# Fabric Selection & Testing

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# Baghouse Applications
# &
# Fabric Selection

# Gas-To-Cloth Ratio

$$G/C = \frac{\text{Gas Volume}}{\text{Cloth Area}}$$

# Net Gas-To-Cloth Ratio

$$\text{Net G/C} = \frac{\text{Total Inlet Gas Volume}}{\text{On Stream Cloth}}$$

# Gross Gas-To-Cloth Ratio

$$\text{Gross G/C} = \frac{\text{Total Inlet Gas Volume}}{\text{Total Filter Cloth Area in Collector}}$$

$$\text{Filtering Velocity} = \frac{\text{FT}^3\ \text{Gas}}{\text{FT}^3\ \text{Cloth}} = \text{FPM}$$

# Baghouse Selection Process

- Review Dust Source Operation
- Define Emission Problem
- Select Cleaning Method
- Size Collector
- Select Filter Media
- Identify materials of Construction
- Identify Auxiliary Equipment Needs

# Essential Information Required

- Description of Application
- Gas Inlet Volume
- Gas Inlet Temperature
- Gas Moisture Content
- Gas Acid Content
- Description of Dust

# Other Information Desired

- Available Space
- Other Equipment in Dust Collection System
- System Operating Pressure
- Existing Utilities
- Additional Comments

# Selected Gas-to-Cloth Ratios

| | Shaker/Woven<br>Reverse Air/Woven | Pulse Jet//Felt<br>Reverse Air/Felt |
|---|---|---|
| Asbestos | 3.0 | 10 |
| Carbon Black | 1.5 | 5 |
| Coal | 2.5 | 8 |
| Cement | 2.0 | 8 |
| Feeds, Grain | 3.5 | 14 |
| Fly Ash | 2.5 | 5 |
| Gypsum | 2.0 | 10 |
| Iron Oxide | 2.5 | 7 |
| Lead Oxide | 2.0 | 6 |
| Lime | 2.5 | 10 |
| Limestone | 2.7 | 8 |
| MICA | 2.7 | 9 |
| Paper | 3.5 | 10 |
| Rock Dust | 3.0 | 9 |
| Sand | 2.5 | 10 |
| Sawdust (wood) | 3.5 | 12 |

# Fabric Selection Considerations

Gas Stream
- Temperature
- Moisture
- Chemistry
- Dust Loading

Dust Characterization
- Abrasiveness
- Stickiness
- Explosiveness
- Flammability

Fabric
- Filtration Performance
- Temperature Max
- Release Properties
- Pressure Drop
- Life/Durability
- Costs

Other
- Scrim
- Coatings/Treatment
- Hardware
- Blends

# Fabric Development Timeline

| High Temperature Pulsejet Media | |
|---|---|
| **Woven Fiberglas** | ’50’s - |
| **Gore-Tex® Patent** | 1975 |
| **Huyglas® 1607 (27 oz) Carbon black/lime** | 1980 |
| **Ryton® and P84®** | ’80’s |
| **Hyglas® 1701 (16 oz) lime; coal/wood/multi-fuel boilers; incinerators** | 1990 |
| **Gore-Tex® patent expires** | 1993 |
| **Generic membrane on glass** | ’93 - |
| **Huyglas® 1405 (22 oz) burned membrane in lime/kaolin; Nomex in clinker cooler** | 1998 |
| **Huyglas® 1105 (19 oz) lime** | 2000 |

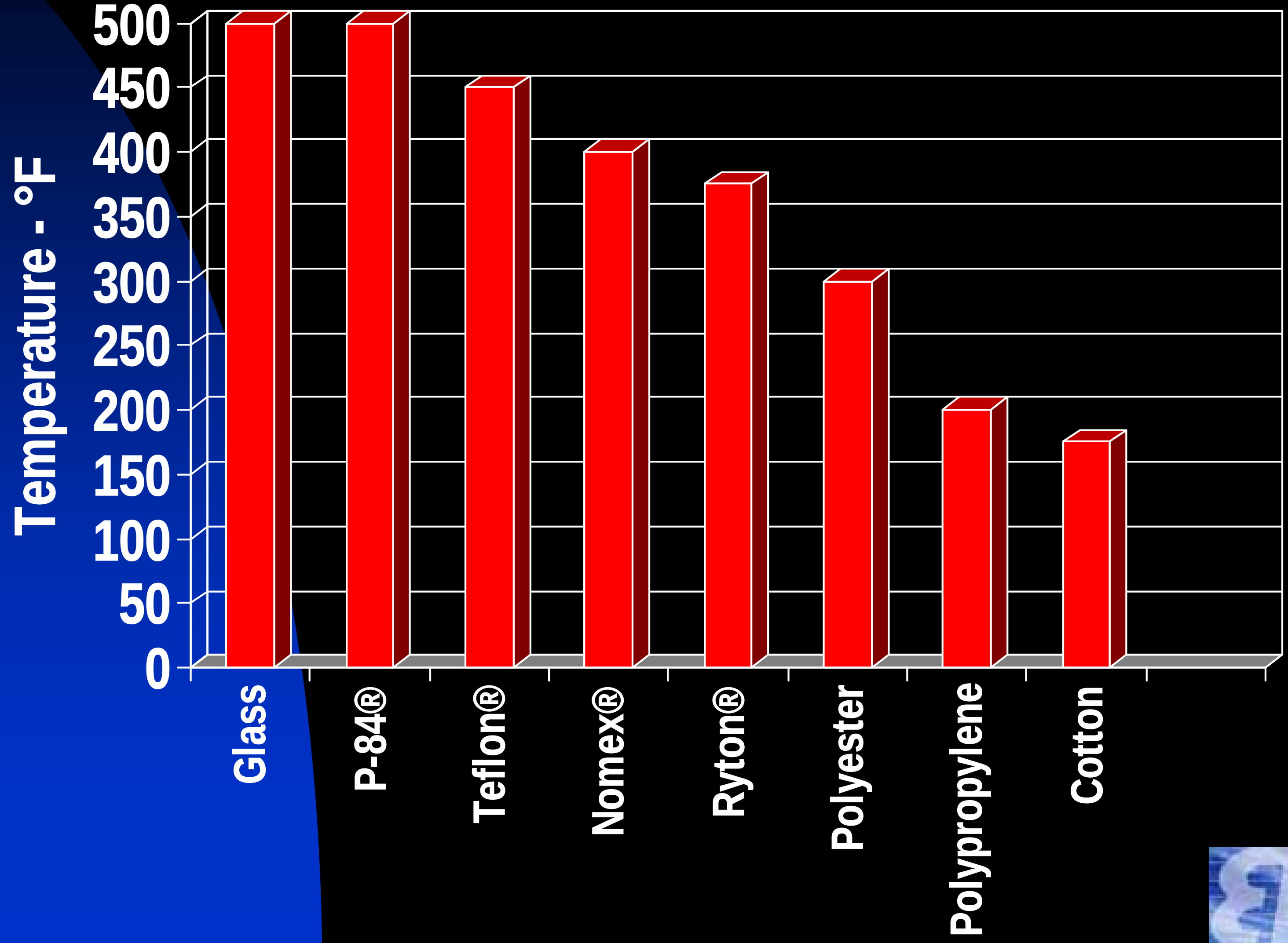
Courtesy of Air Purator Corporation

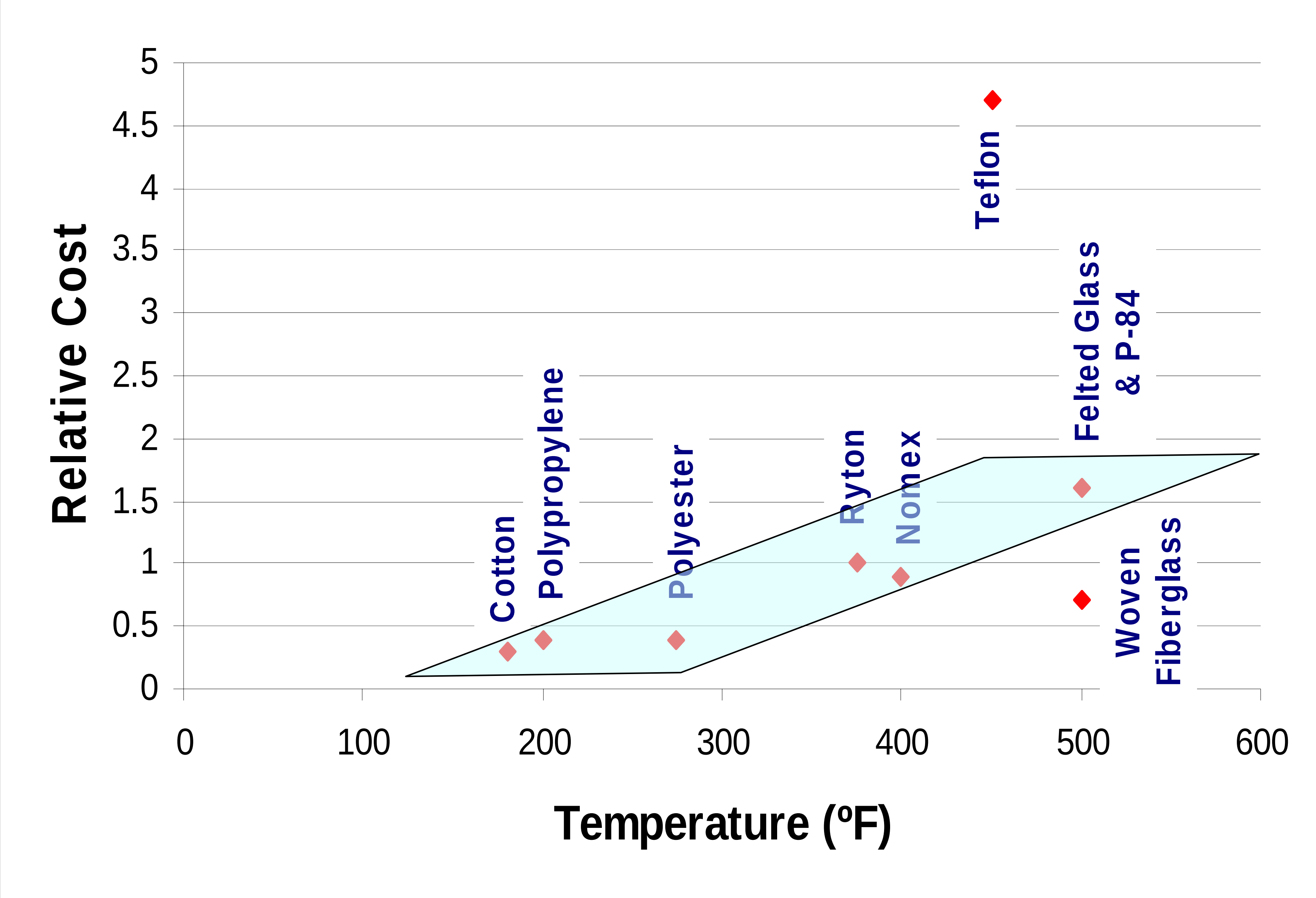
# Fabric Selection Chart

| Fabric | Max Continuous Temp | Surge Temp. | Acid Resistance | Fluoride Resistance | Alkali Resistance | Flex Abrasion Resistance | Relative Cost* |
|---|---|---|---|---|---|---|---|
| Cotton | 180 °F | 200 °F | Poor | Poor | Good | Very Good | 0.3 |
| Wool | 200 °F | 230 °F | Good | -- | Poor | Fair | -- |
| Polypropylene | 200 °F | 200 °F | Excellent | Poor | Excellent | Very Good | 0.4 |
| Dralon®/ Acrylic | 265 °F | 284 °F | -- | -- | Fair | Good | 0.4 |
| Polyester | 275 °F | 300 °F | Good | Poor to Fair | Good | Very Good | 0.4 |
| Basofil®/ Melamine | 375 °F | -- °F | Good | -- | Excellent | -- | -- |
| Ryton®/PPS | 375 °F | 425 °F | Good | Good | Very Good | Very Good | 1.0 |
| Nomex®/ Aramid | 400 °F | 425 °F | Poor to Fair | Good | Excellent | Excellent | 0.9 |
| Teflon®/PTFE | 450 °F | 500 °F | Excellent | Excellent | Excellent | Fair | 4.7 |
| Glass Felt | 500 °F | 550 °F | Good | Poor | Fair | Fair | 1.6 |
| Woven Fiberglass | 500 °F | -- °F | Fair to Good | Poor | Fair to Good | Fair | 0.7 |
| P-84®/ Polyimide | 500 °F | 550 °F | Fair | Fair to Good | Fair | Good | 1.6 |

*Relative Cost – Ryton Pulse Jet Bag 5"∅ x 10' Long

# Recommended Maximum Operating Temperatures for Fabrics



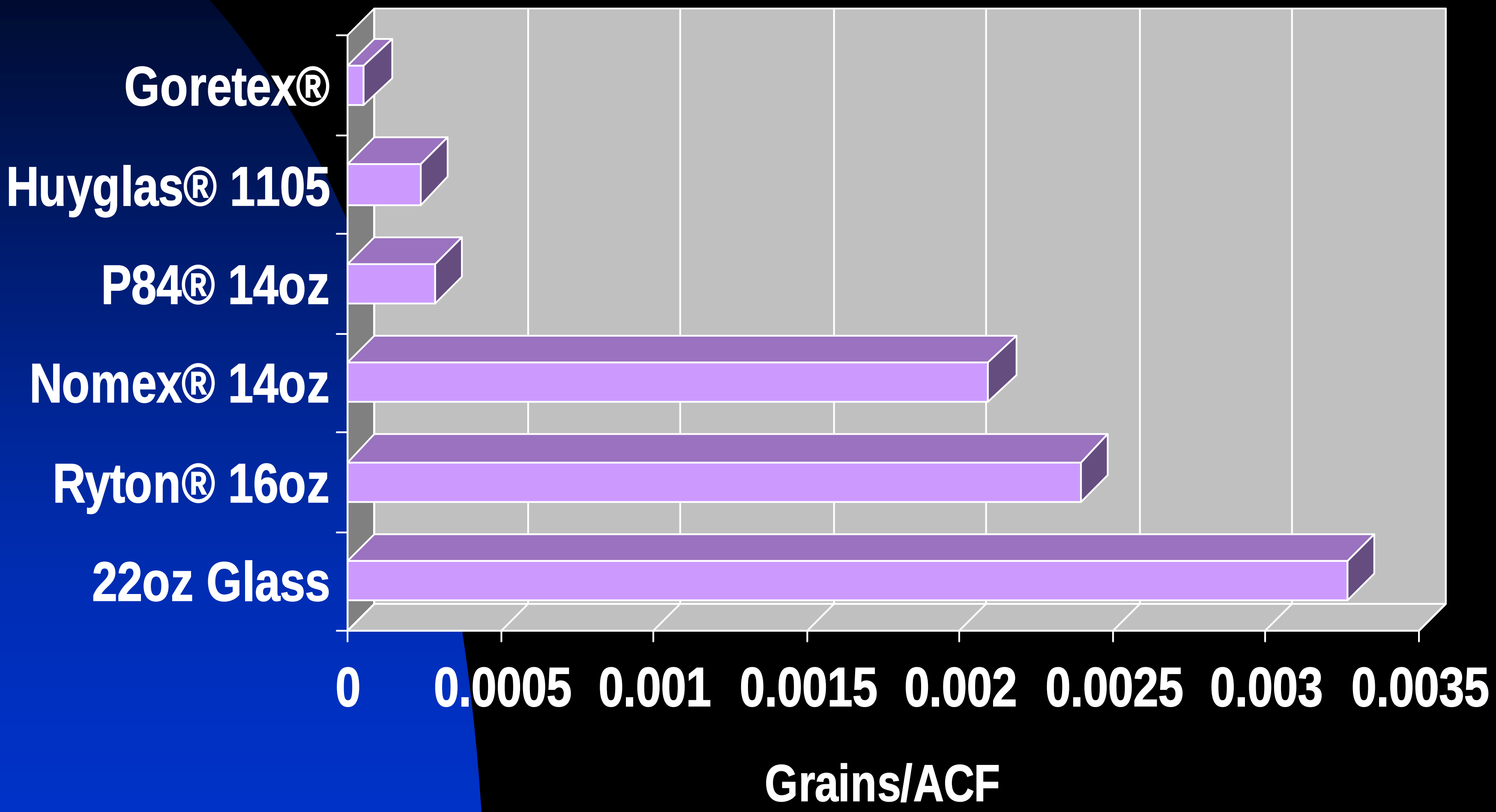


Relative Cost
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
Temperature (ºF)
Teflon
Felted Glass
& P-84
Cotton
Polypropylene
Polyester
Ryton
Nomex
Woven
Fiberglass

# Pressure Drop Comparison

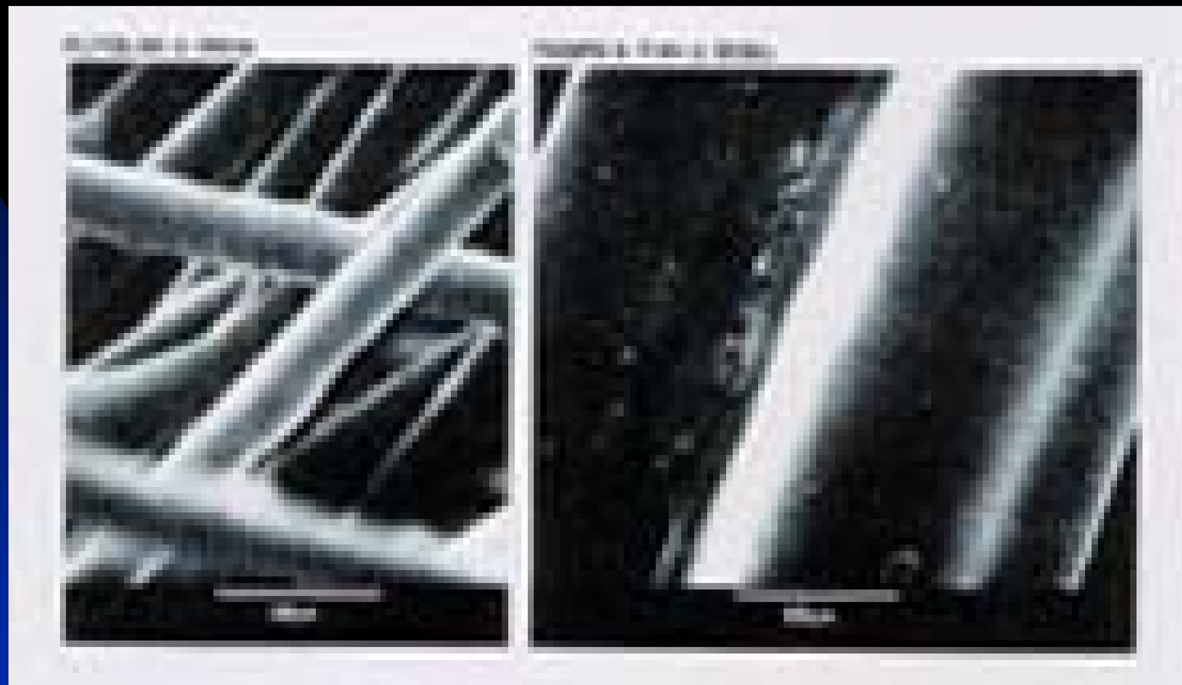

Courtesy of Air Purator Corporation

# Equivalent Emissions




Courtesy of Air Purator Corporation

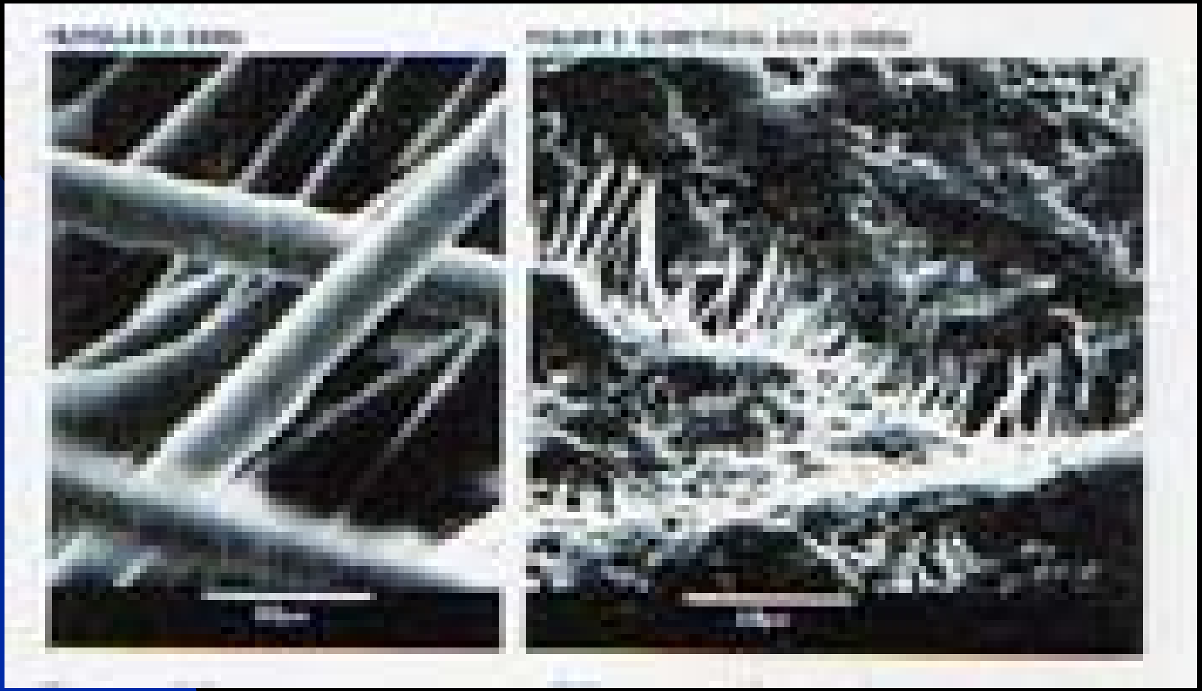
# Huyglas® vs. P84®



- Lower emissions from capturing fines
- Small fibers to capture fines
- Low DP

Courtesy of Air Purator Corporation

# Huyglas® vs. Gore®



- **Small pores or fibers for fines**
- **Caution: Pore structure above 525 F**
- **Caution: Fines with liquid carryover**

Courtesy of Air Purator Corporation

# Fine Particulate Filtration Performance

## First Round ETV* Testing 2000

| Fabric | Outlet Particulate | |
|---|---|---|
| | PM 2.5 (gr/dscf) | Total Mass (gr/dscf) |
| Membrane/Glass Felt | 0.0000065 | 0.000010 |
| Coated Polyester Felt | 0.000014 | 0.000030 |
| Basofil® Felt | 0.00011 | 0.00012 |
| PTFE Membrane/Felt | 0.0000009 | 0.0000009 |
| P-84® | 0.00016 | 0.00018 |
| Polyester | 0.0000083 | 0.000031 |
| PTFE Membrane/Felt | 0.0000041 | 0.0000082 |
| PTFE Membrane/Felt | 0.000022 | 0.000052 |
| PTFE Membrane/Felt | 0.0000059 | 0.0000096 |

- ETV = EPA's Environmental Technology Verification Program
- For Details, go to www.epa.gov/etv/
- For Fabric Testing, go to www.etsi-inc.com

# Fabric Selection Process

All Fabric Options

Key Decision Factors

- Filtration & Temperature

Remaining Options

Other Decision Factors

- Purchase Price & Bag life & Pressure Drop

Cost Analysis

Final Selection

# Fabric Testing

# Reasons For Fabric Testing

- Quality Assurance
- Diagnostic Aid or Troubleshooting
- Fabric Monitoring
- Alternative Fabric Selection
- Research & Development

# Standard Fabric Tests

| Test | Method |
| --- | --- |
| Weight | ASTM D1910 |
| Thickness | ASTM D1777 |
| Count | ASTM D1910 |
| Permeability | ASTM D737 |
| Tensile Strength | ASTM 1682 – Method IR-T |
| Mullen Burst | ASTM D231 |
| MIT Flex | ASTM D2176 |
| Organic Content | ASTM D578 |
| Water Repellency | ASTM D2721 |
| Yarn Weight | ASTM D578 |
| Yarn Twist | ASTM D578 |
| Filtration Performance | ASTM D6830-02 |

# Bag Quality Control Program

## Fabric

- Construction
- Tensile
- Permeability
- Burst
- Flex
- Finish
- Filtration Performance

## Thread

- Material
- Strength

## Hardware

- Caps
- Rings
- Bands

## Bags

- Inspect for general quality of workmanship
- Length as fabricated
- Length under tension
- Cuff to thimble & cap mate

# QA/QC Inspection

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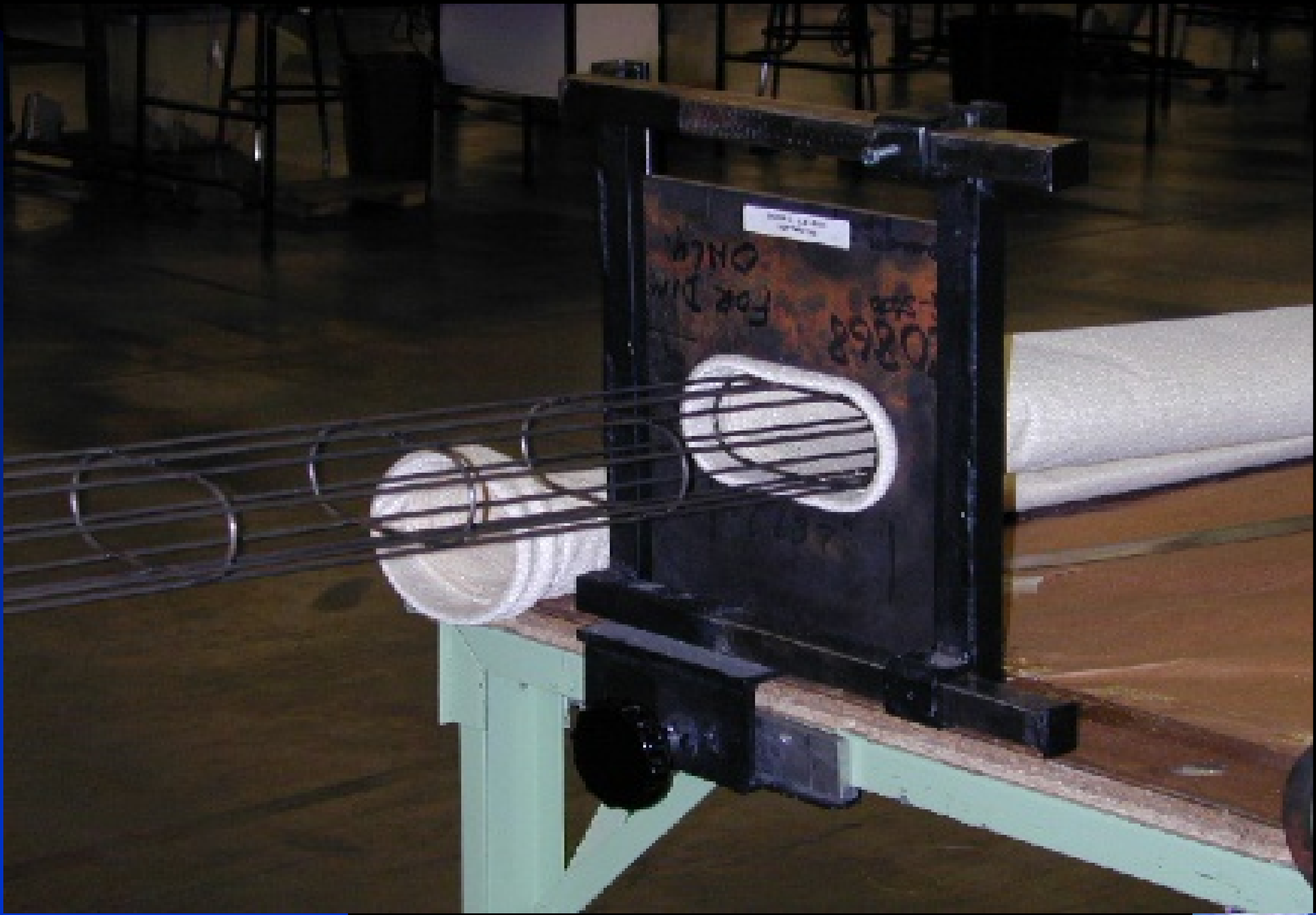

# QA/QC Inspection

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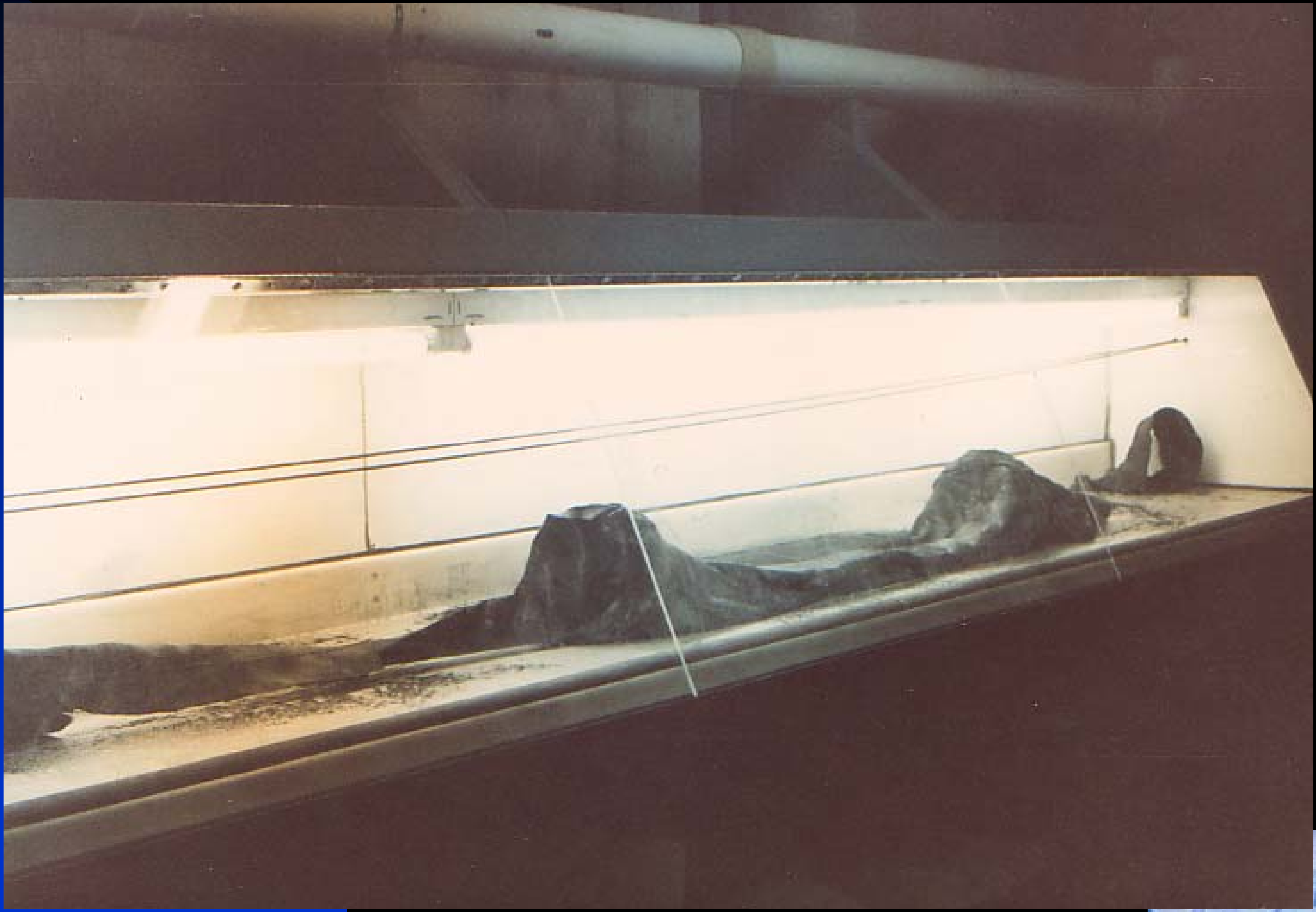
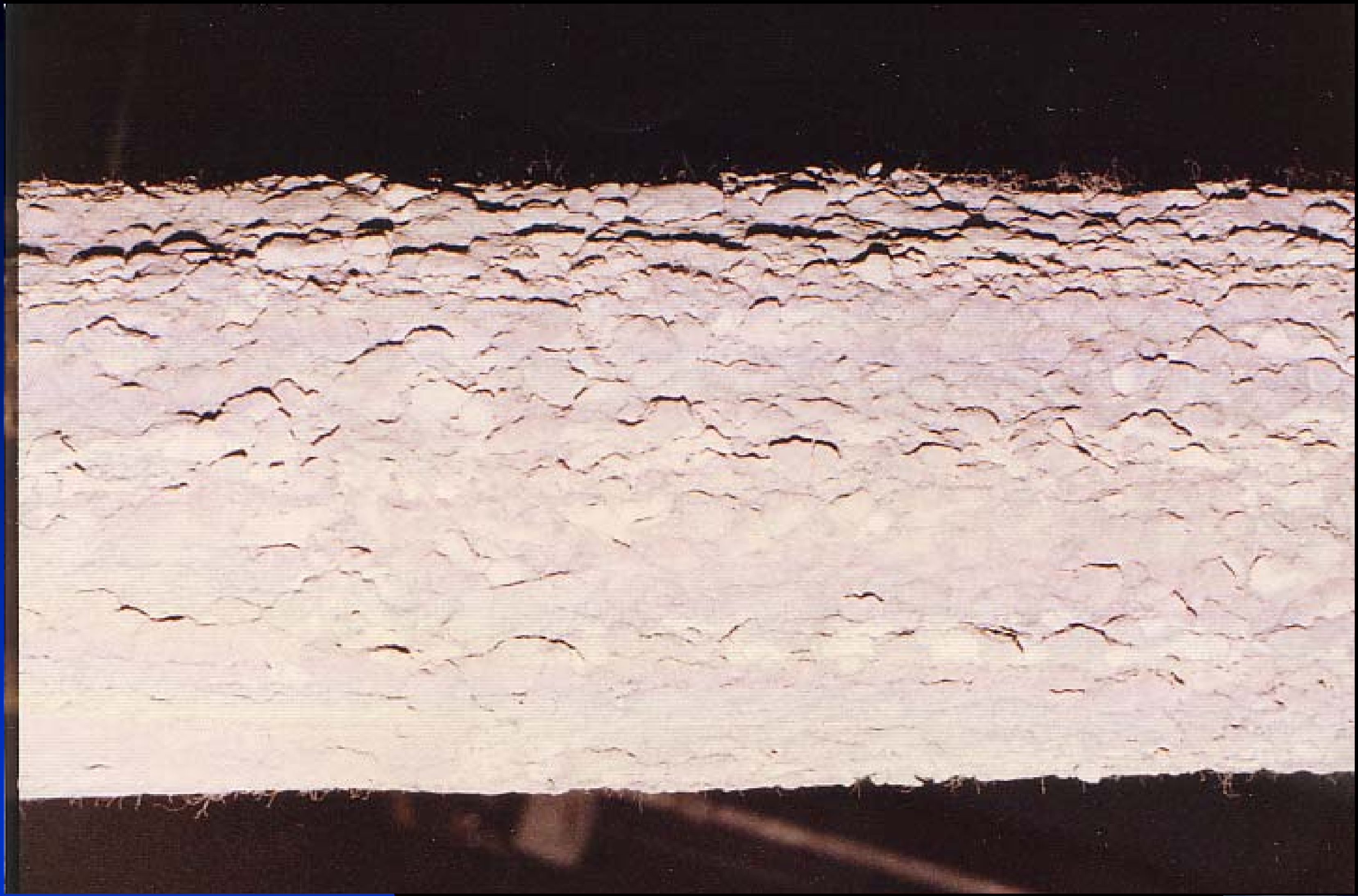
# Visual Inspection



# Permeability Test

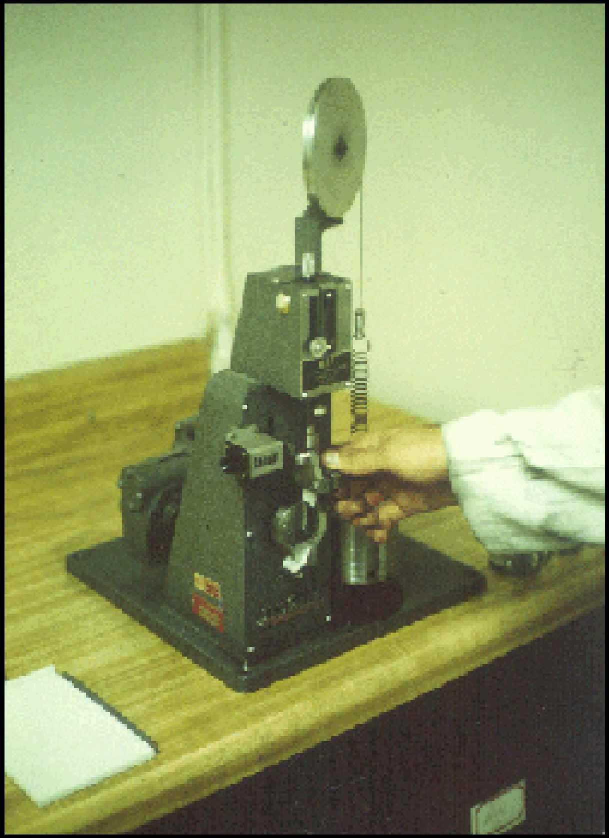
- Frazier Permeability apparatus is used to determine air handling capability of filter media.
- Includes capability to measure air flow over a wide (0-20” w.g.) differential pressure.
- Ambient to 400 °F temperature range.
- Non-destructive manner.

# Pearling

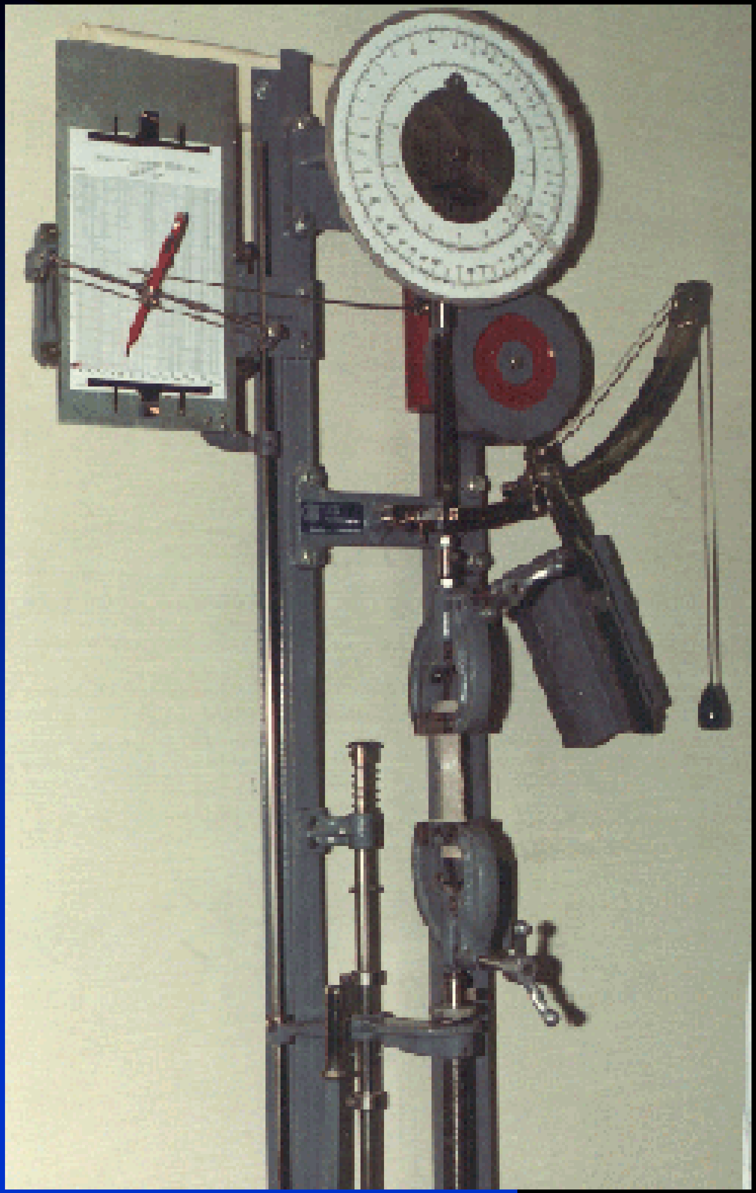


# MIT Flex Test

- Primarily measures relative value of fiberglass fabric weaves and finishes to withstand self abrasion from flexing by measuring the number of flex cycles necessary to break a fabric sample



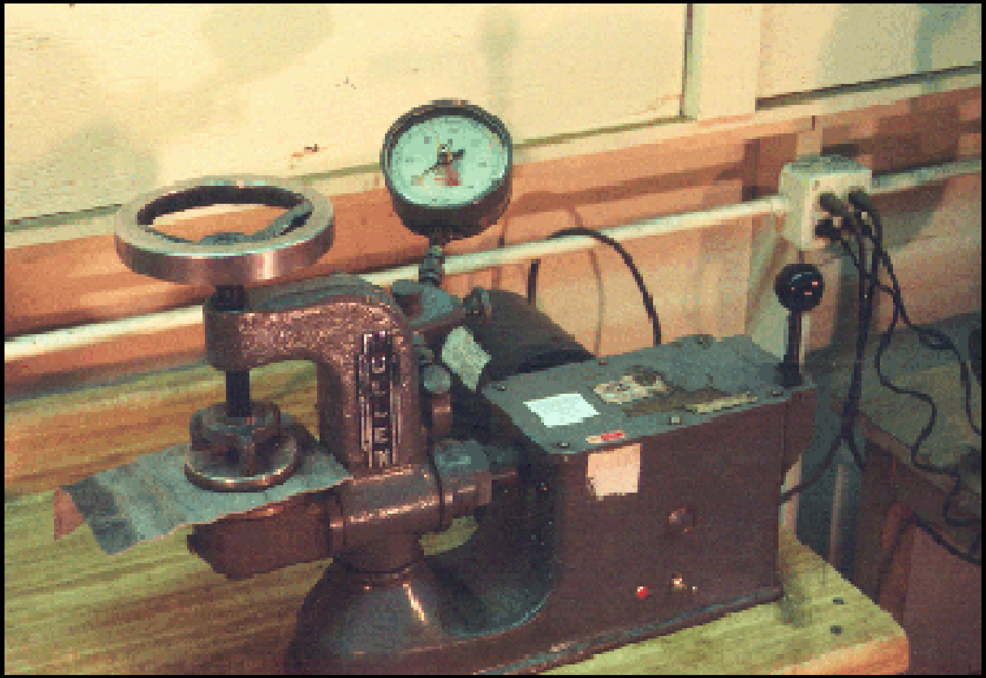
# Tensile Test



- Provides stretch, elongation, and tear data for fabrics.
- Measures relative strength of warp and filling yarns in fabric samples.

# Mullen Burst Test

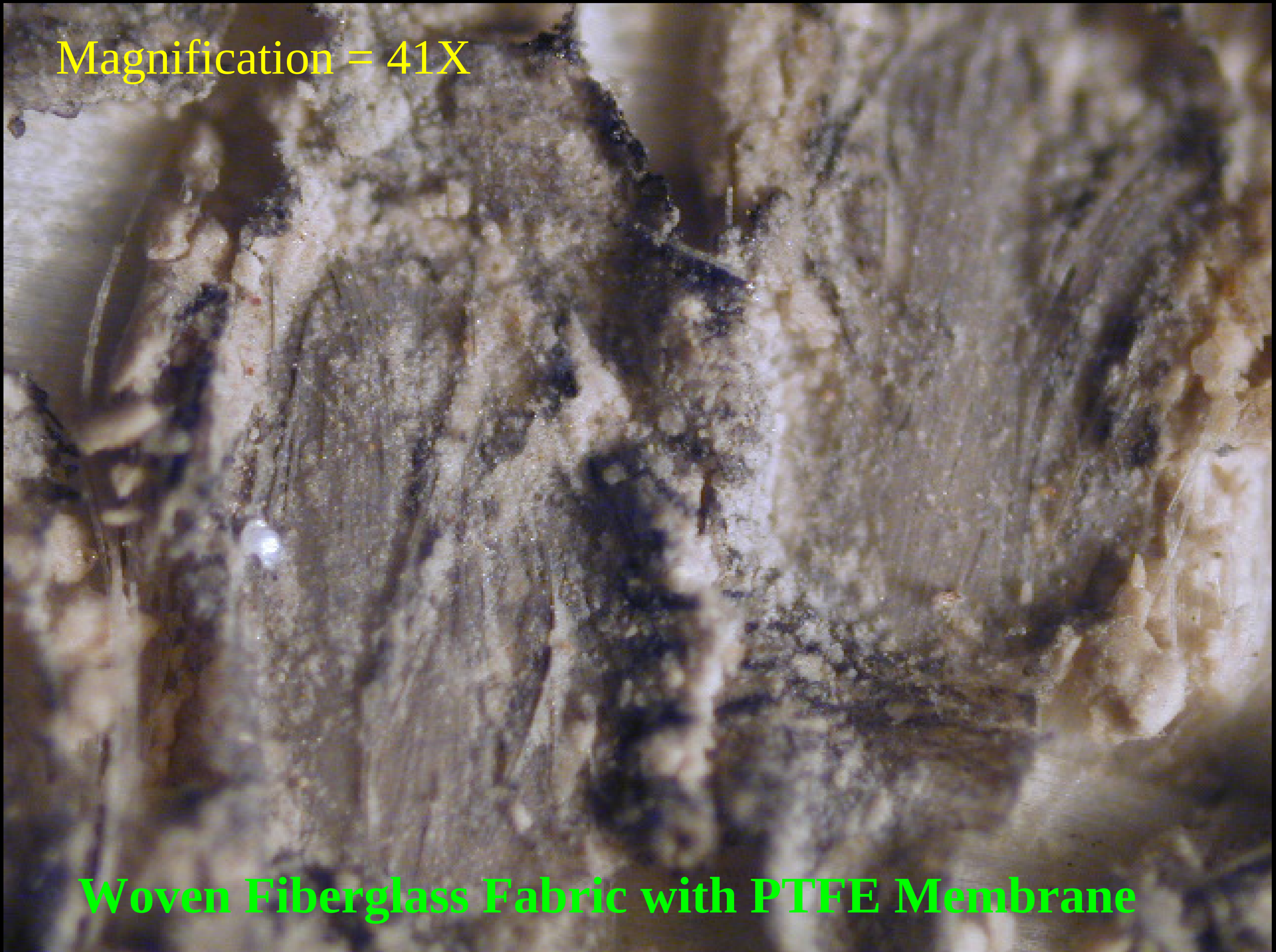
- Shows the relative total strength of fabrics to withstand severe pulsing or pressure.
- Fabric strength is measured by determining the force equivalent to driving a 1” diameter steel ball through a clamped fabric sample.



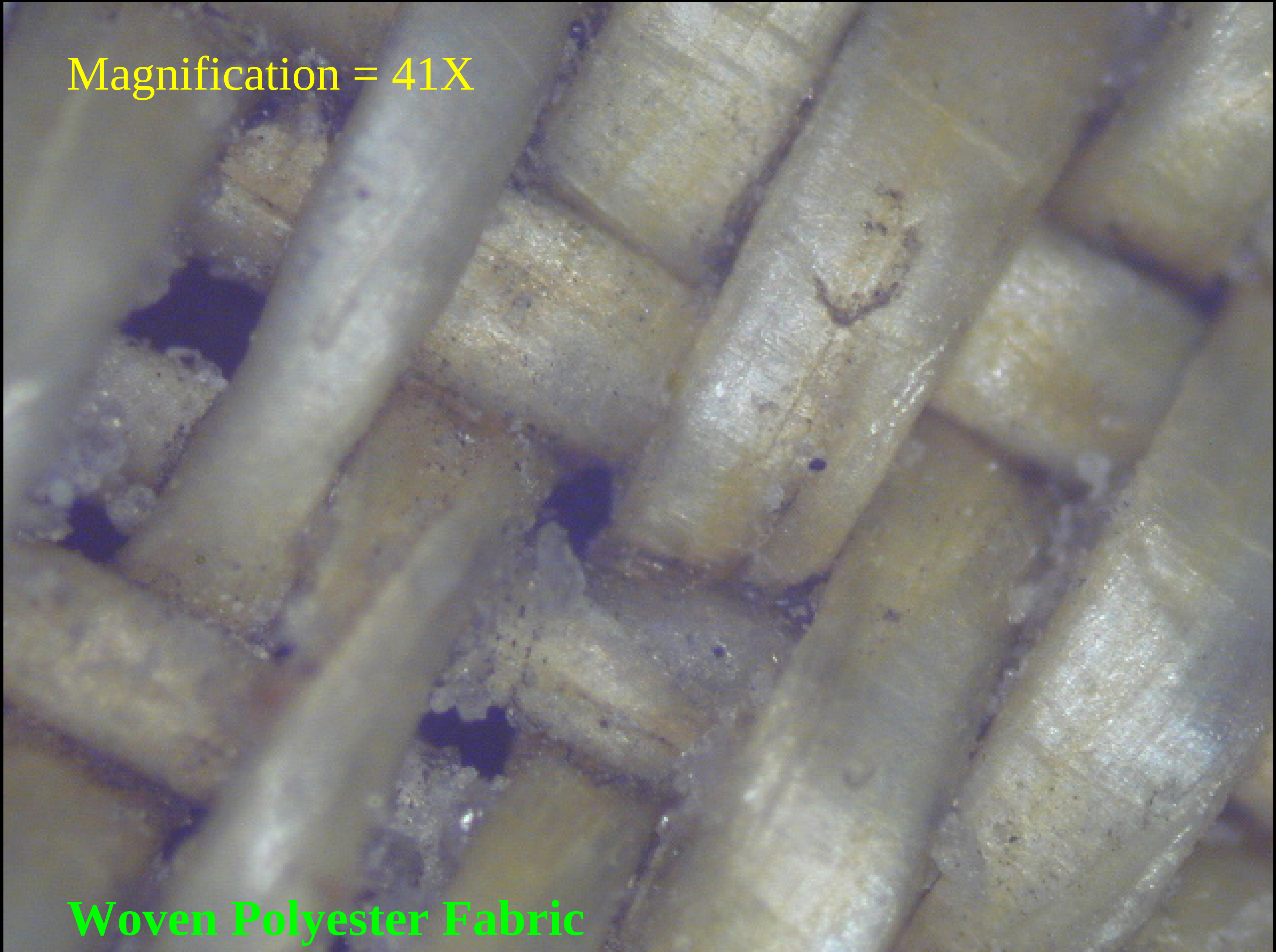
# Microscopic Analysis

- Aides in determining causes of bag deterioration and bag blinding.

# Photomicrograph



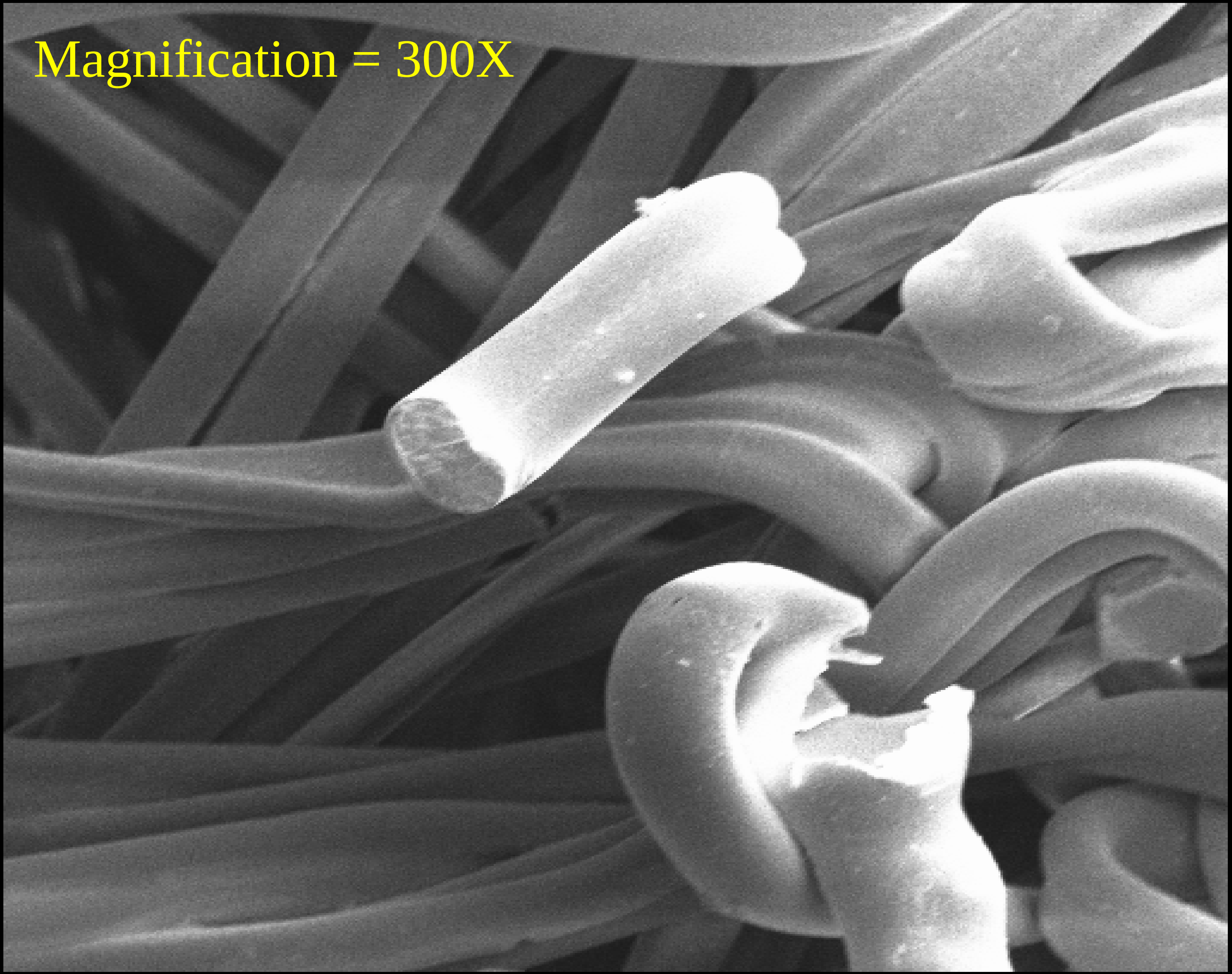
# Photomicrograph



# Photomicrograph

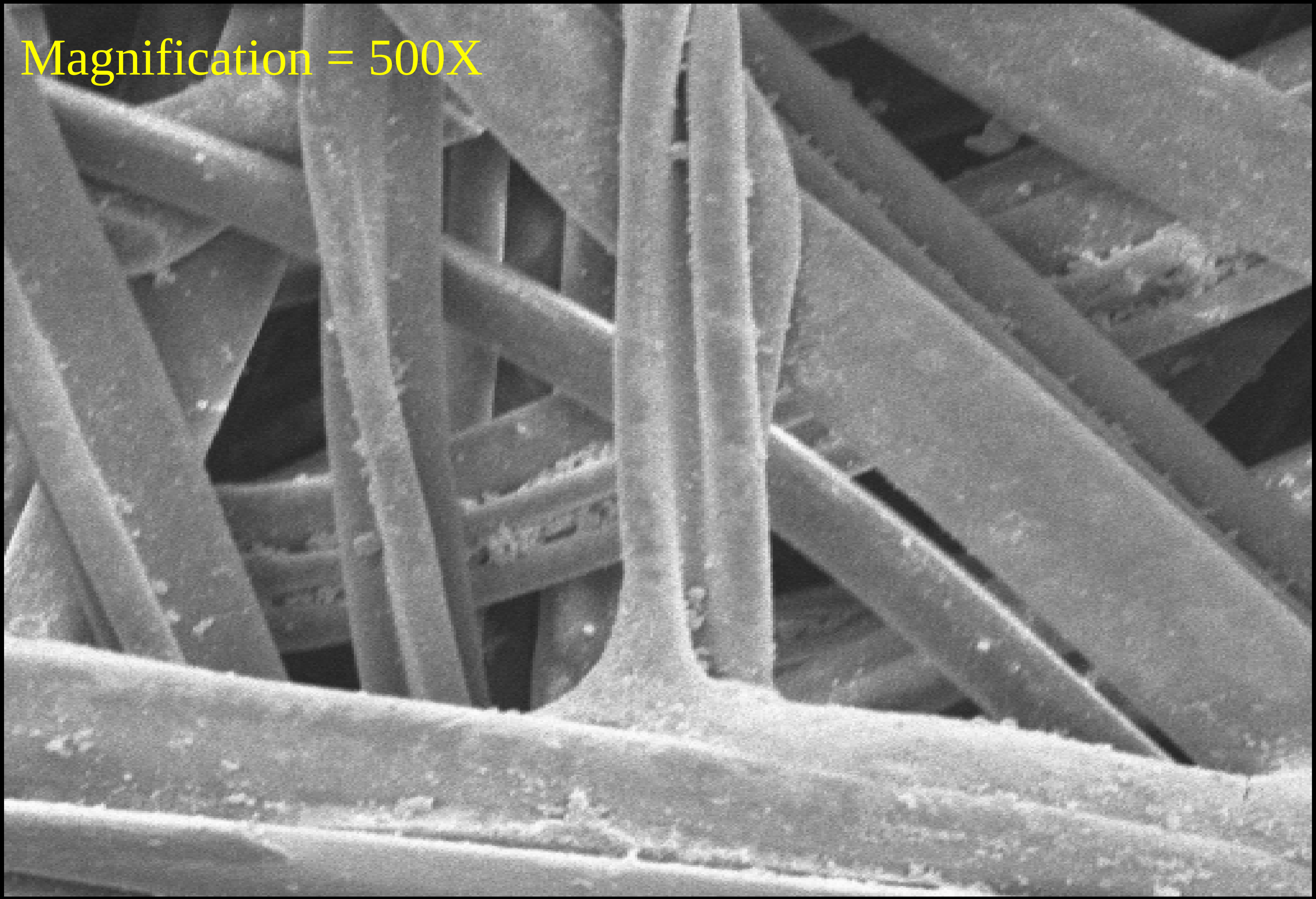

**Polyester Felt Fabric Cross Section**

# SEM Photomicrograph




**Aramid Felt Fabric**

# SEM Photomicrograph

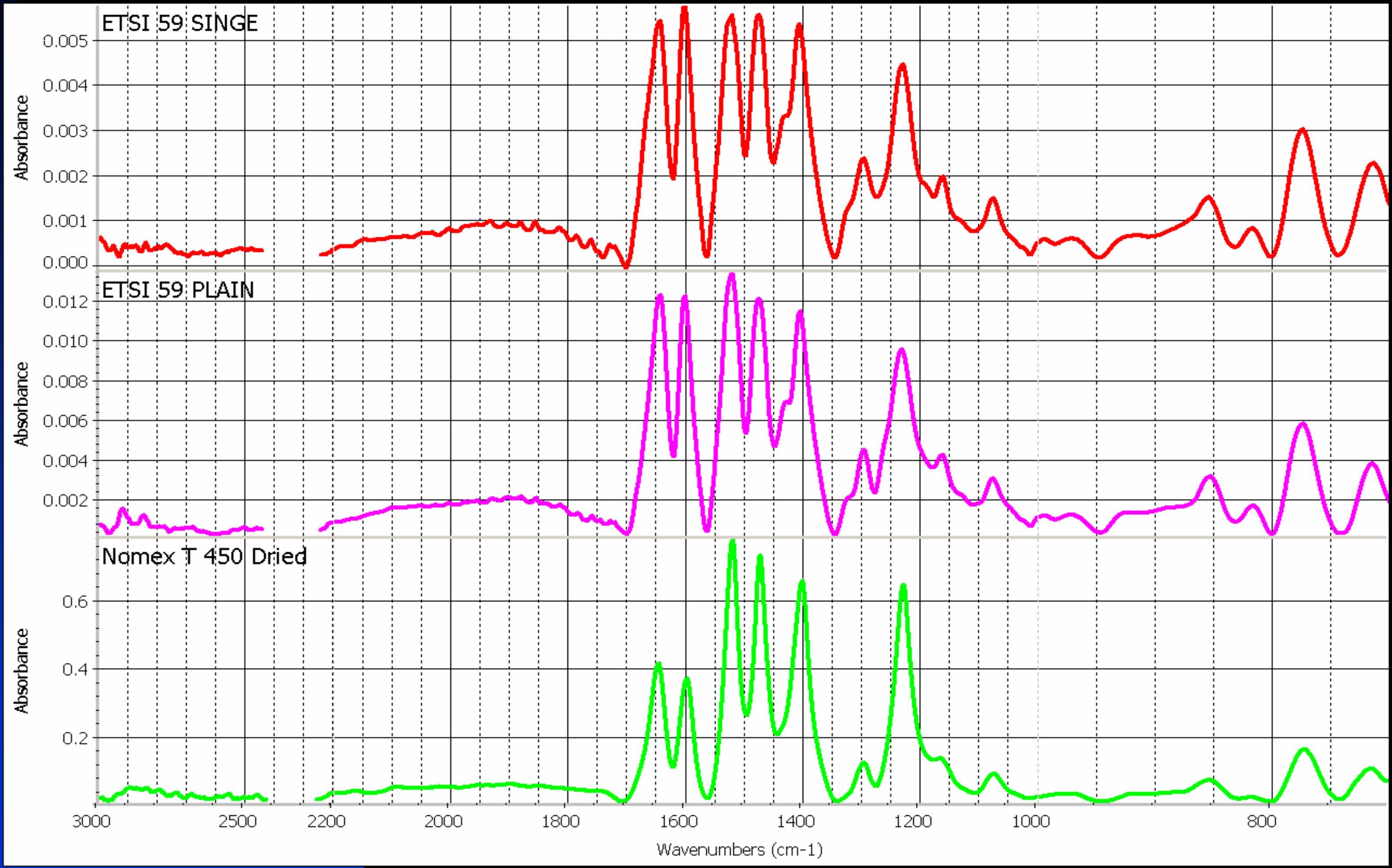



**P-84 Felt Fabric**

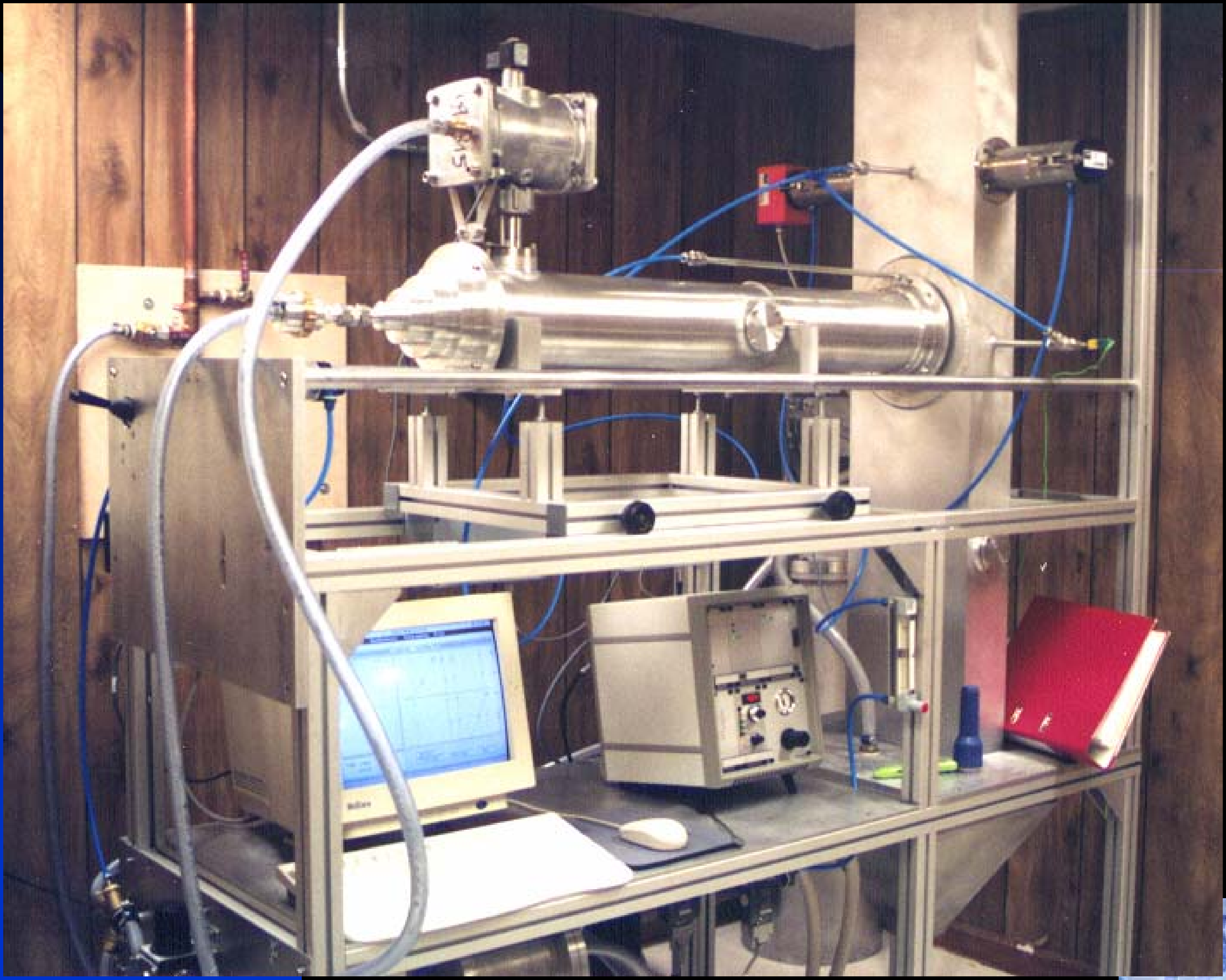
# Chemical Analysis

- Used either to predict or determine what effect on-stream conditions would have on the performance of a bag.

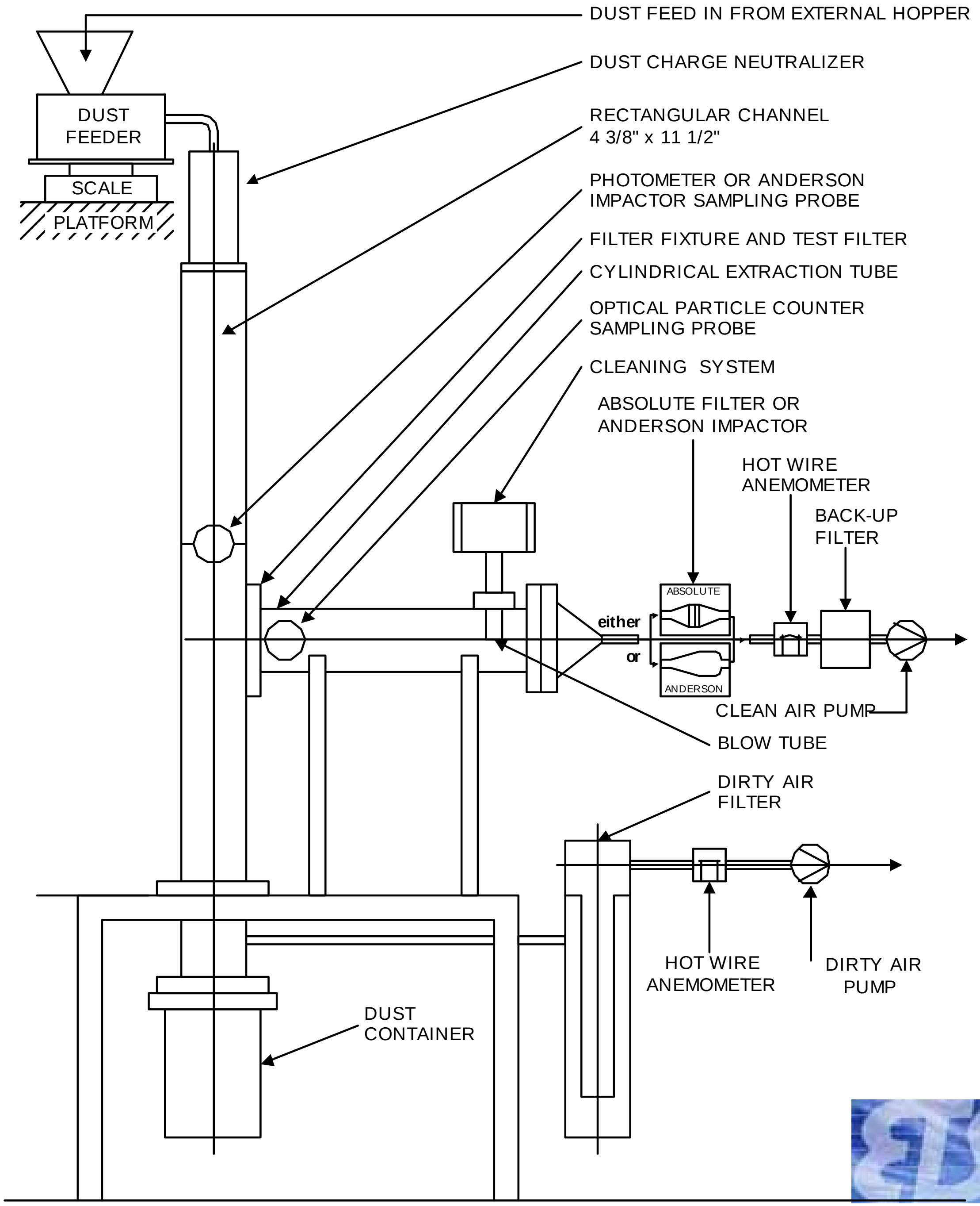
# Fiber Identification by FTIR



# ETS Filtration Performance Test Apparatus



# ETS-FPTA Schematic



# ETS FPTA Test Parameters

- Outlet particle Concentration, PM 2.5
- Outlet particle Concentration, Total Mass
- Average Residual Pressure Drop
- Initial Residual Pressure Drop
- Filtration Cycle Time
- Number of Filtration Cycles
- Mass Gain of Test Filter

# Bag Monitoring With Stream Time

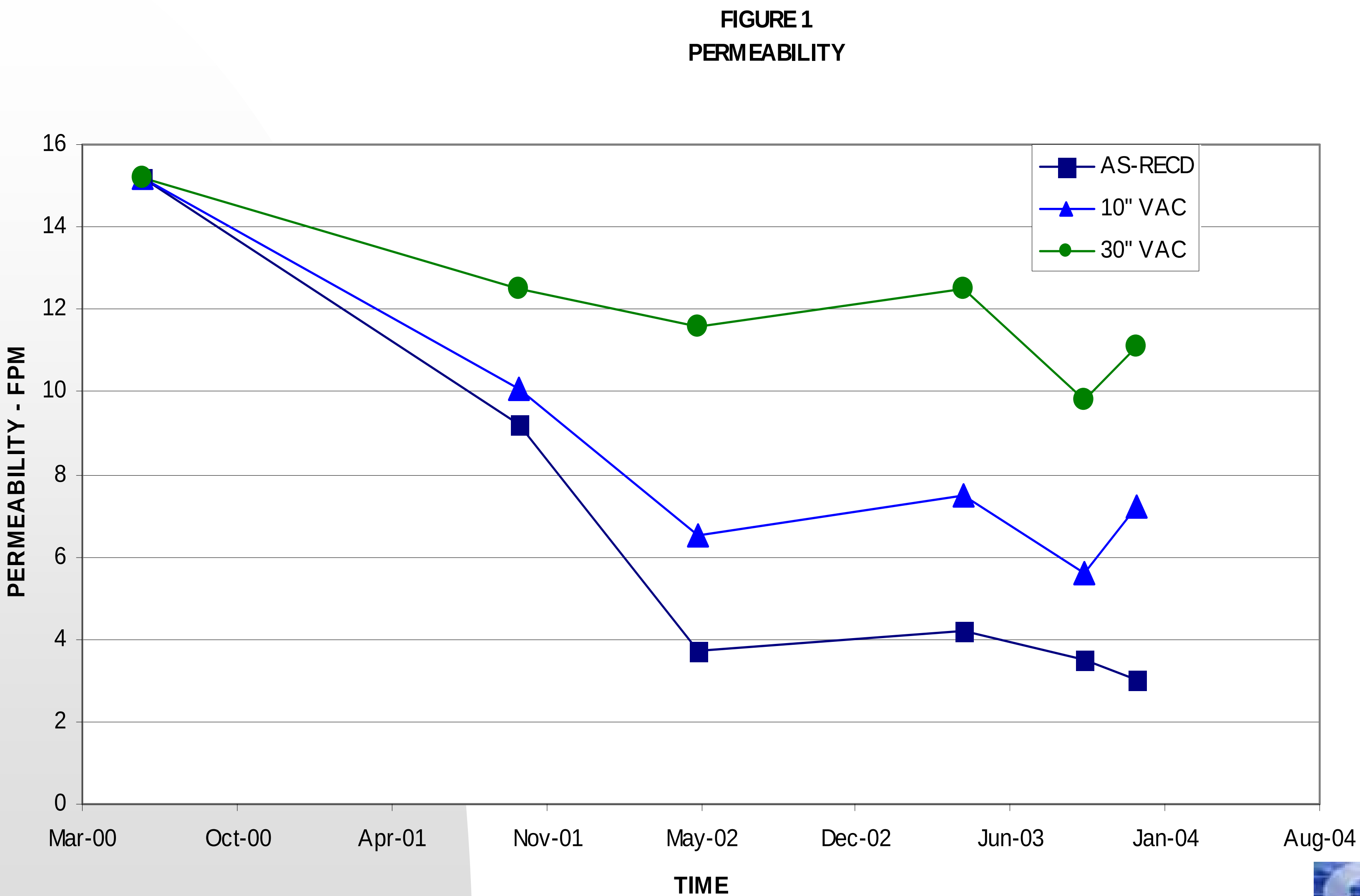
Fabric Type A

| Bag Status | Tensile (lb/in) | | Flex (#cycles) | | Burst (lb/psi) | Permeability (FPM) | |
|---|---|---|---|---|---|---|---|
| | Warp | Fill | Warp | Fill | | Dirty | Clean |
| New | 232 | 226 | 3100 | 778 | 405 | 68 | 68 |
| 4-wk | 117 | 57 | 550 | 68 | 209 | 10.9 | 83 |

Fabric Type B

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| New | 123 | 109 | > 50,000 | > 50,000 | 307 | 37.2 | 37.2 |
| 4-wk | 101 | 81 | > 50,000 | > 50,000 | 263 | 10.8 | 36.2 |

# Bag Monitoring



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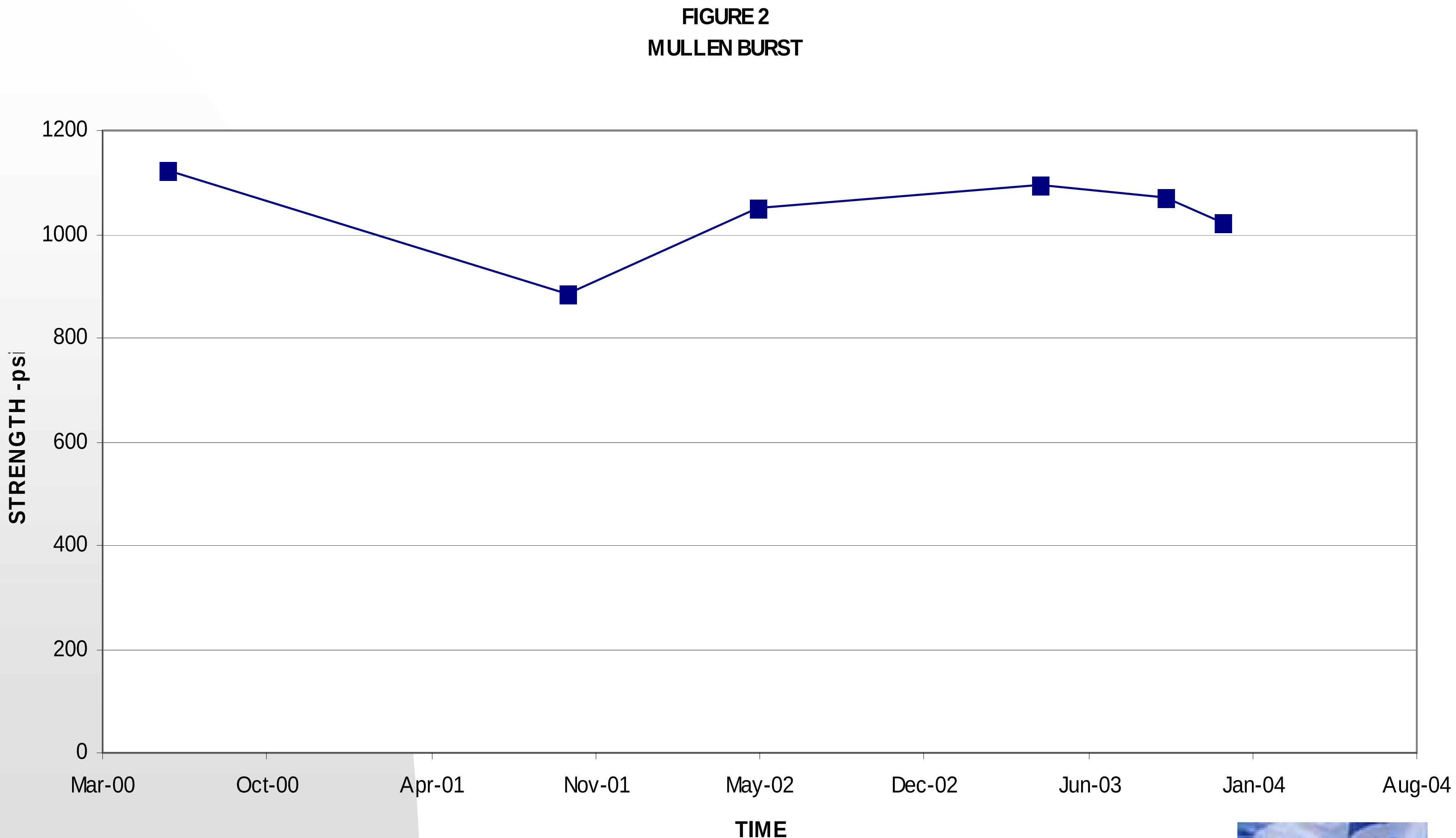

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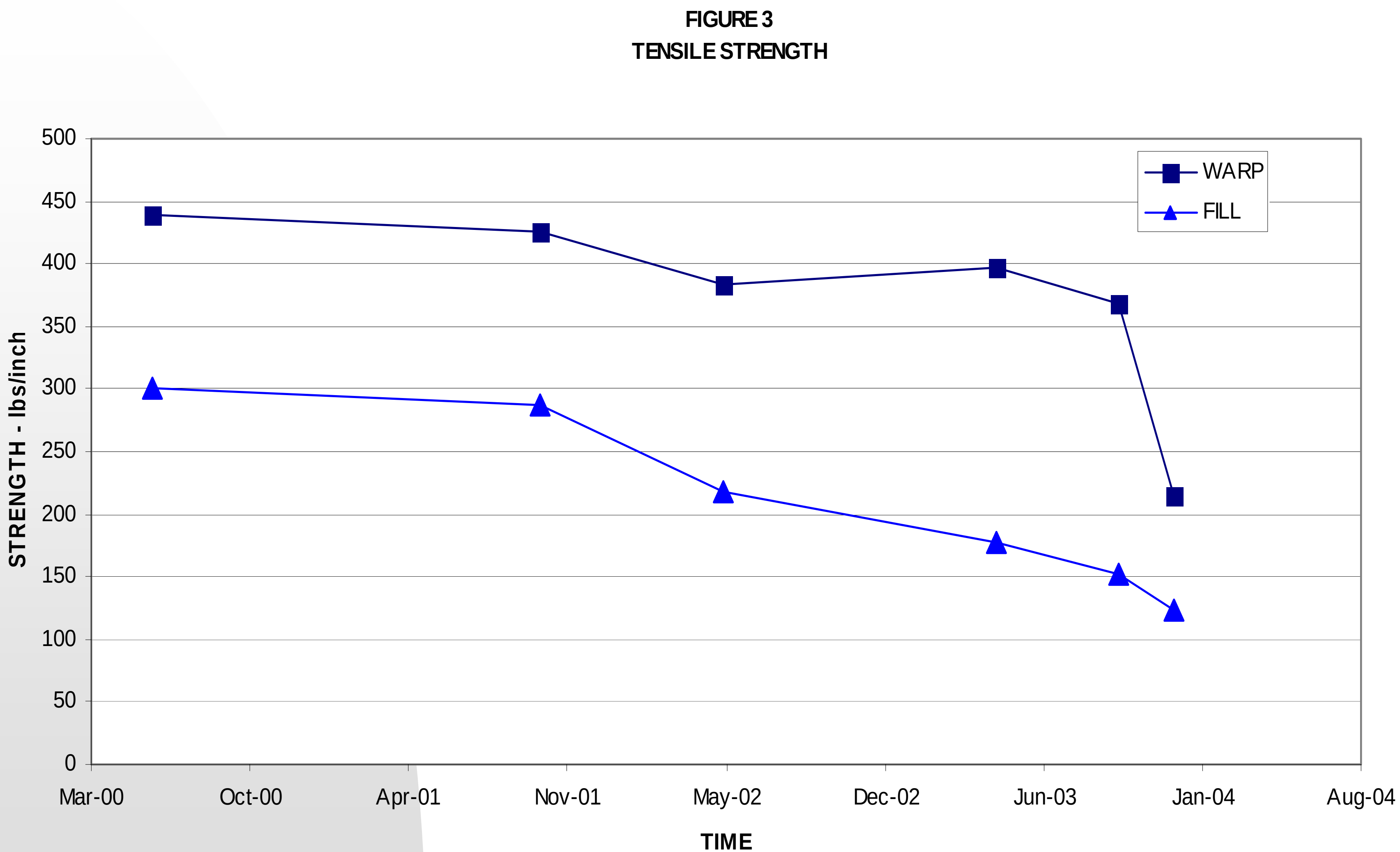

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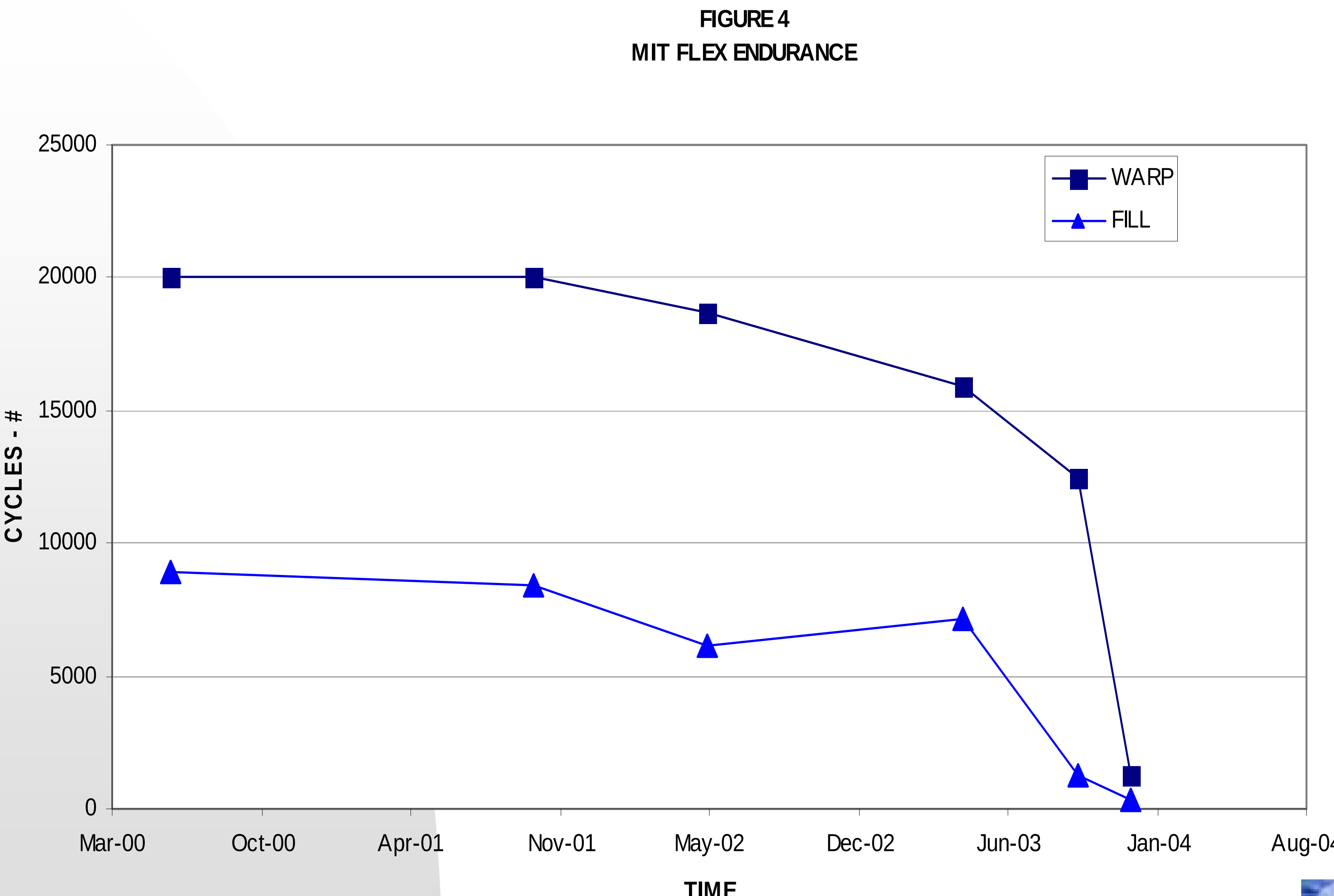
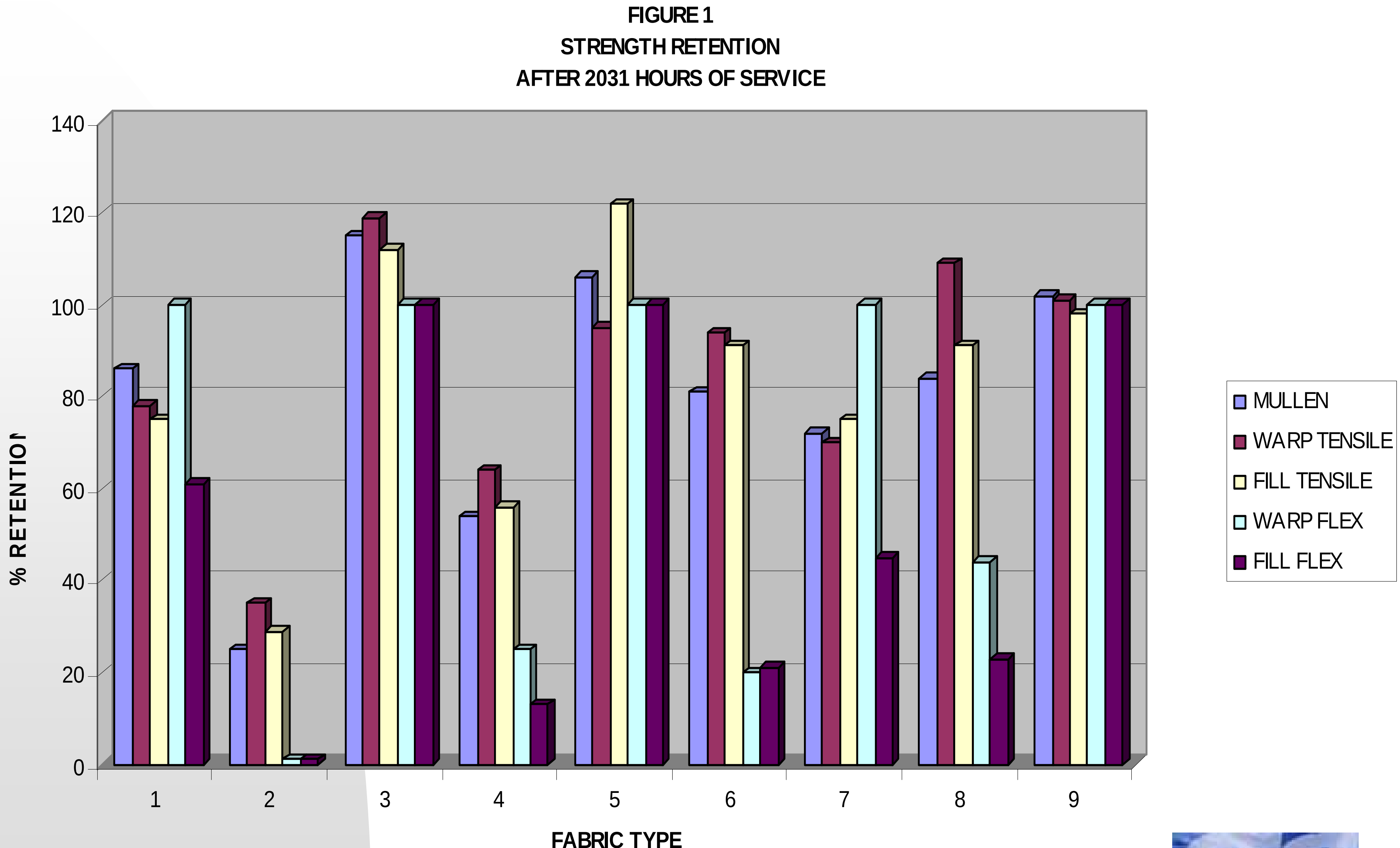


# Alternative Fabric Study



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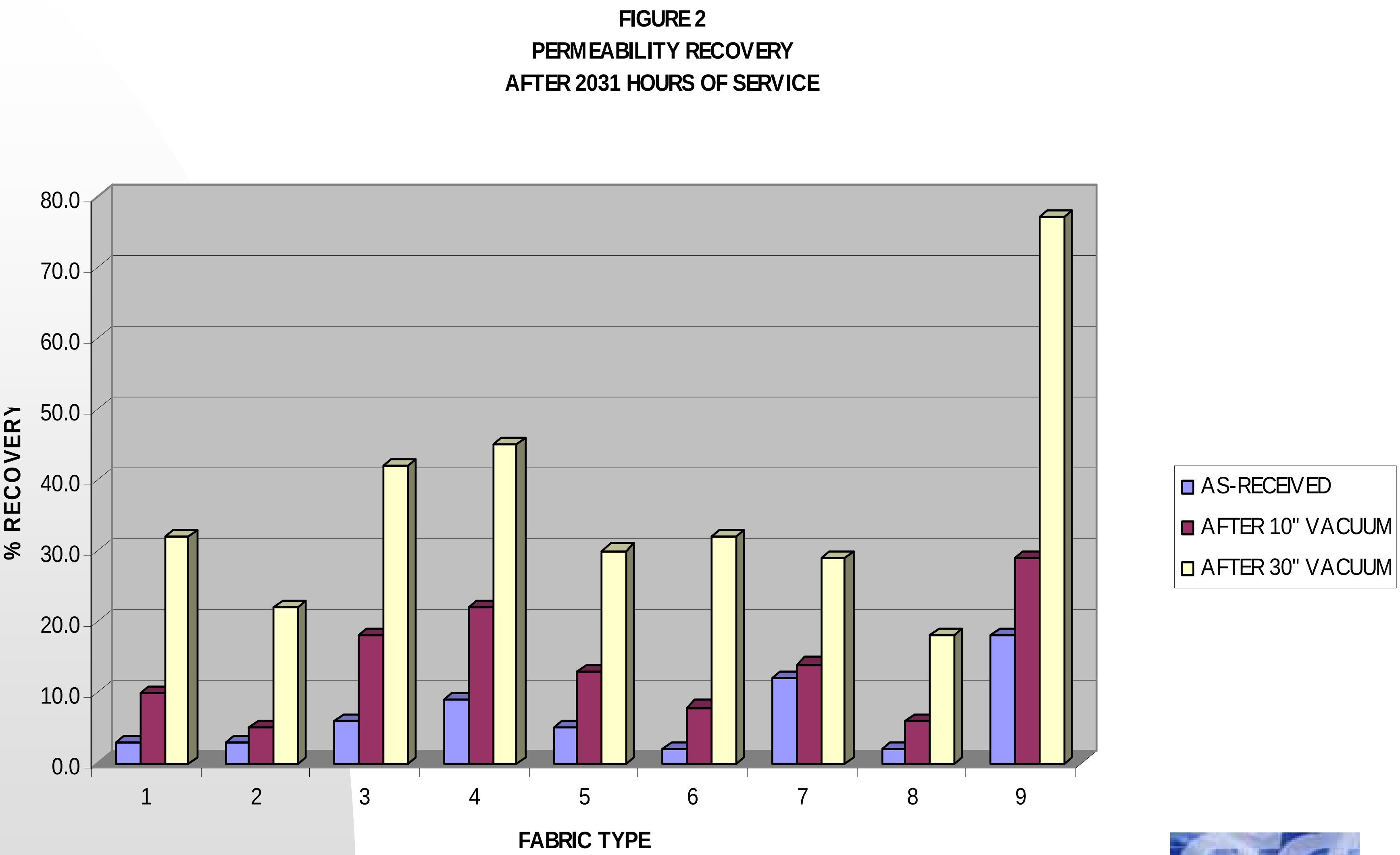

# THANKS FOR LISTENING

# --- QUESTIONS? ---