Test Results of Energy-Saving and Performance-Improving Software for AC Induction Motor Drives

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Session I3: Varied Strategies Produce Results for Industrial Energy Efficiency

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Association of Energy Engineers

Georgia-Pacific

- One of the world's leading makers of tissue, pulp, packaging, building products and related chemicals
  - Brawny® paper towels
  - Quilted Northern® bath tissue
  - Dixie® cups and tableware

AC Kinetics

- Engineering and motion control design and development company
- Thirty years of experience developing machine and vibration control software logic

AC Kinetics' Expertise

- Optimization Experts – proprietary optimization algorithm for nonlinear dynamic systems
- Developed a replacement run-time algorithm for Variable Speed Drives (VSDs) to control AC induction motors

Why AC Induction Motors?

- 45% of the world's produced energy goes into motors
- 90% of the cost of ownership of a motor is energy

- ACK's run-time software
  - Reduces energy consumption
  - Improves machine performance
  - No trade-off
  - Reduces motor temperature, increasing reliability
  - Auto-configures for optimal operation

AC Induction Motors are Over 90% Efficient

- Paradox:
  How can we possibly save 10% to over 30% energy?
- Rated efficiency
  - is only at rated load and speed
- Motor Temp >225°F!

CERTIFICATION DATA SHEET

Model#:	404THFS8092 BR	**WINDING#:**	T404665 NONE 3
CONN. DIAGRAM:	A-EE7308T	**ASSEMBLY:**	F1/F2 CAPABLE
OUTLINE:	B-SS518552-1525		

TYPICAL MOTOR PERFORMANCE DATA

HP	KW	SYNC. RPM	F.L. RPM	FRAME	ENCLOSURE	KVA CODE	DESIGN
60	45	1200	1180	404TC	TEBC-AXIAL	H	INV

PH	Hz	VOLTS	FL AMPS	START TYPE	DUTY	INSL	S.F.	AMB°C	ELEVATION
3	60	230/460	142/71	INVERTER ONLY	CONTINUOUS	H1	1.0	40	3300

FULL LOAD EFF: 92.4	3/4 LOAD EFF: 92.4	1/2 LOAD EFF: 91.5	GTD. EFF	ELEC. TYPE	NO LOAD AMPS
FULL LOAD PF: 86	3/4 LOAD PF: 82	1/2 LOAD PF: 73	91	SQ CAGE INV DUTY	57 / 28.5

F.L. TORQUE	LOCKED ROTOR AMPS	L.R. TORQUE	B.D. TORQUE	F.L. RISE°C
267 LB-FT	1020 / 510	500 LB-FT 187	850 LB-FT 318	68

SOUND PRESSURE @ 3 FT.	SOUND POWER	ROTOR WK^2	MAX. WK^2	SAFE STALL TIME	STARTS /HOUR	APPROX. MOTOR WGT
88 dBA	98 dBA	35.5 LB-FT^2	- LB-FT^2	- SEC.	-	1200 LBS.

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OVERTEMPERATURE INFORMATION

- BUT … READ THE FINE PRINT:

NOTICE: INSULATION DEGRADATION WARNING
Insulation at high temperatures ages at an accelerated rate. Each 10°C increase in temperature reduces the insulation life by one half.

Table 4-2 Service Conditions

Use highest level Multiplier: Maximum Ambient Temperature and Contamination are independent factors

Severity of Service	Maximum Ambient Temperature	Atmospheric Contamination	Multiplier
Standard	Less than 40° C (104° F)	Clean, Slight Corrosion, indoors, less than 16 hrs per day	1.0
Severe	Above 40° C (104° F) to 50° C	Moderate dirt or Corrosion or outdoors or more than 16 hrs per day	0.5
Extreme	Greater than 50° C or Class H Insulation	Severe dirt or Abrasive dust or Corrosion	0.2

- MUST DE-RATE THE MOTOR (LIGHTLY LOADED)

Derated to 1/5

Real-World Efficiencies are Lower in Practice

- Motors in industrial applications tend to be lightly loaded for reliability
- Actual efficiency is significantly lower than rated efficiency
  - Varying loads and/or varying speeds
  - High motor torque only needed for a portion of the duty cycle
- Existing VSD "Energy Saving Modes" hurt performance (handling of load and speed variations)
- Opportunity: to improve efficiency in real world applications while maintaining or even improving motor performance

Proven in Laboratory and Controlled Settings

- Benefits demonstrated on a 5hp dynamometer
  - Purchased drives from many major manufacturers
  - Ran efficiency tests over various loads and speeds and dynamic variations
  - Ran performance tests over various loads and speeds and dynamic variations
- Independently Certified Laboratory Data
  - Advanced Energy, Raleigh, NC
  - Tested from 5hp up to 200hp over various loads and speeds and dynamic variations
  - Used real inputs gathered from production machines

Auto-configuration Enables Fast Setup

- The run-time algorithm would be too difficult for a human to configure
- ACK software automatically identifies all necessary parameters of the system
- ACK software automatically configures the run-time algorithm to optimize performance and energy savings
- Setup is fast and effortless without costly hand tuning and experimentation
- Reduces time spent with technical support

ADVANCED ENERGY – INDEPENDENT LAB TESTING

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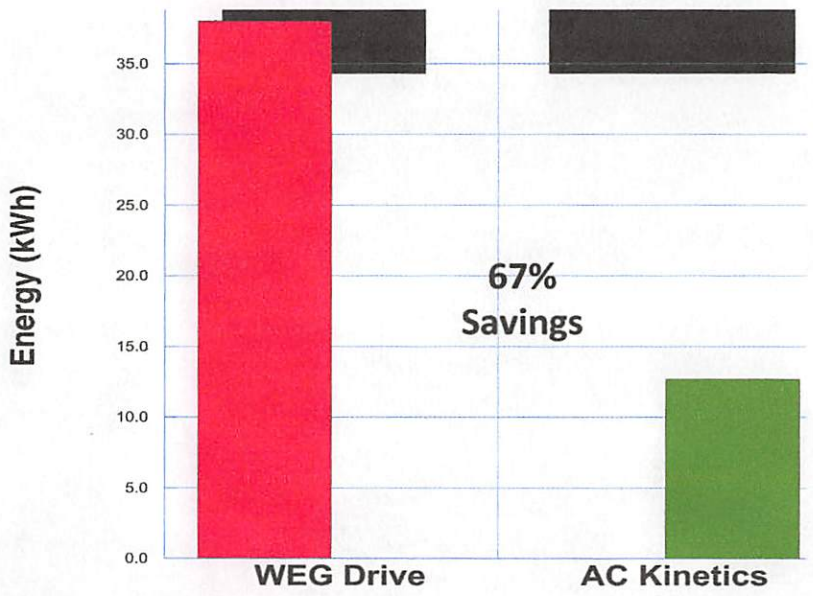
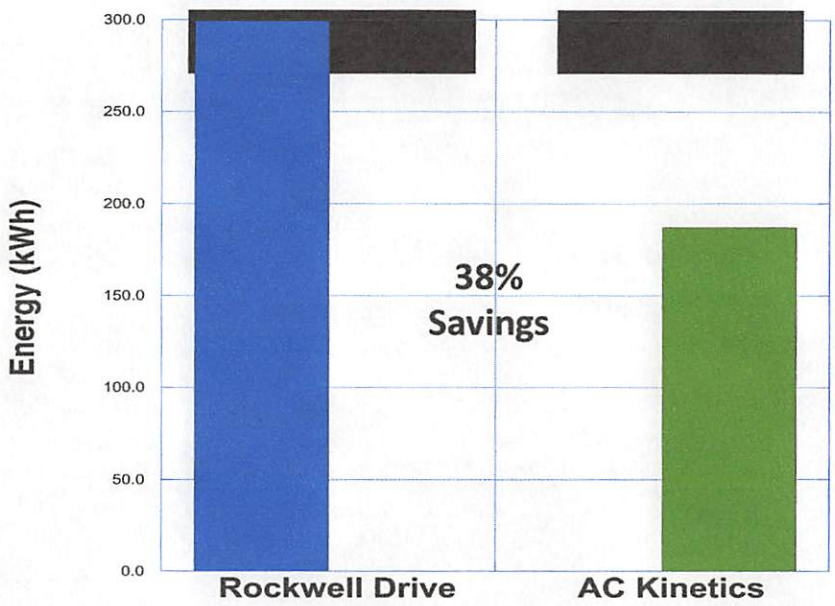
COMPARATIVE INDEPENDENT LAB TESTS
DYNAMIC LOAD PROFILE

5HP – TOTAL ENERGY CONSUMED



50HP - TOTAL ENERGY CONSUMED



SOURCE: ADVANCED ENERGY CERTIFIED TESTS – RALEIGH, NC

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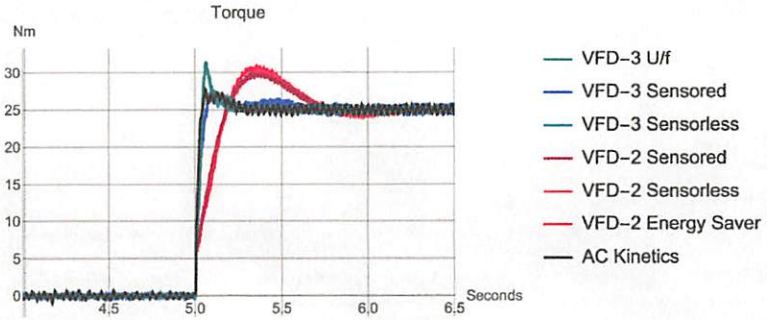
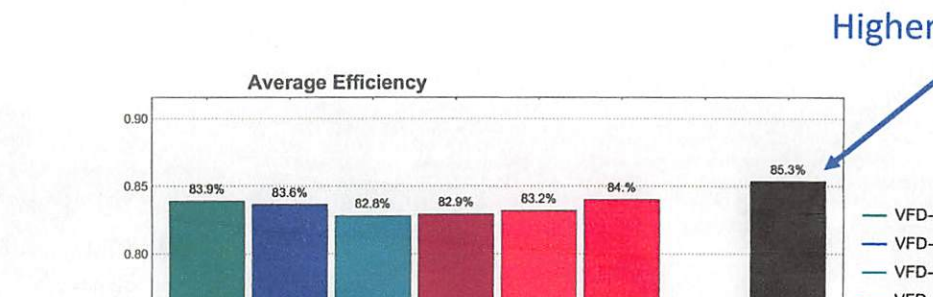
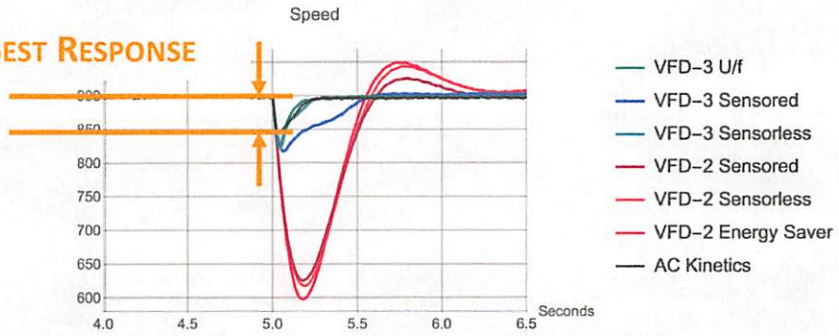
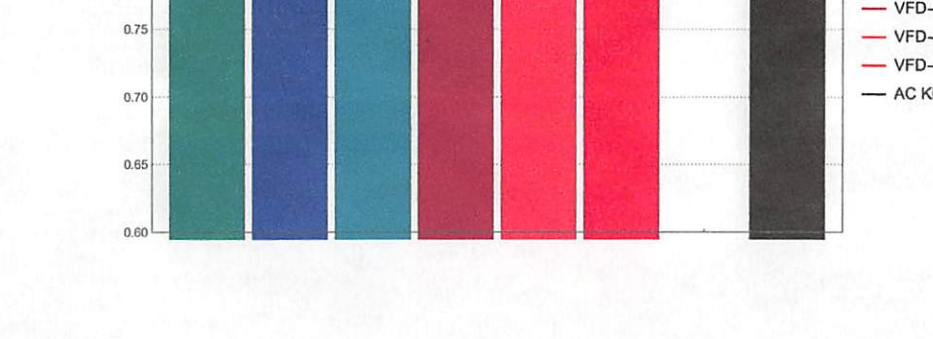
Example of Collected Data: 900 RPM with a 25 Nm Torque Step Applied (5hp)





Best Response





Higher is Better

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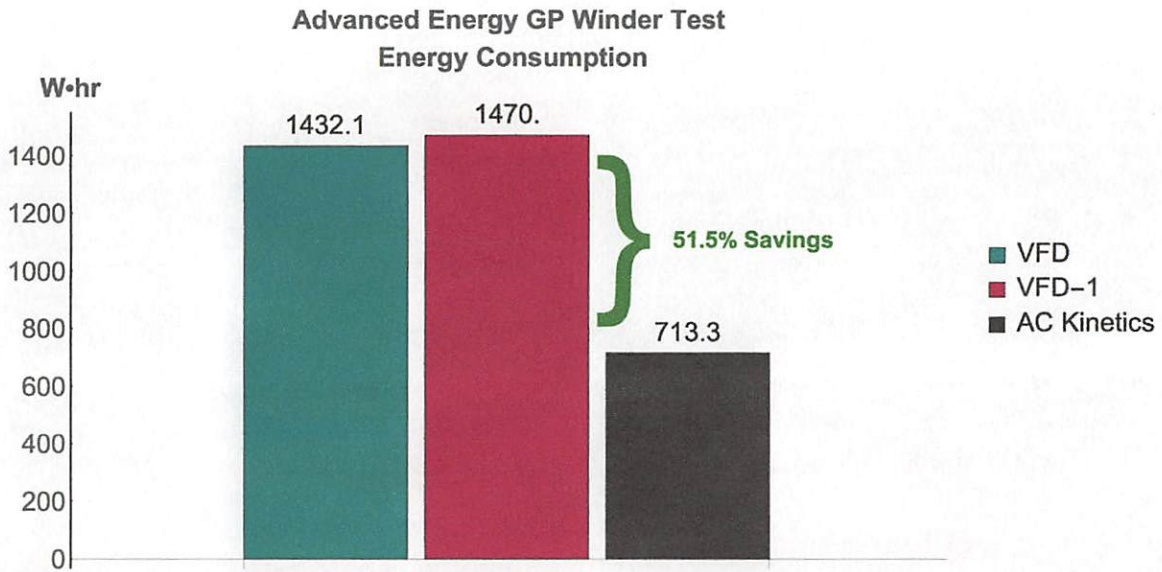
60HP TOWEL WINDER ENERGY CONSUMED



SOURCE: ADVANCED ENERGY CERTIFIED TESTS – RALEIGH, NC

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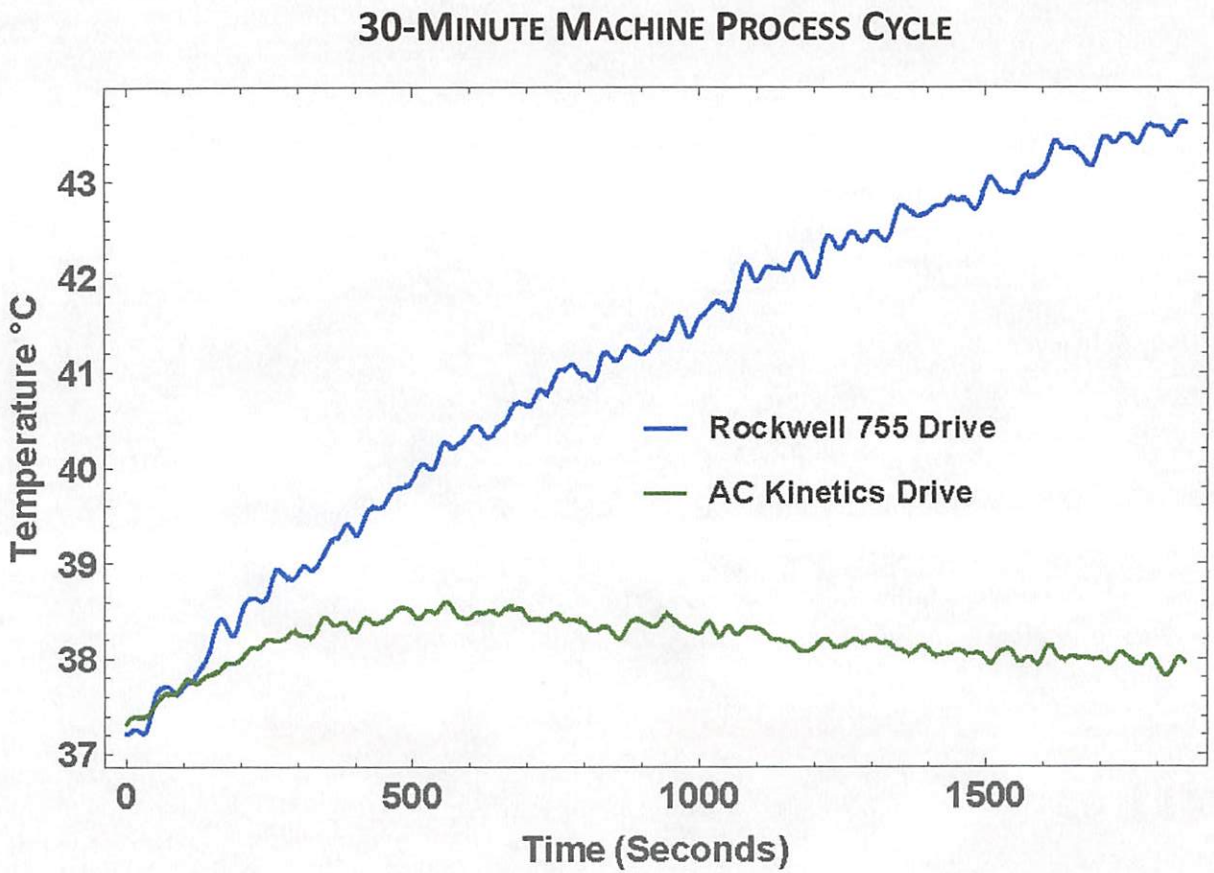
REWINDER MOTOR (60HP) INTERNAL TEMPERATURE



SOURCE: ADVANCED ENERGY CERTIFIED TESTS – RALEIGH, NC

Field Test at a Paper Mill

- Start-stop converting line for jumbo bath rolls

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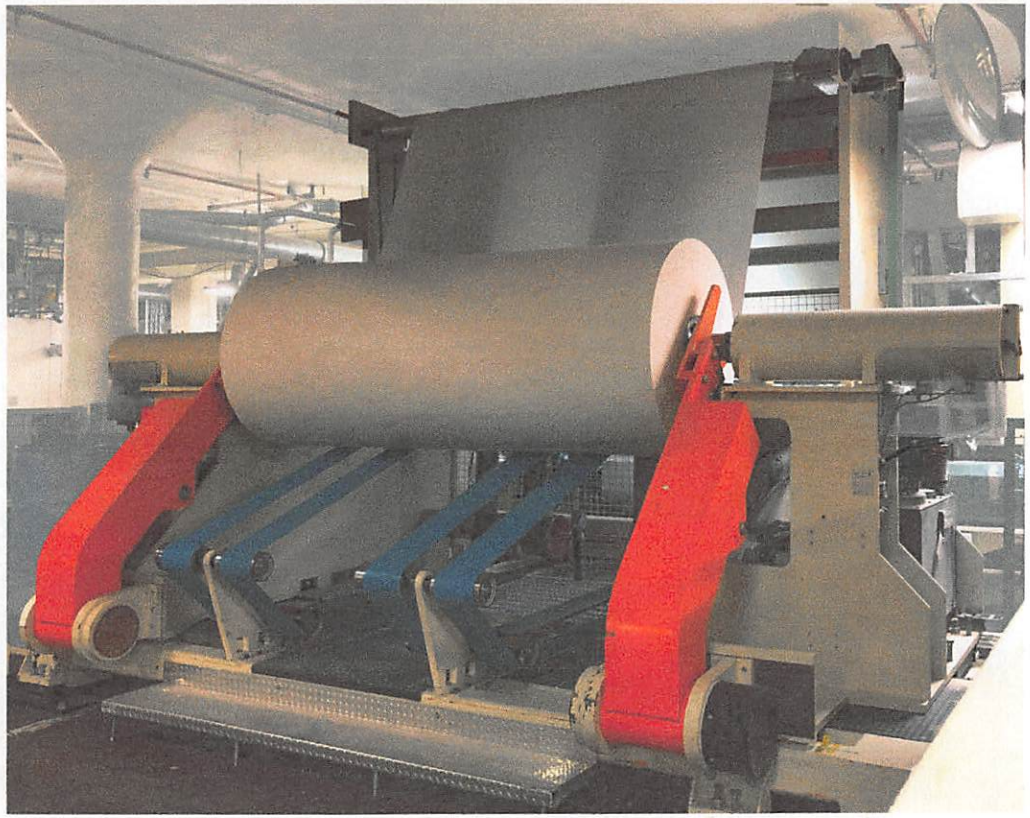
CONVERTING THE TISSUE PAPER – UNWINDING



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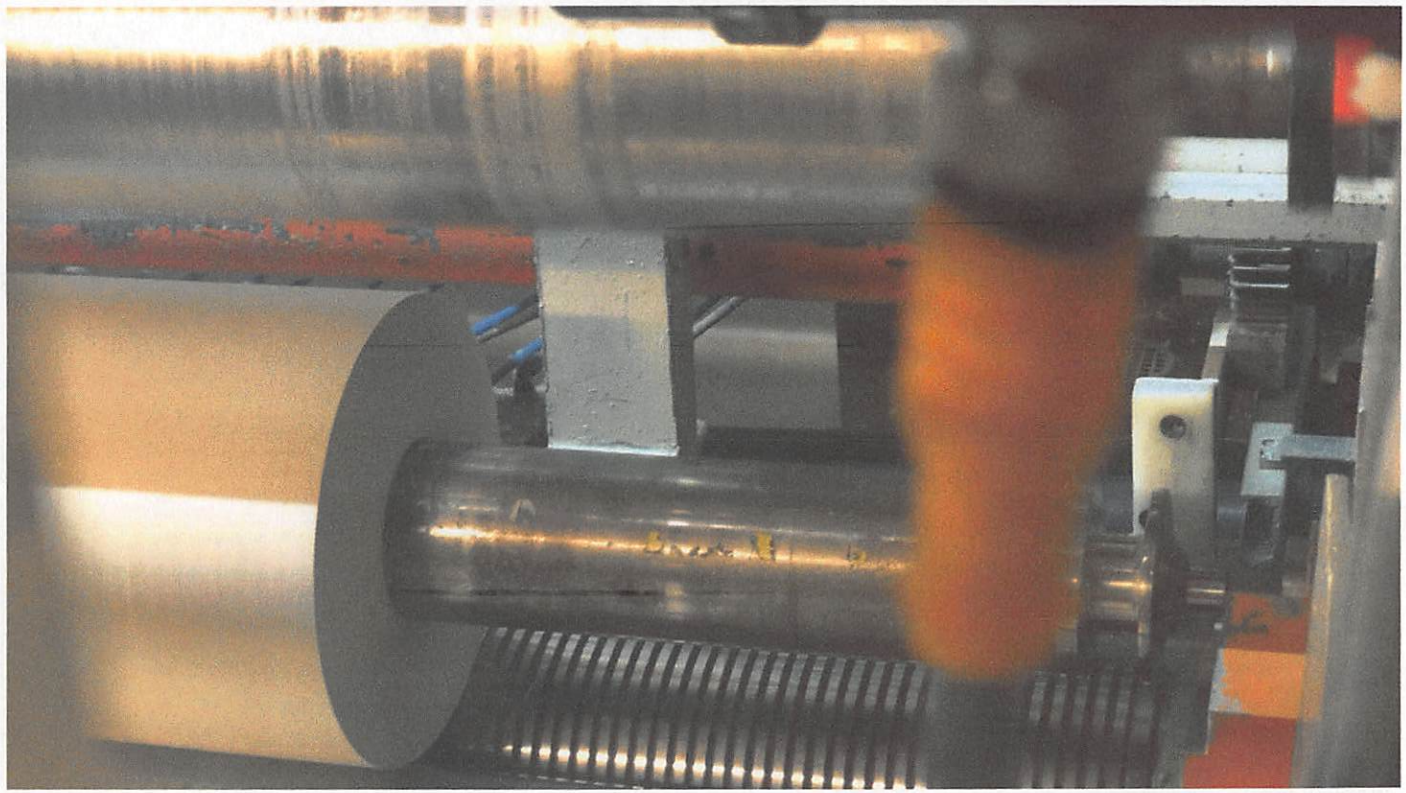
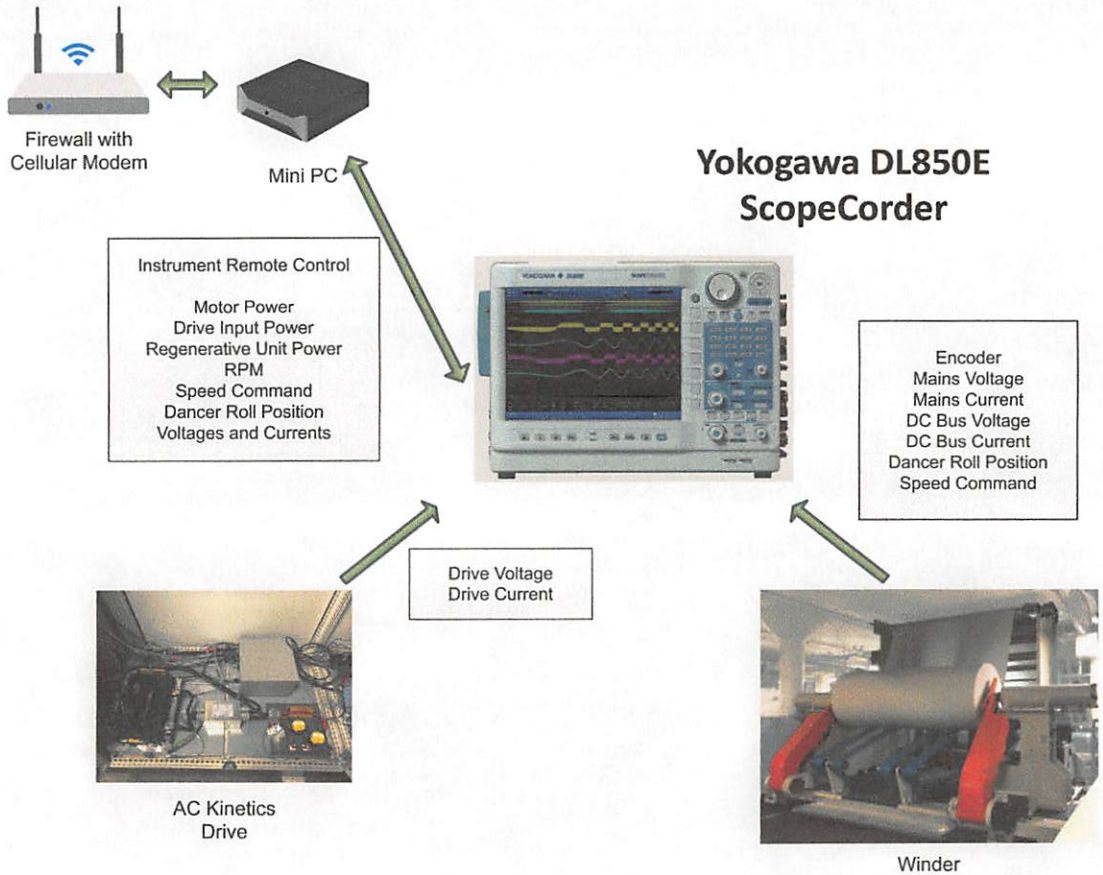
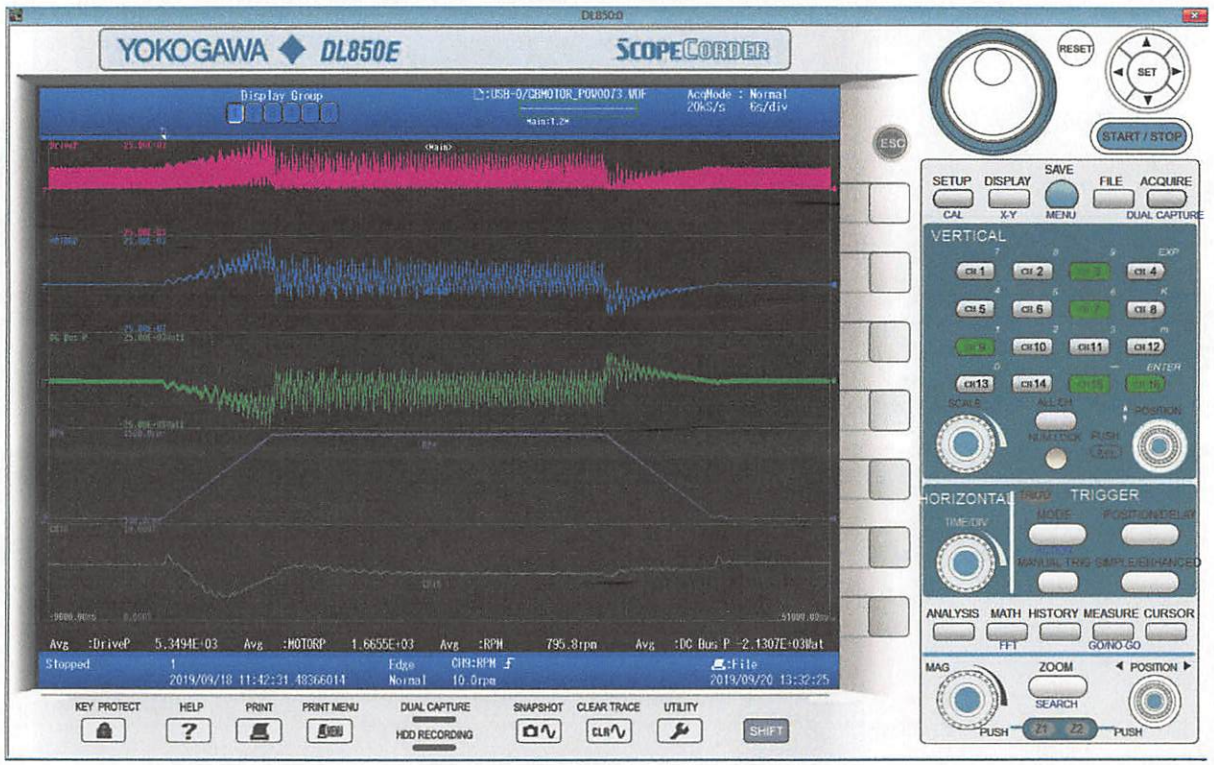


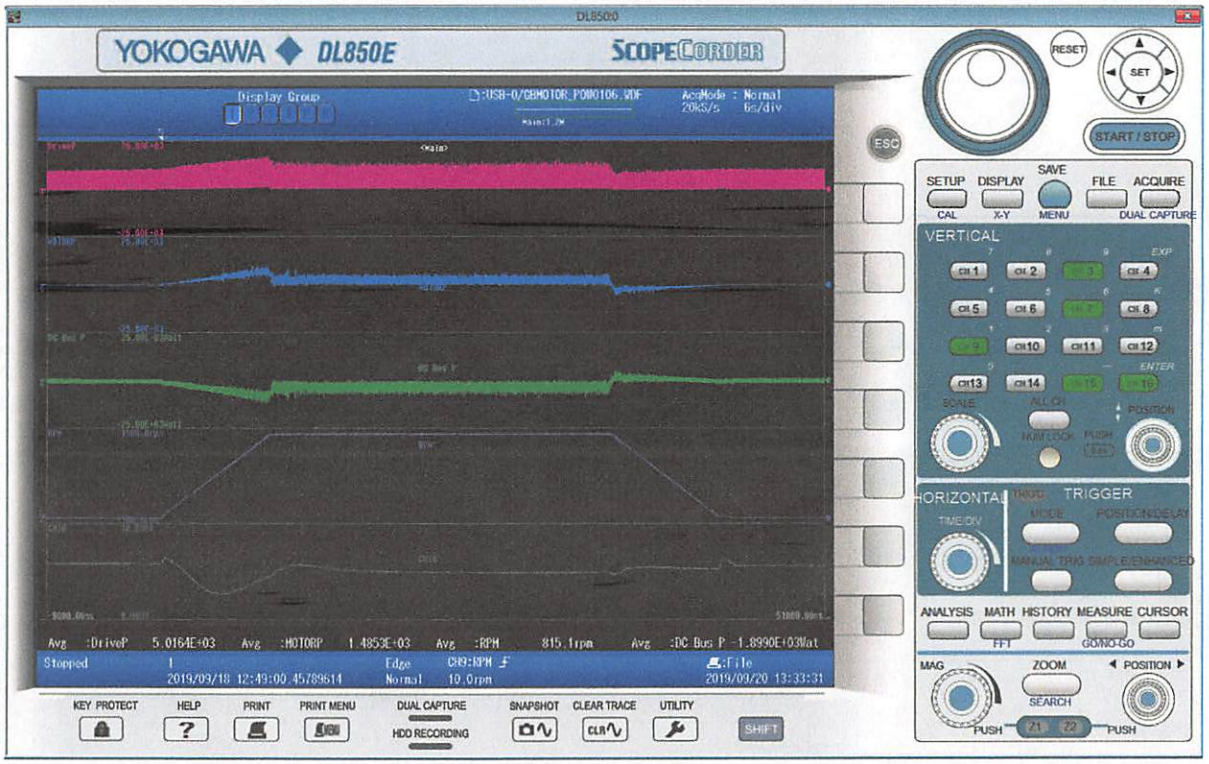
INSTRUMENTATION BLOCK DIAGRAM



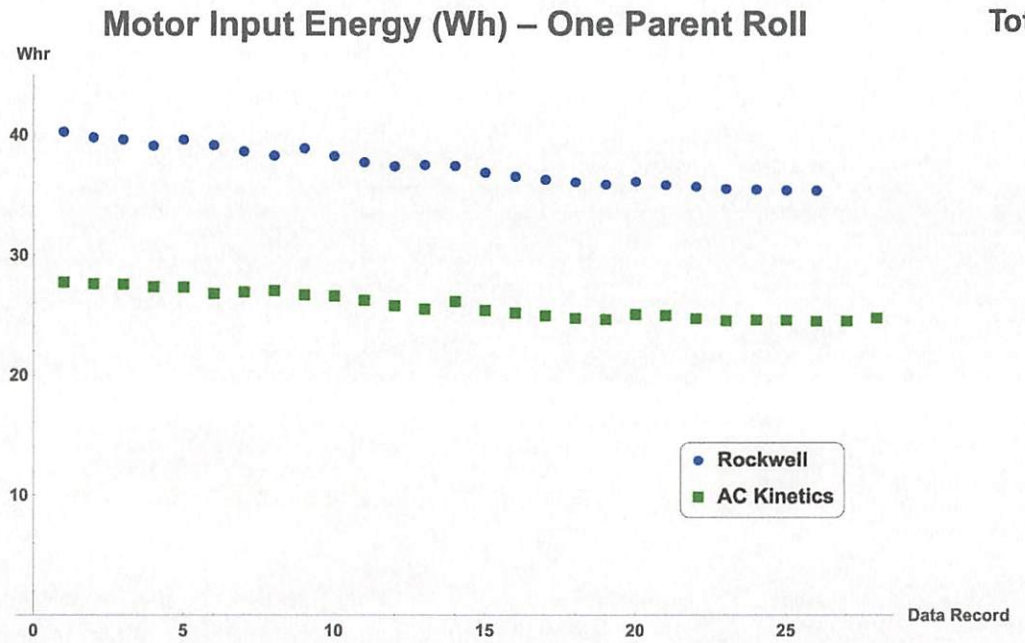
SCREEN SHOT OF DATA (PARENT ROLL START)

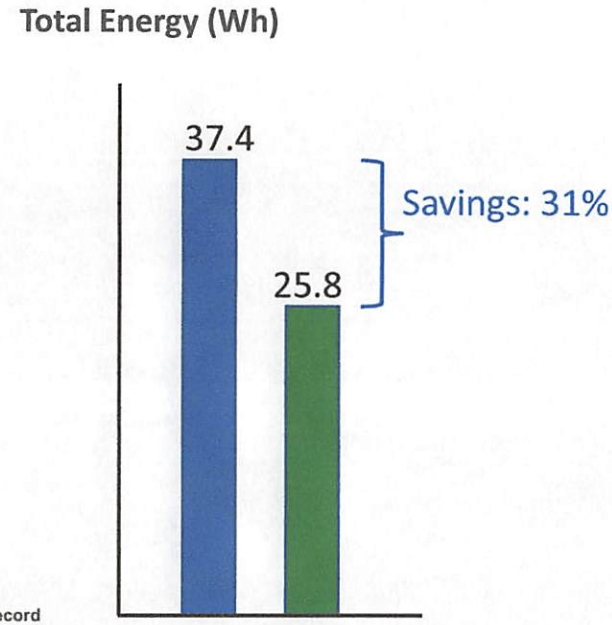


SCREEN SHOT OF DATA (PARENT ROLL FINISH)



Field Data From Actual GP Start-Stop Rewinder for One Parent Roll





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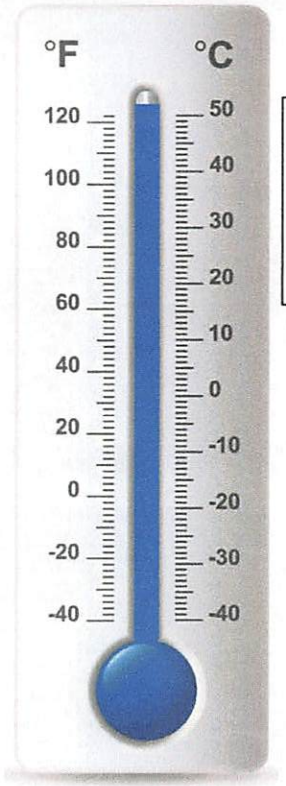
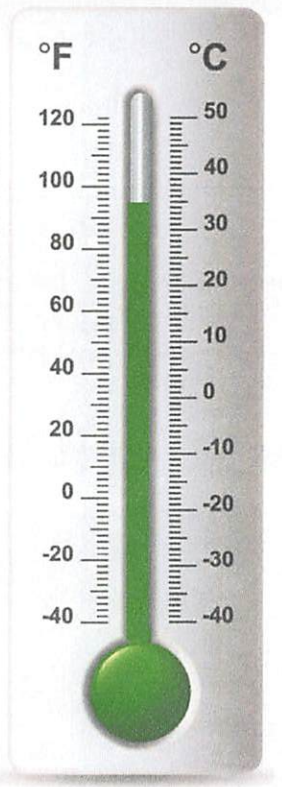
Field Data From Actual GP Start-Stop Rewinder Steady State External Temperature (Motor Case)

123°F



Rockwell

25°F Motor Temperature Difference



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98°F

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Summary

- Verified results from
  - Laboratory testing
  - Independent laboratory testing
  - Field testing on
    - A 10hp recycled paper conveyor (7.2% savings)
    - A Start-Stop Converting Rewinder (31% savings) *New!*
- demonstrated that AC Kinetics run-time AC Induction Motor Software
  - Saves significant energy over existing drive software
  - Meets or exceeds the performance of existing drive software
  - Saving Energy and Increasing Performance are not mutually exclusive
  - Lowers motor temperatures and thereby increases motor reliability
  - Auto-configures for optimal operation