WEB TENSION IN AN ACCUMULATOR AND INDUSTRY NEEDS FOR THE FUTURE

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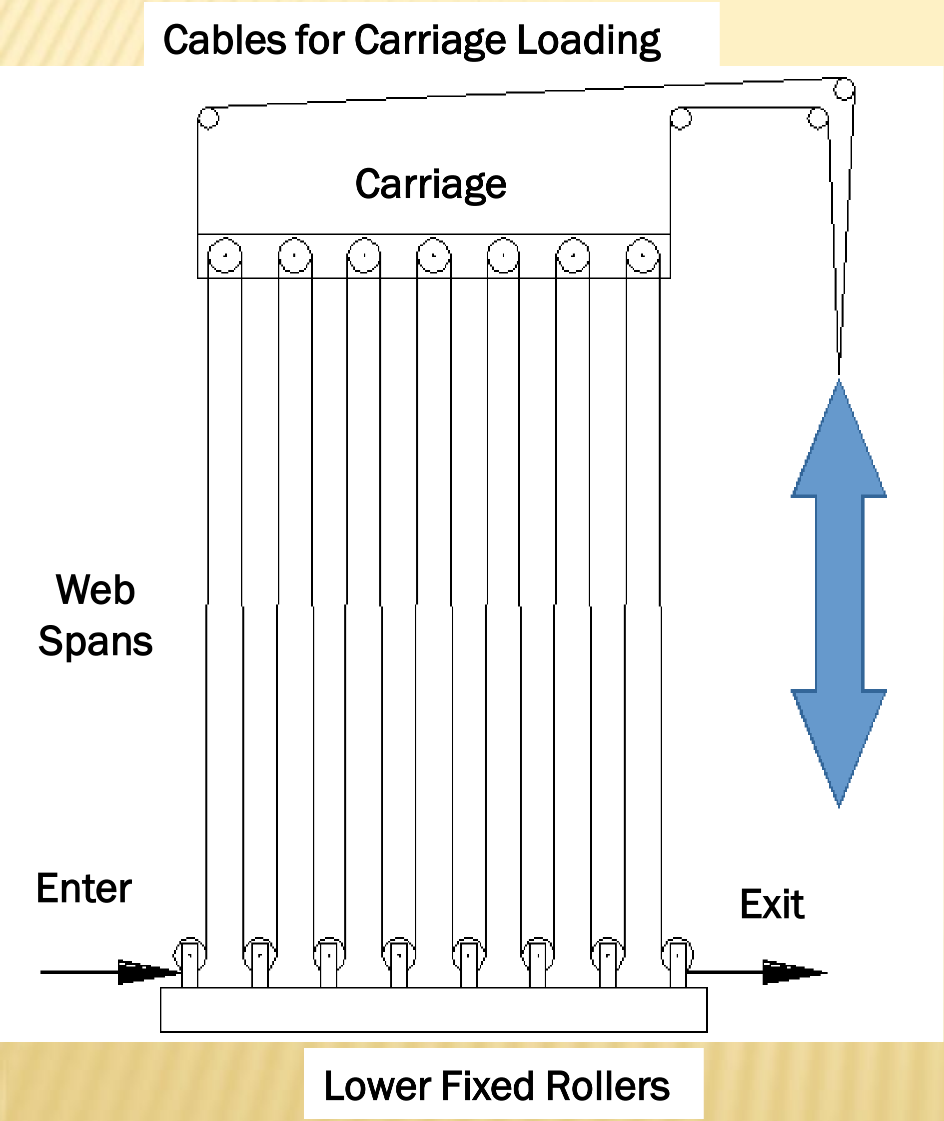
OVERVIEW

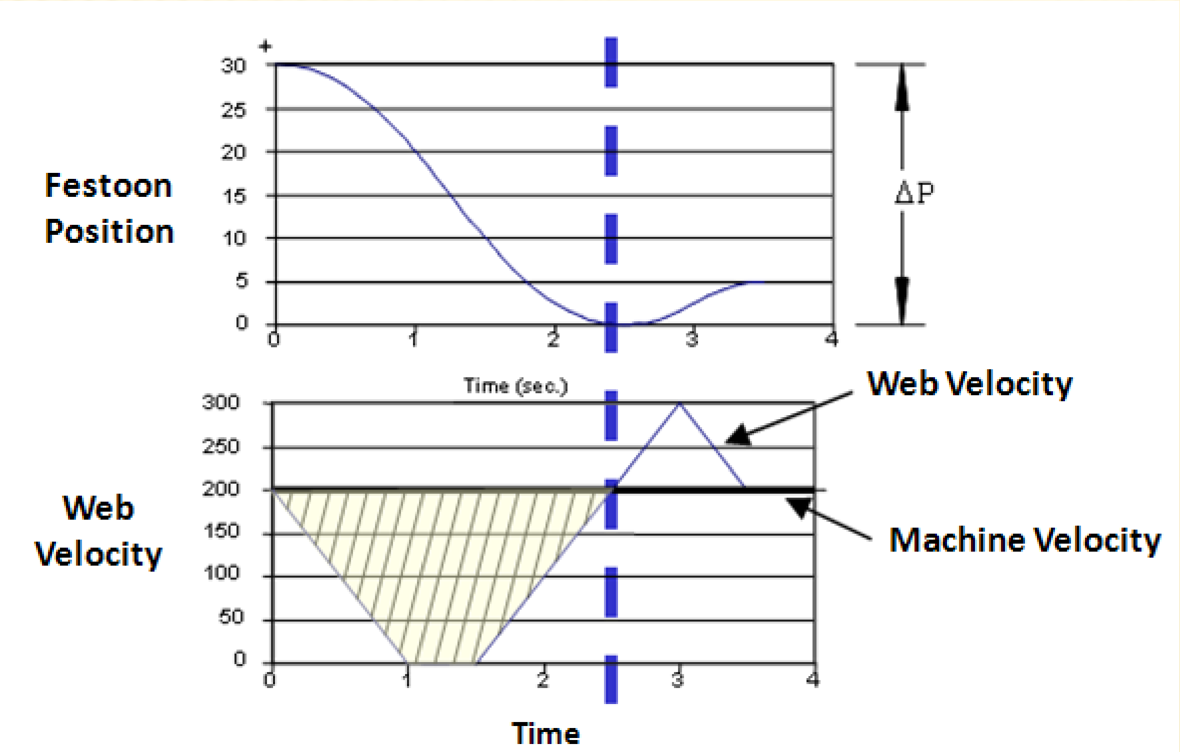
- Definition
- Design
- Challenges
- Experimental Setup
- Tension Plots
- Steady State
- Accumulator Fill
- Accumulator Feed
- Current Research
- Top Ten Research Needs
- Acknowledgments

WHAT IS AN ACCUMULATOR?



- Web storage device
- Allows different velocities
  - Winders / Unwinds
- Lower fixed rollers
- Moving carriage
- Loading by various means
  - Air / hydraulic / servos
- Span tensions
  - Steady state
  - Fill & Feed

ACCUMULATOR DESIGN

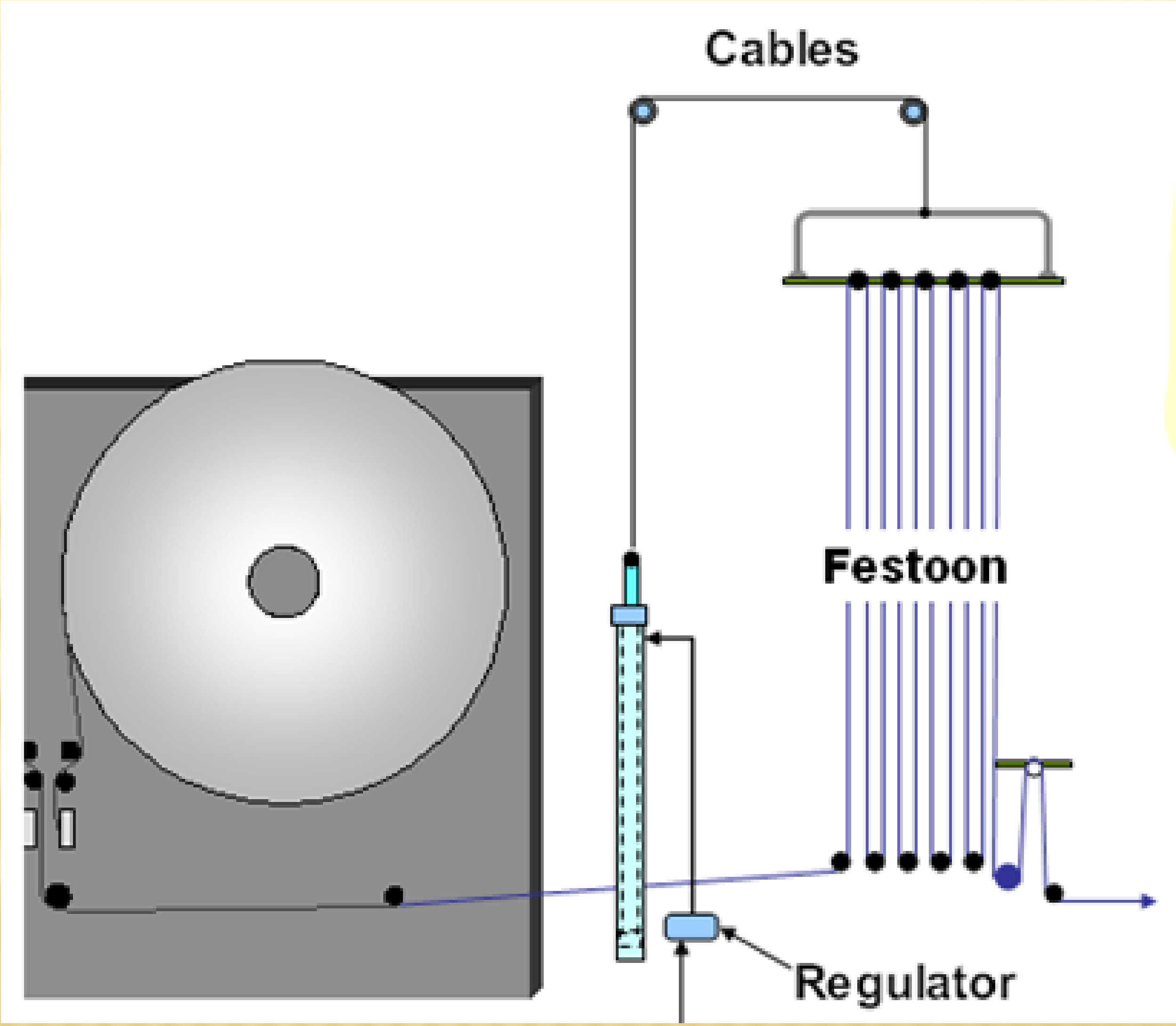


- Timing & Storage Calculations
- Most designs are incremental improvements
- Many designs are available: which is best?

PROCESS CHALLENGES

- Wrinkles are the #1 issue
  - Web camber, baggy lanes, floppy edges
  - Seasonal & storage time
- Poor tension control
  - Flutter, weave, fold-over and complete collapse
  - Neckdown, expansion wrinkles and web breaks
- Top waste and delay in converting processes

EXPERIMENTAL SETUP



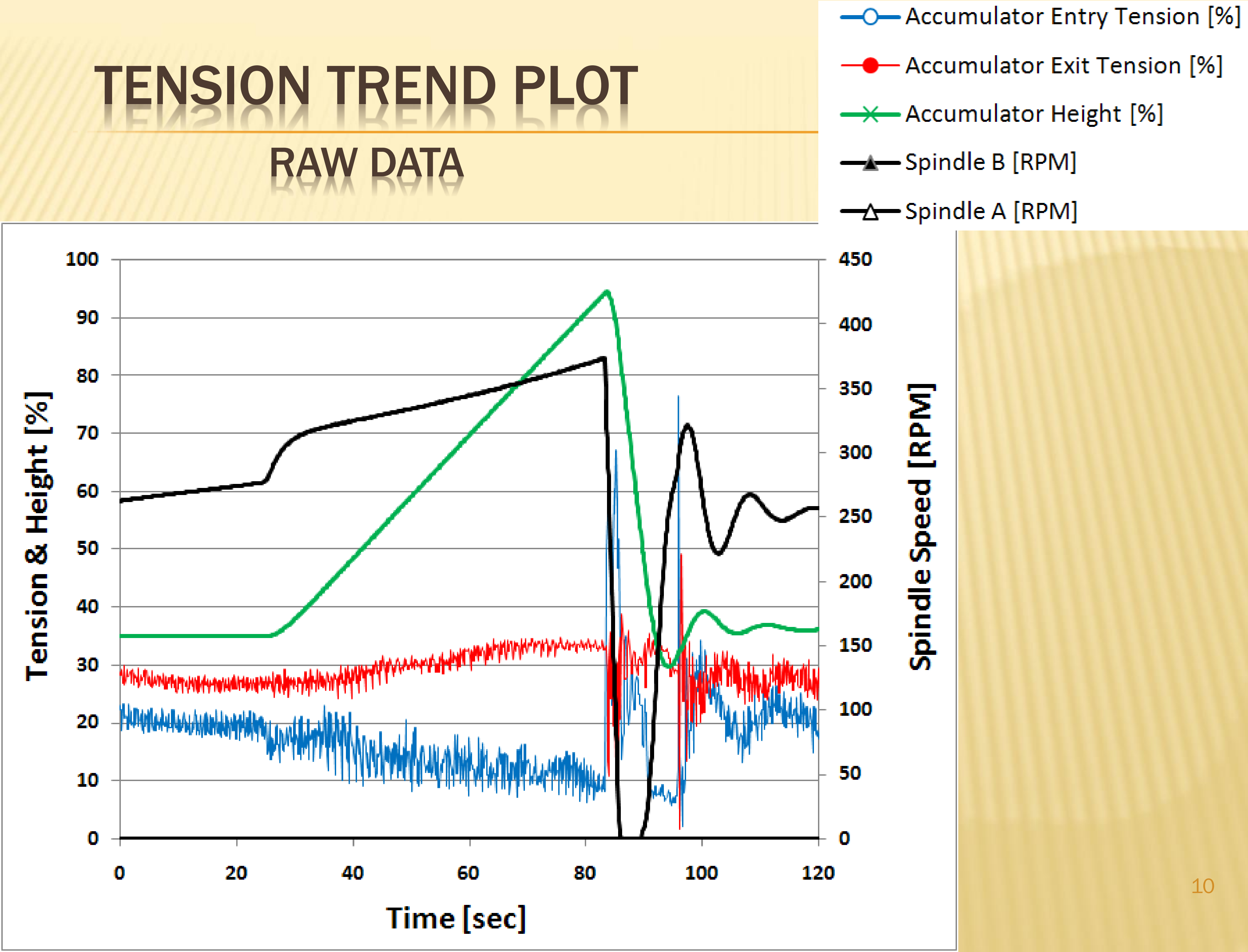
ACCUMULATOR - COLLAPSED

Accumulator Info	
Total Rollers	17
Fixed Rollers	9
# Carriage Rollers	8
# Web Spans	16
Roller Diameter	165.1 mm
Roller Mass	7.28 kg
Roller Length	3.6 m
Roller Inertia	43603 kg*mm^2
Accumulator Stroke	5.1 m
Total Accumulation	81.6 m
Spindle Drive Info	
Motor Base Speed	1,765 rev/min
Gear Ratio	11.375:1

Operating Parameters	
Machine Speed	259 m/min
Deceleration Rate	91.4 m/min/sec
Acceleration Rate	91.4 m/min/sec
Stop Time	2.7 sec
Material Info	
Web Material	Polypropylene Spunbond
Young's Modulus	55 MPa @ 1% Strain
Basis Weight	13.6 g / m^2
Web Width	3162 mm
Material Caliper	0.1016 mm
Poisson's Ratio	3 @ 1% Strain
Load Cell Info	
Manufacturer	ABB
Model #	PFTL301E
Calibration	400 N

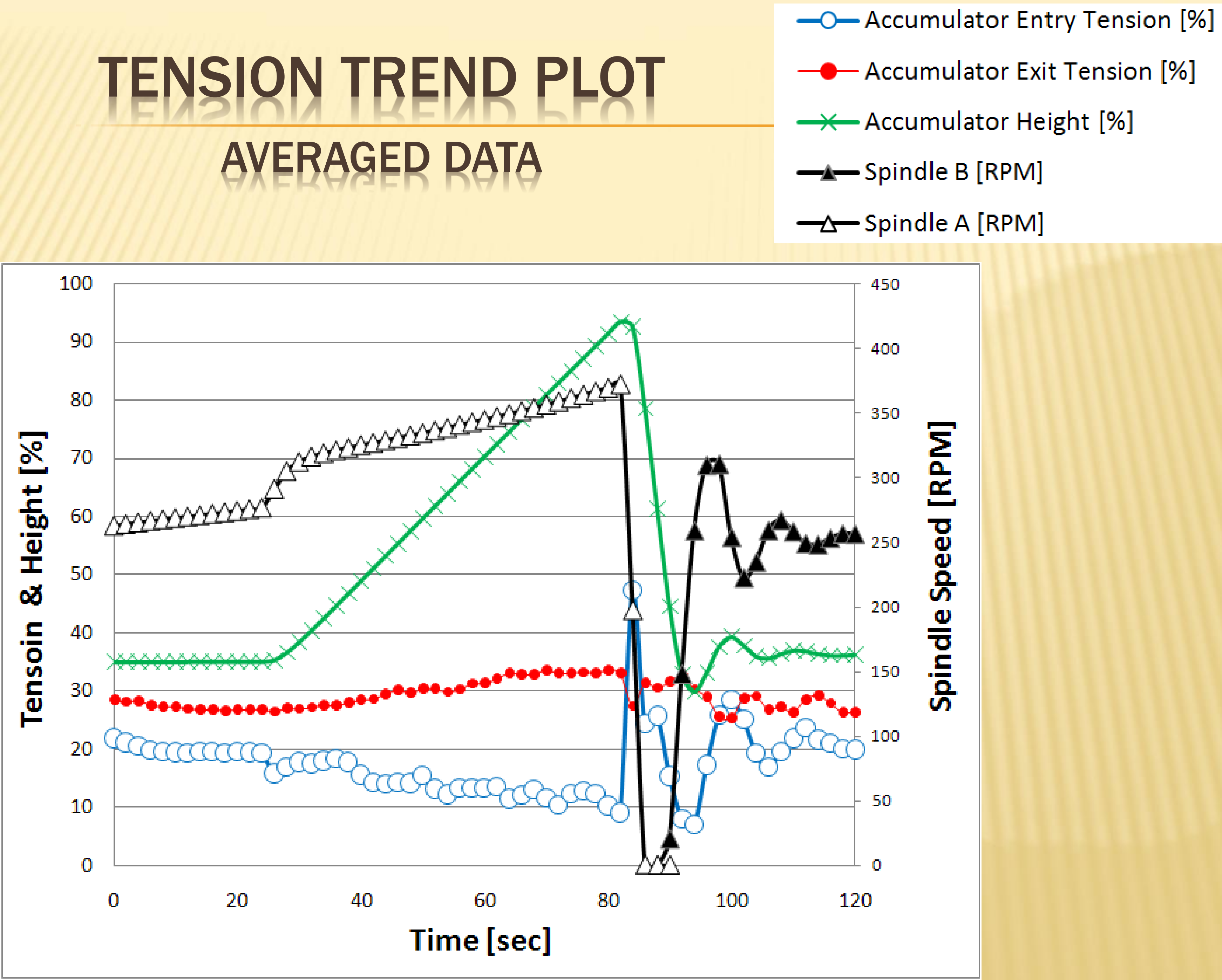
TENSION TREND PLOT

RAW DATA

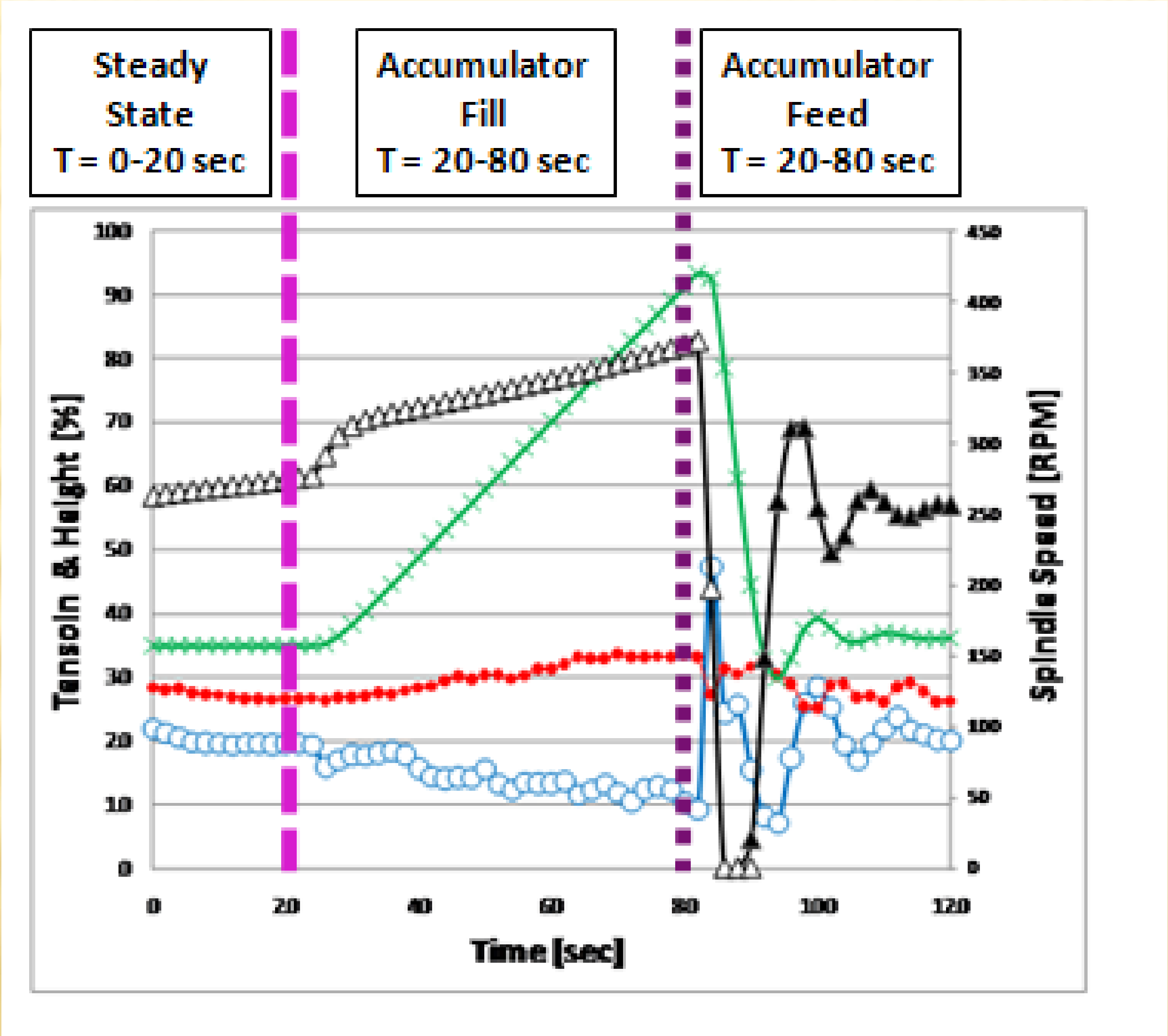


TENSION TREND PLOT

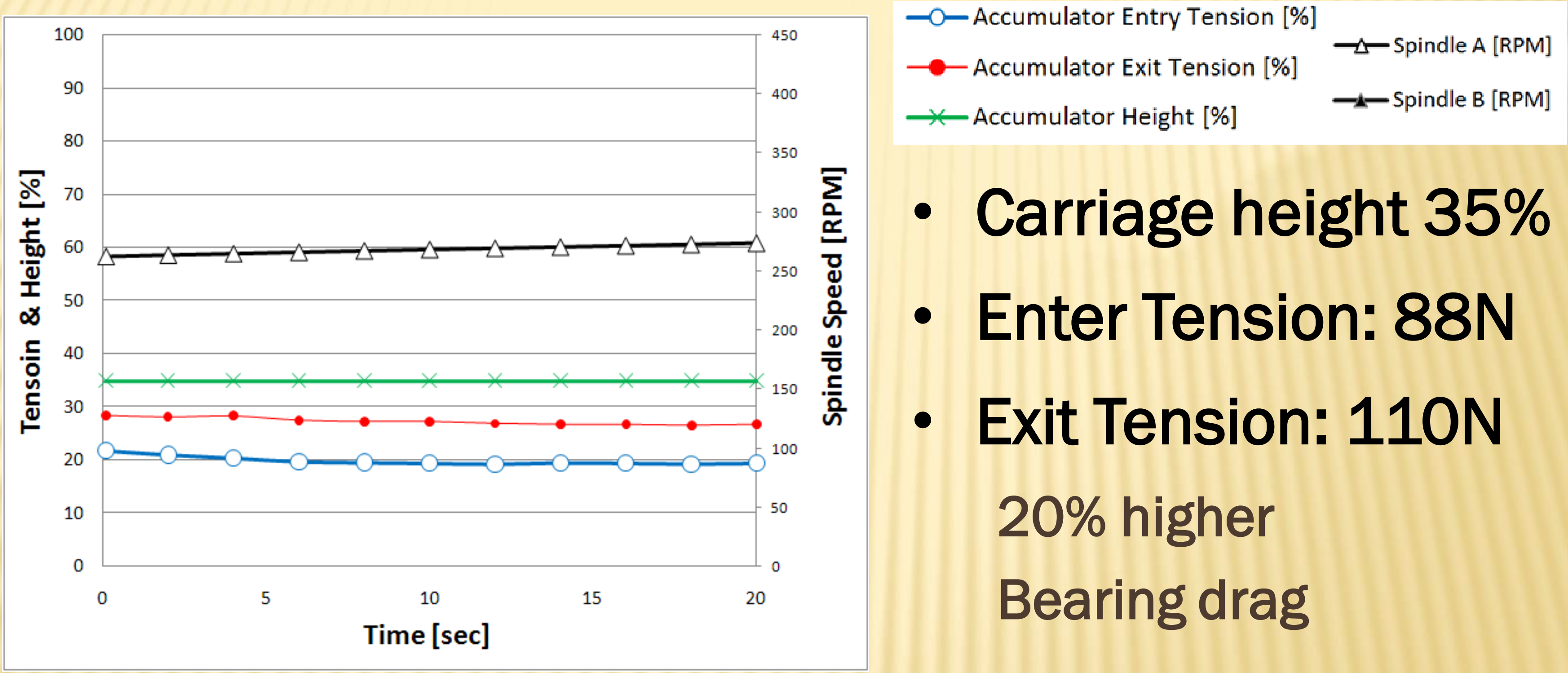
AVERAGED DATA



THREE PHASES



STEADY STATE



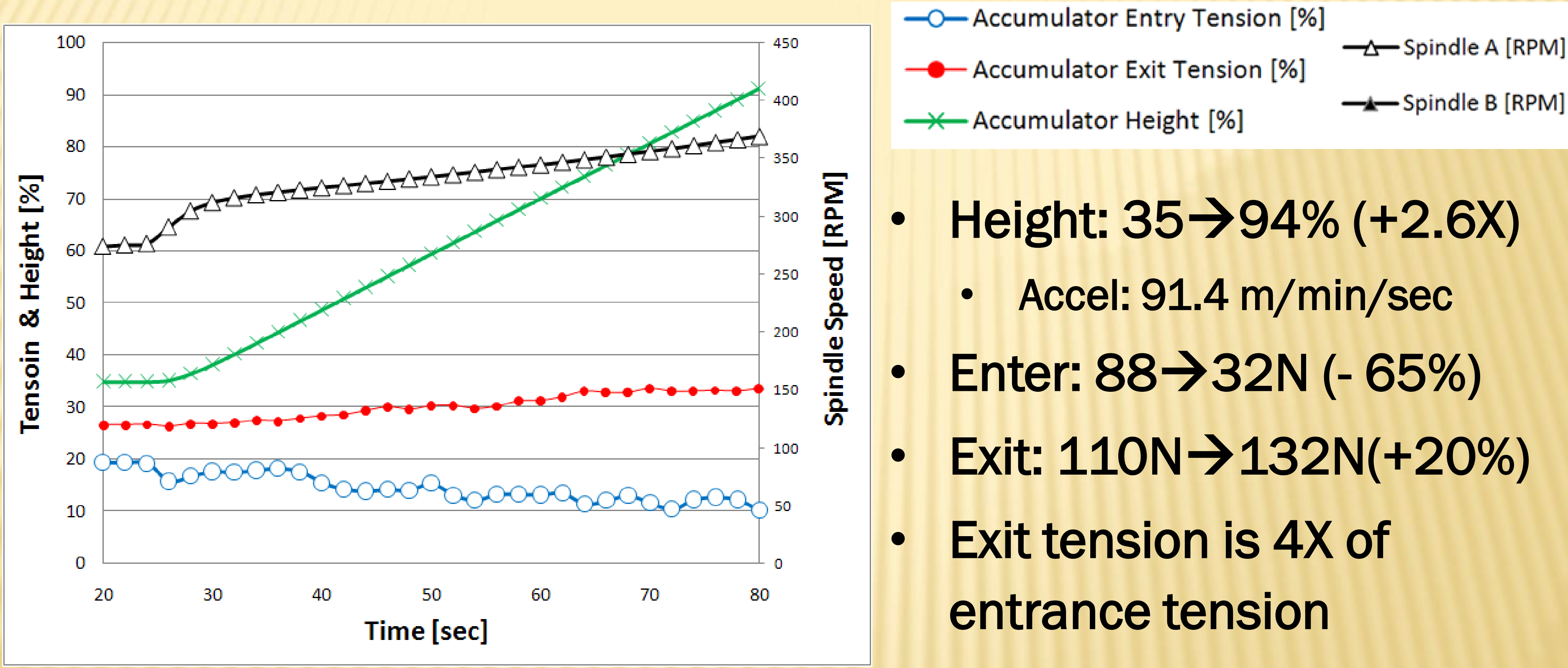
- Carriage height 35%
- Enter Tension: 88N
- Exit Tension: 110N

  20% higher

  Bearing drag

- How many rollers should be used?
- Misalignment of the carriage?
- Critical length / width ratio to be avoided?

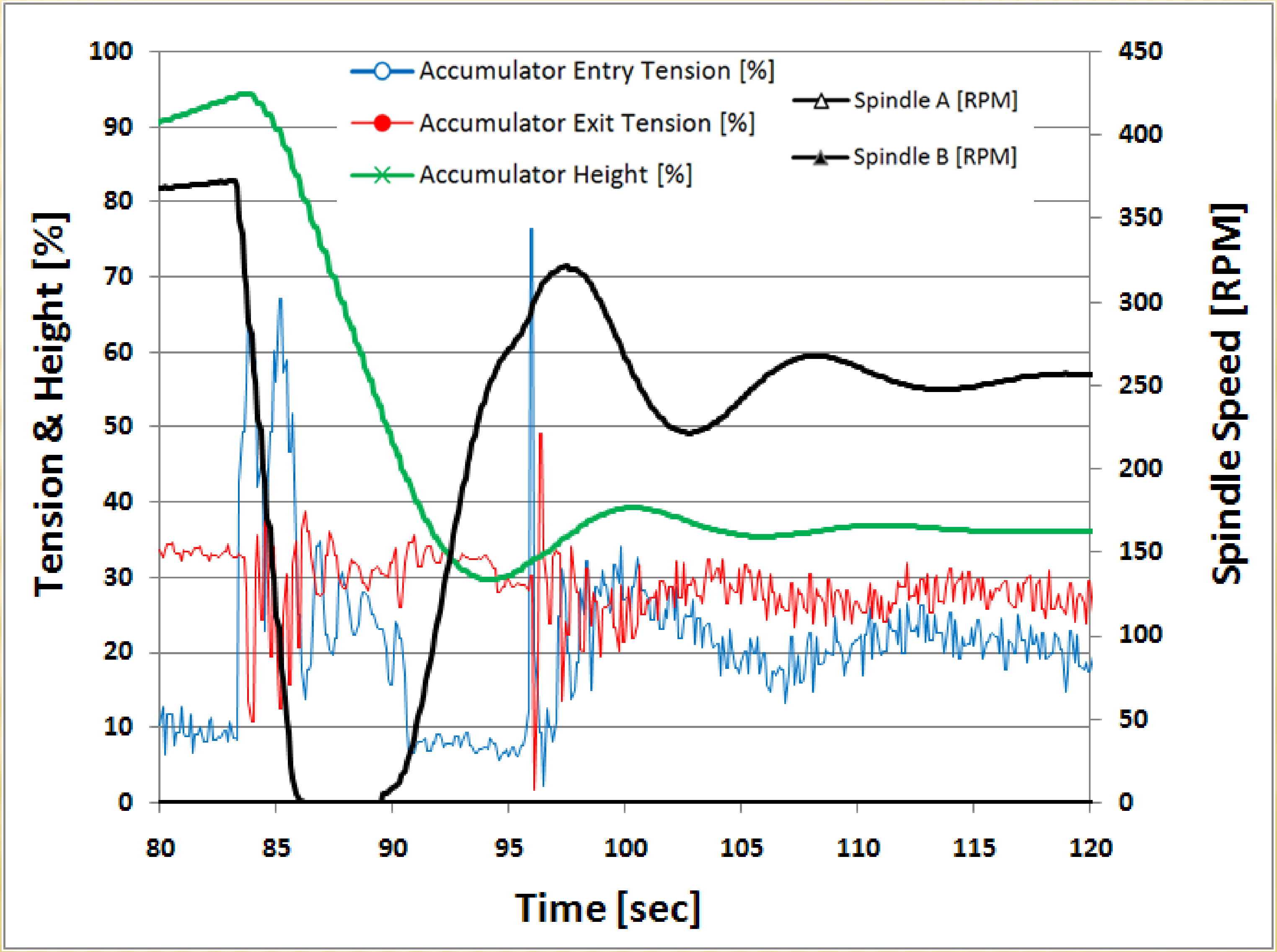
ACCUMULATOR FILL

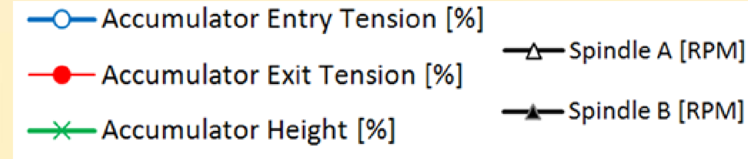


- Height: 35→94% (+2.6X)
  - Accel: 91.4 m/min/sec
- Enter: 88→32N (- 65%)
- Exit: 110N→132N(+20%)
- Exit tension is 4X of entrance tension

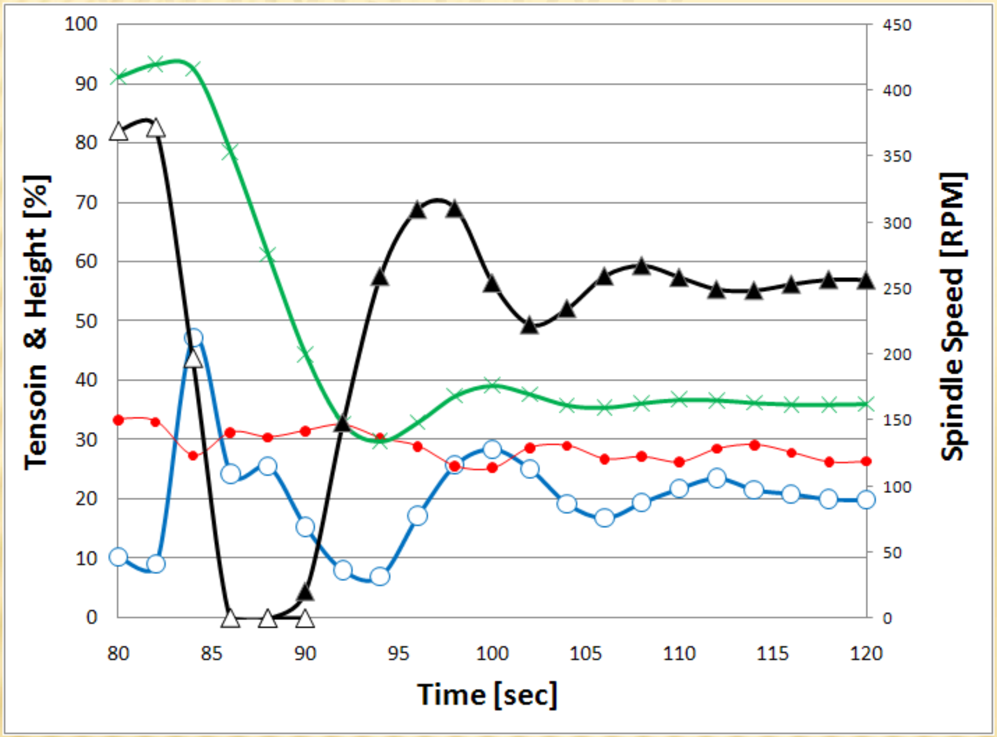
- Why does entering tension not return after accel?
- What mechanical design would reduce the tension differential? What control method should be used?
- Should we drive the rollers? If so how?

ACCUMULATOR FEED - RAW DATA





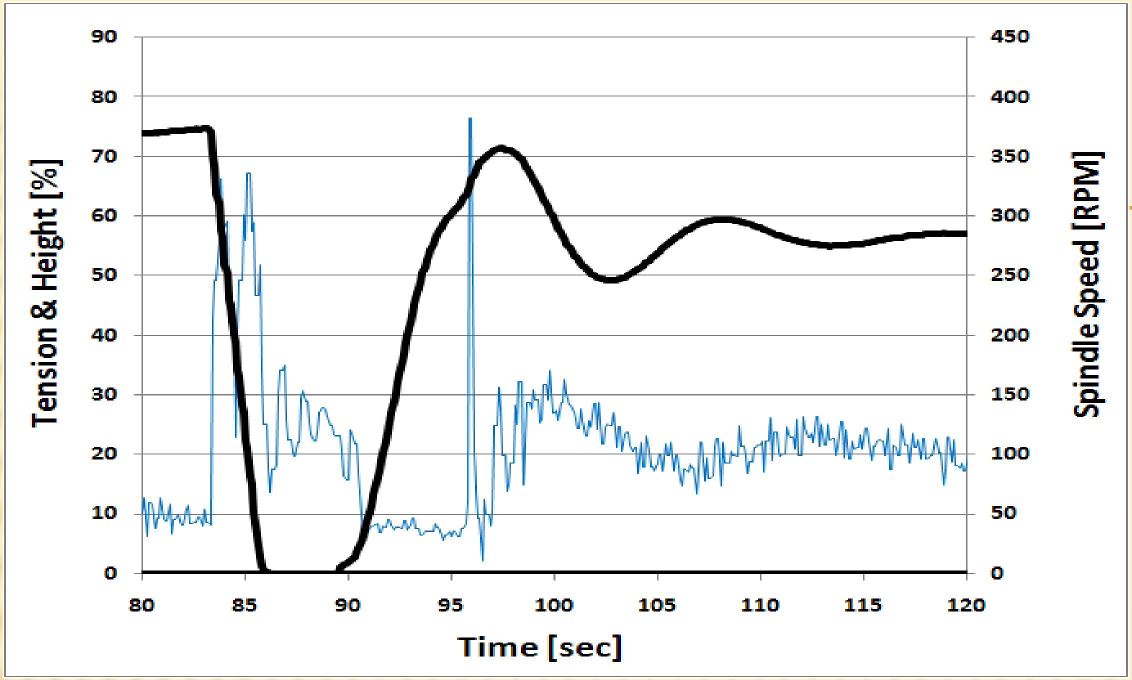
ACCUMULATOR FEED AVERAGED DATA



- Stop in 2.7 sec
- Enter:
  - 40N → 272N
  - + 680%
- Web neckdown
- Expansion wrinkles
- Splice failures

- How do we reduce tension extremes?
- Correlate: Decel rate / Roller mass / Neckdown / Wrinkles ?
- When should the rollers be driven? What controls?

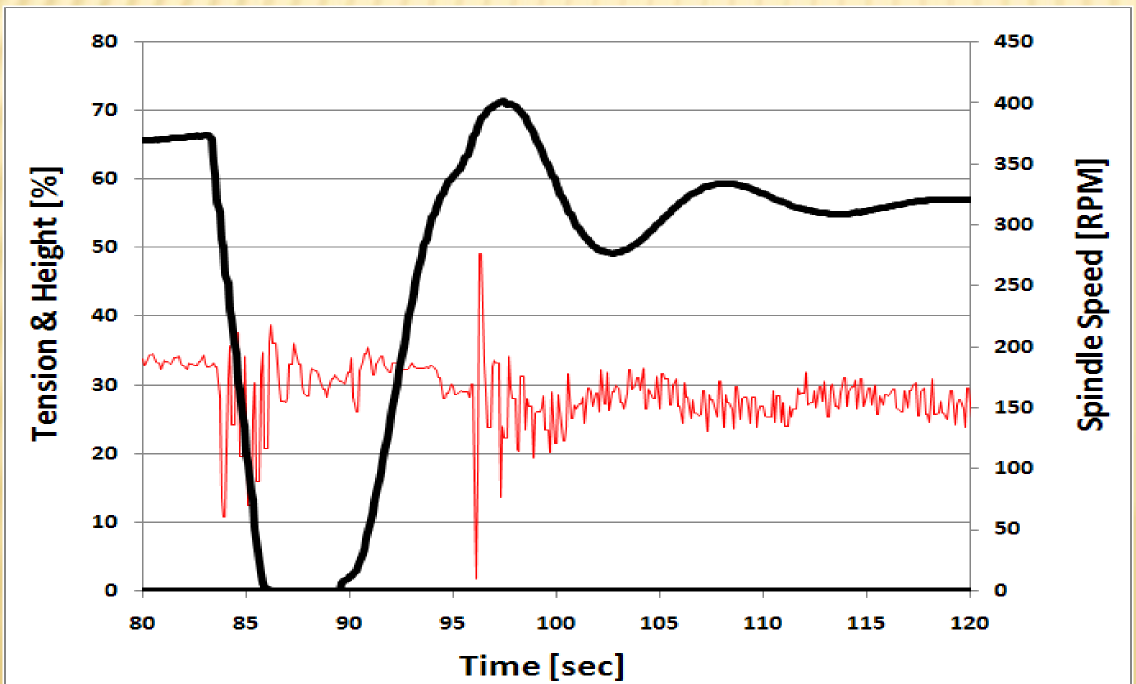
Tension



Entrance

40 - 272 - 120 - 32 - 312 - 120 – 88

88N (+232N /- 48N)

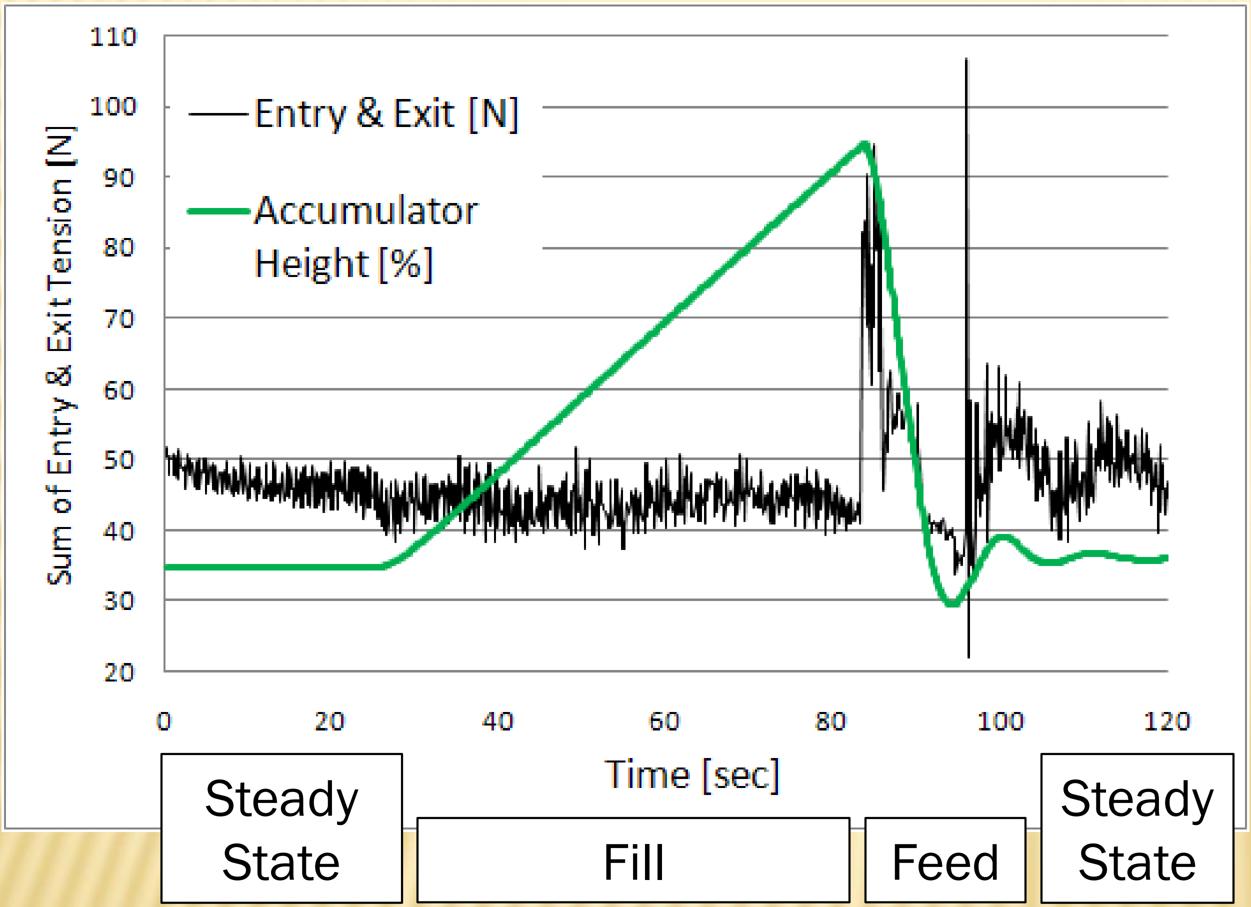


Exit

140 – 48 – 140 – 8 – 196 – 112

110N (+86N / -102N)

SUM OF ENTRY & EXIT TENSION



- Start at 198N
- End of fill 168N
  - 16%
- Spikes to 396N during decel
  + 235%
- Drops to 144N during accel
  - 64%
- What about air/web interaction? Span interaction?
- What is the best mechanical & electrical design?

CURRENT RESEARCH

- Several dozen papers on winding, wrinkling and air / web interaction (WHRC, Good, others)
- Focus is on a single roller in an open span
- Only four research papers on accumulators
- Apparently existing papers are not well understood
- Equipment designs do not reflect research
- Most accumulator information is internal, confidential and empirical in nature

“TOP 10” RESEARCH NEEDS

1. Validated computer models are needed
2. Air / web interaction within a accumulator
3. Non-ideal webs in accumulators
4. Multi-span interaction: tension, wrinkles, lateral
5. Misalignment of a moving carriage
6. High speed –vs- traction for a porous web
7. Larger rollers –vs- wrinkles –vs- roller mass
8. Should we drive rollers in the accumulator? How?
9. What is the best general arrangement?
10. How should the accumulator be controlled?

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Questions?

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