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Determination of Acetate Tow Capability Responses Across Standard, Slims and Super-slims Filter Rod Circumferences

Francisco Ruvalcaba
Celanese Acetate LLC
3520 Virginia Avenue
Narrows, VA 24124 USA

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Objectives

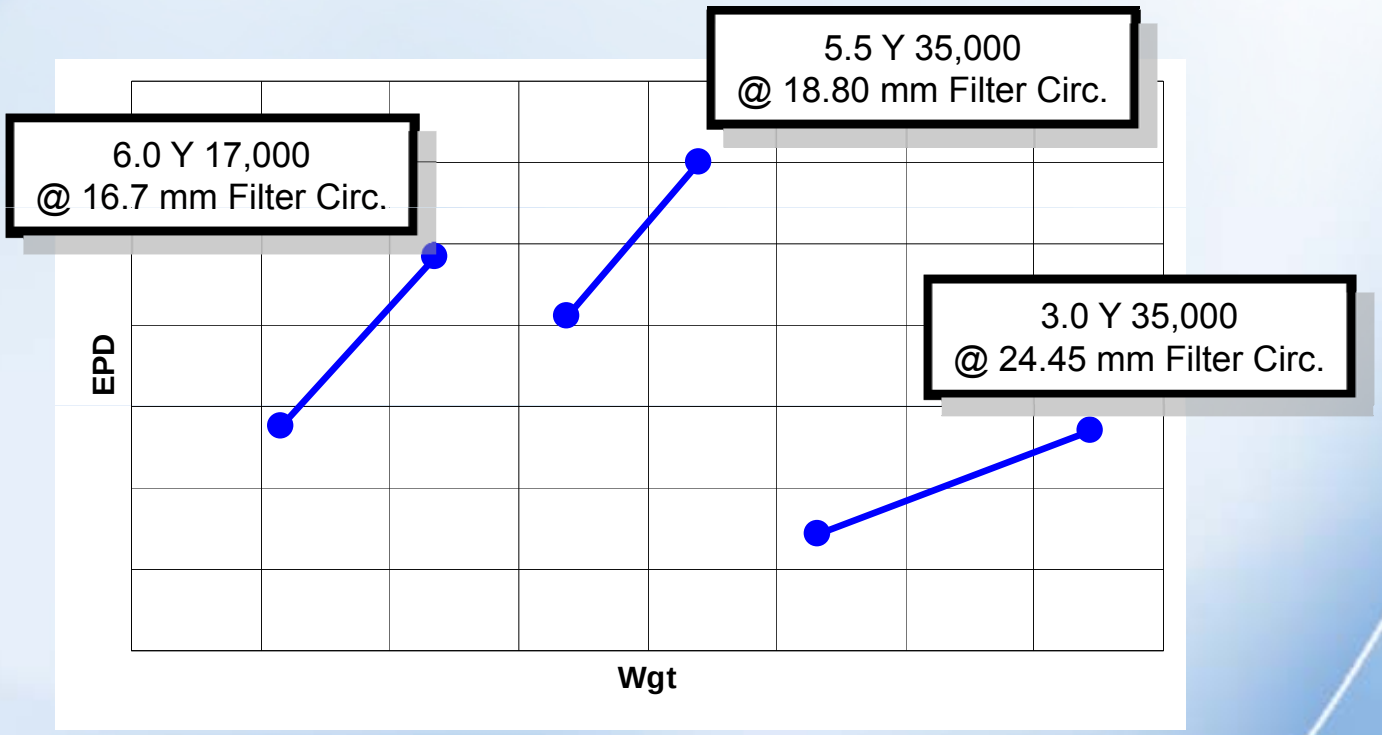
- Propose theoretical concepts to explain the differences observed in acetate tow capability lines when producing filters rods across standard, slims and super-slims circumferences.
- Demonstrate the proposed concepts by determining actual acetate tow capabilities across the circumferences above.
- Obtain better predictive equations of yield for tow items working at filter rod circumferences for which they were not designed for.

Background

- Growing market of slims and superslims cigarettes.
- Limited experience in tow performance on filters produced at very diverse circumferences.
- Need of a predictive tool for filter/cigarette design at a wide range of circumferences including slims and superslims.

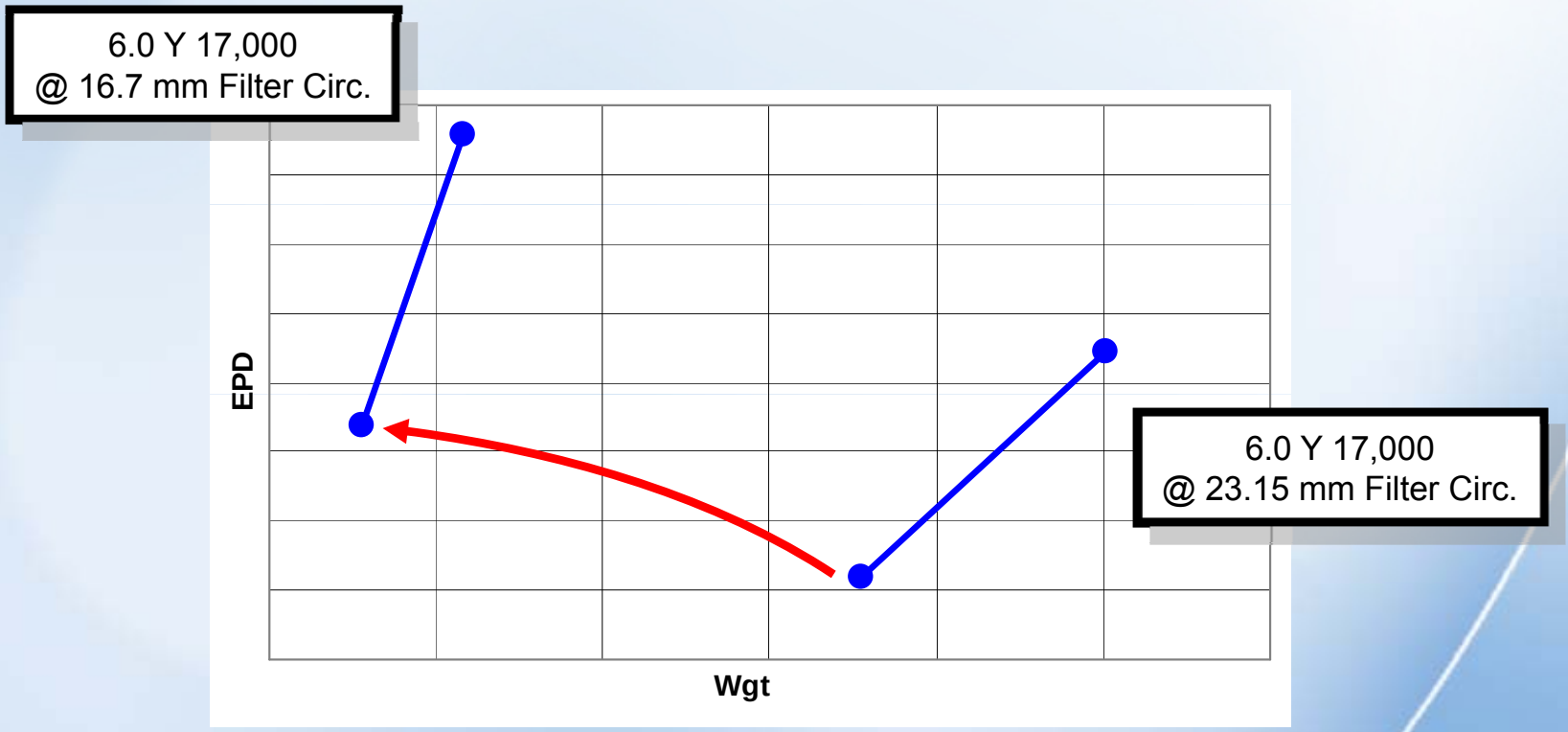
- Need of improved estimations are based on the following observations:

Observation No. 1
Yield line slope changes across the range of circumferences.

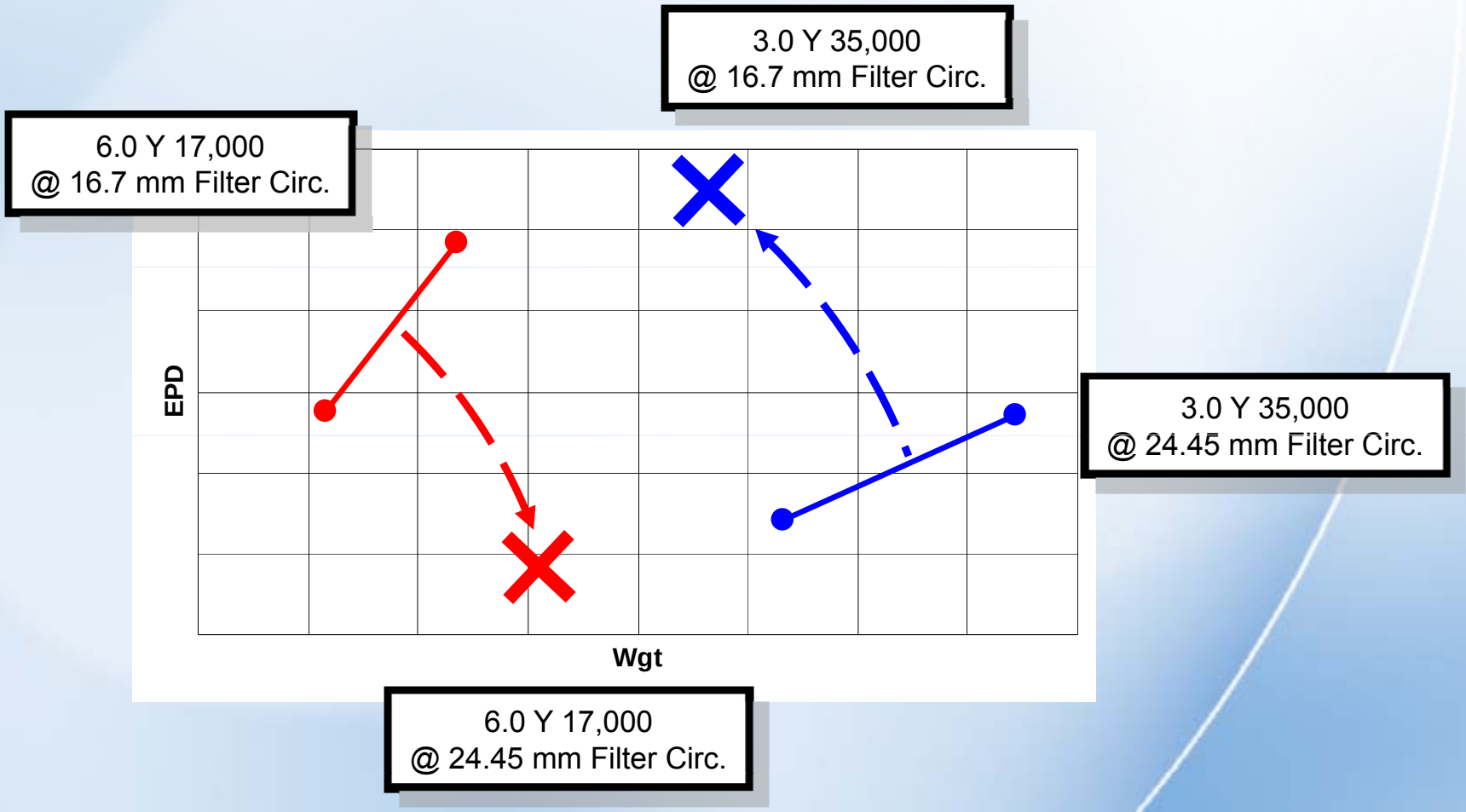


EPD: Encapsulated Pressure Drop
Wgt: Filter Weight

Observation No. 2
Not only yield slope, but also yield minimum point changes when adjusting filter circumference.



Observation No. 3
Not every tow item can produce all filter circumferences

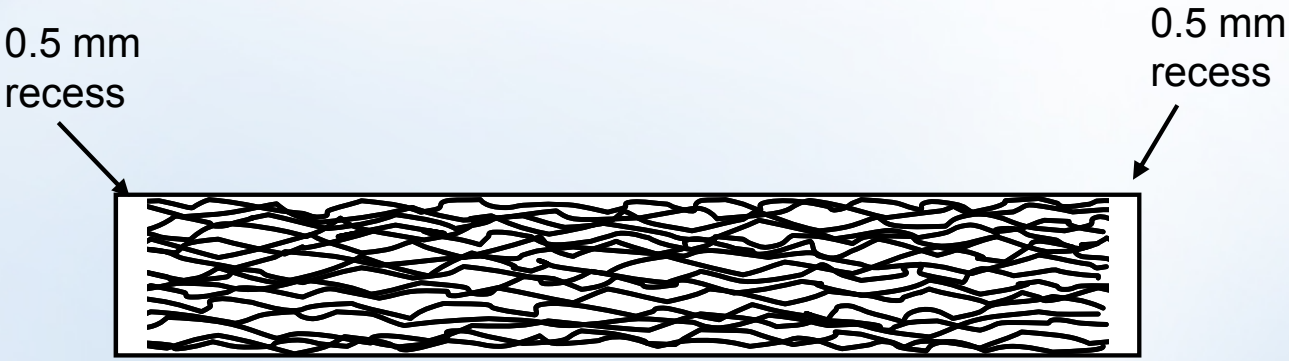


Understanding the Concept (Hypothesis)

Back to Minimum and Maximum Point Concepts

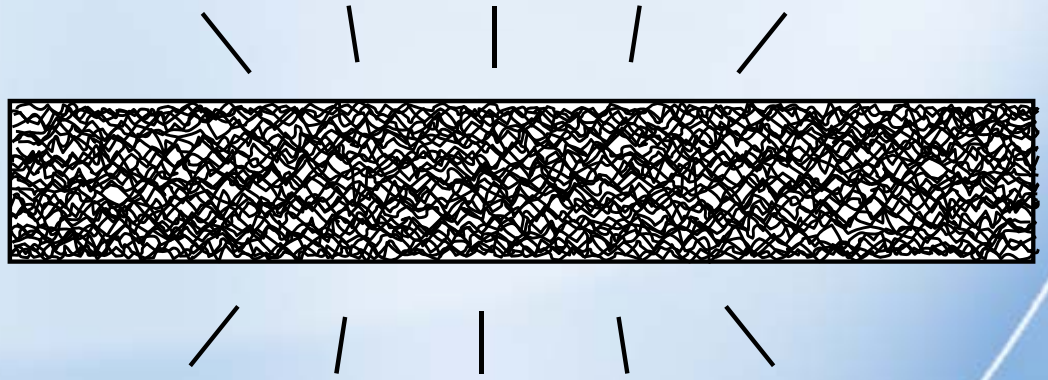
Minimum Point:

Minimum Weight
Minimum Pressure Drop



Maximum Point:

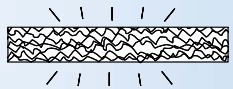
Maximum Weight
Maximum Pressure Drop



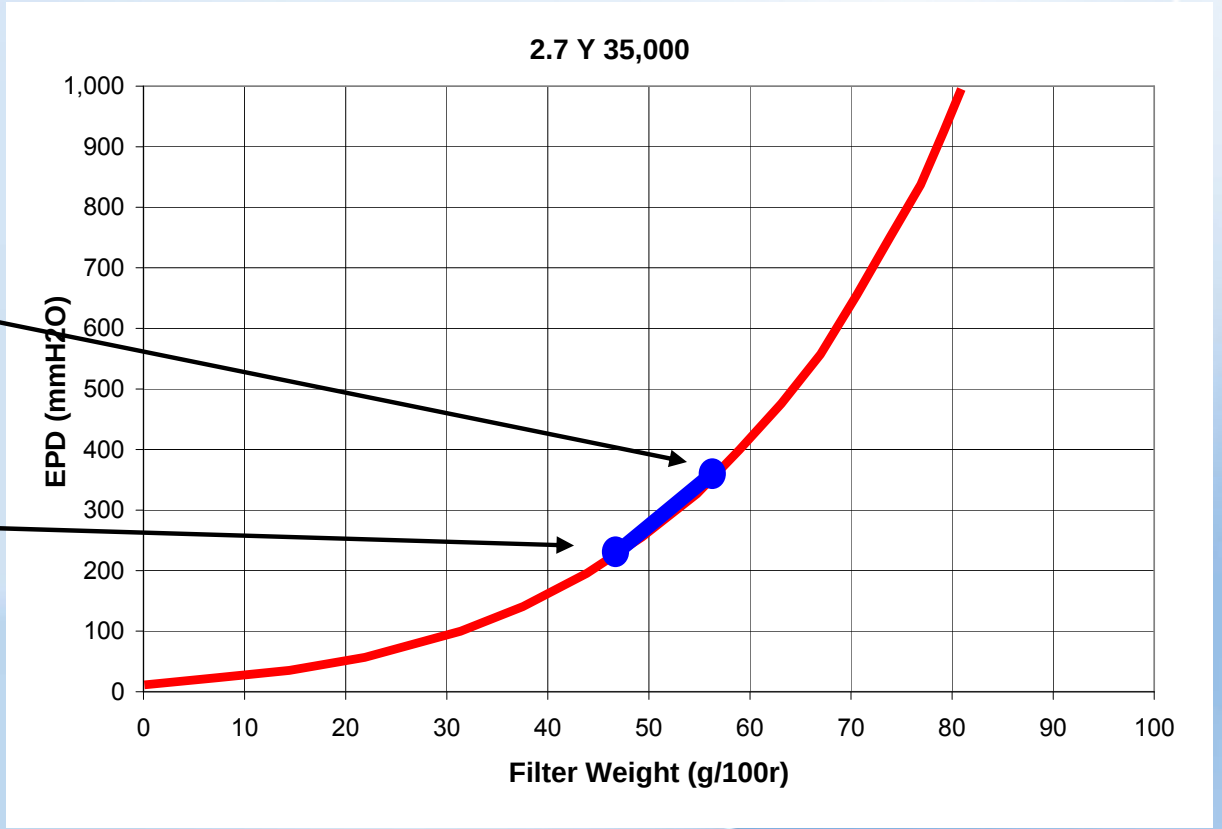
Min and Max Points to the Extreme

- What if rod integrity were not an issue?
  What if it were possible to make filters from “empty” to “infinite density” filter?

Very High Density

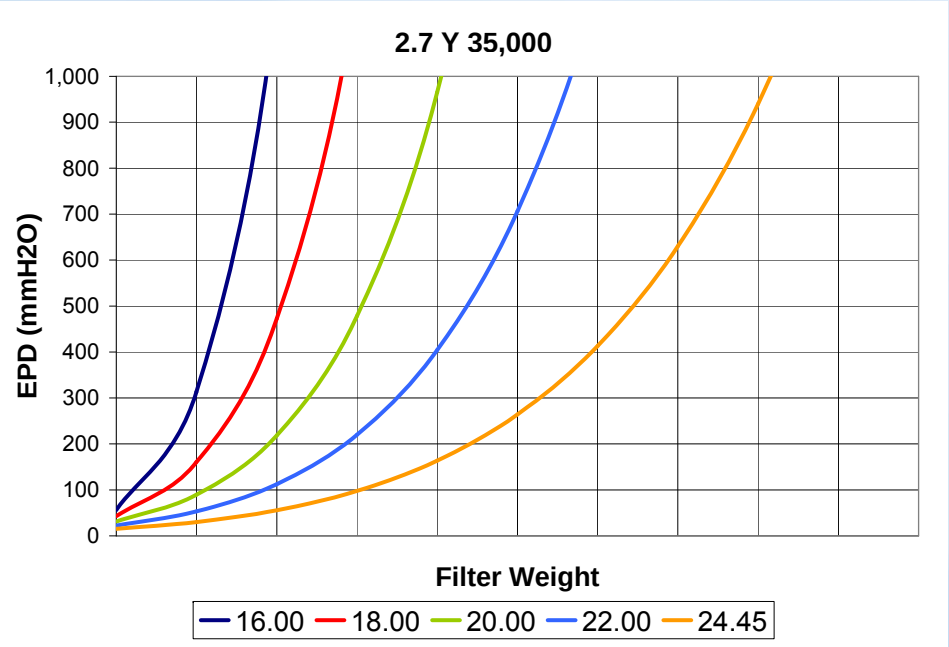


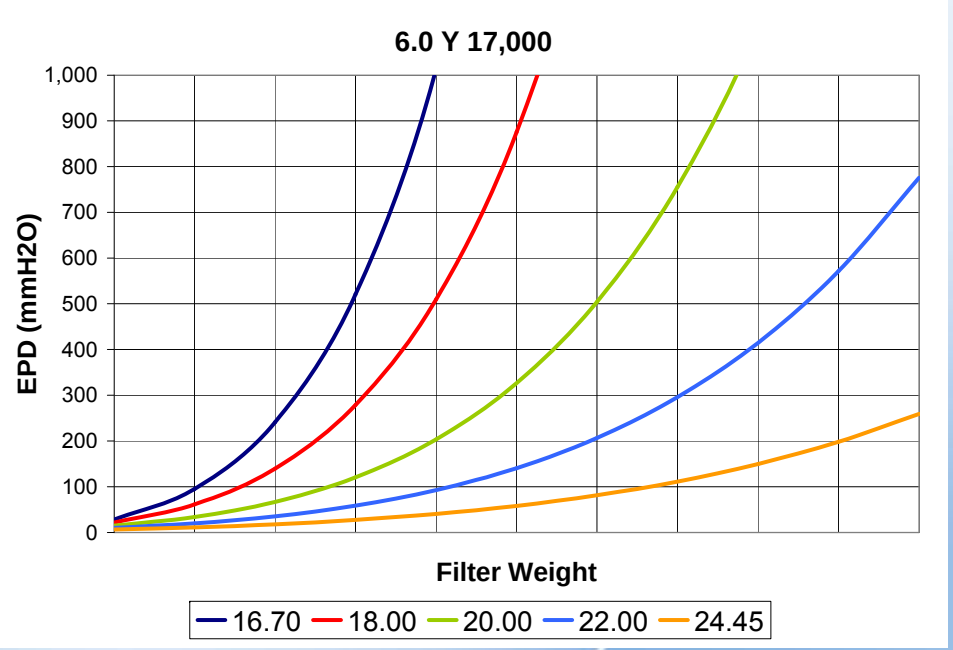
Empty Filter



Yield line slope changes when adjusting filter circumference.

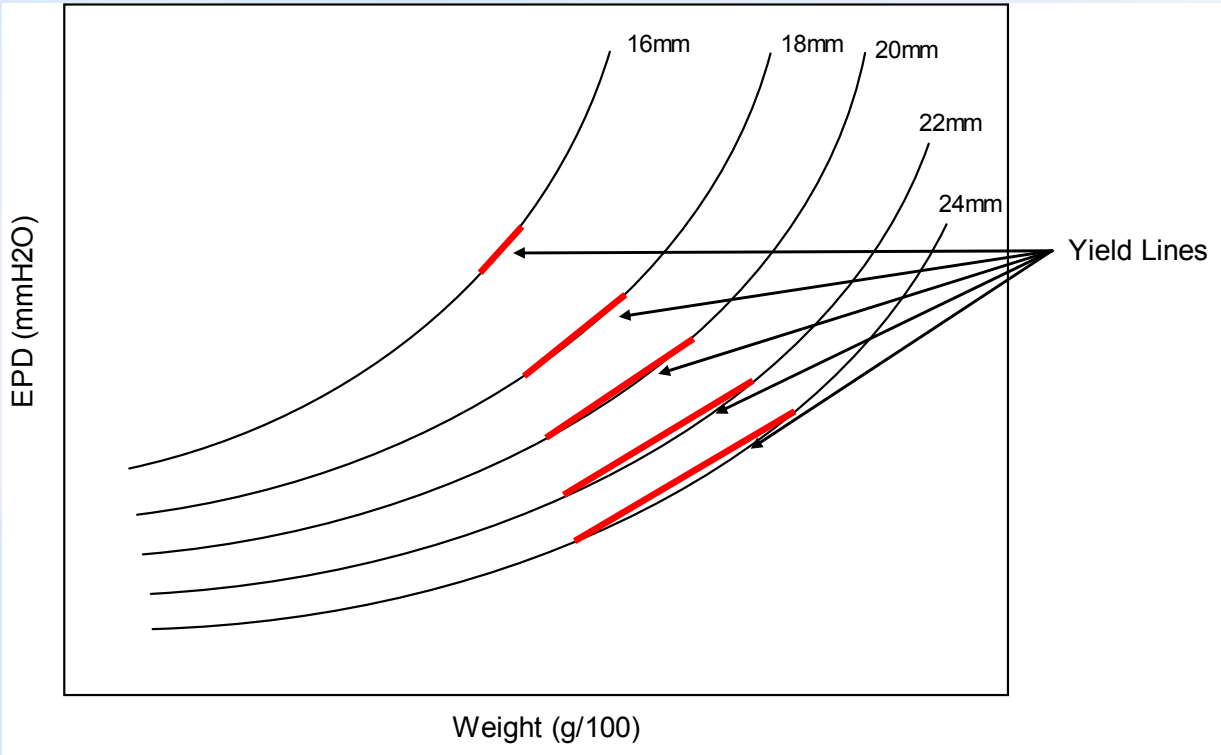
- Slope also depends on Total Denier and Denier per Filament





Yield line location and extension also change when adjusting filter circumference.

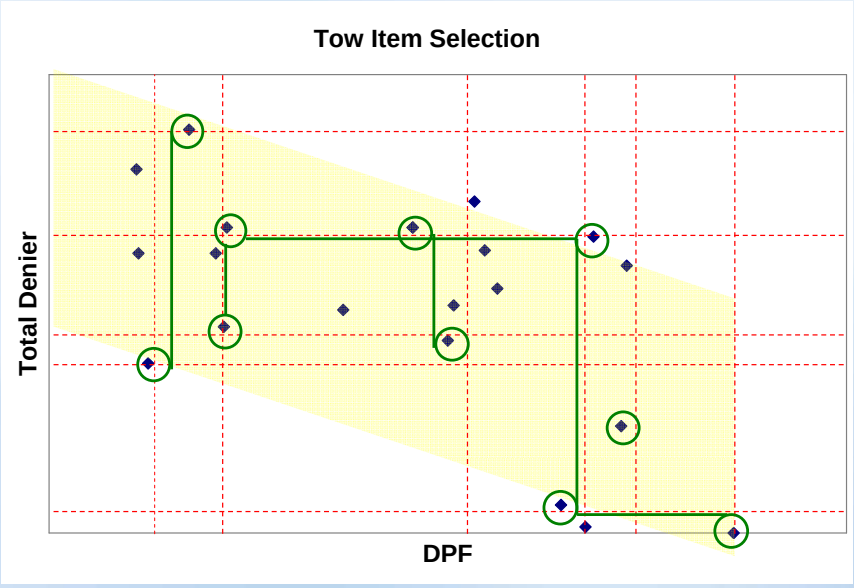
- Minimum point and maximum point related to rodmaker and filter integrity restrictions.
- There is a point where the yield line “disappears” (Max point)



Trial Design

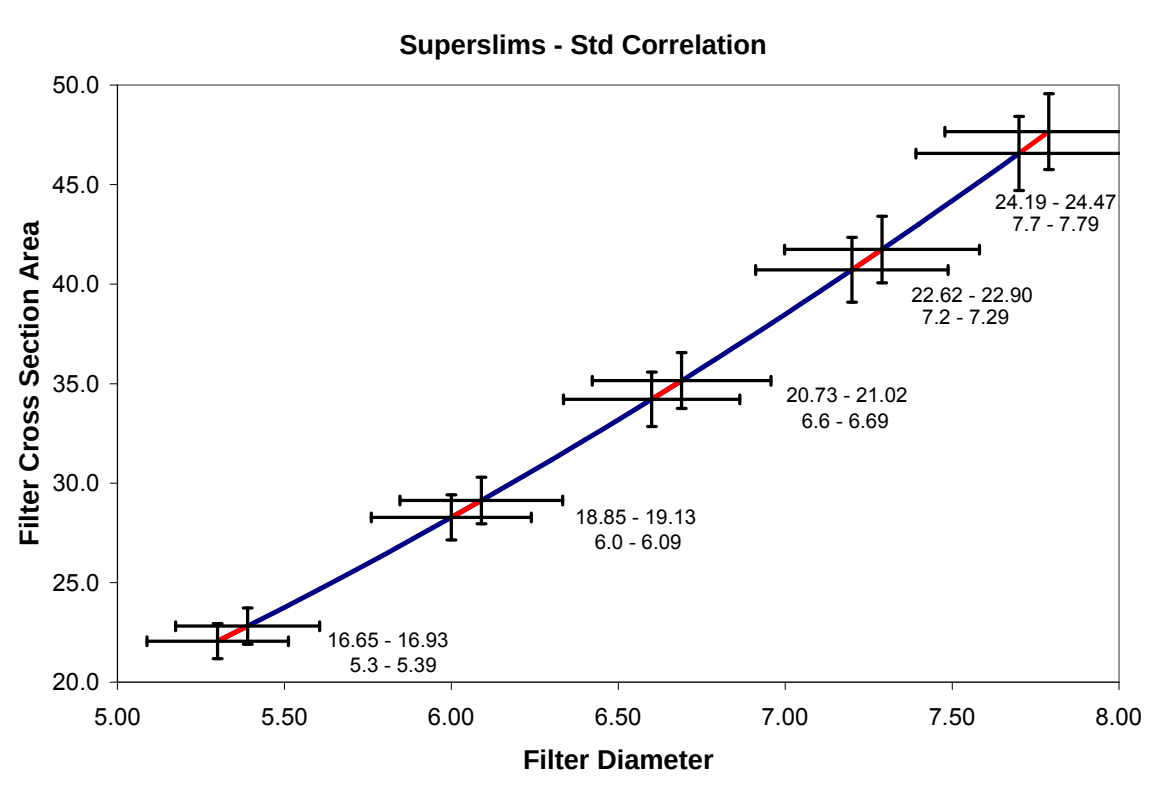
Trial Design

- Study conducted to obtain relationships and predictive equations on capability line Minimum Point, Maximum Point and Slope as a function of total denier and denier per filament.
- A wide combination of tow items was selected to cover a wide range of denier per filament and total denier products used in the market.



Trial Design

- Produce filter rods in a standard AF2 rodmaker at 24.35, 22.75, 20.90, 19.00, and 16.80 mm circumferences.
- These circumferences cover the whole range of market needs.



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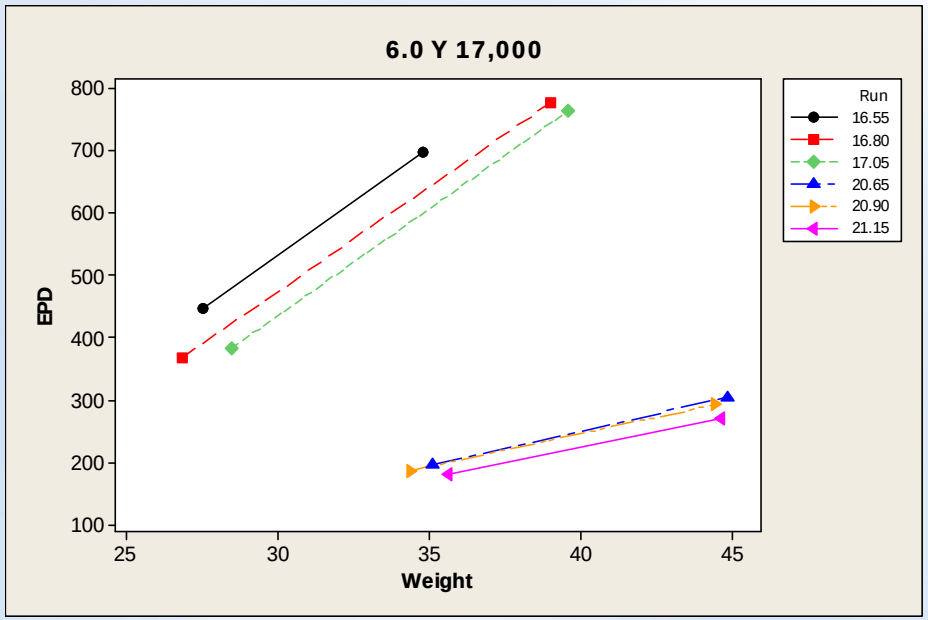
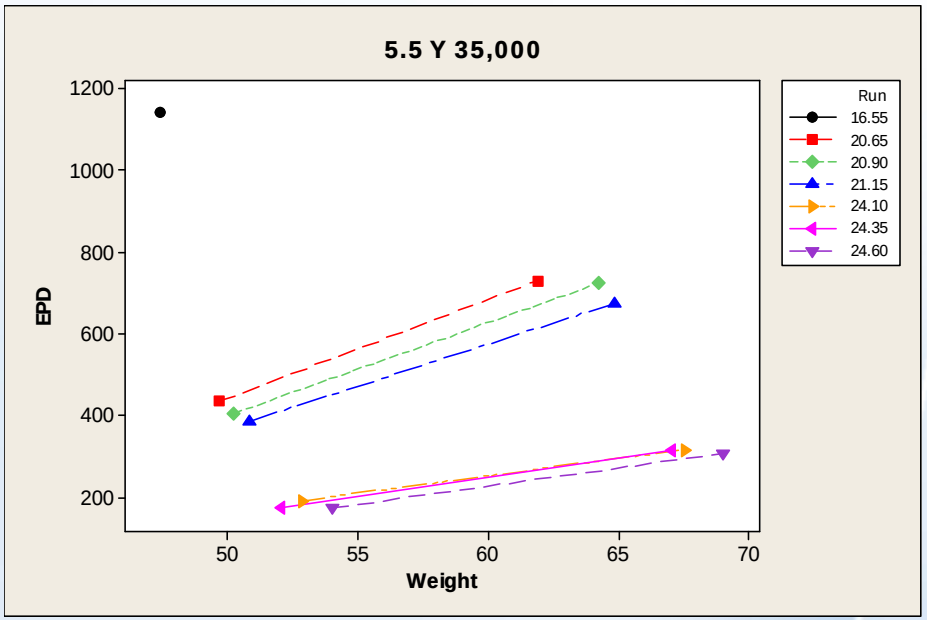
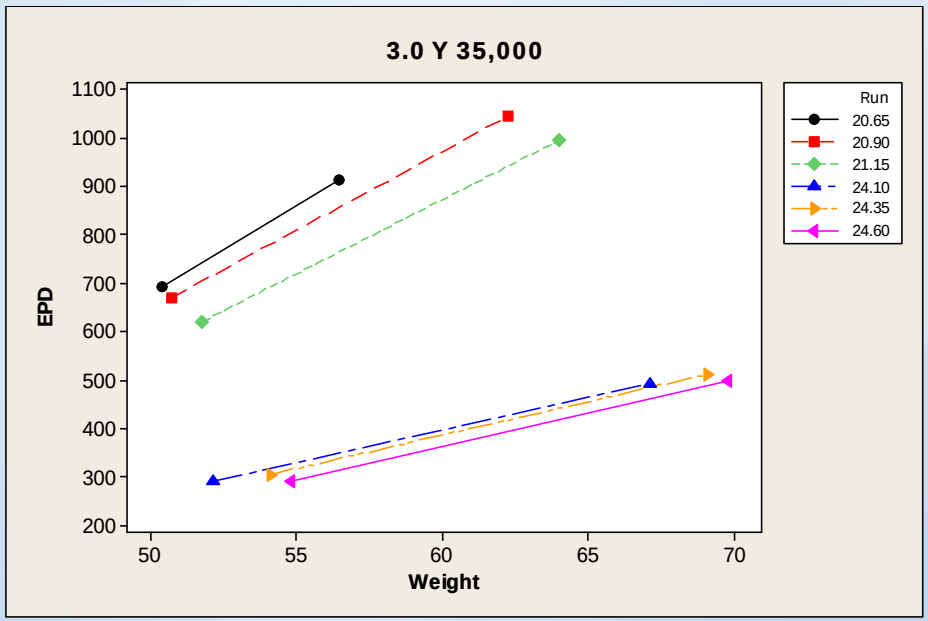
Results

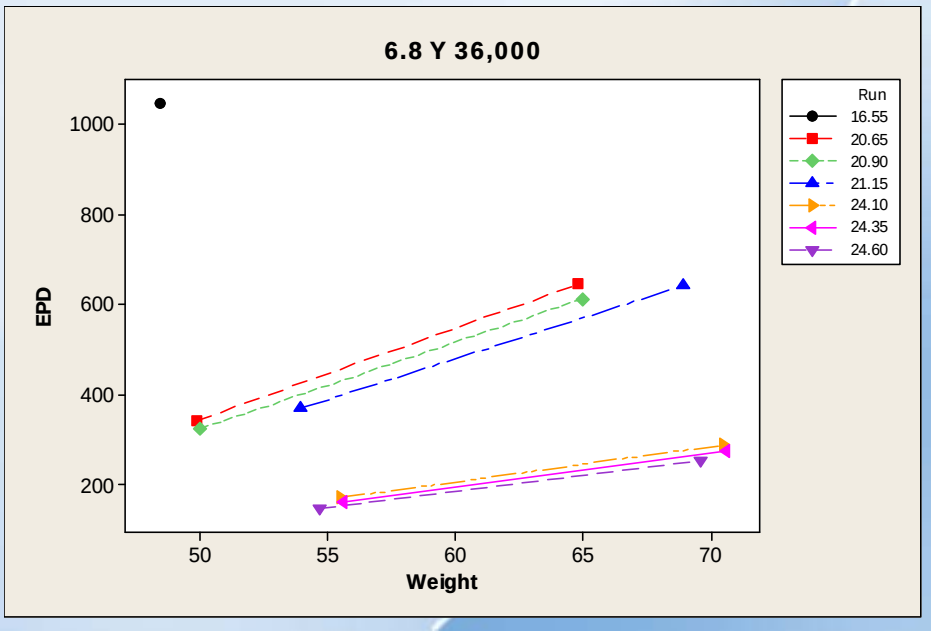
Results

- Study completed for 24.35, 20.9, 19.00 and 16.80 mm filter rods.





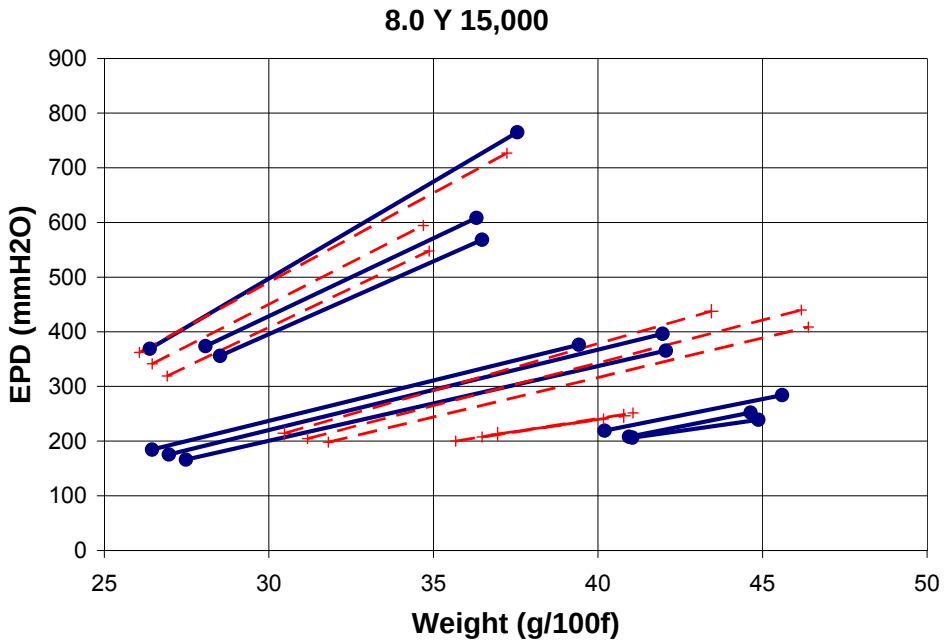


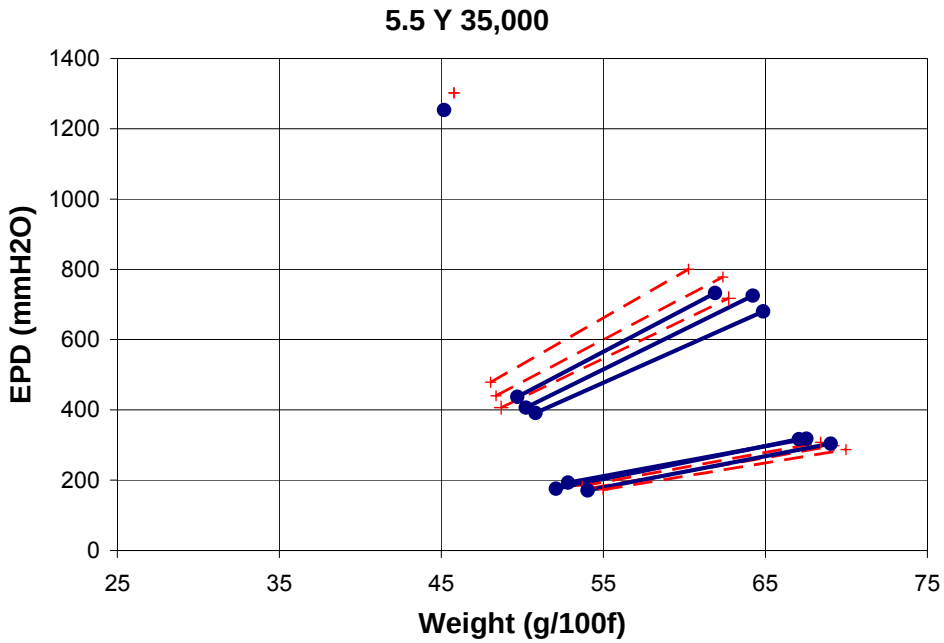


Model Design

- To model the interaction of circumference, total denier and denier per filament:
  - Celanese's Charles-Keith equation
  - Celanese's Darcy approximation
  - Celanese's TowPlus™ 2.0 predictive equations
  - Multiple non linear regression approach

Model Results

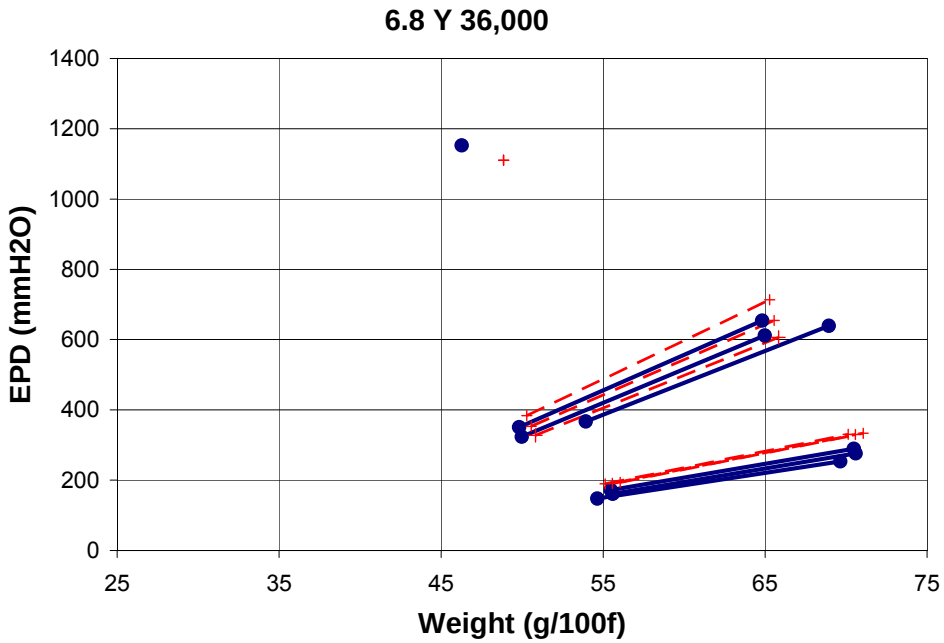


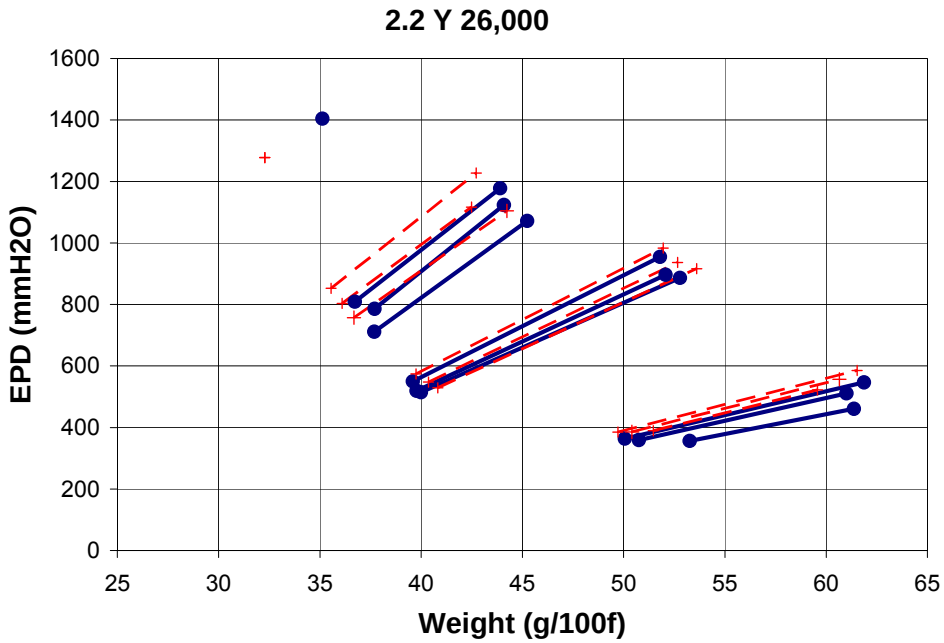


Real
Prediction

Slope regression: 95.4 % R-Sq (adj)
Min Weight regression: 93.0 % R-Sq (adj)
Min EPD regression: 97.6 % R-Sq (adj)

Model Results (Cont)





Real
Prediction

Slope regression: 95.4 % R-Sq (adj)
Min Weight regression: 93.0 % R-Sq (adj)
Min EPD regression: 97.6 % R-Sq (adj)

Next Steps

- Complete slims filter evaluation.
- Enhance predictive equations.
- Incorporate predictive equations into Celanese TowPlus™ 3.1

Acknowledgements

- Carl Curry
  Gary Robertson
  Melissa Aldrich-Welch

  Celanese Acetate filter rodmaker technicians