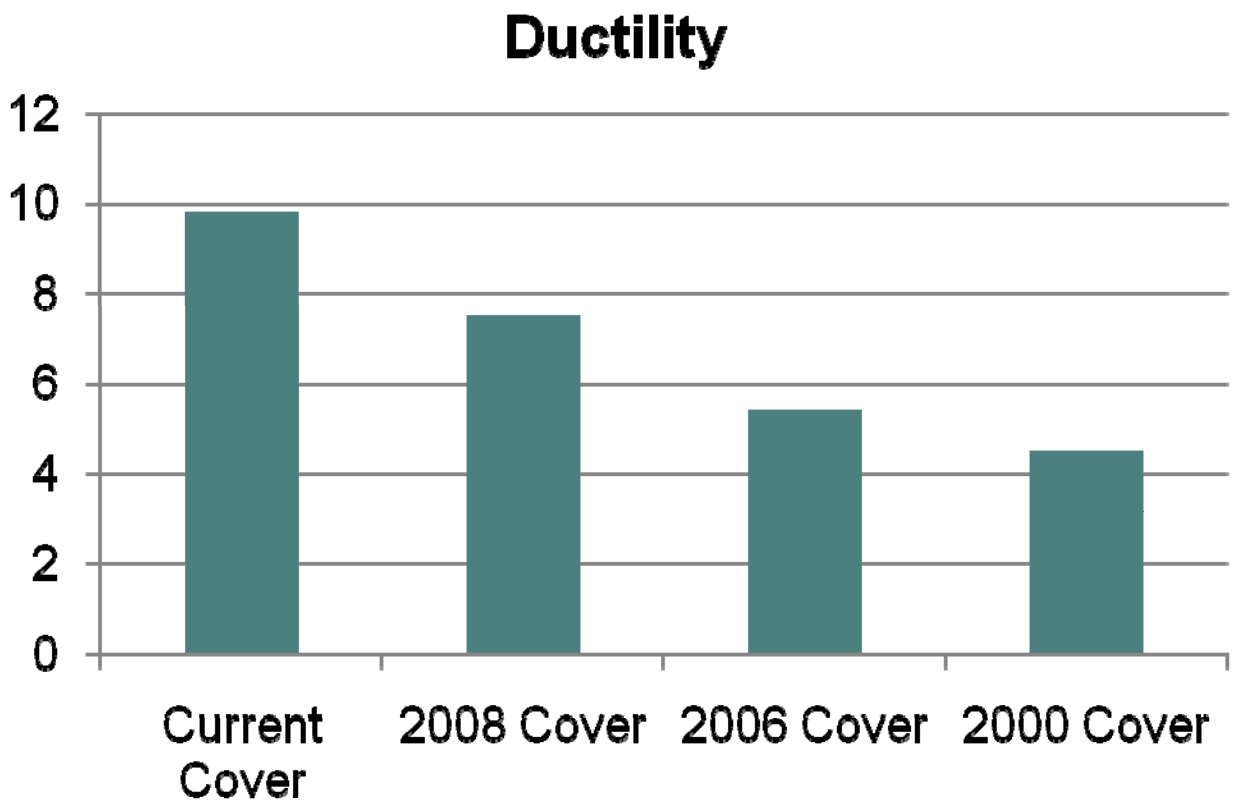
Composite Cover Abrasion Resistance



Ductility Improvements

- Ductility allows the cover to come back after an impact
- Improvements increase damage resistance

Ductility Index

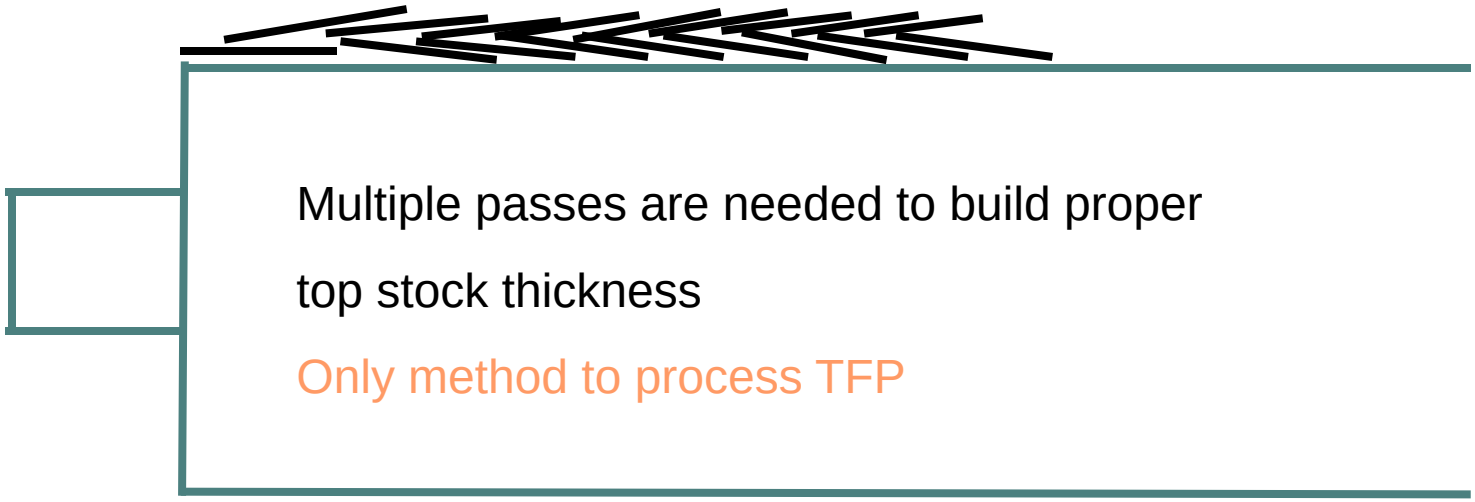


Resin Mixture Improvements

- Converted from Torsional/paddle mixer to shear mixers
- Improved mixing insured even distribution of fillers
- Shear mixers helped to overcome the thixotropic properties of the heavily filled resin

Manufacturing Changes
Wrapping Methods

- Flat pass (original method)
  - **Opportunity for resin rich areas to form**
  - **Chance for dry edges/defects**



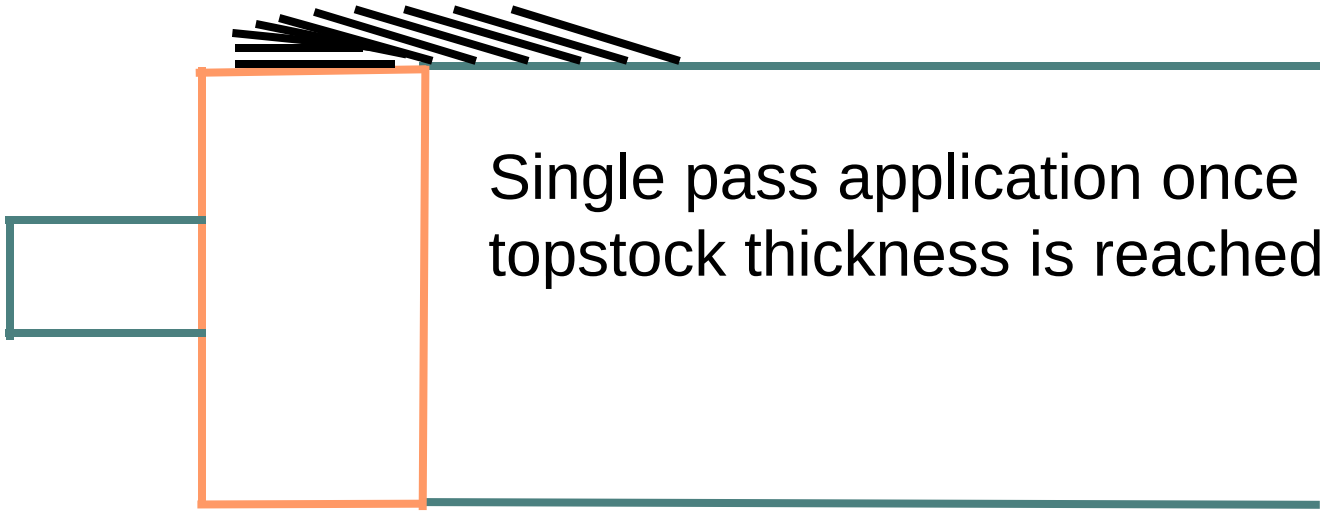
Manufacturing Changes
Wrapping Methods

Angle Wrap Application Method

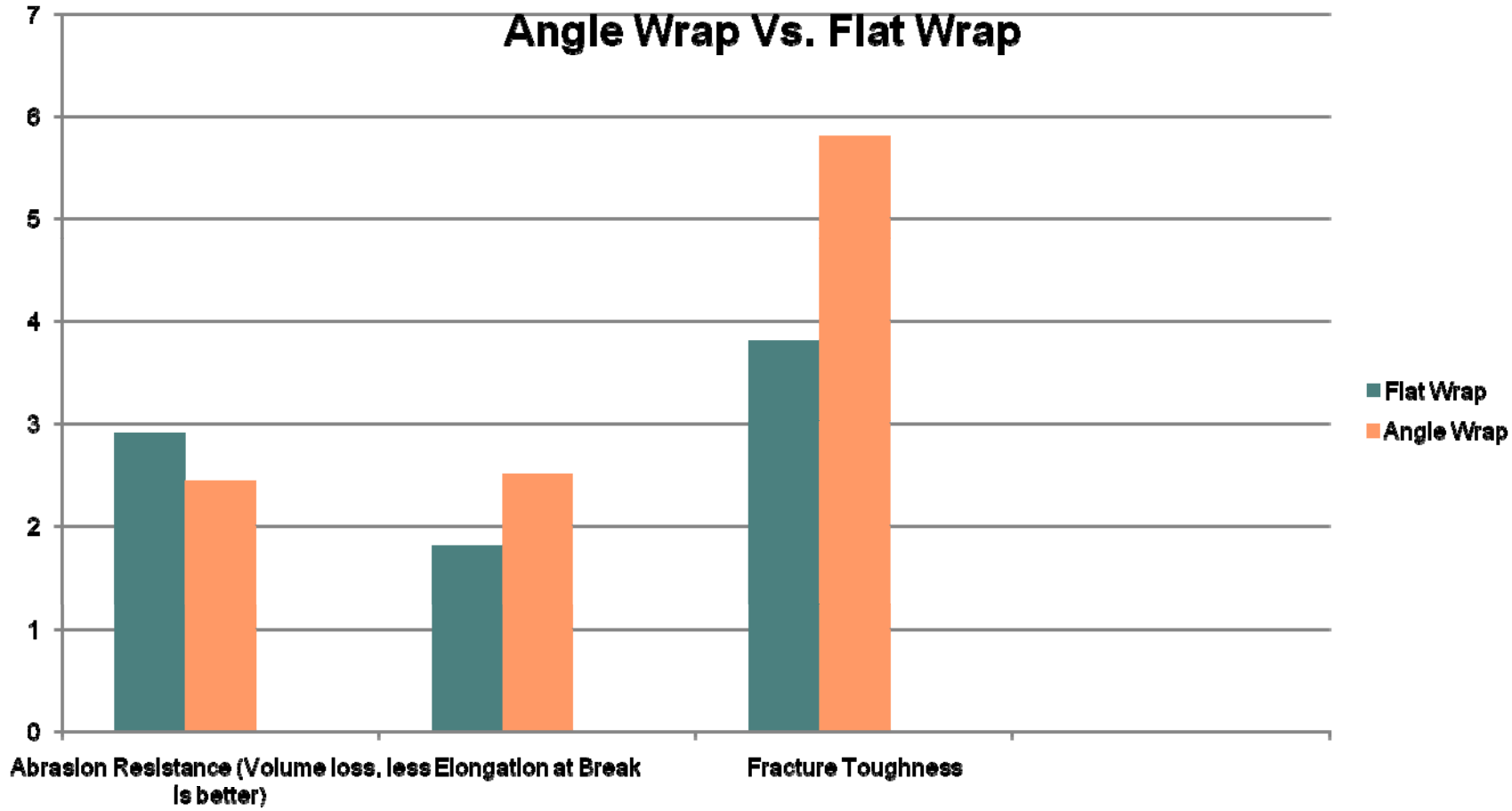
–Higher fiber fraction

–Virtual elimination of defects

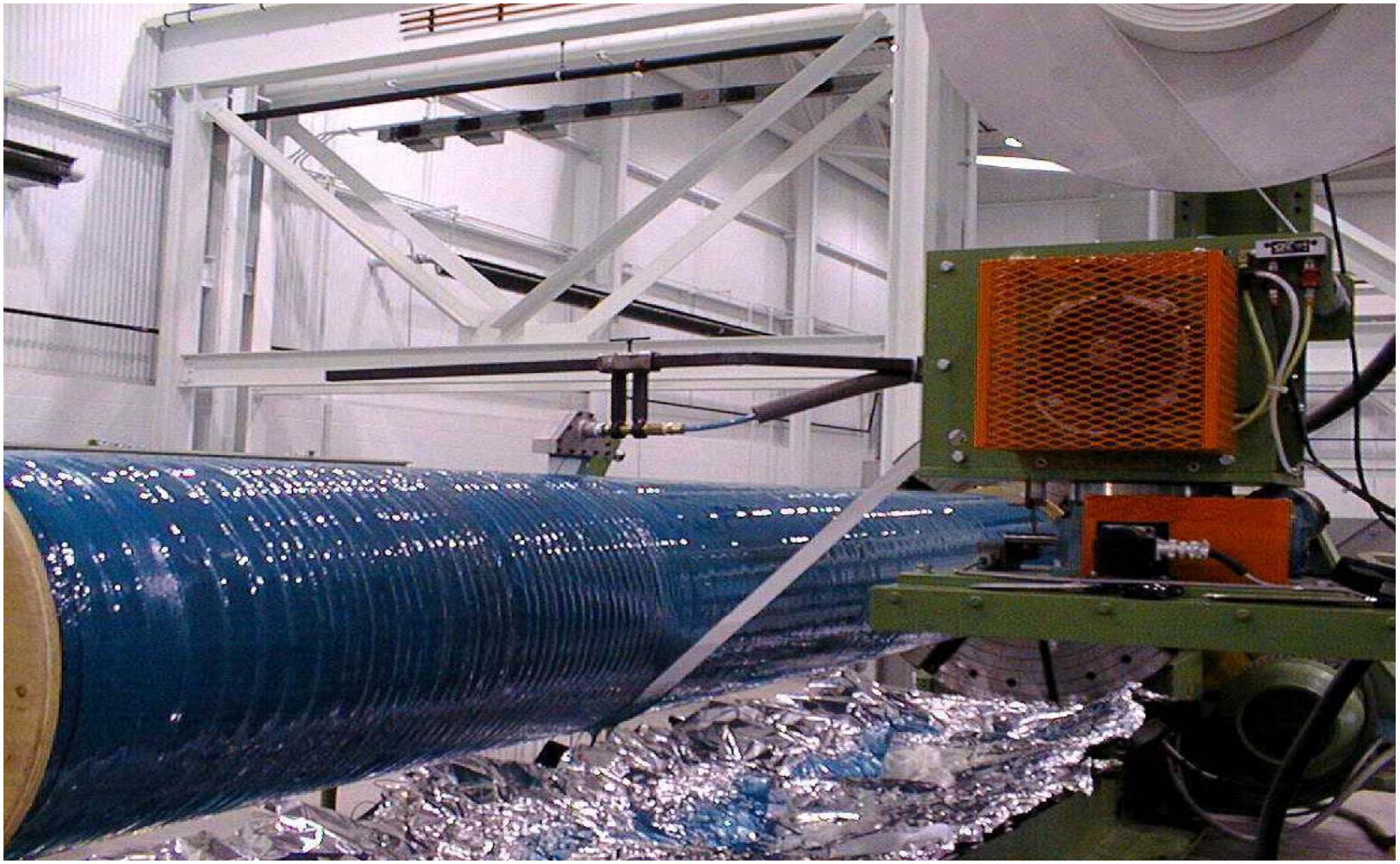
–Eliminates resin rich areas



Wrapping Method Comparison



Manufacturing The Wrapping Process



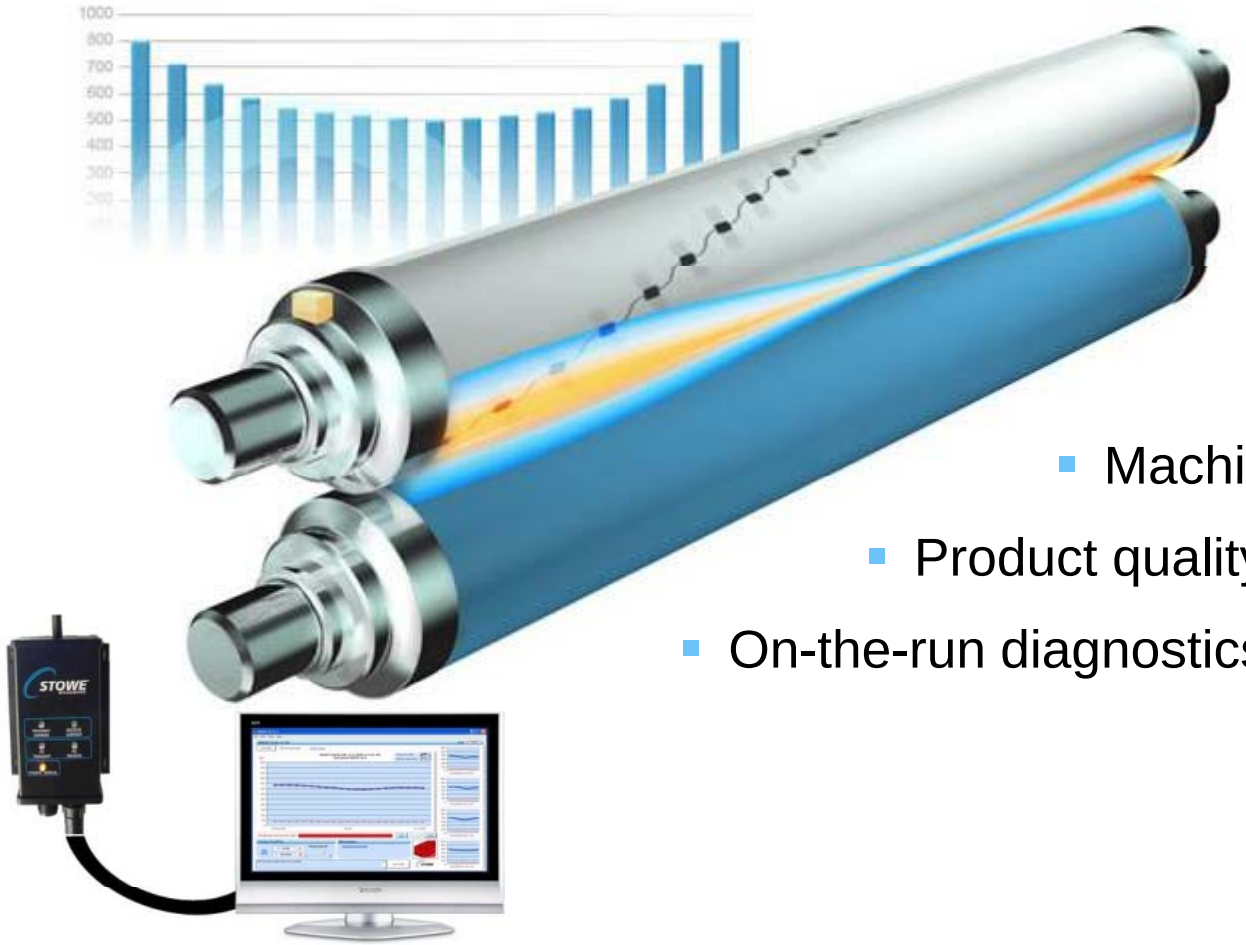
Manufacturing Improvements

- Kevlar tension control
  - Computerized control
  - Improved Kevlar consistency
- Improved resin flow control
  - Computerized flow monitoring
  - Improved pumps
- Improved resin mixture systems

Additional Technological Advances

- Addition of real time nip monitoring
- Thermal conductive base materials

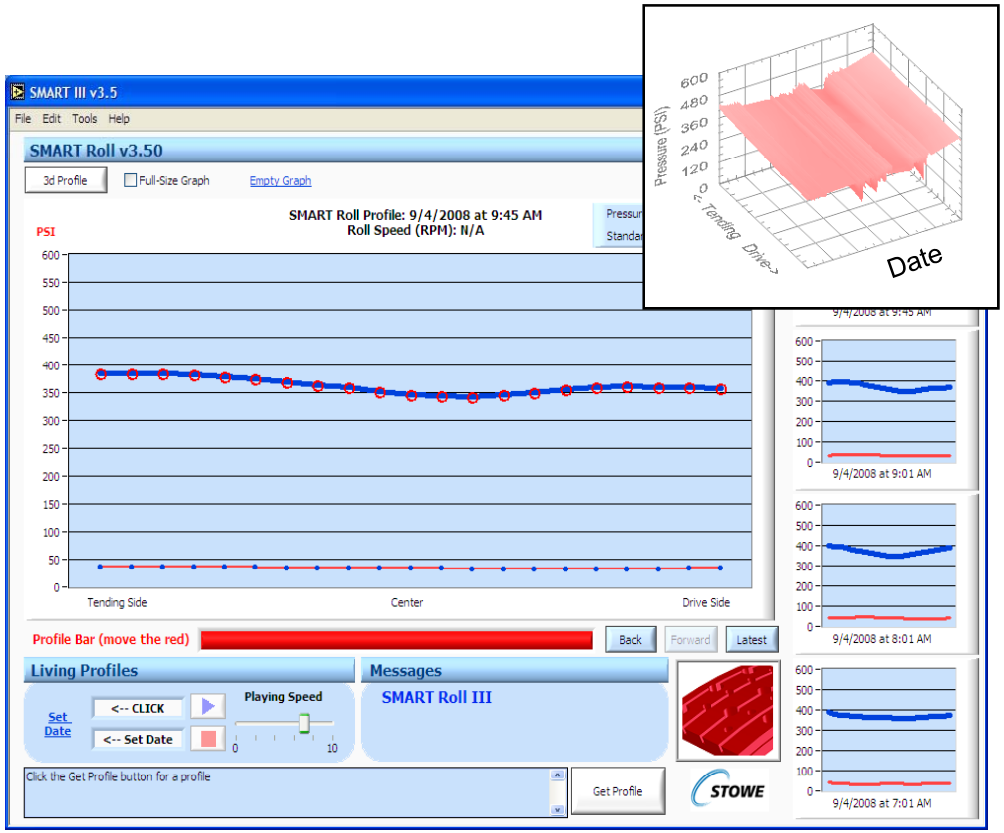
Continuous Monitoring of Nip Performance



- Machine efficiency
- Product quality
- On-the-run diagnostics

Benefits of Continuous Nip Monitoring

- Real Time Knowledge
- True operating conditions
  - Temperature, vacuum, etc.
- Dynamic vs. static measurement
- On-the-run feedback
  - Eliminates uncertainty
  - Enables immediate adjustments

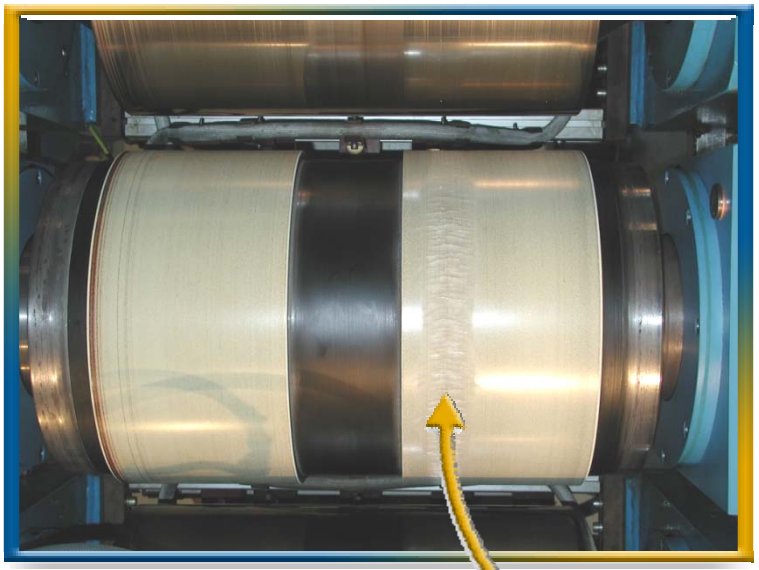


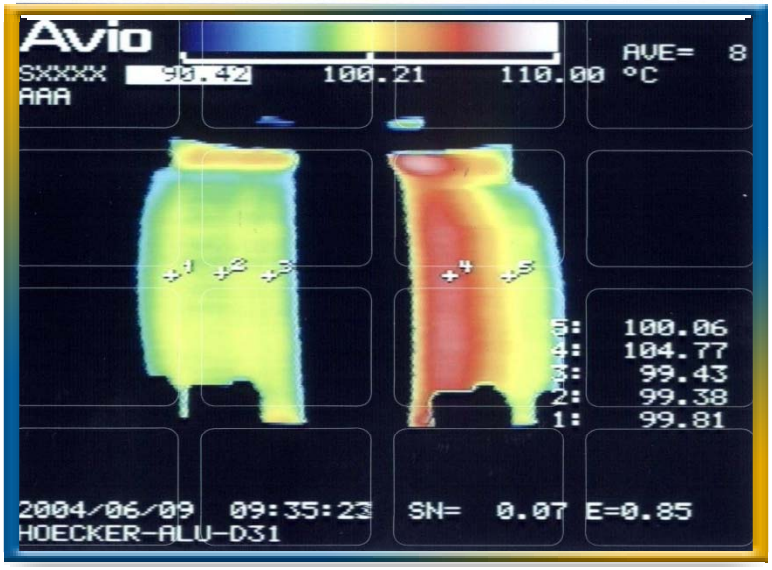
Thermal Conductive Base Material

- **Minimizes or eliminates localized hot spots**
  - **Impacts**
  - **Varying web width**
  - **Coating streaks**
- **Potential for increased gloss by running warm water in the roll**

ThermaGuard Base

- **Test calender roll**
  - **Thermally conductive matrix (left side)**
  - **Standard matrix (right side)**
- **Thermo scan showing the temperature distribution**
  - **Left side homogeneous distribution**
  - **Right side no thermal distribution**





Damage caused by thermal overloading

Conclusion

- **New Technology has improved composite cover performance**
  - **Improved impact resistance**
  - **Improved wear resistance**
  - **Improved ductility**
- **Manufacturing improvements have improved cover characteristics**
- **Calender performance has improved because of the new cover technologies**