Producers of Specialty Chemicals

Struktol Company of America

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Processing Influences of Additives on a Silica Filled Tread

by:

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presented at:

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Objective
Green tire tread

- Examine Silica influence
- Additive addition point
- Influence of zinc soap

- Mixing
- Processing
- Physicals

BANBURY

1600 ml

65-70% fill factor

3 pass mix

Addition variable, either 1st pass or 2nd

EXTRUDER

Brabender 17mm 20-1
3-1 compression screw
Garvey die
Triangle die
3 zones at 100C

Additive Variations

- Struktol EF 44A –soap blend
  - DP 96C
  - Zn 8.5%
- Struktol JV 46F (exp. Mixed surfactant)
  - DP ~95C
  - Zn 5.1%

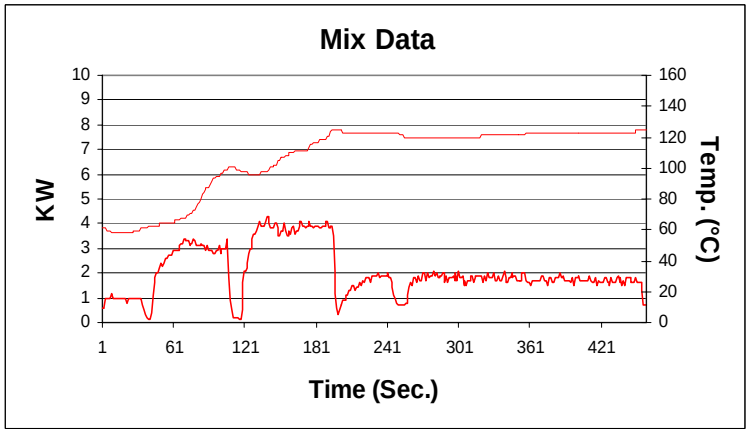
FORMULATION

• Duradene 751	103.1		
• Taktene 220	25		
• Ultrasil 7000 GR	80	50	30
• N220	0	20	40
• SCA 98 CB (TESPT-50%)	12.5	8	5
• Sundex 790	5		

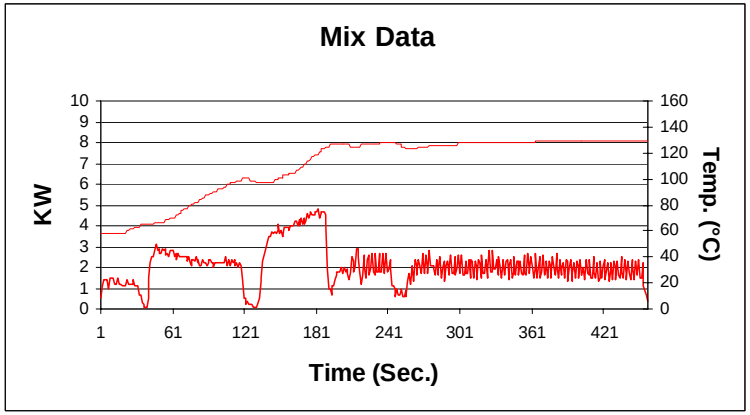
Formulation Addition point

Wax	1.5	1st or 2nd
Stearic acid	1.0	1st or 2nd
6PPD	2.0	1st or 2nd
EF 44A	0 or 3	1st or 2nd
46F	0 or 3	1st or 2nd
ZnO	2.5	2nd

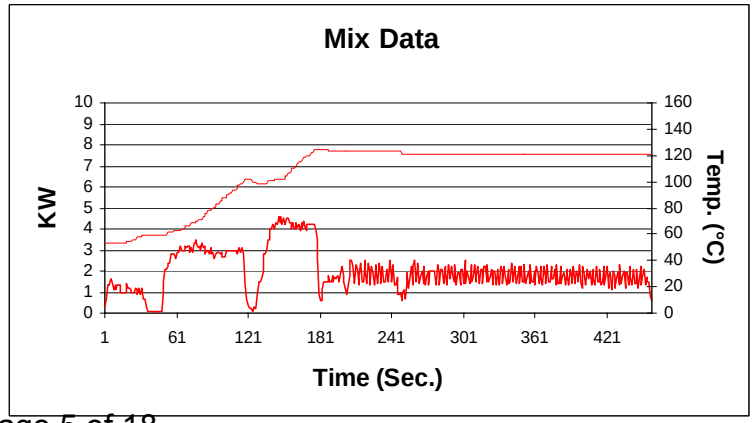
Sulfur 1.4
CBS 1.7
DPG 2.0



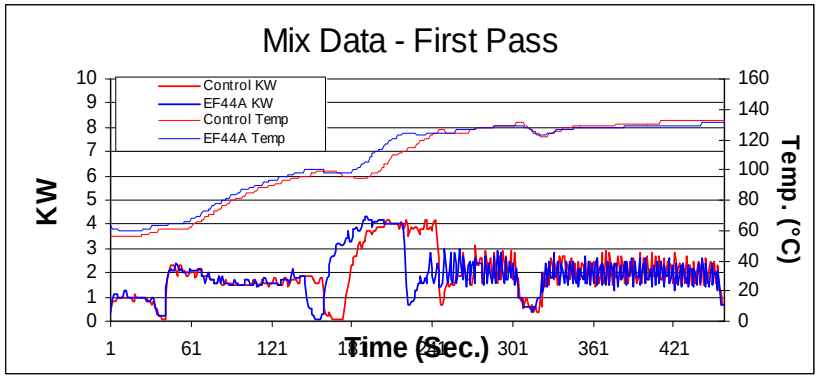
Silica – 80phr; No additive; First pass



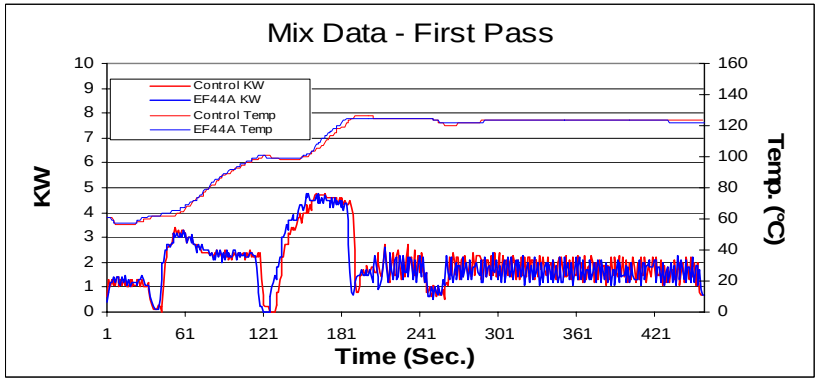
Silica – 50phr; No additive; First pass



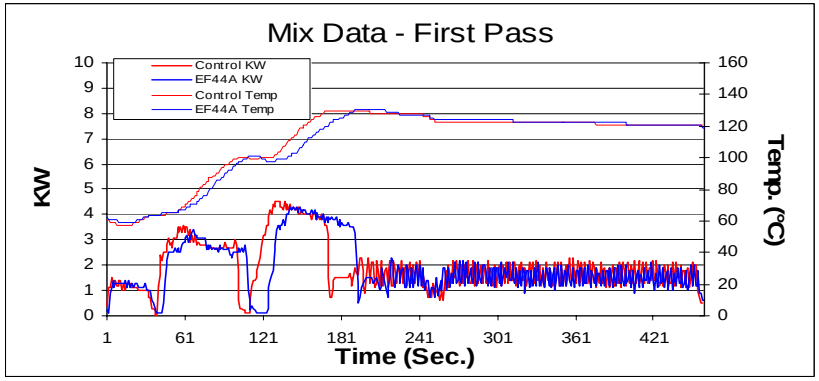
Silica – 30phr; No additive; First pass



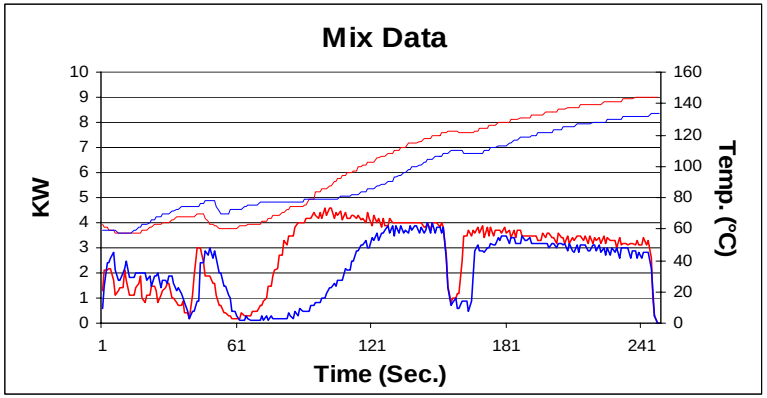
Silica – 80phr; EF44A in 1st pass (blue)



Silica – 50phr; EF44A in 1st pass



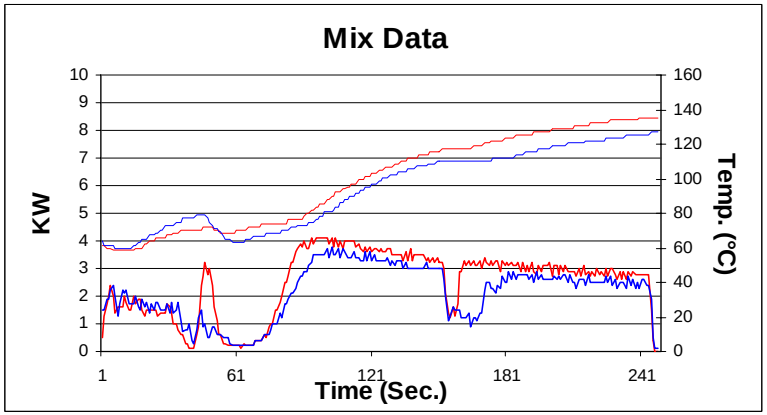
Silica – 30phr; EF44A in 1st pass



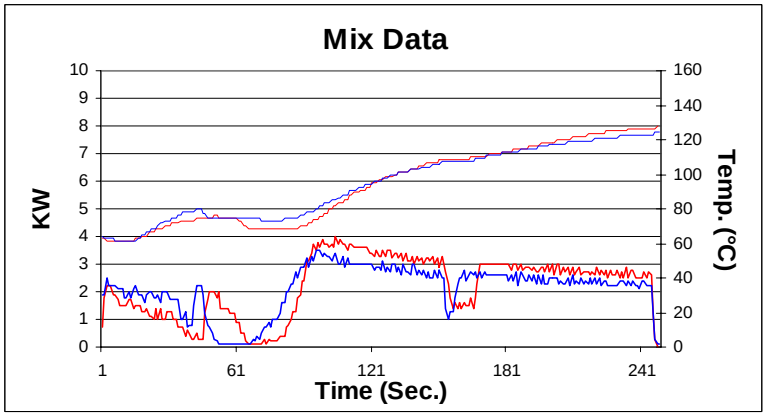
Silica – 80phr;
Additive in 2nd pass

Red Control
Blue EF 44A

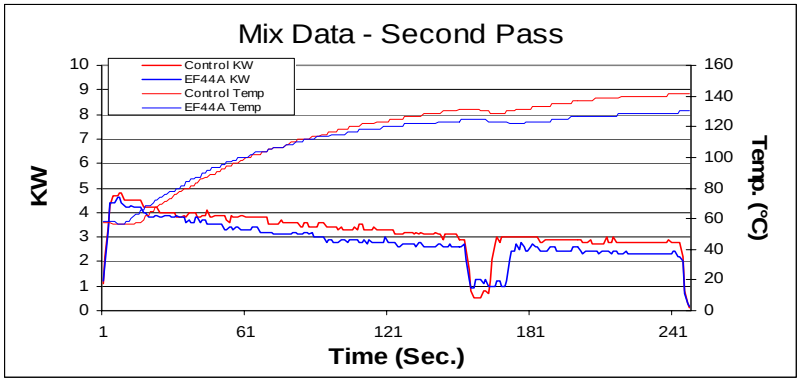
2nd pass



Silica – 50phr;
Additive in 2nd pass

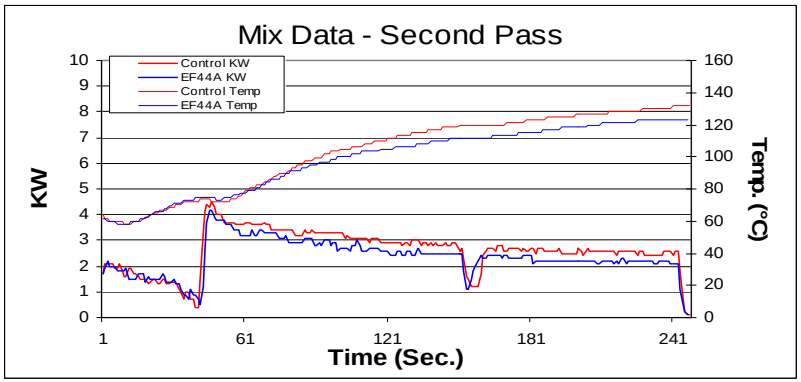


Silica – 30phr;
Additive in 2nd pass

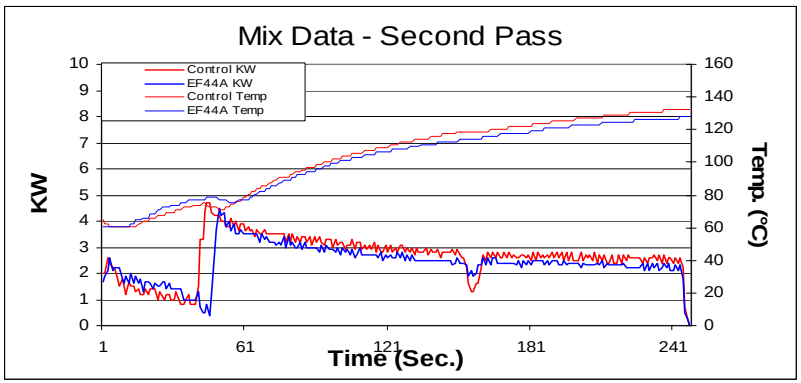


Silica – 80phr; EF44A in 1st pass

2nd pass



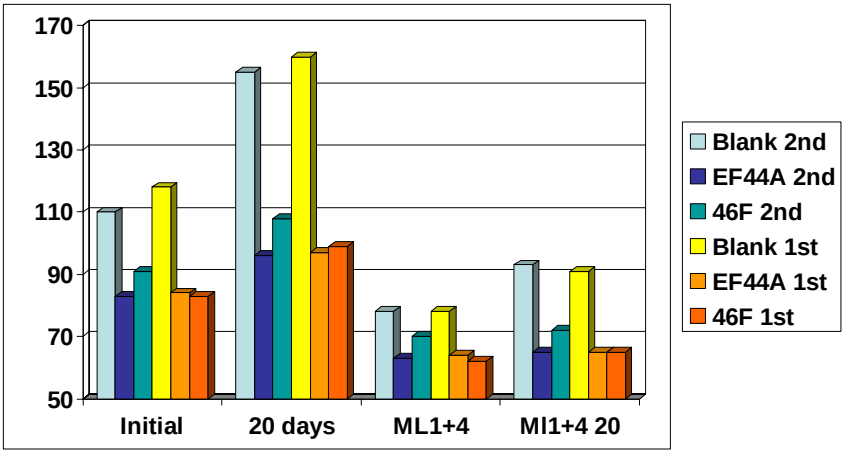
Silica – 50phr; EF44A in 1st pass



Silica – 30phr; EF44A in 1st pass

Mooney Viscosity

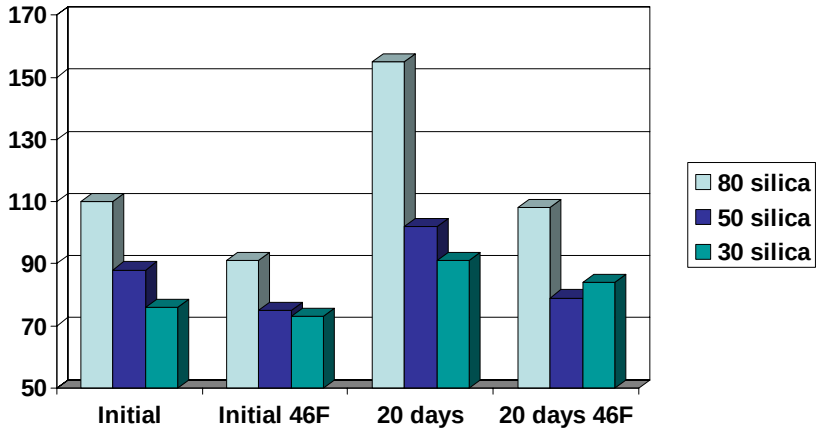
80 silica



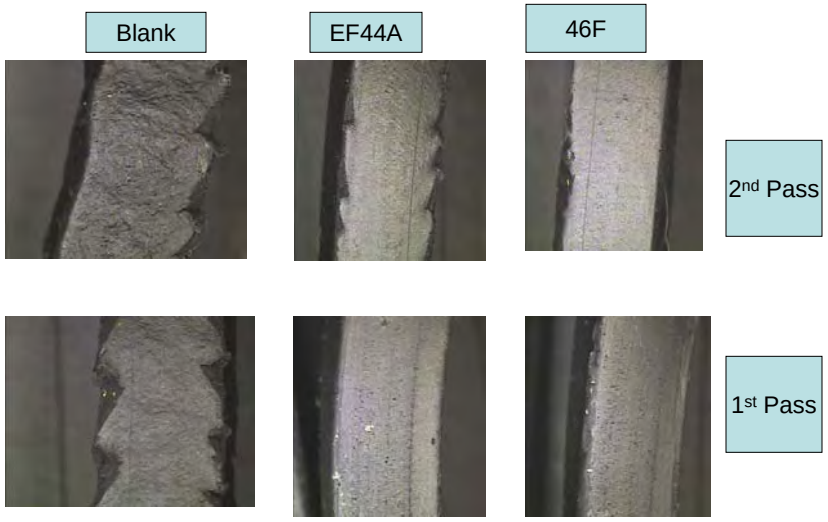
Initial Viscosity

Silica influence

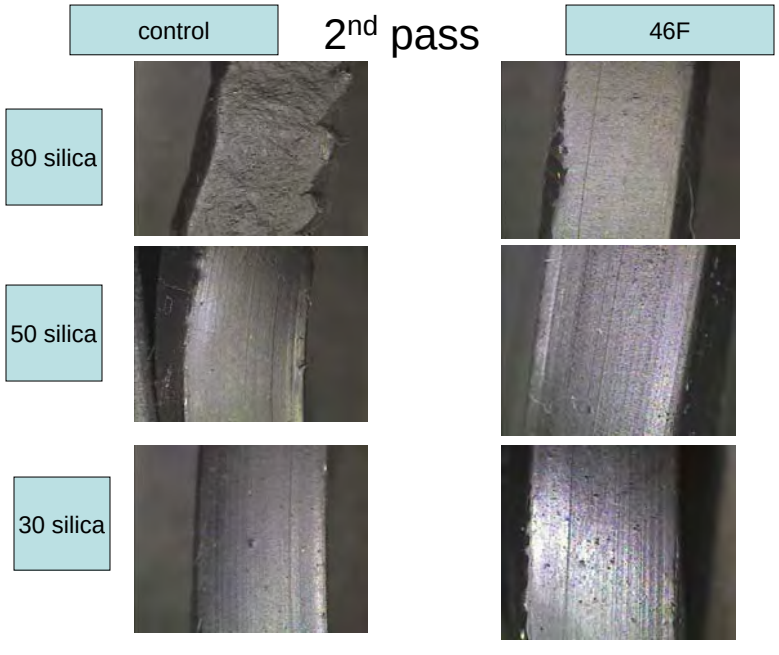
2nd pass

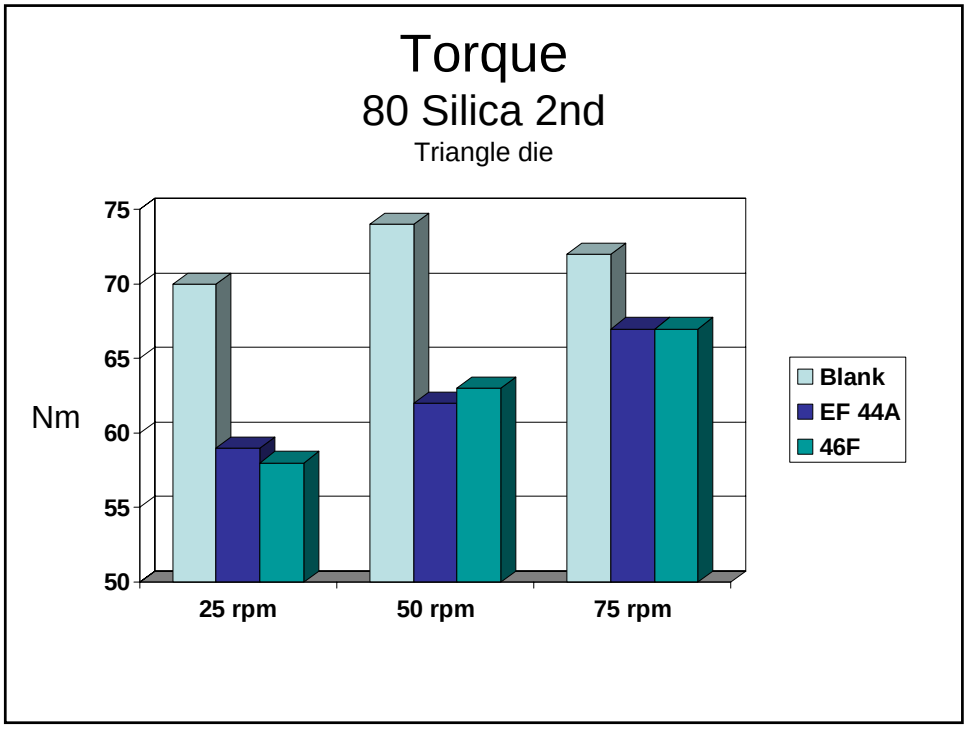


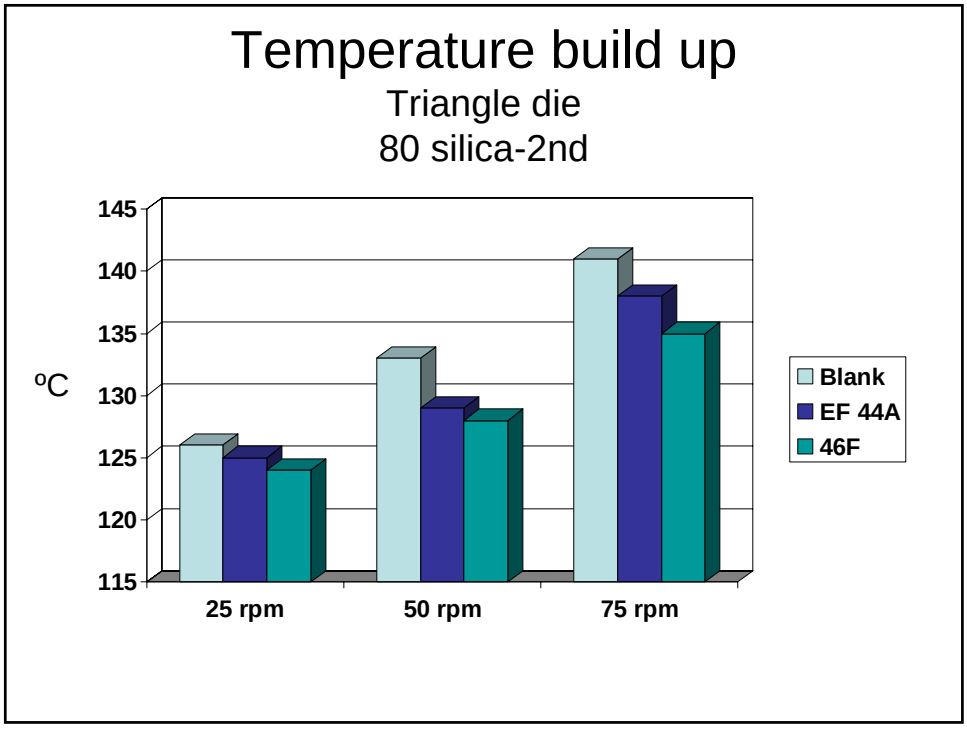
Garvey Die – 80 phr Silica- 25 RPM

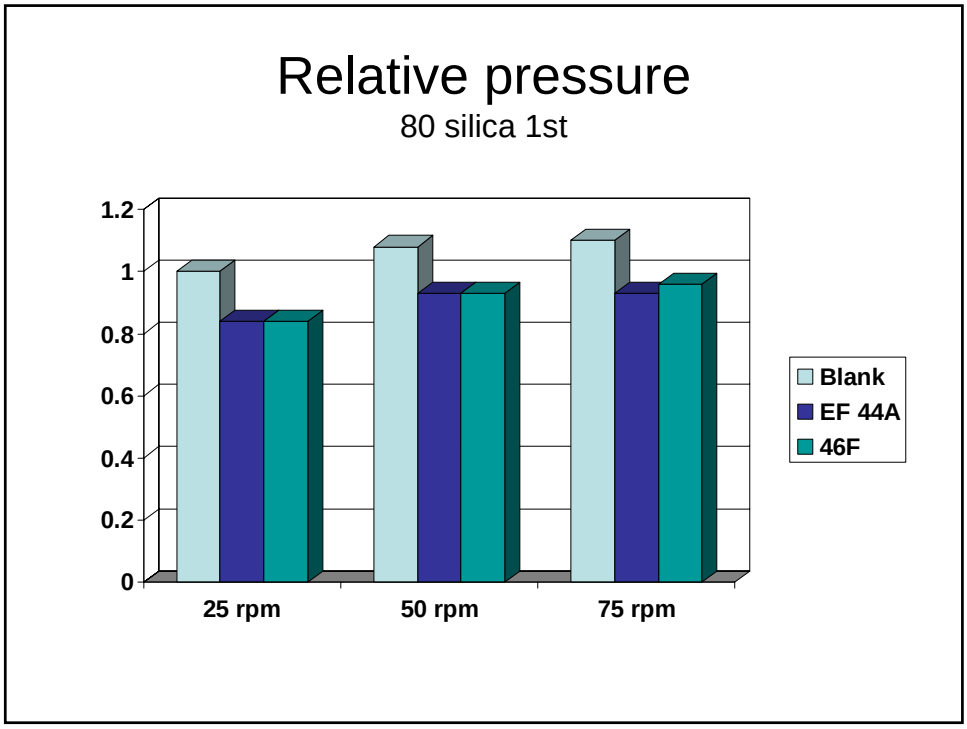


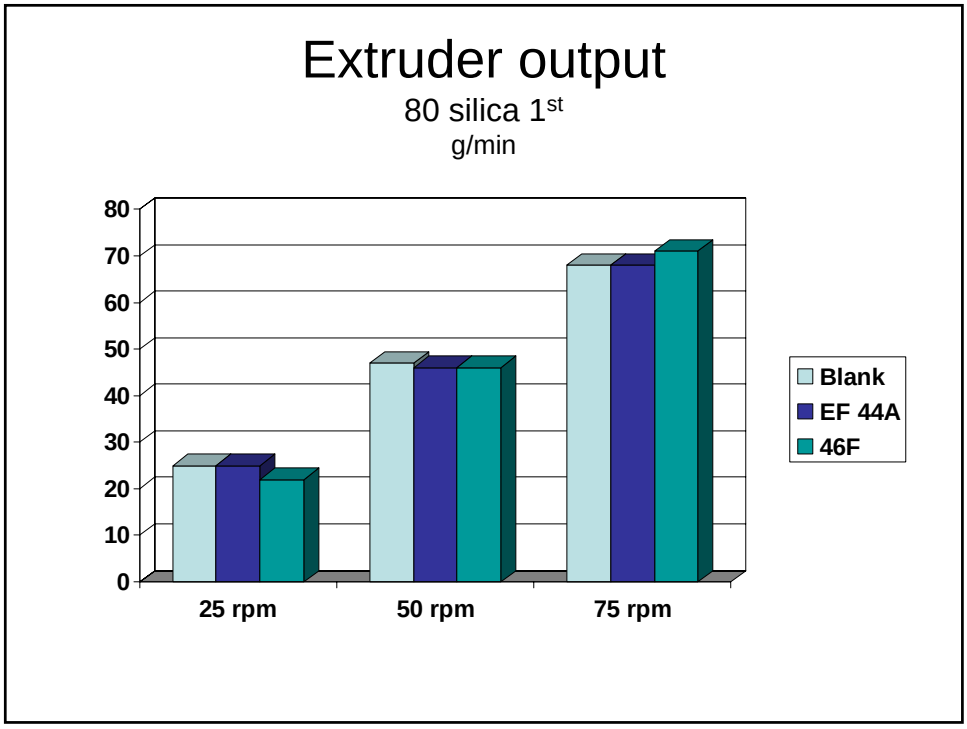
Silica Influence



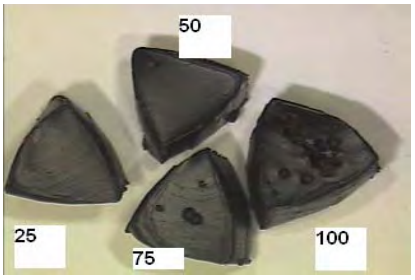

Torque
80 Silica 2nd
Triangle die
Nm
75
70
65
60
55
50
25 rpm
50 rpm
75 rpm
Blank
EF 44A
46F


Temperature build up
Triangle die
80 silica-2nd
°C
145
140
135
130
125
120
115
25 rpm
50 rpm
75 rpm
Blank
EF 44A
46F


Relative pressure
80 silica 1st
1.2
1
0.8
0.6
0.4
0.2
0
25 rpm
50 rpm
75 rpm
Blank
EF 44A
46F

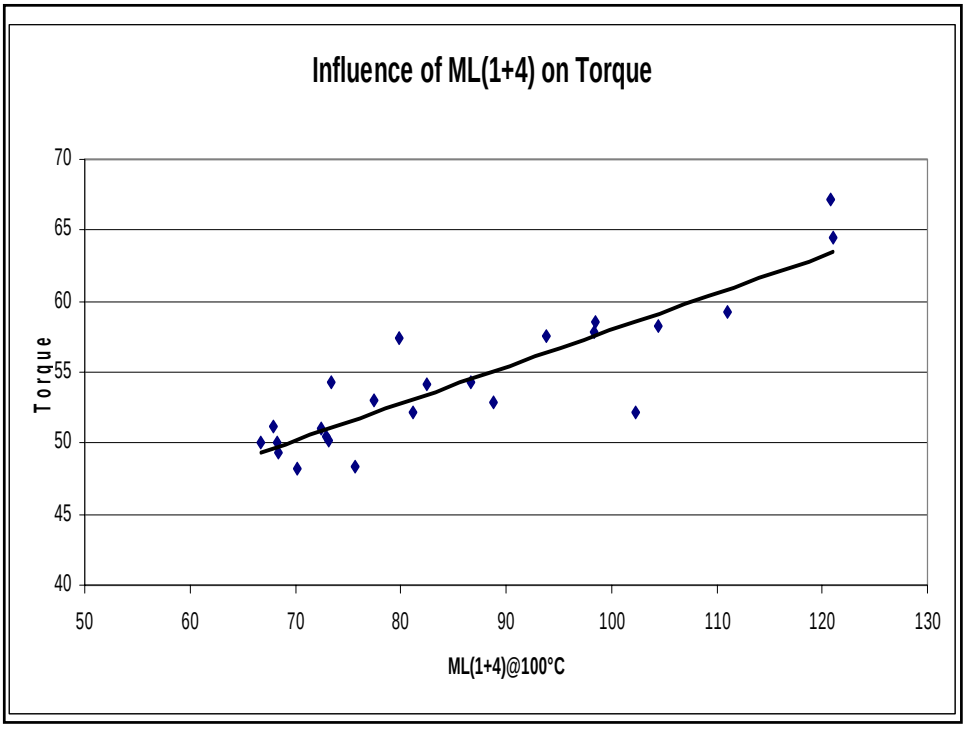

Extruder output
80 silica 1st
g/min
80
70
60
50
40
30
20
10
0
25 rpm
50 rpm
75 rpm
Blank
EF 44A
46F

Extrudate Profile
50 parts Silica 1st pass additives

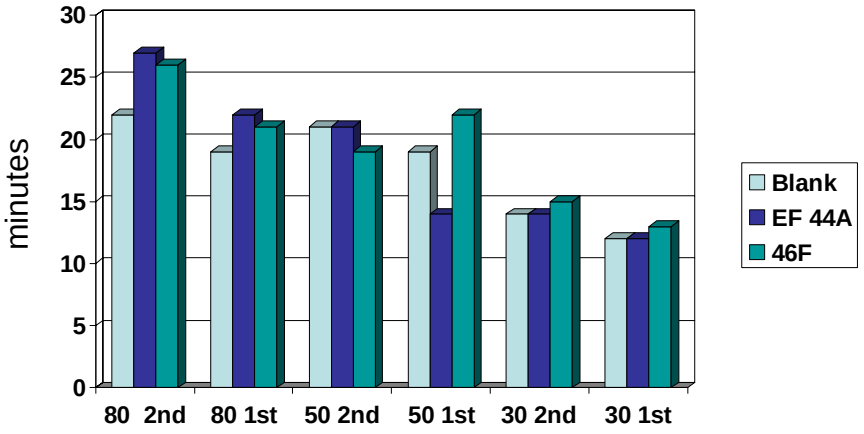


127 133/140 153 ºC

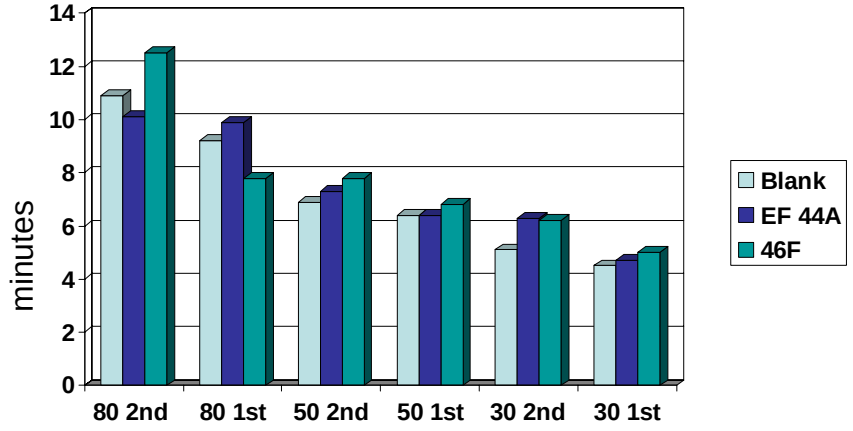
Temperature



Silica level-addition point
Mooney T_5

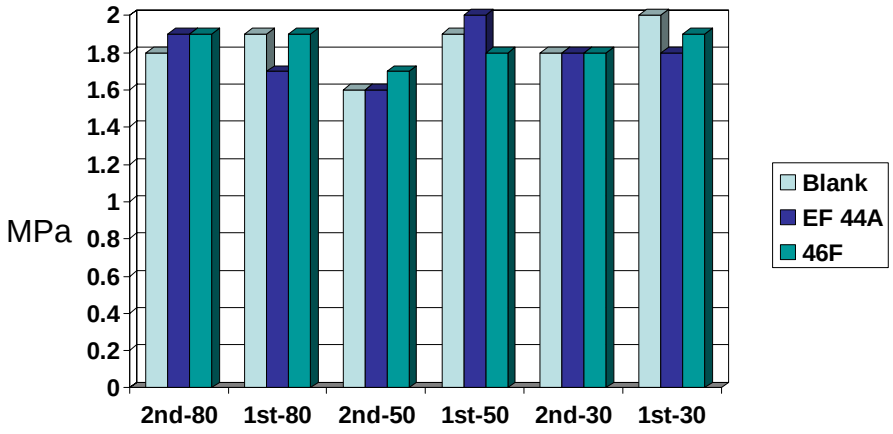


Silica and addition point
Rheometer T_{90}



Cured Properties

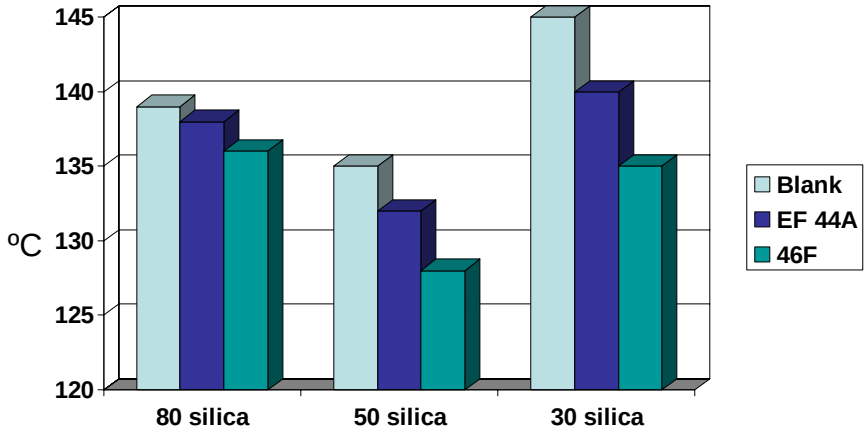
100 % Modulus

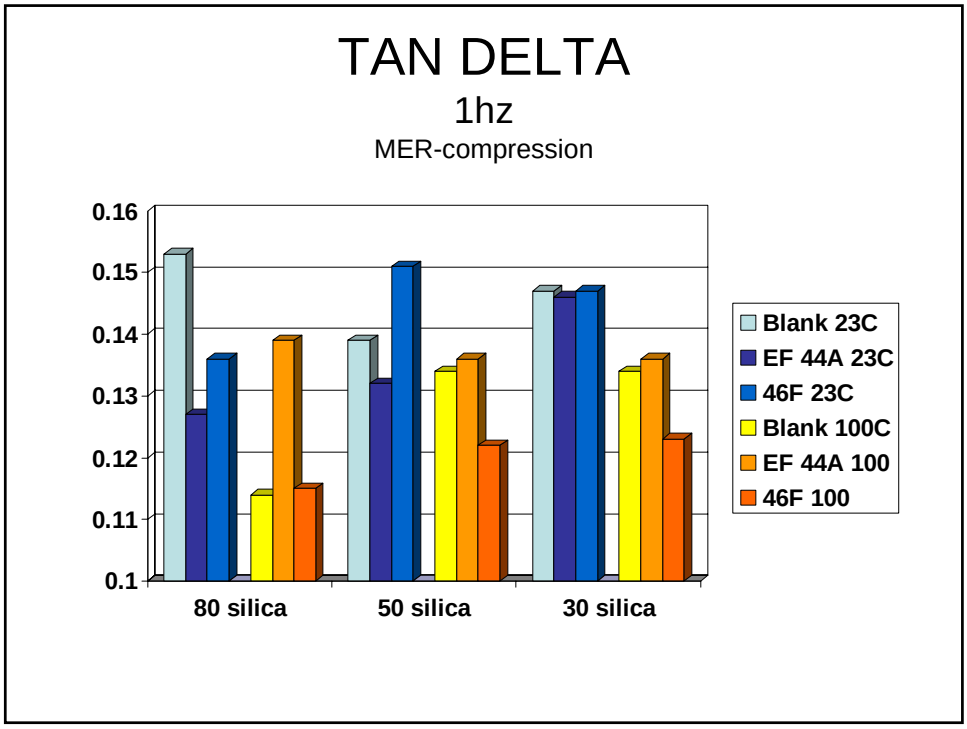


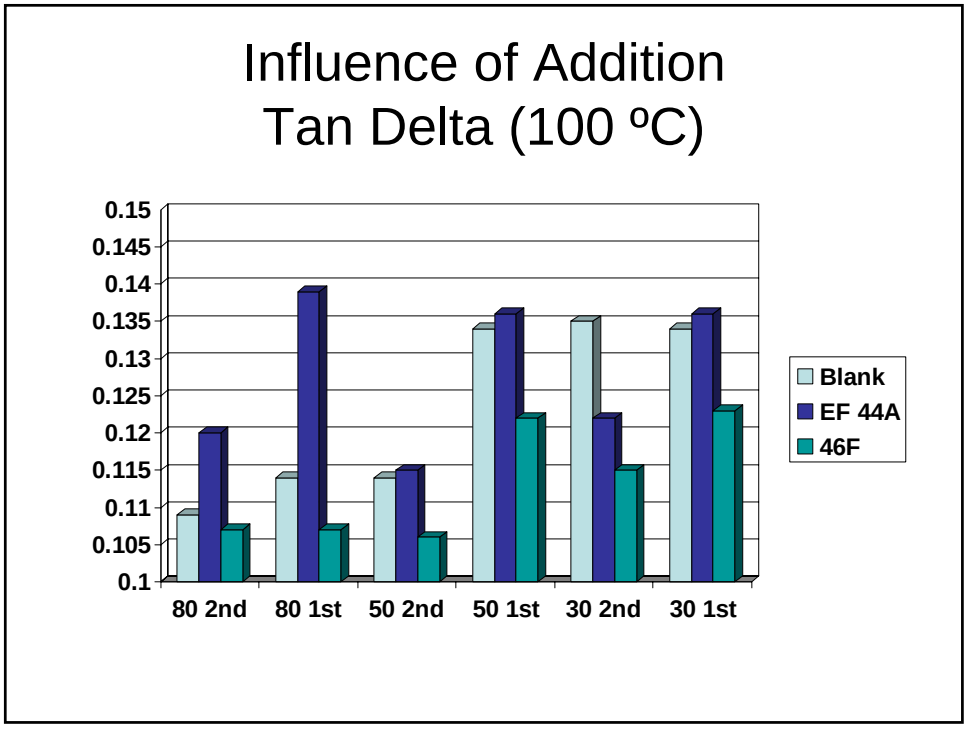
Heat Build up

Firestone Flexometer

2nd pass

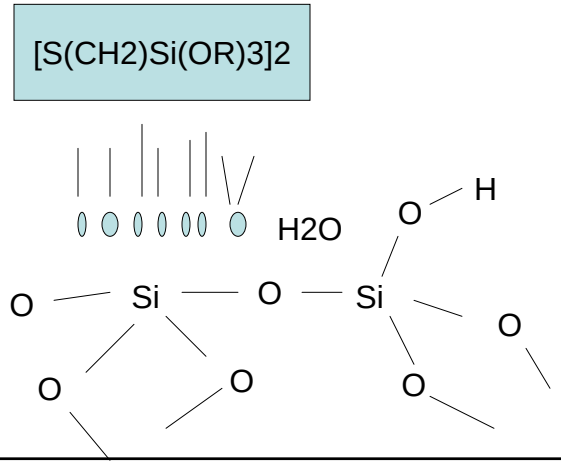



TAN DELTA
1hz
MER-compression
0.16
0.15
0.14
0.13
0.12
0.11
0.1
80 silica
50 silica
30 silica
Blank 23C
EF 44A 23C
46F 23C
Blank 100C
EF 44A 100
46F 100


Influence of Addition
Tan Delta (100 ºC)
0.15
0.145
0.14
0.135
0.13
0.125
0.12
0.115
0.11
0.105
0.1
80 2nd
80 1st
50 2nd
50 1st
30 2nd
30 1st
Blank
EF 44A
46F

SURFACTANT/SILANE/SILICA

INTERFACE/INTERPHASE



Summary

- Additive addition point
  - Limited changes in processing effects
  - Some changes in physicals
- Surfactant JV 46F
  - Major changes in processing
    - Excellent extrusion properties
  - Improved dynamic physical properties
  - Modifies polar filler/nonpolar rubber interface

Future work

- Look at other mixing procedures
  - Temperature influences
  - Chemical addition points
- Vary the silane structure
- Study influence of storage conditions
- Study concentration effects

Acknowledgements

- The following assisted in the experiments
  - Zoran Brdarski
  - Barbara Eikelberry
  - Paul Danilowicz
  - Roger Evans
  - Kevin Tracy

06001, 06003, 06004
06013, 06014, 06015
06019, 06020, 06021
06022, 06023, 06024