Using doughLAB to mimic commercial high energy dough development and predict flour blend performance.

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Perten Instruments of Australia

Introduction

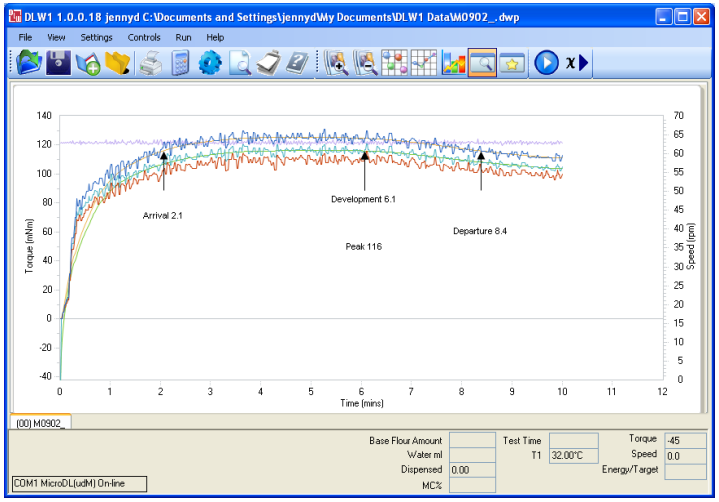
- doughLAB
  - 300g/50g (lab/factory scale) z- arm mixing to determine flour processing quality.
  - Same results as Farinograph for conventional test (63 rpm, 30°C).

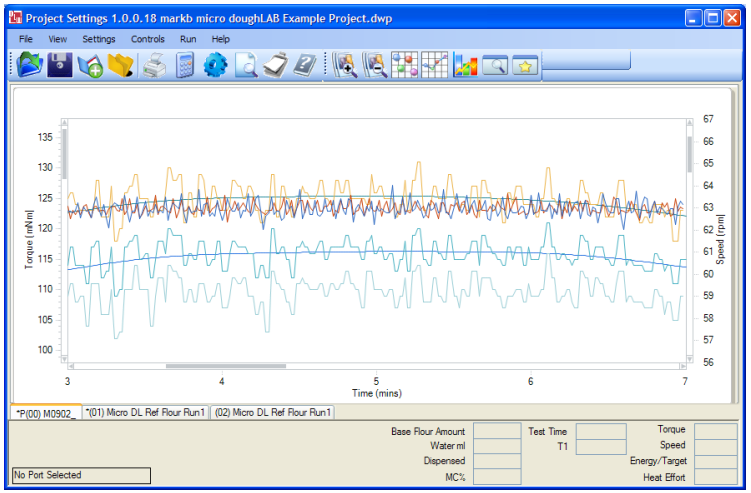
Perten INSTRUMENTS

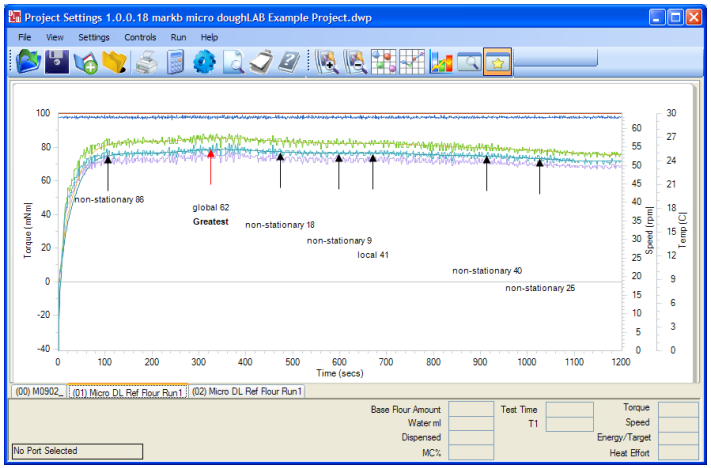
doughLAB

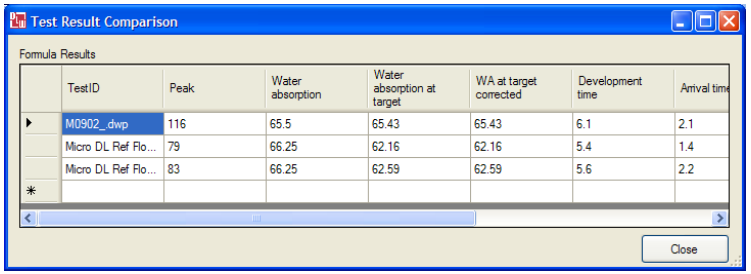
- High energy / accelerated mixing: develop samples that are difficult to develop, incorporate ingredients such as fat, reduce test time, give a better indication of dough stability.
- Programmable temperature to cook starch / stress dough.
- Mimic commercial processes: rapid dough, high energy mixing.
- DLW software: instrument control, data acquisition, data analysis, curve analysis, flour blending.
- Model flour blends to predict their performance without having to run extra tests. Blending different flour varieties and mill streams enables the miller to reduce costs and maximize profits while blending to specification for specific customers and specific uses.
- Relevant and timely information about products and processes: water absorption, mixing energy, stability.

DLW Software Data Analysis









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Goals

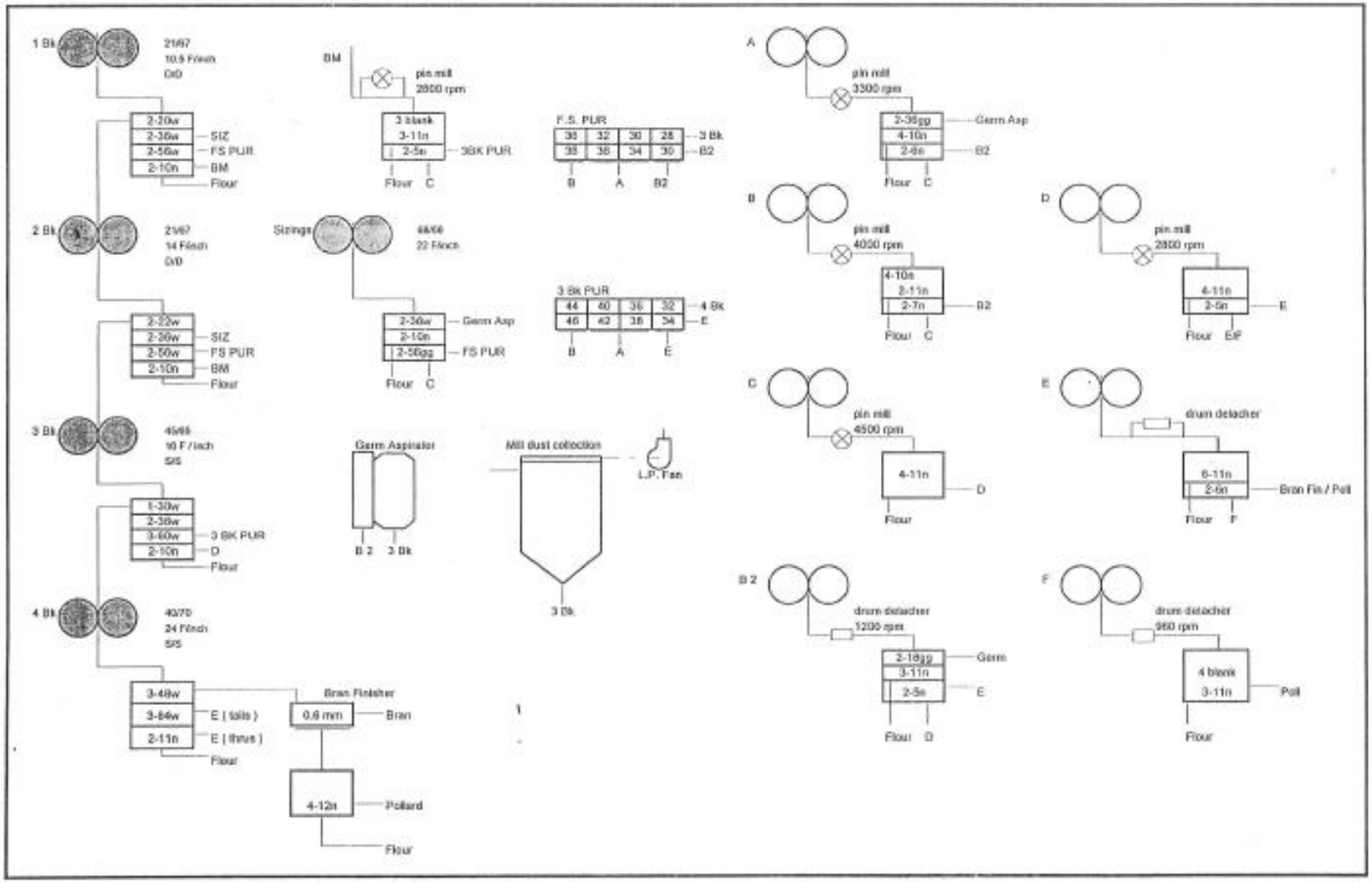
- Assess the quality of commercial flour mill streams and their blends by low and high energy mixing.
- Assess ability of virtual mixing to predict actual blend quality.

Methodology

- Samples
  - Prime hard wheat from Qld 2009 harvest
  - Commercial pilot scale mill (155 Kg flour recovered)
  - 13 mill streams
    - 4 break
    - 5 reduction
    - Size, break middlings, bran & fines
  - Blends
    - Straight (all fractions at yield ratios)
    - High/Low WA (1st & 4th break)
    - High/Low mix stability (1st break & 4th reduction)

Mill Schematic

1Bk
2Bk
3Bk
4Bk
A
B
C
D
E
BM
B2
SIZ
BF&F



Blends (%)

Stream	Straight	WA HiLo	Stab HiLo
1Bk	8.2	50.0	50.0
2Bk	7.1		
3Bk	5.2		
4Bk	2.6	50.0	
A	17.7		
B	4.1		
C	13.2		
D	11.4		50.0
E	7.4		
BF&F	4.7		
SIZ	3.6		
B2	9.5		
BM	5.2		

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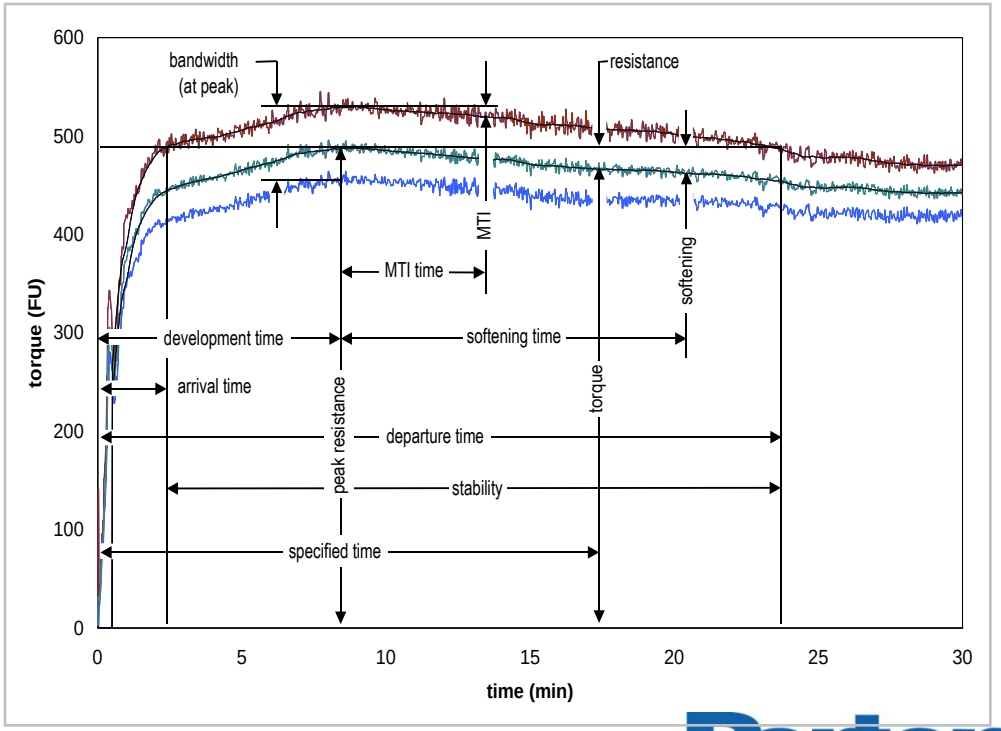
Testing & Analysis

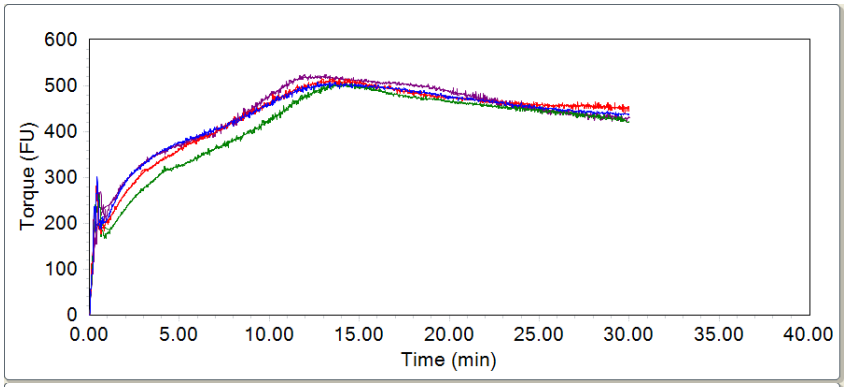
- doughLAB with 300g sigma-arm mixing bowl
- AACC 54-21 (63 rpm slow blade, 30 °C, 20 min, 500+/-20 FU)
- Same WA for 120 & 180 rpm tests
- Measuring
  - WA (%)
  - DDT (min)
  - Stability (min)
  - Softening (FU, 5 min)
  - Peak Energy (Wh/Kg)
- Virtual Blending
  - Weighted averages



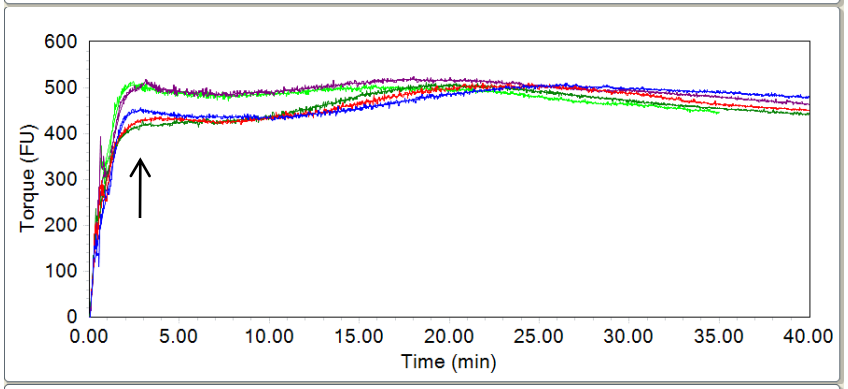
Results & Discussion: Mixing Characteristics of Mill Streams

- There was a wide range in the mixing properties of the different mill streams as measured by the doughLAB.
- Break streams
  - Within the group: WA ⇧, Stability ⇩, other ⇨
- Reduction streams
  - Most parameter higher than for break stream flours
  - Within the group: DDT ⇩, Energy ⇩, Stability ⇩⇧
- Other streams
  - Very high WA in BF&F
  - Large difference in mixing parameters
- Results reflect generally higher proportion of damaged starch, bran (esp. pentosans) and protein through the milling steps.
- Large ranges in the results show potential to blend to specification.

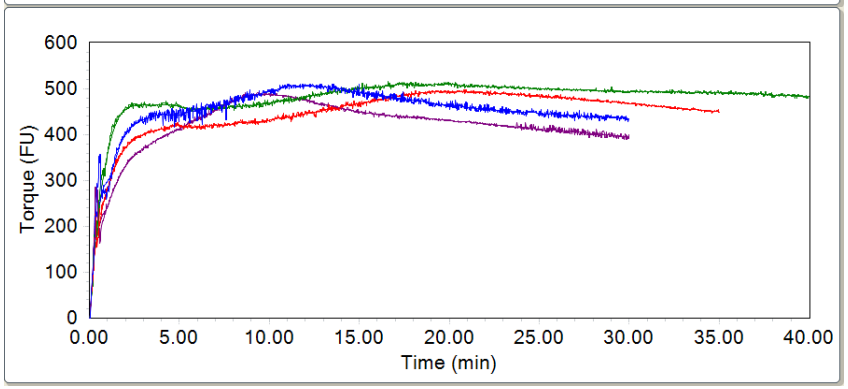
Mixing Curves (63 rpm)



Break streams



Reduction streams



Other streams

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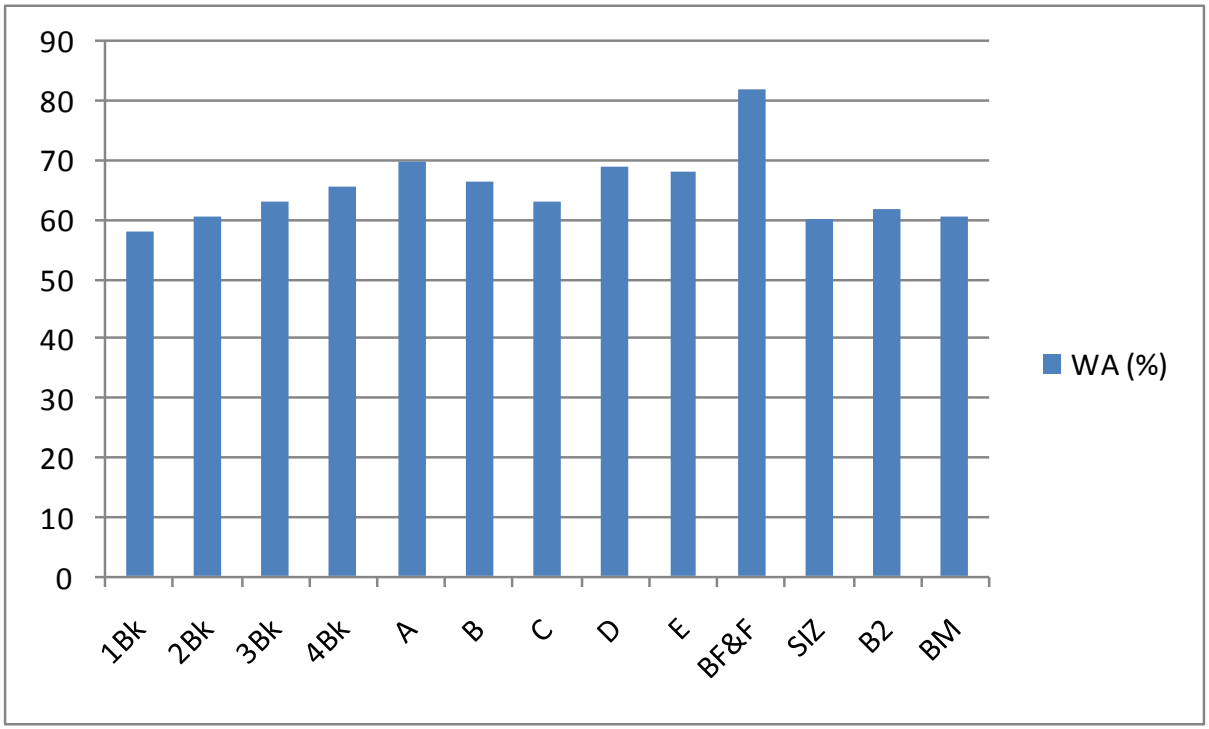
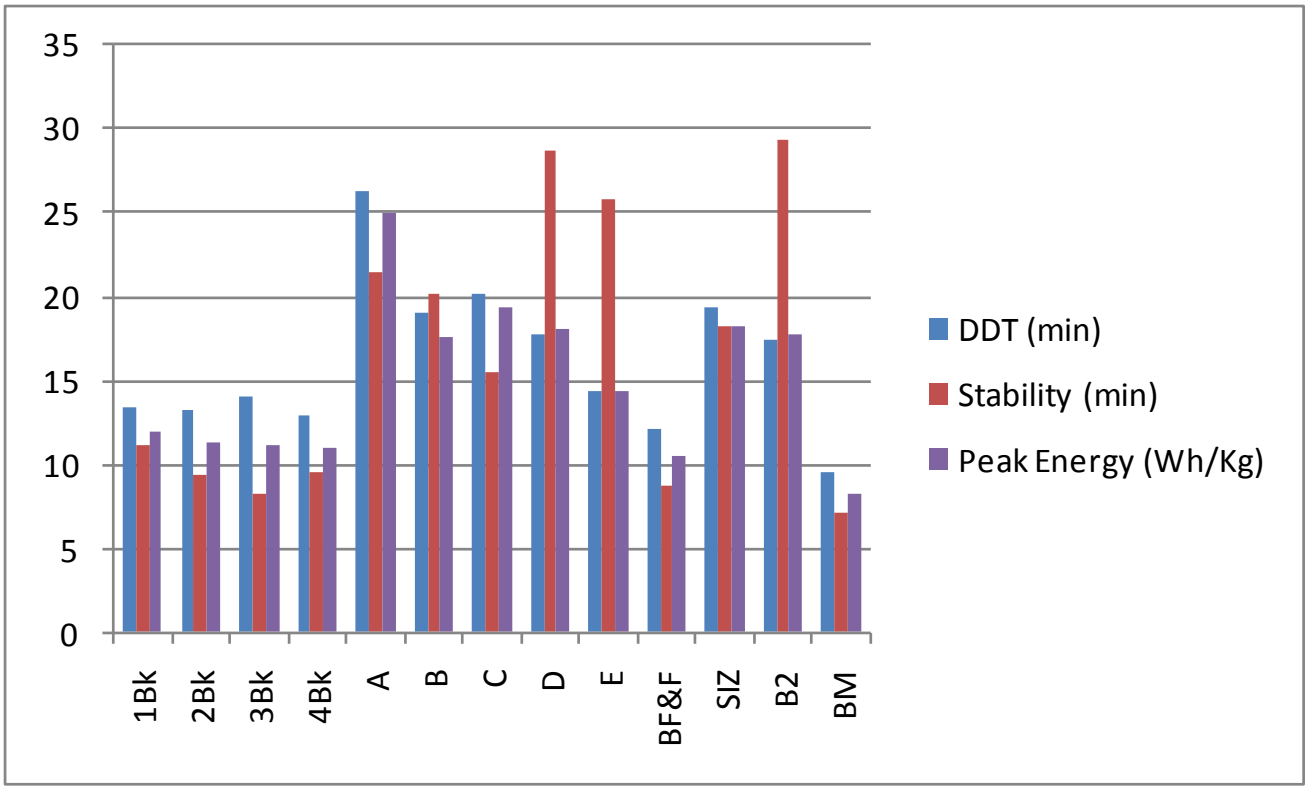
WA (63 rpm)

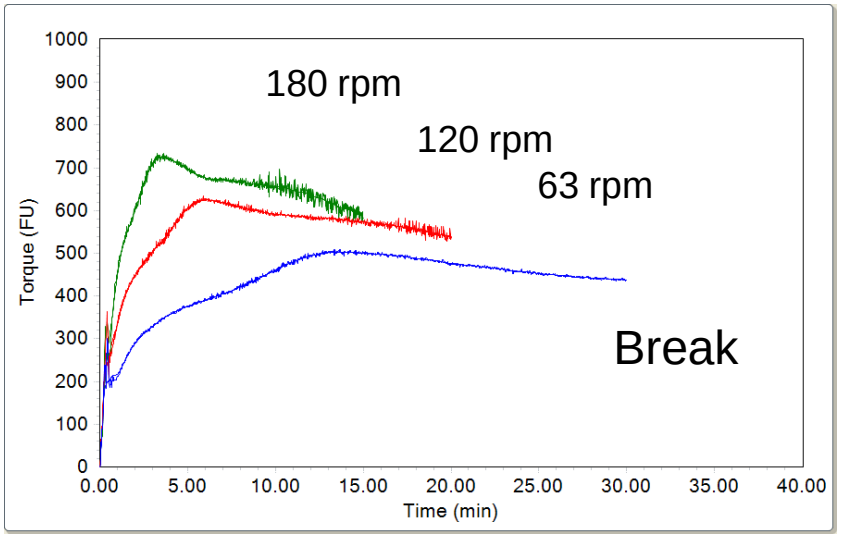


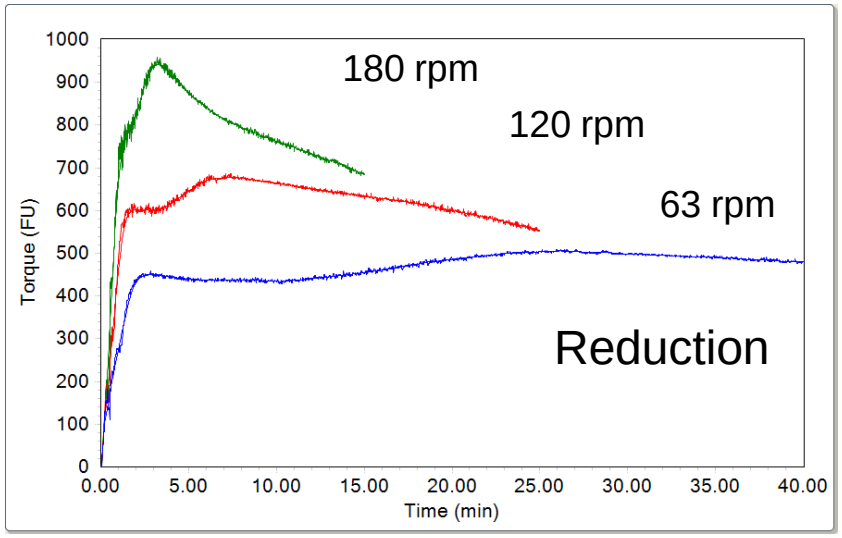
DDT, Stability, Peak Energy (63 rpm)



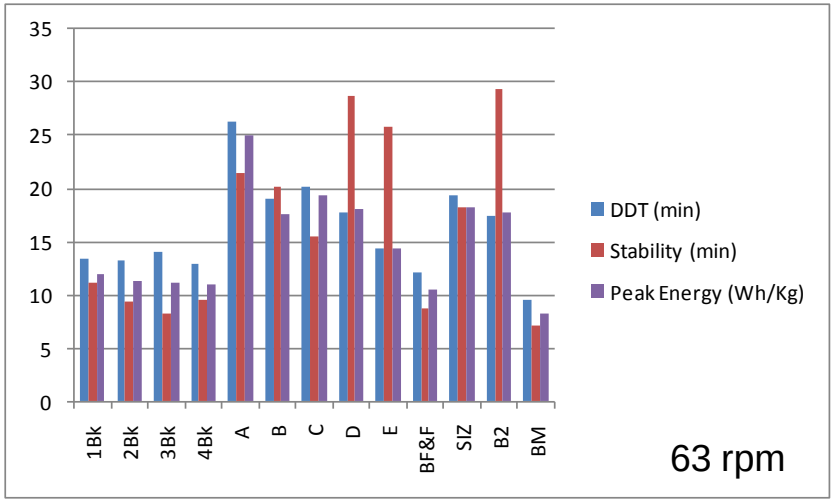
Effect of High Speed Mixing

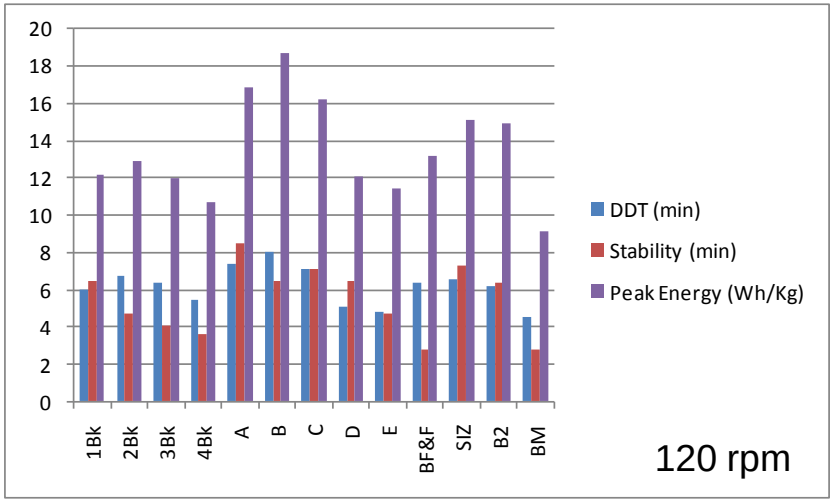
- Faster tests (<10 min)
- Removal of spurious 'hydration' peak
- Process relevant

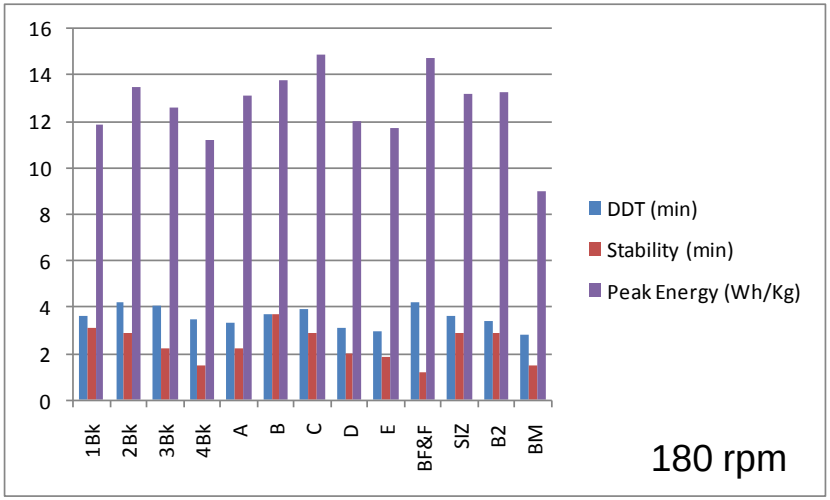




DDT, Stability, Peak Energy







- Clearer trending in stability data at higher speeds within the reduction group (A-E)
- Dough development energy requirements decreased slightly with faster mixing

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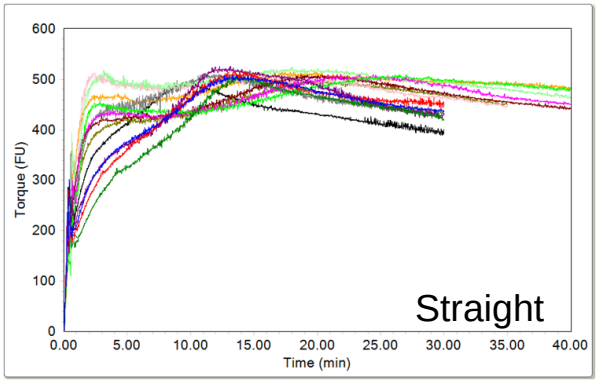
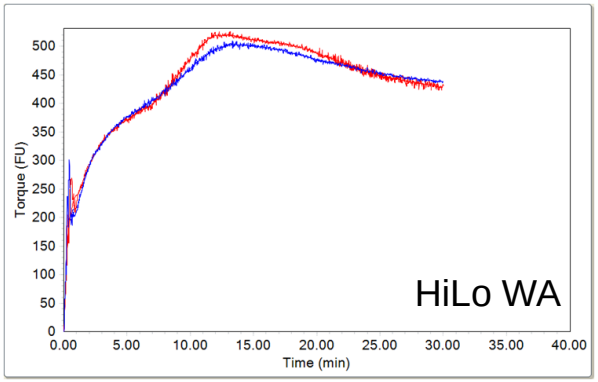
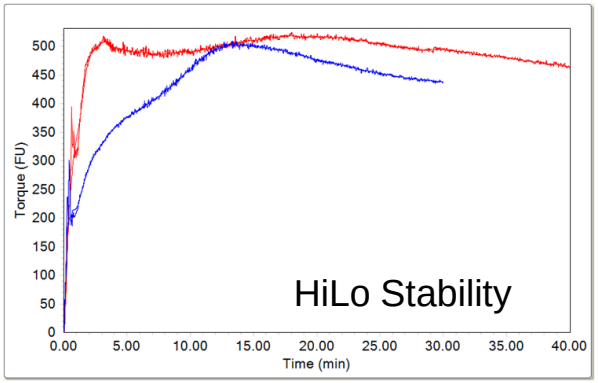
Mill Streams for Blends (63 rpm)



All fractions at yield ratios



High/Low WA (1st & 4th break)



High/Low mix stability (1st break & 4th reduction)

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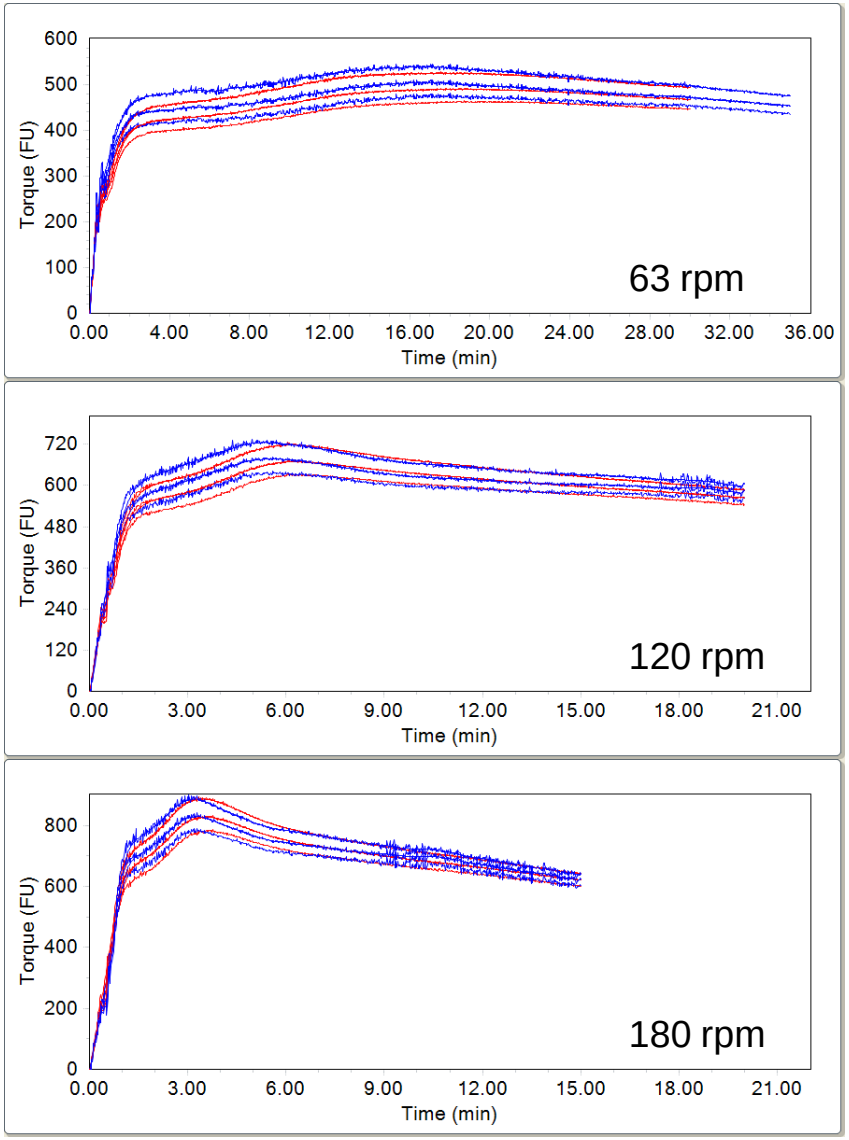
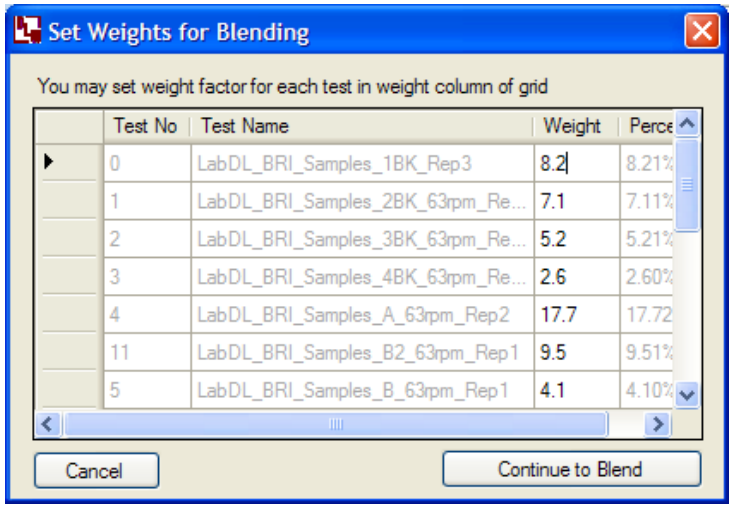
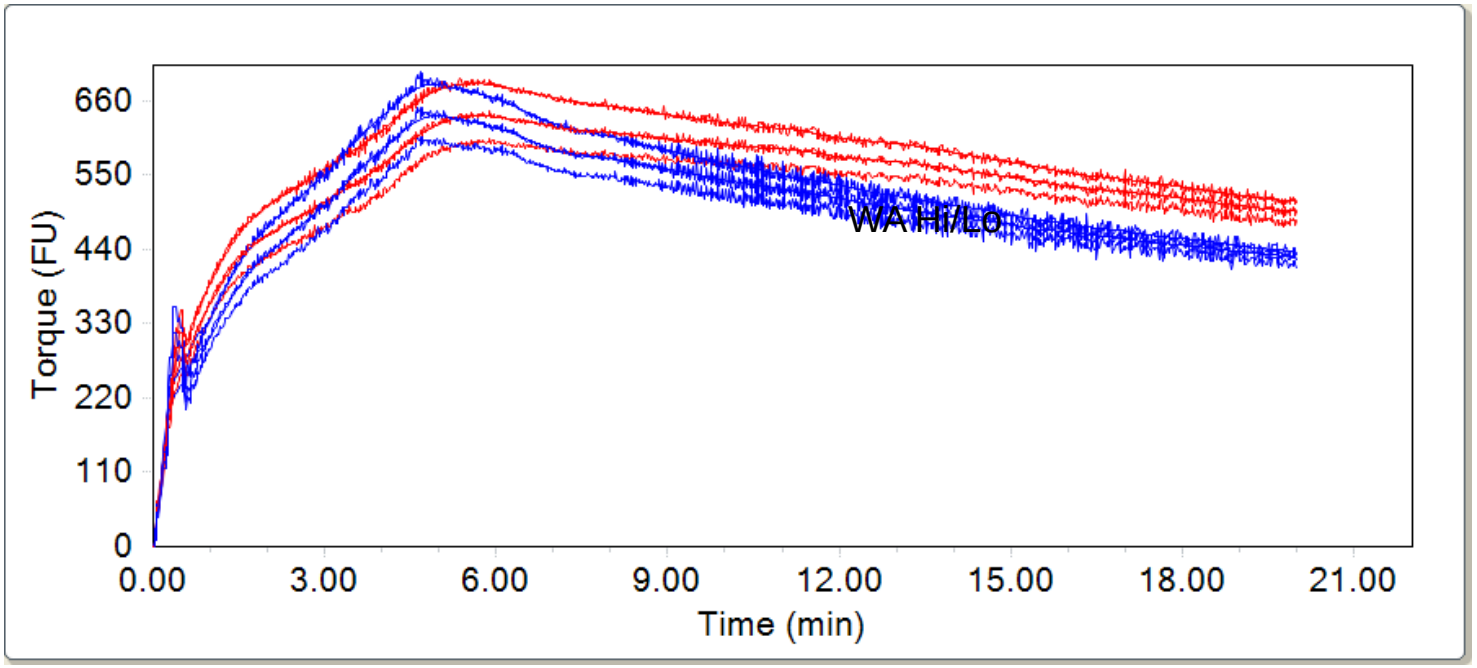
Straight Flour Blend





- All mill streams
- Blue = Actual
  Red = Virtual

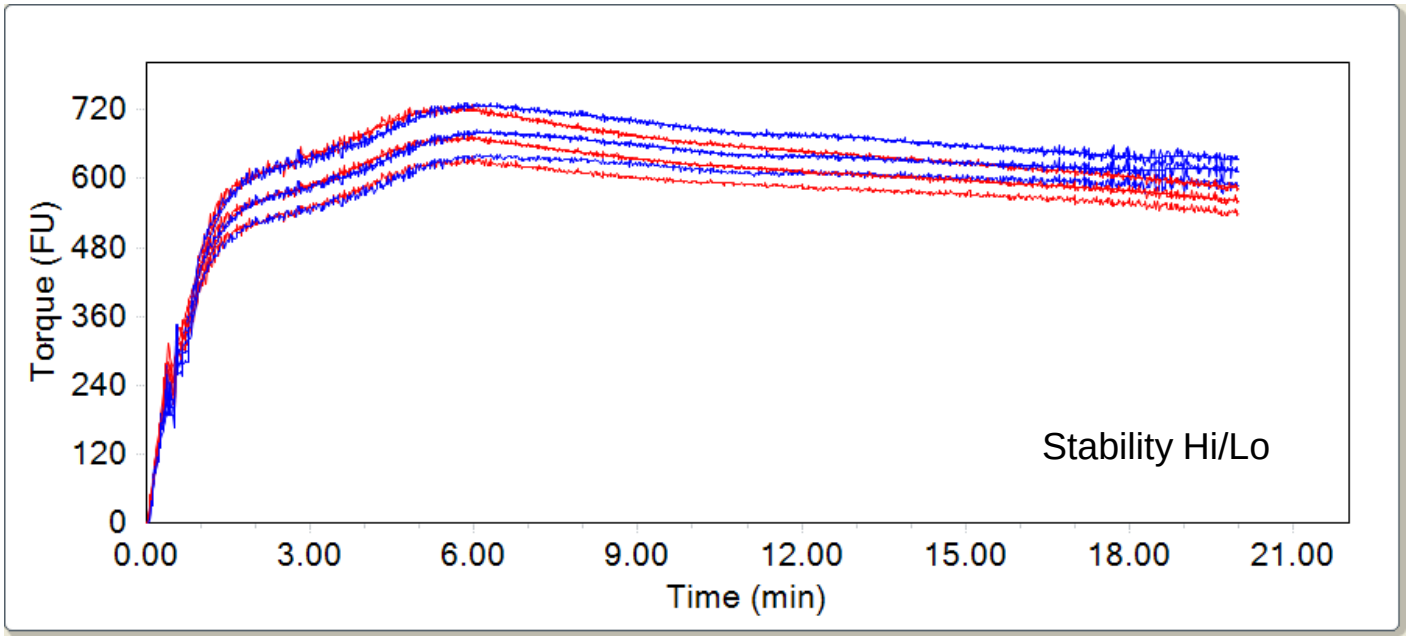
WA Blend at 120 rpm



Blue = Actual

Red = Virtual

Stability Blend at 120 rpm



Blue = Actual

Red = Virtual

Actual vs Virtual Mixing Results

Flour blend	Speed	WA	DDT	Stab	Soft(5)	Pk E
Straight	63	64.8 (65.0)	17.2 (18.5)	18.2 (20.7)	13 (6)	16.9
	120		5.5 (6.2)	5.4 (6.2)	54 (44)	12.4
	180		3.3 (3.6)	2.3 (2.6)	115 (121)	12.0
HiLo WA	63	62.5 (61.8)	10.8 (13.2)	5.9 (10.0)	41 (17)	9.0
	120	-	5.0 (5.7)	2.7 (4.8)	94 (47)	9.1
	180	-	3.1 (3.5)	1.5 (2.0)	162 (121)	9.8
HiLo Stability	63	63.7 (63.3)	17.2 (16.2)	22.5 (16.4)	5 (13)	17.0
	120	-	6.3 (5.8)	6.5 (5.6)	40 (49)	14.2
	180	-	3.5 (3.2)	2.8 (2.4)	82 (113)	12.8
Average Error	-	*0.4*	*0.8*	*2.0*	*20.3*	-

Conclusions

- Mill fractions exhibited a wide range of dough mixing properties as measured by the doughLAB.
- High speed testing provided more relevant and timely information about dough processing quality, including water and mixing energy requirements, for different products and processes.
- The doughLAB software's virtual mixing function provided reasonable prediction of actual mixed flour performance. It can be used to assist the miller in blending operations. It is possible to reduce costs and maximize profits while blending to specification for specific customers and specific uses.

Acknowledgments

- Matthew Rees, BRI
- Sam Bason
- Jennifer Dang