Stretching Polychloroprene Supplies in Solvent Borne Adhesives

by
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Overview

- Phenolic resins are an important and necessary component of high performance polychloroprene solvent-borne adhesives.
- Global supply of polychloroprene has diminished due to growing demand and plant closures.
- A study was done where resin loads were increased or combined to make up to 1/3 more adhesive with standard loads of polychloroprene without sacrificing performance.
- Standard test methods were used for evaluation of the compounded adhesives, and test results are discussed.

Variable 1 – Phenolic Resin

- Reactive vs. Non-reactive

- Different reactive resins
  - Molecular Weight
  - Degree of reactivity
  - Monomer
    - PTBP, PTOP

- Different non-reactive resins
  - Terpene phenolic
  - Alkylphenolic
    - Different monomers
      - PTBP, PTOP, Blended alkyl phenols

Variable 2 – Resin Load

- Reactive resin
  - 45 parts resin
  - 75 parts resin
  - 100 part resin blends

- Resin blends reactive and non-reactive
  - Combined loads to 100 parts total resin

Variable 3 - MgO

- MgO Loads
    - 2.25 – 7.5 parts

- Pre-reacted with resin
  – Multiple resins reacted together
  – Resins reacted separately

- Non pre-reacted
  – Added as solutions to adhesive

Reactive Resins

– Reactive Resin made from Butylphenol

- Low MW with high reactivity (RBLH)
  - –Commercial Name HRJ-1367
- Low MW with low reactivity (RBLL)
  - –Commercial Name SP-103
- High MW with High Reactivity (RBHH)
  - –Commercial Name Rezilite® 888[1]

– Reactive Resin made from Octylphenol (RO)

  - –Commercial Name SP-1045

[1]Rezilite is a registered trademark of SI Group, Inc., Schenectady NY

Non-reactive Resins
Terpene Phenolic Resins

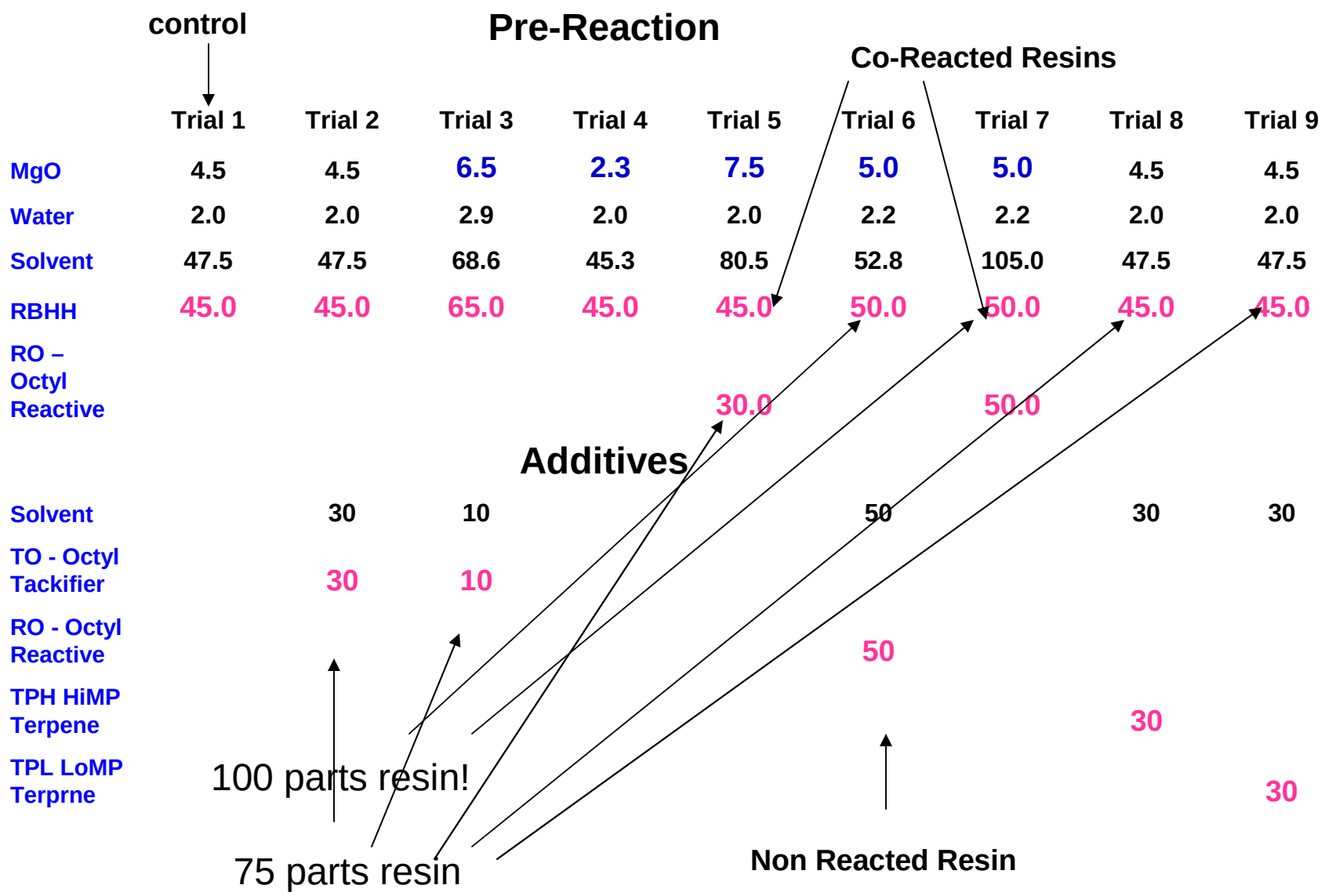
- High Melting Point (TPH)
  - Commercial Name SP-560

- Low Melting Point (TPL)
  - Commercial Name SP-553

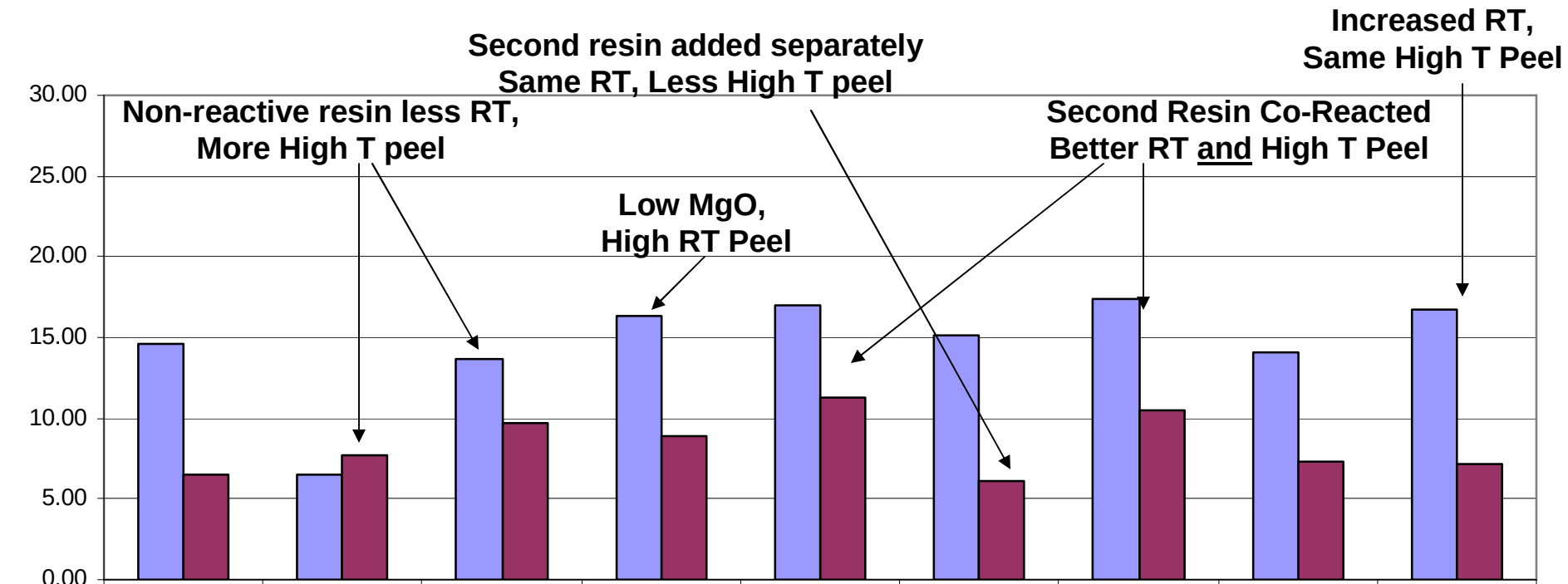
Non-Reactive Resins
Alkylphenolic Resins

- Octylphenol Based Resin (TO)
  - Commercial Name SP-1068
- Butylphenol Based Resin (TB)
  - Commercial Name HRJ-2355
- Mixed alkylphenol Resin (TM)
  - Commercial Name SP-25

Resin Loads Trials 1-9



Dynamic Peel Test Results
Trials 1-9

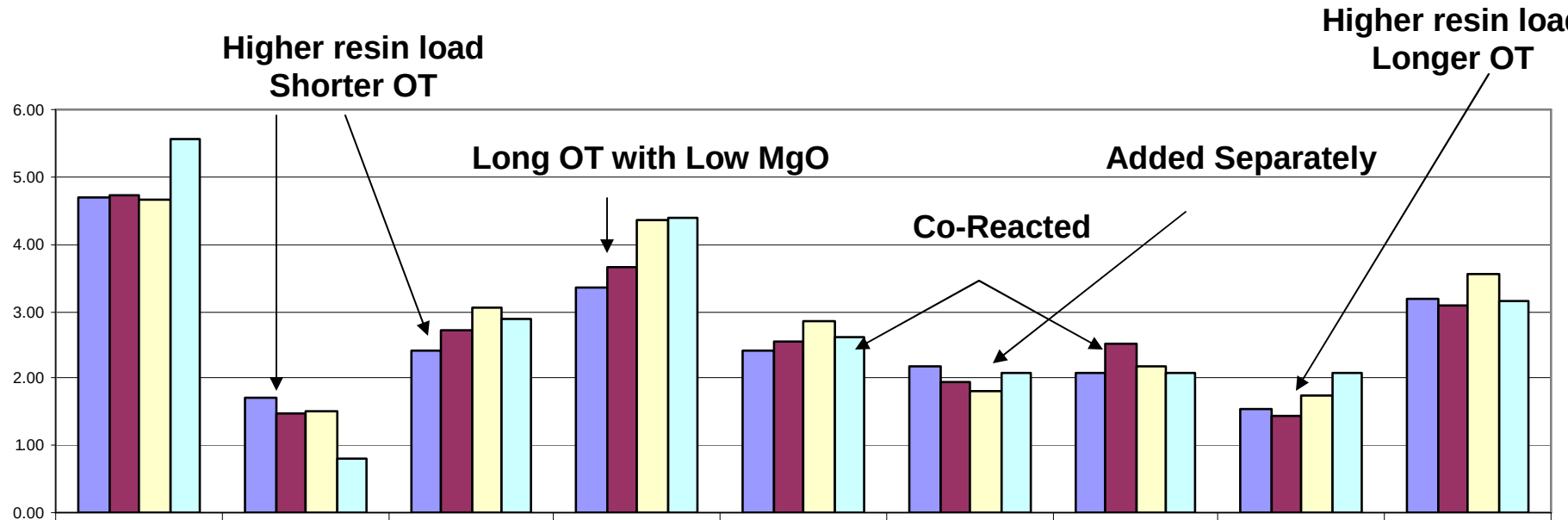


	45 RBHH	45/30 RBHH/TO	65/10 RBHH/TO	RBHH Lo MgO	45/30 RBHH/RO	50/50 RBHH/RO	50/50 RBHH/RO	45/30 RBHH/TPH	45/30 RBHH/TPL
RT	14.54	6.49	13.64	16.31	16.94	15.09	17.37	14.01	16.73
158℉	6.57	7.64	9.69	8.84	11.31	6.10	10.55	7.25	7.18

Control

Alkylphenol Tackifiers less effective at RT than terpene phenolic tackifiers

Shear Adhesion – Open Time Trials 1-9

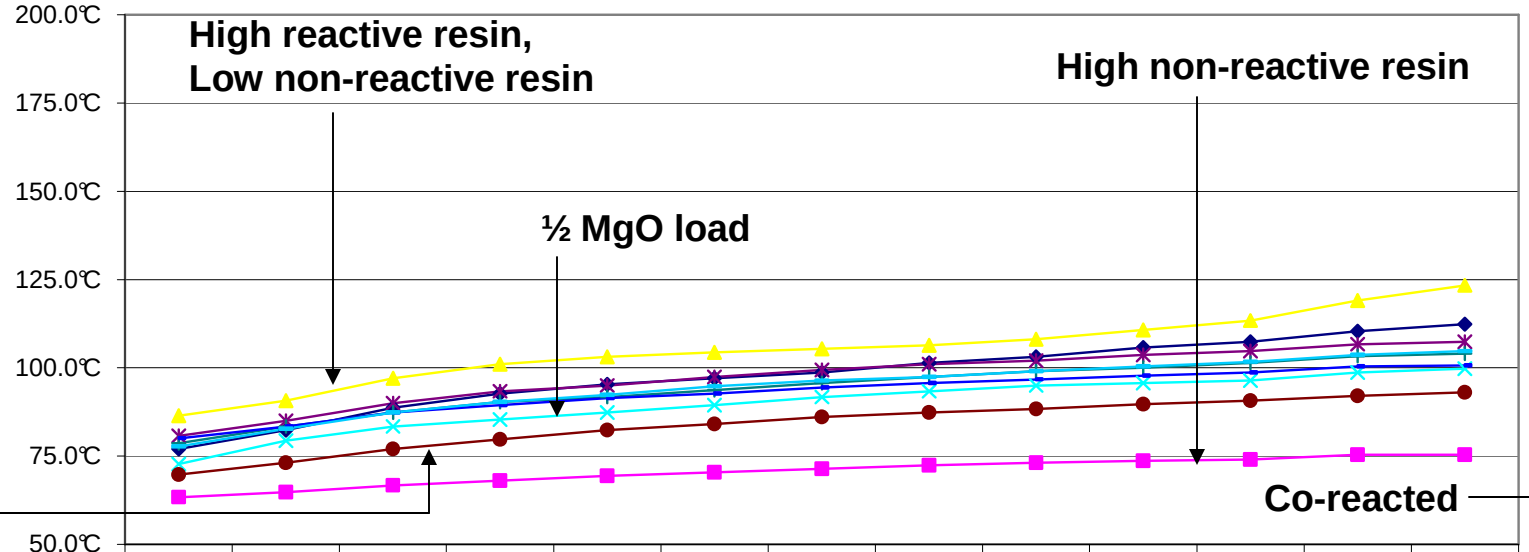


	45 RBHH	45/30 RBHH/TO	65/10 RBHH/TO	RBHH Lo MgO	45/30 RBHH/RO	50/50 RBHH/RO	50/50 RBHH/RO	45/30 RBHH/TPH	45/30 RBHH/TPL
30'	4.69	1.71	2.42	3.35	2.40	2.19	2.09	1.54	3.20
60'	4.74	1.47	2.73	3.66	2.55	1.95	2.51	1.43	3.08
90'	4.65	1.49	3.05	4.35	2.86	1.82	2.17	1.74	3.54
120'	5.58	0.82	2.87	4.38	2.63	2.08	2.07	2.08	3.14

Control

CRT for Trials 1-9

Constant Rising Temperature, (CRT)
2℃/minute



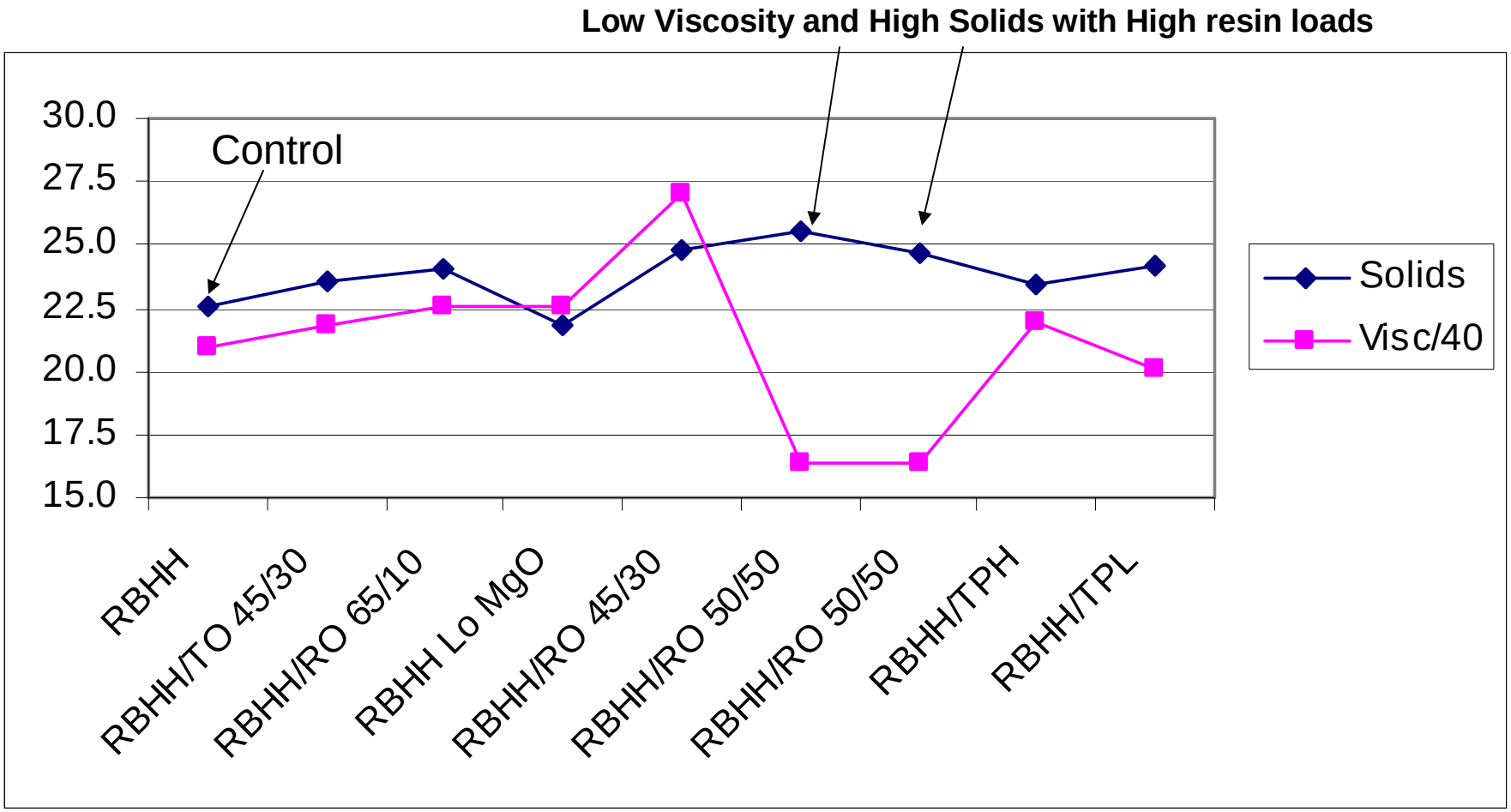
Control

Co-reacted

Added Separately

	0.5cm	1cm	2cm	3cm	4cm	5cm	6cm	7cm	8cm	9cm	10cm	12cm	12.5cm (Fail)
45 RBHH	77.0℃	82.3℃	88.7℃	92.7℃	95.3℃	97.0℃	98.7℃	101.3℃	10	3.0℃	105.7℃	107.3℃	110.3℃	112.3℃
45/30 RBHH/TO	63.3℃	64.7℃	66.7℃	68.0℃	69.3℃	70.3℃	71.3℃	72.3℃	73.	0℃	73.7℃	74.0℃	75.3℃	75.3℃
65/10 RBHH/TO	86.3℃	90.7℃	97.0℃	101.0℃	103.0℃	104.3℃	105.3℃	106.3	℃	108.0℃	110.7℃	113.3℃	119.0℃	123.3℃
RBHH Lo MgO	72.7℃	79.3℃	83.3℃	85.3℃	87.3℃	89.3℃	91.7℃	93.3℃	95.	0℃	95.7℃	96.3℃	98.7℃	99.7℃
45/30 RBHH/RO	80.7℃	85.0℃	90.0℃	93.3℃	95.0℃	97.3℃	99.3℃	101.0℃	10	2.0℃	103.7℃	104.7℃	106.7℃	107.3℃
50/50 RBHH/RO	69.7℃	73.0℃	77.0℃	79.7℃	82.3℃	84.0℃	86.0℃	87.3℃	88.	3℃	89.7℃	90.7℃	92.0℃	93.0℃
50/50 RBHH/RO	78.7℃	83.3℃	87.3℃	90.3℃	91.7℃	93.7℃	95.7℃	97.3℃	99.	0℃	100.0℃	101.3℃	103.3℃	104.0℃
45/30 RBHH/TPH	80.0℃	83.3℃	87.3℃	89.3℃	91.3℃	92.7℃	94.3℃	95.7℃	96.	7℃	97.7℃	98.7℃	100.3℃	100.7℃
45/30 RBHH/TPL	77.7℃	82.7℃	87.3℃	90.3℃	92.3℃	94.7℃	96.3℃	97.3℃	99.	0℃	100.3℃	101.7℃	103.7℃	104.7℃

Solids/Viscosity Relationship Trials 1-9



Key to Trials 10-16

control

Pre-Reaction

MgO	4.5	7.5	5.0	5.0	7.5	4.5	4.5	4.5
Water	2.0	3.3	3.3	2.2	3.3	2.0	2.0	2.0
Solvent	47.5	79.2	79.2	105.0	79.2	47.5	47.5	47.5
RBLH	45	75		50	75	45	45.0	
RBLL			75	50				
RBHH								45.0

Additives

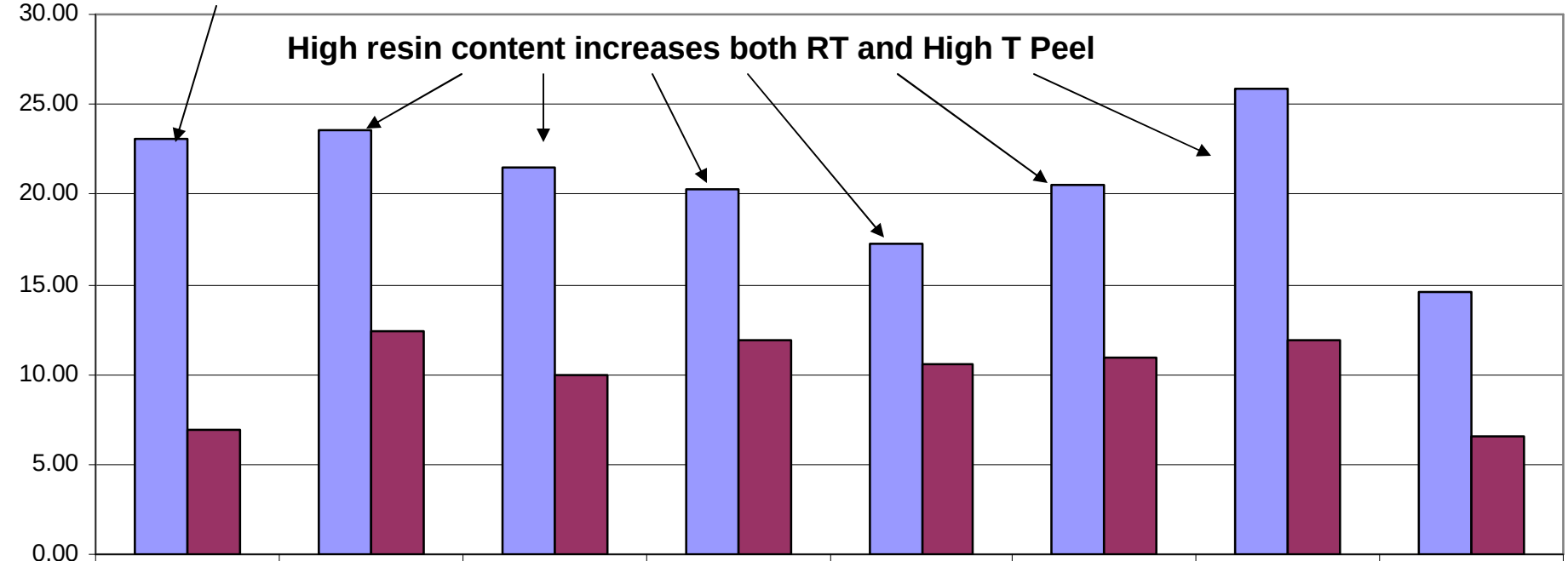
Solvent					25	30	30	
TO					25			
TB						30		
TM							30	

100 parts resin!

75 parts resin

Dynamic Peel Results
Trials 10 – 16

Low MP Hi Reactive Resin
Better RT, same High T peel

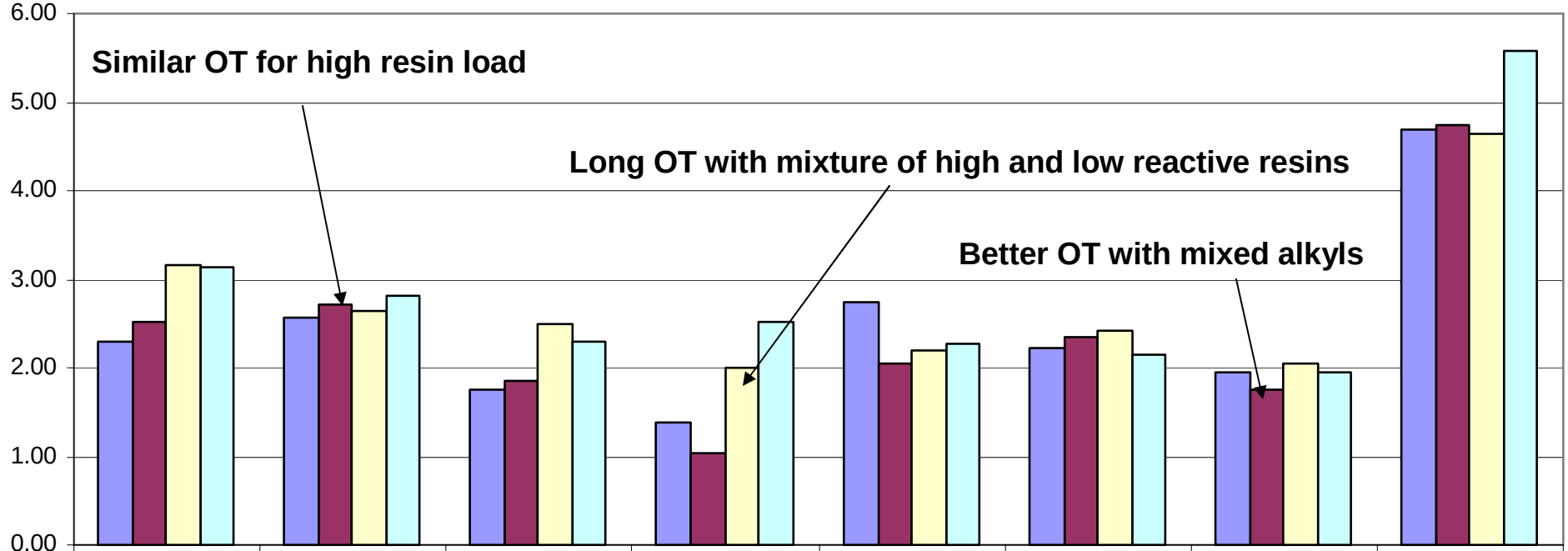


	45 RBLH	75 RBLH	75 RBLL	RBLH/RBLL 50/50	RBLH/TO 75/25	RBLH/TB 45/30	RBLH/TM 45/30	45 RBHH
RT	23.07	23.57	21.46	20.26	17.26	20.48	25.82	14.54
158°F	6.88	12.44	9.92	11.92	10.55	10.97	11.94	6.57

RT Peel trend Octyl < Butyl < Mixed alkyls

Control

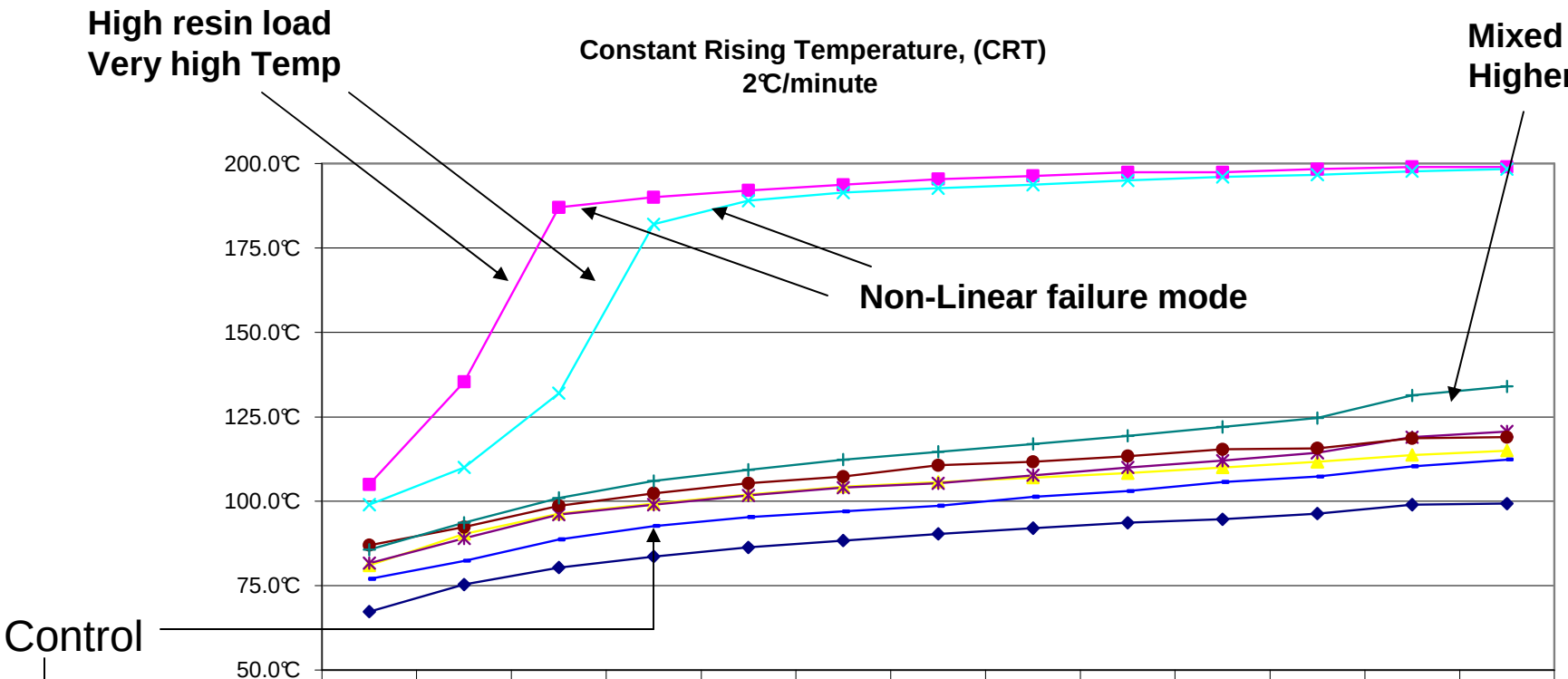
Shear Adhesion – Open Time
Trials 10 - 16



	45 RBLH	75 RBLH	75 RBLL	RBLH/RBLL 50/50	RBLH/TO 75/25	RBLH/TB 45/30	RBLH/TM 45/30	45 RBHH
30'	2.30	2.58	174	138	2.73	2.22	195	4.69
45'	2.52	2.72	184	104	2.05	2.35	175	4.74
60'	3.16	2.65	2.49	199	2.20	2.43	2.05	4.65
90'	3.14	2.80	2.28	2.53	2.28	2.16	196	5.58

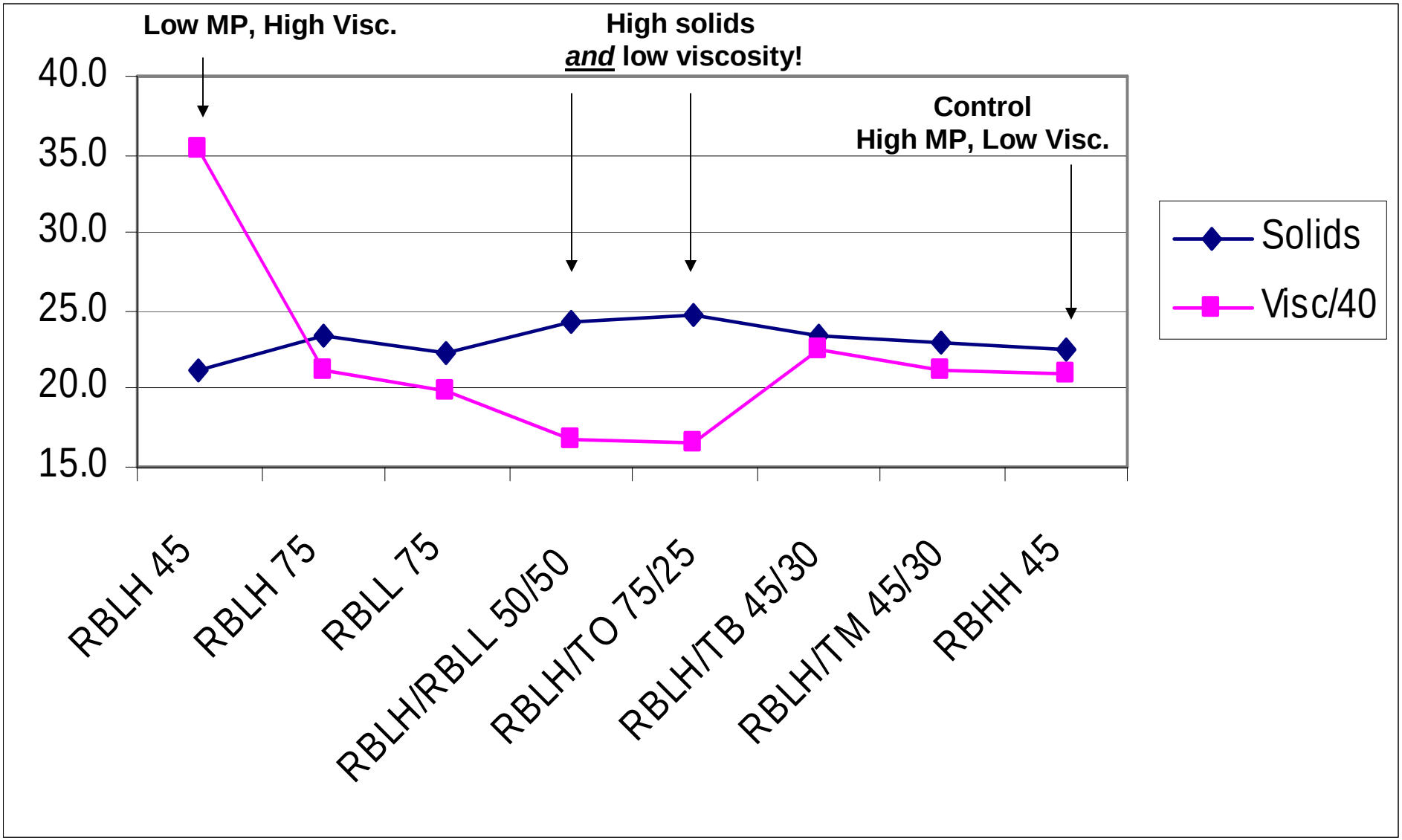
Control

CRT for Trials 10 - 16



	0.5cm	1cm	2cm	3cm	4cm	5cm	6cm	7cm	8cm	9cm	10cm	12cm	12.5cm (Fail)
45 RBLH	67.3℃	75.3℃	80.3℃	83.7℃	86.3℃	88.3℃	90.3℃	92.0℃	93.7℃	94.7℃	96.3℃	99.0℃	99.3℃
75 RBLH	105.0℃	135.3℃	187.0℃	190.0℃	192.0℃	193.7℃	195.3℃	196.3℃	197.3℃	197.3℃	198.3℃	199.0℃	199.0℃
75 RBLL	81.0℃	90.3℃	96.3℃	99.3℃	102.0℃	104.3℃	105.7℃	107.0°C	108.3℃	110.0℃	111.7℃	113.7℃	115.0℃
RBLH/RBLL 50/50	99.0℃	110.0℃	132.0℃	182.0℃	189.0℃	191.3℃	192.7℃	193.7℃	195.0℃	196.0℃	196.7℃	197.7℃	198.3℃
RBLH/TO 75/25	81.7℃	89.0℃	96.0℃	99.0℃	101.7℃	104.0℃	105.3℃	107.7°C	110.0℃	112.0℃	114.3℃	119.0℃	120.7℃
RBLH/TB 45/30	87.0℃	92.3℃	98.7℃	102.3℃	105.3℃	107.3℃	110.7℃	111.7℃	113.3℃	115.3℃	115.7℃	118.7℃	119.0℃
RBLH/TM 45/30	85.7℃	93.7℃	101.0℃	106.0℃	109.3℃	112.3℃	114.7℃	117.0℃	119.3℃	122.0℃	124.7℃	131.3℃	134.0℃
45 RBHH	77.0℃	82.3℃	88.7℃	92.7℃	95.3℃	97.0℃	98.7℃	101.3℃	103.0℃	105.7℃	107.3℃	110.3℃	112.3℃

Solids/Viscosity Relationship
Trials 10-16



Conclusions

- Higher than typical resin loads can be used to extend the available supply of PCR to make 1/3 more adhesive without sacrificing performance
- High solids content adhesives can be prepared at acceptable viscosity by increasing resin load
- Low viscosity adhesives can be prepared for spray applications at constant solids content by replacing polychloroprene with phenolic resin
- Properties of adhesives can be enhanced by choice and load of resin

Acknowledgements

- Thank you to ASC allowing us to present this information

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- Special Thanks to Wally Allison, John Cuff, and Ben Lamb for conducting the testing presented here

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Rubber Base Solution

- Neoprene®[1] AD-20 100
- Elastomag®[2] 170S 4
- Zinc Oxide 5
- Antioxidant 2246 2
- Solvent System 593

[1]Neoprene is a registered trademark of DuPont Performance Elastomers, Wilmington DE
[2]Elastomag is a registered trademark of Rohm & Haas Company, Philadelphia PA

Standard Pre-Reaction Formulation

- Phenolic Resin 45.0 grams
- Elastomag®[1] 170S 4.5 grams
- Water 2.0 grams
- Solvent System 47.5 grams

[1]Elastomag is a registered trademark of Rohm & Haas Company, Philadelphia PA

Standard Solvent System

- Toluene 33.3 Parts by Weight
- Hexane 33.3 Parts by Weight
- MEK 33.3 Parts by Weight

Test 1
Peel strength

- Substrates are canvas to canvas
- 3 coats air dried at RT for 30 minutes
- 1 coat air dried at RT for 2 minutes
- Assembled and press with 3 passes of 4.5 pound roller
- Aged 7 days at RT after assembly
- Tested at RT
- Tested at 158℉ with 5 minute heat soak
- Tests were run in triplicate and averaged
- Reported values in pounds per 1 inch width

Test 2
Shear Adhesion – Open Time

- Substrates are Canvas and Steel
- Base coat on canvas air dried 30 minutes
- Second coat and steel coated
- Assembly made at 30, 60, 90, 120 minutes
- 2.5 pound Weighted roller used 3 times
- Assembled specimens are aged 7 days
- Specimens heat soaked 5 minutes
- Testing conducted at 250 ℉
- Tests done in triplicate and averaged

Test 3
CRT (Dead Weight Test)

- Same coating and assembly as peel test
- Test specimens marked from 1 – 12.5 cm
- Dead weight of 1250 grams attached
- Temperature increase 2℃ per minute
- Onset is when 1 cm separation occurs
- Failure is when 12.5 cm separation occurs

Test 4
Solids and Viscosity

Solids

- 1.5 grams of adhesive in aluminum dish
- Forced air oven at 135℃
- Held for 1 hour
- Samples tested in triplicate and averaged

Viscosity

- Brookfield Cone & Plate Viscometer
- Cone #41
- Test run at 25 ℃