

Recovered Asphalt Testing Three Challenges Users Must Consider

Amma Wakefield, MASC, PEng
Regional Engineer, Canada
Asphalt Institute

Outline

- Background
- Recovered Asphalt Cement
- The Challenges – The ABCs
- Options and Precautions for Users



Asphalt binders specified based on their properties in an original state

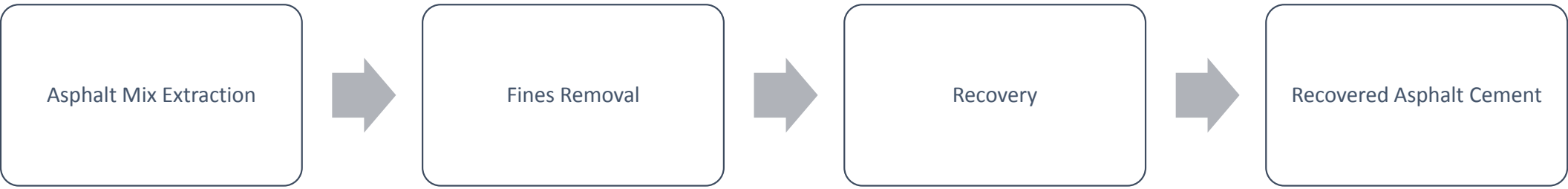
- Performance Graded by AASHTO or ASTM

What about properties of asphalt in asphalt mixtures?

- Increased usage of reclaimed asphalt pavement (RAP) in asphalt mixes
- Correct binder used in production
- Evaluate properties of blended asphalt binder



Recovered Asphalt Cement



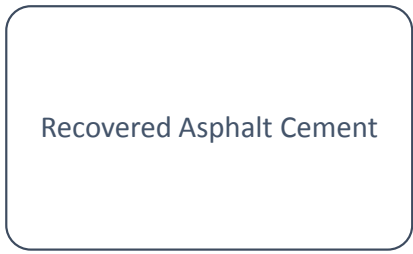
Centrifuge Extractor



Highspeed Centrifuge



Rotary Evaporator



SHRP Extractor

The Challenge

- A. The procedure and solvent can have an impact on the resulting physical properties of the recovered asphalt binder
- B. Physical properties test results of recovered binders have much higher variability compared to unrecovered binders
- C. The effect of solvent extraction on polymer modified binders and impact on physical properties is still being investigated

A Review of Solvent Extraction-Recovery Procedures and their Effect on Recovered Asphalt Binder Properties

Amma Wakefield, M.A.Sc., P.Eng.
Regional Engineer
Asphalt Institute
London, Ontario

R. Michael Anderson, P.E.
Director of Research and Laboratory Services
Asphalt Institute
Lexington, Kentucky

Zachary McKay
Senior Asphalt Technician
Asphalt Institute
Lexington, Kentucky

Susan L. Tighe, Ph.D., P.Eng., MCSCE
Norman W. McLeod Professor in Sustainable Pavement Engineering
University of Waterloo, Department of Civil and Environmental Engineering
Waterloo, Ontario

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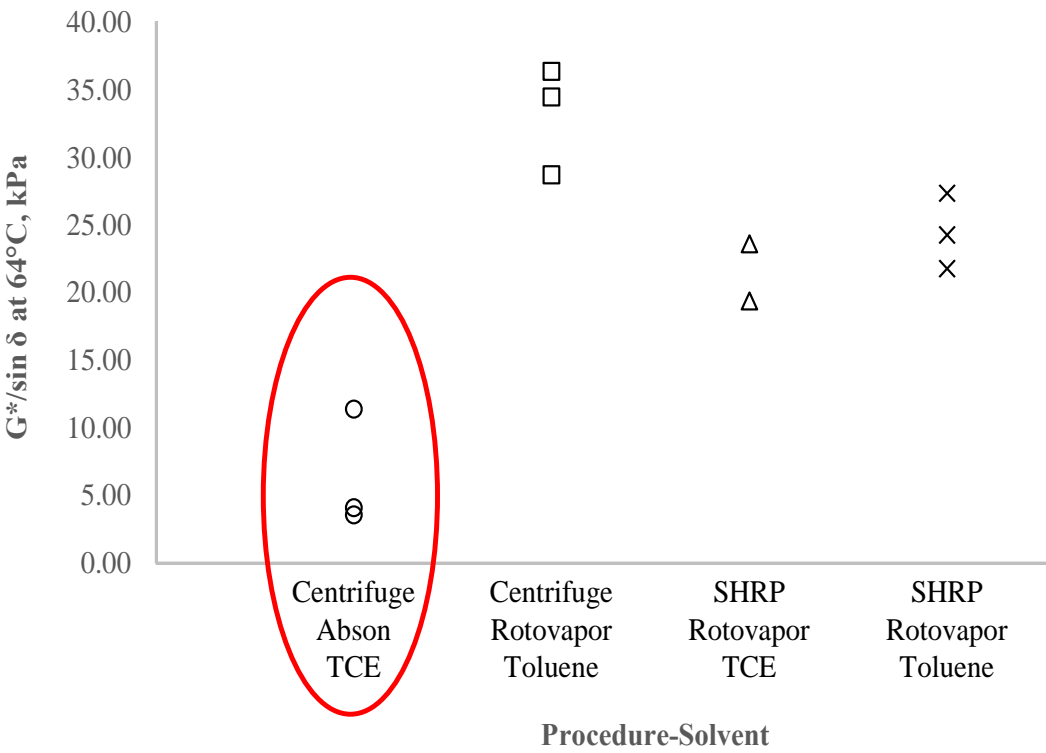
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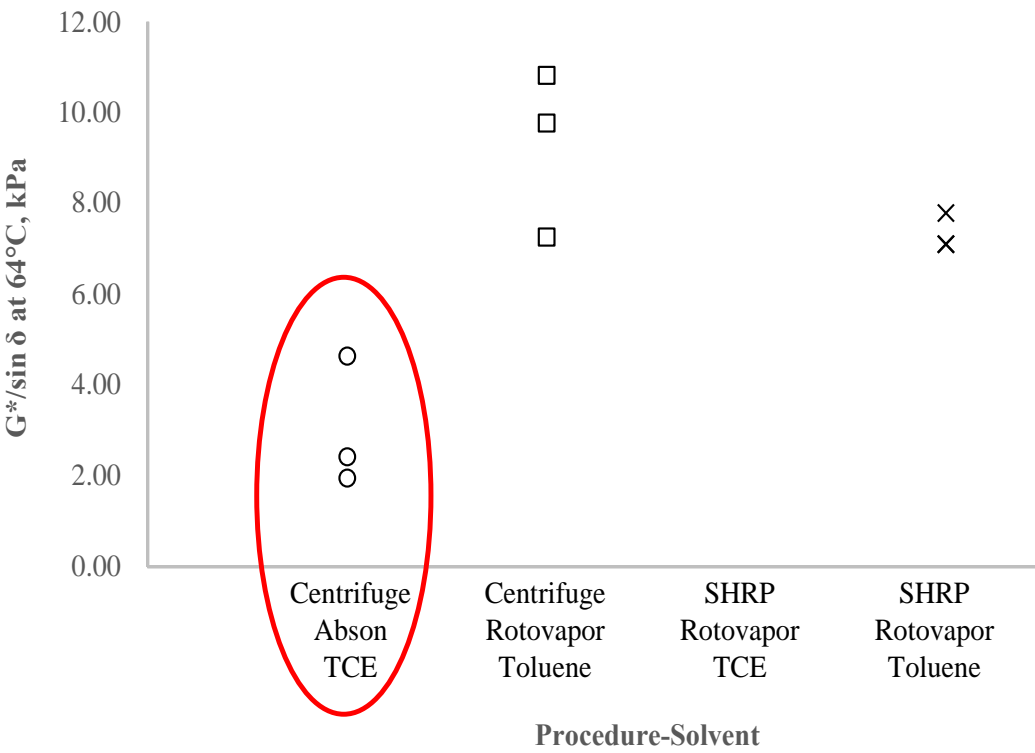
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NCHRP Project 09-12: RAP in Superpave System

Kentucky RAP



Florida RAP



Centrifuge-Abson-TCE treatment consistently produced the lowest $G^*/\sin \delta$ values, also had the poorest repeatability which was shown through the standard deviation data

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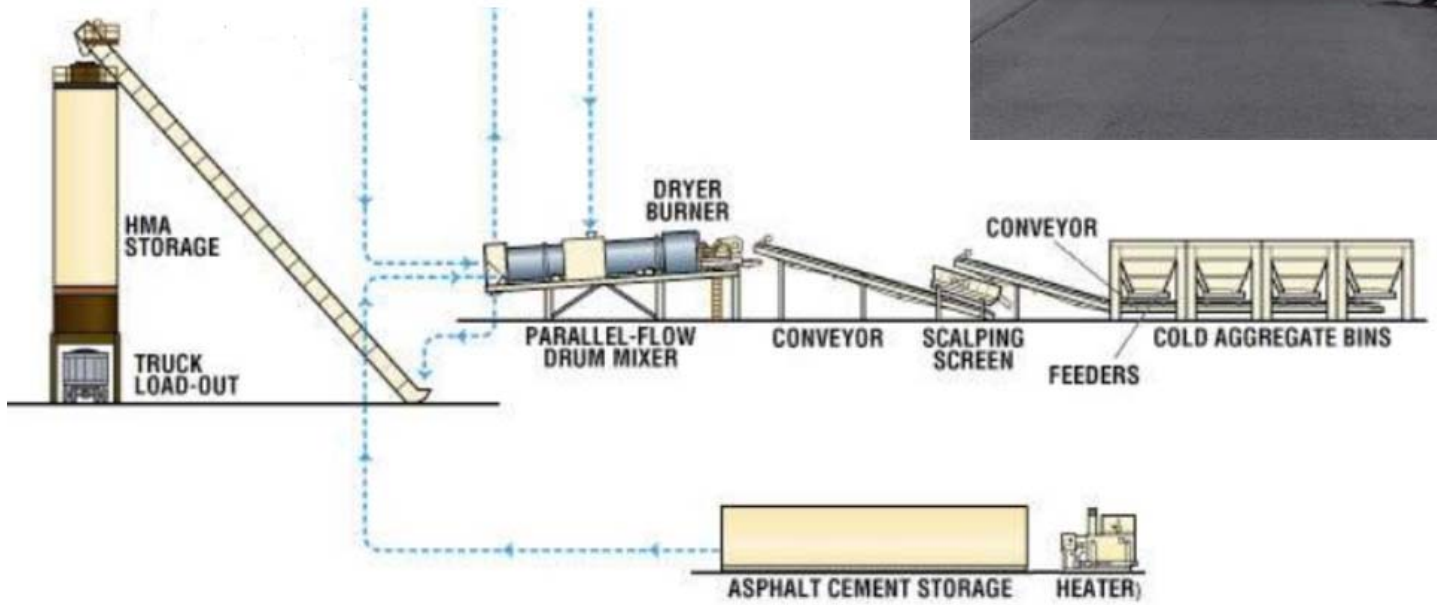


Sample D – Job Site (Recovered)



Compare physical properties and testing variability of original (tank) asphalt to recovered asphalt

Sample C – Plant Mix (Performance Testing)



Sample A - Terminal



Sample B – Tank Asphalt

Asphalt Materials Collected

HMA Mix Class	PG Grade	RAP Content
HL1	70-28	0
12.5FC2	70-28	15
12.5	58-34	15
12.5	58-34	0
12.5	58-28	0
12.5FC2	64-28	0
12.5FC1	58-34	0

Tank	Ash (%)	PG High (°C)	PG Low (°C)	MSCR Jnr (3.2kPa-1)	Grade Loss (°C)	LTLG (°C)	CTOD (15°C, mm)
Average	0.1	59.8	-34.3	2.2	2.7	-30.2	13.8
Min	0.05	58.9	-35.4	2.0	2.2	-31.2	9.7
Max	0.11	60.6	-33.0	2.4	4.0	-28.9	17.9
StDev	0.0	1.2	1.2	0.1	0.9	1.0	3.5
COV	0.0	2.0	3.5	4.5	33.3	3.2	25.4
Sample Size	4	2	3	4	4	4	4

Recovered Virgin Mix	Ash (%)	PG High (°C)	PG Low (°C)	MSCR Jnr (3.2kPa-1)	Grade Loss (°C)	LTLG (°C)	CTOD (15°C, mm)
Average	2.6	58.2	-35.5	4.8	5.3	-29.1	8.6
Min	1.32	51.5	-37.8	1.3	3.5	-30.0	1.5
Max	4.11	64.8	-34.1	8.7	8.2	-27.5	14.7
StDev	1.2	9.4	2.0	3.7	2.1	1.4	6.6
COV	44.7	16.2	5.6	77.5	40.6	4.9	76.8
Sample Size	4	2	3	4	4	3	4

Summary

	Ash (%)	PG High (°C)	PG Low (°C)	MSCR Jnr (3.2kPa-1)	Grade Loss (°C)	LTLG (°C)	CTOD (15°C, mm)
StDev (Tank)	0	1.2	1.2	0.1	0.9	1.0	3.5
StDev (Rec - OR)	1.2	9.4	2	3.7	2.1	1.4	6.6
% Change StDev	100	87	40	97	57	29	47

Asphalt mix did not contain RAP.

PG 64-28



Tank	Ash (%)	PG High (°C)	PG Low (°C)	MSCR Jnr (3.2kPa-1)	Grade Loss (°C)	LTLG (°C)	CTOD (15°C, mm)
Average	0.1	65.4	-35.3	0.3	3.5	-30.4	14.0
Min	0.04	64.9	-37.1	0.2	3.1	-31.4	6.4
Max	0.1	65.9	-33.3	0.4	3.9	-29.2	21.2
StDev	0.0	0.7	1.9	0.1	0.4	0.9	6.1
COV	45.2	1.1	5.4	25.7	11.1	3.0	43.8
Sample Size	4	2	3	4	4	4	4

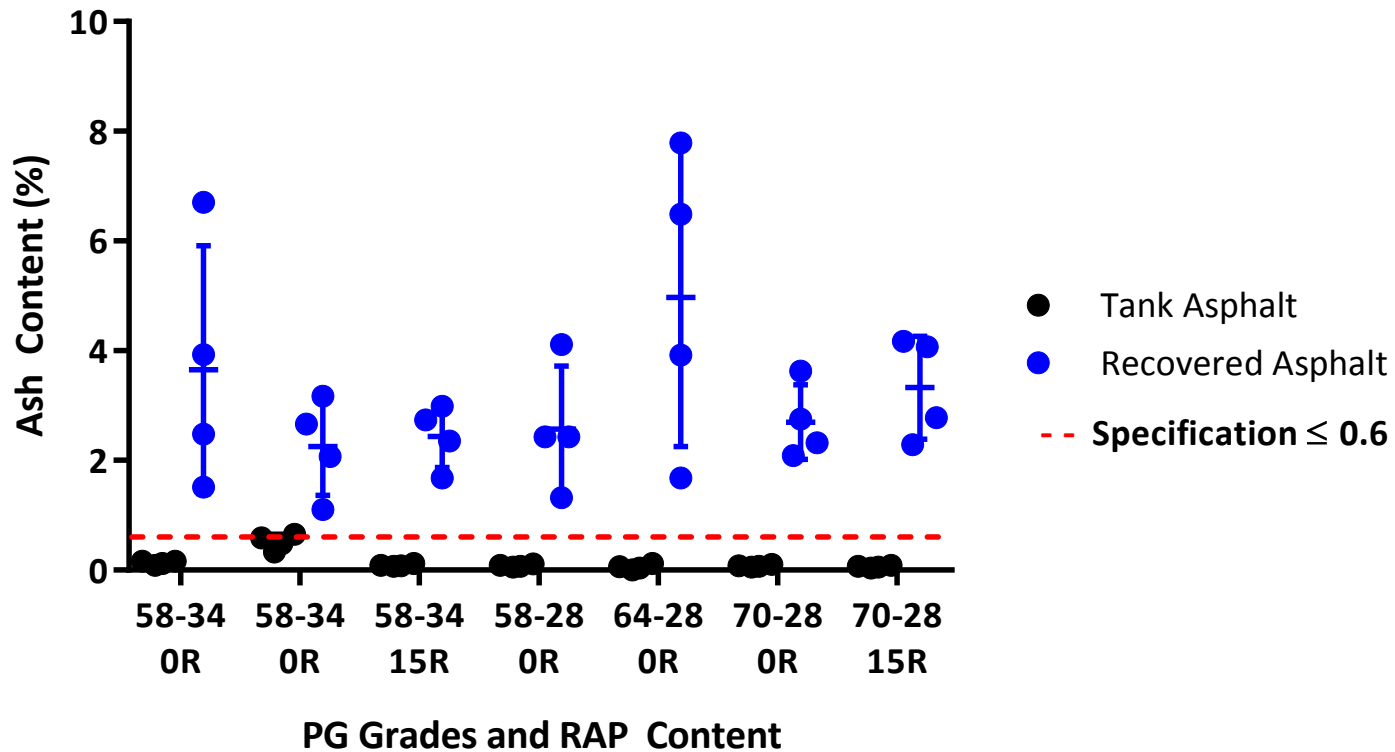
Recovered Virgin Mix	Ash (%)	PG High (°C)	PG Low (°C)	MSCR Jnr (3.2kPa-1)	Grade Loss (°C)	LTLG (°C)	CTOD (15°C, mm)
Average	5.0	76.3	-31.6	0.4	5.5	-25.1	6.7
Min	1.68	69.9	-32.2	0.1	3.9	-28.7	4.9
Max	7.8	82.6	-31.2	0.8	9.7	-20.5	8.9
StDev	2.7	9.0	0.5	0.3	2.8	3.4	1.9
COV	54.7	11.8	1.6	80.9	50.5	13.6	28.0
Sample Size	4	2	3	4	4	4	4

Summary

	Ash (%)	PG High (°C)	PG Low (°C)	MSCR Jnr (3.2kPa-1)	Grade Loss (°C)	LTLG (°C)	CTOD (15°C, mm)
StDev (Tank)	0	0.7	1.9	0.1	0.4	0.9	6.1
StDev (Rec - OR)	2.7	9	0.5	0.3	2.8	3.4	1.9
% Change StDev	100	92	-280	67	86	74	-221

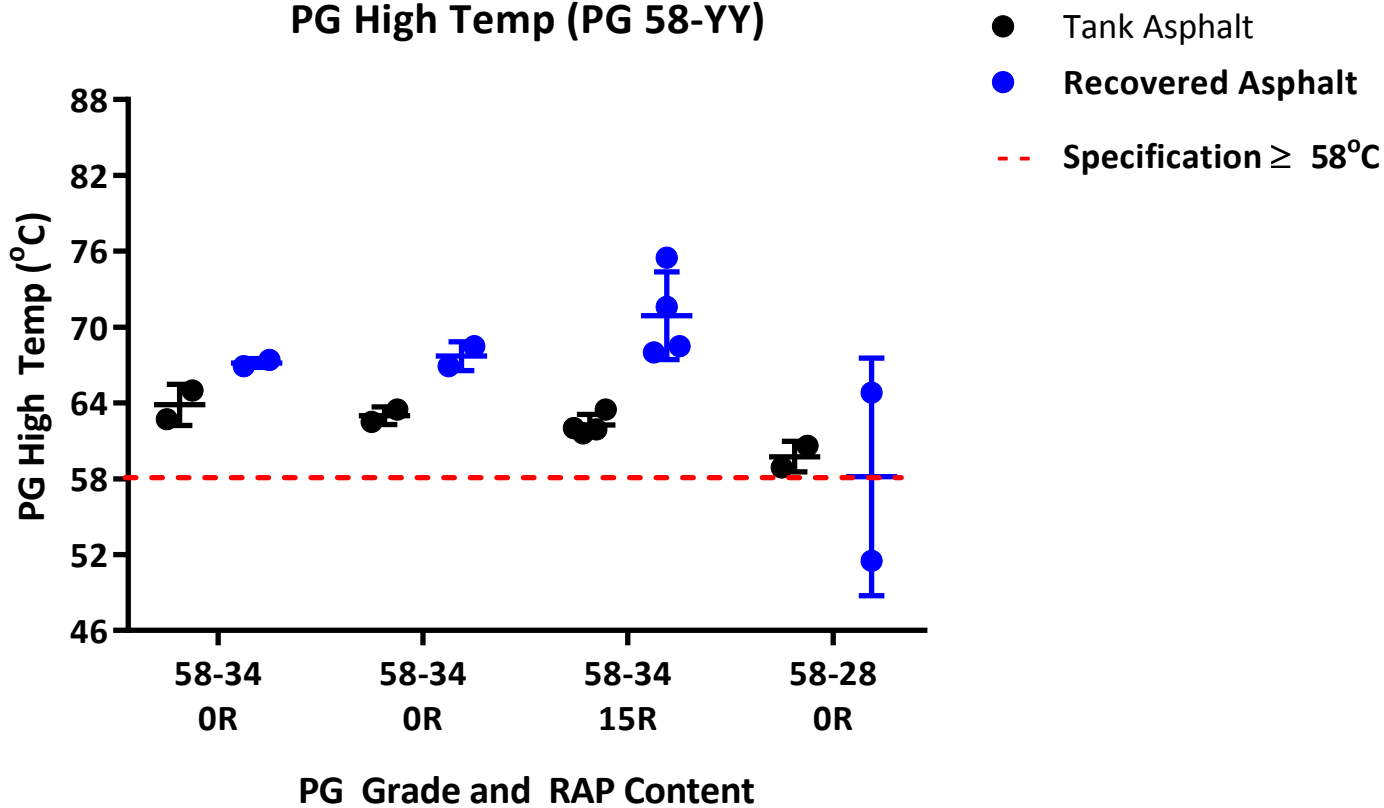
Asphalt mix did not contain RAP.

Tank Asphalt and Recovered Asphalt Ash Content



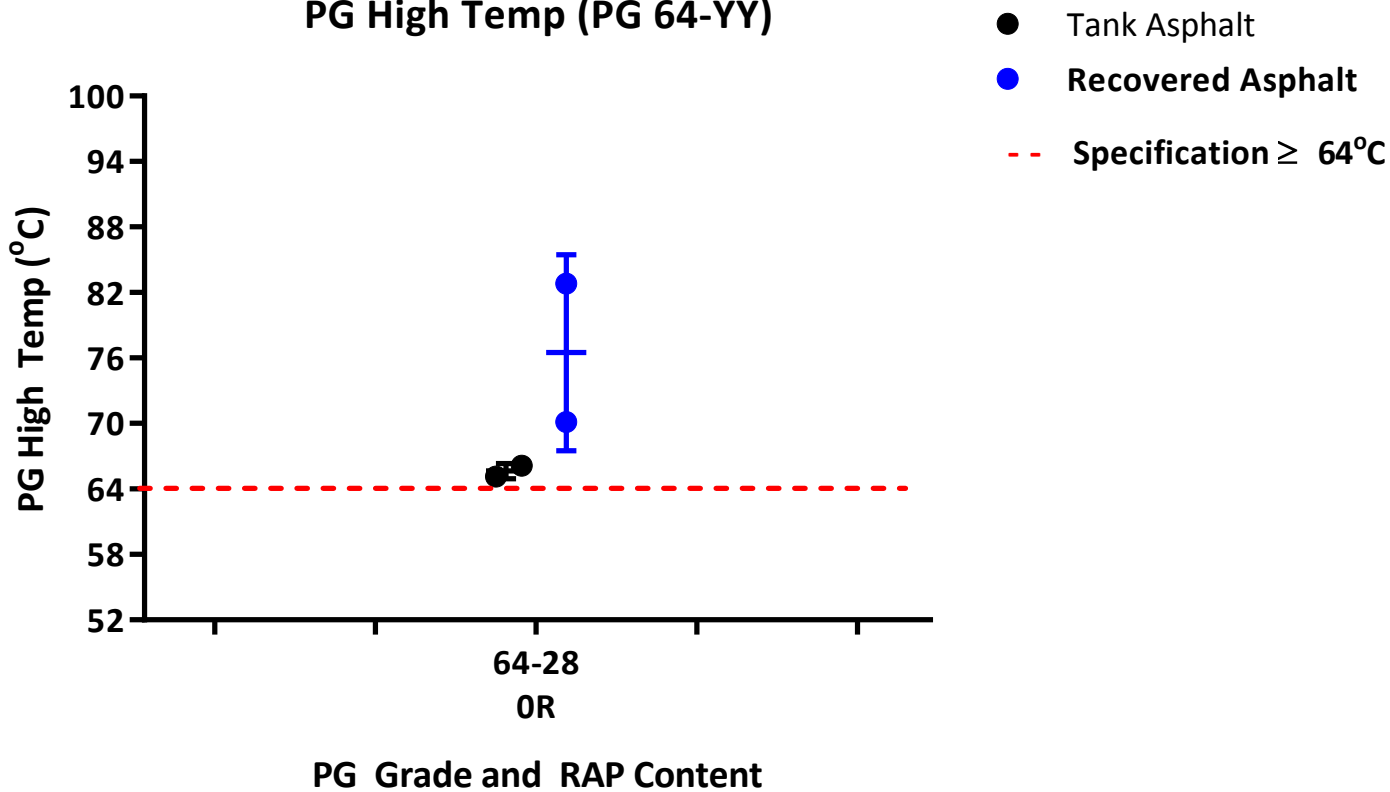
0% of tank samples failed
100% recovered asphalt failed

Tank Asphalt and Recovered Asphalt PG High Temp (PG 58-YY)



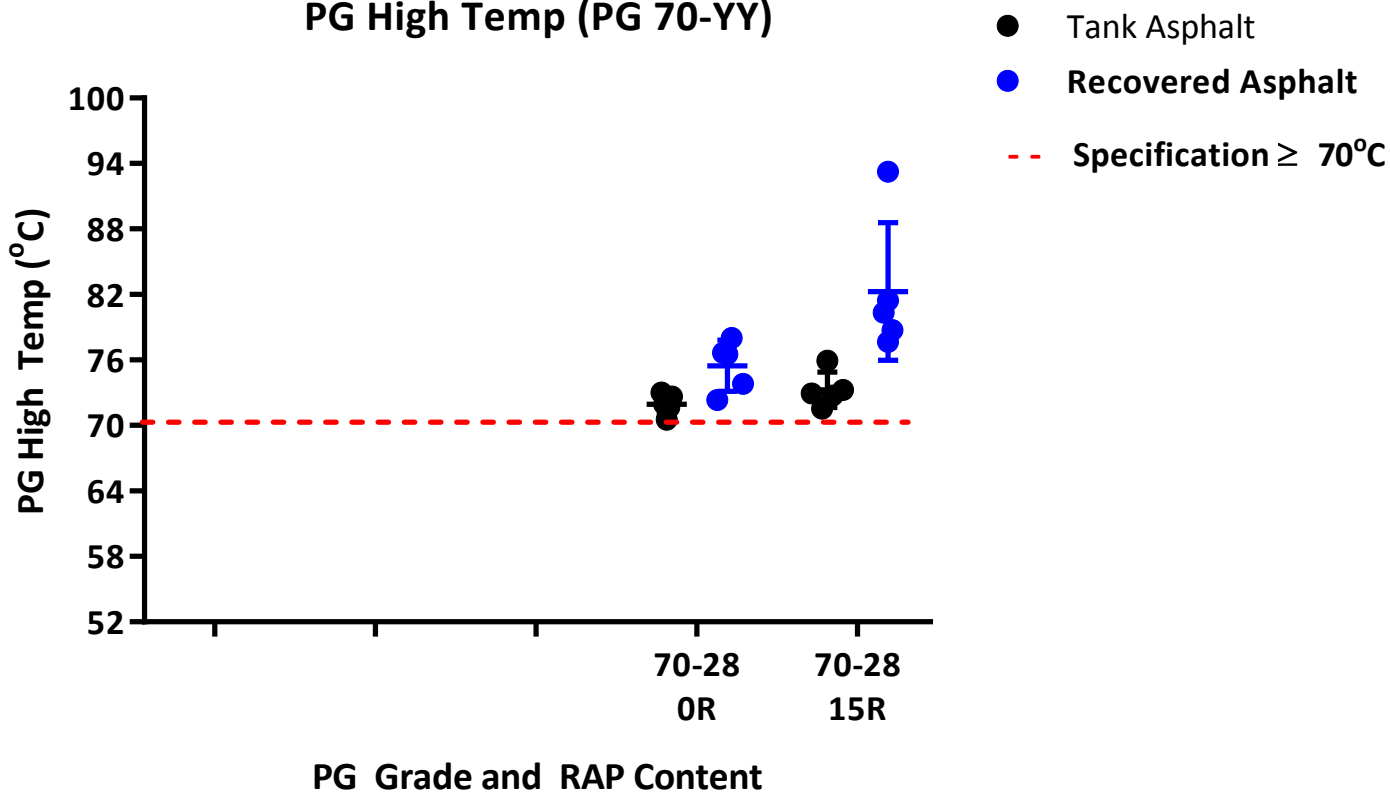
0% of tank samples failed
10% recovered asphalt failed

Tank Asphalt and Recovered Asphalt PG High Temp (PG 64-YY)



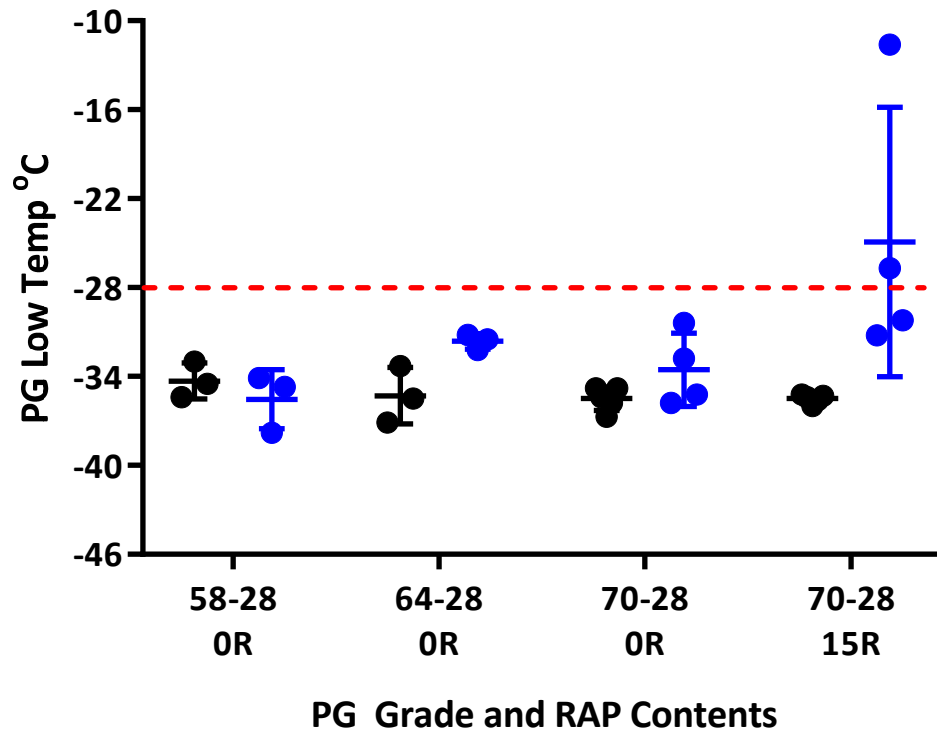
0% of tank samples failed
0% recovered asphalt failed

Tank Asphalt and Recovered Asphalt PG High Temp (PG 70-YY)



0% of tank samples failed
0% recovered asphalt failed

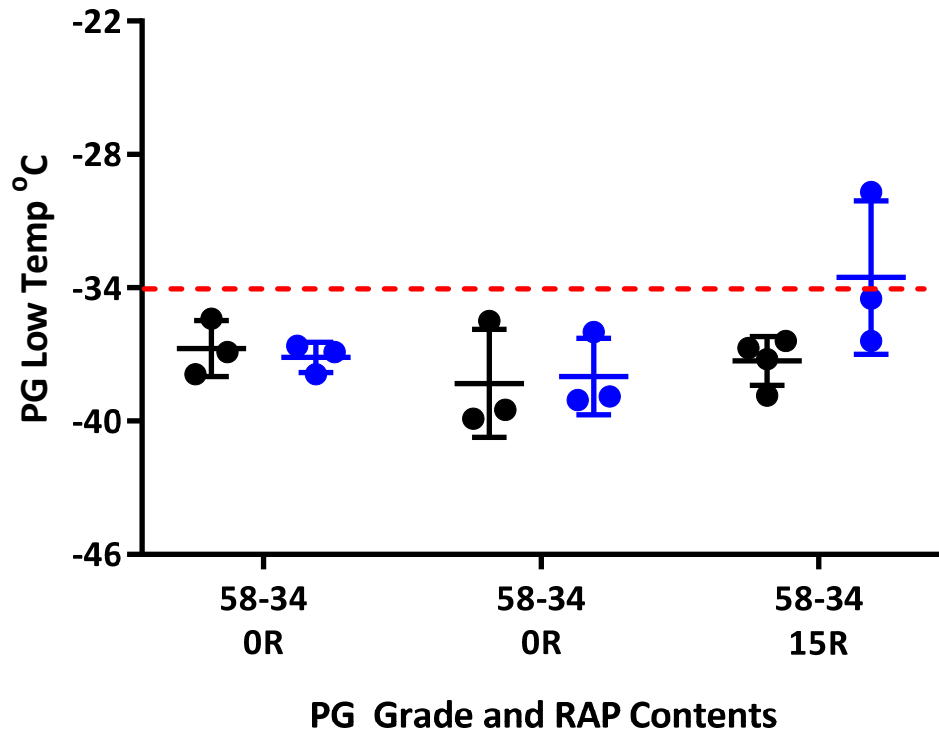
Tank Asphalt and Recovered Asphalt PG Low Temp (PG XX-28)



- Recovered Asphalt
- Tank Asphalt
- - - Specification ≤ -28

0% of tank samples failed
14 % recovered asphalt failed

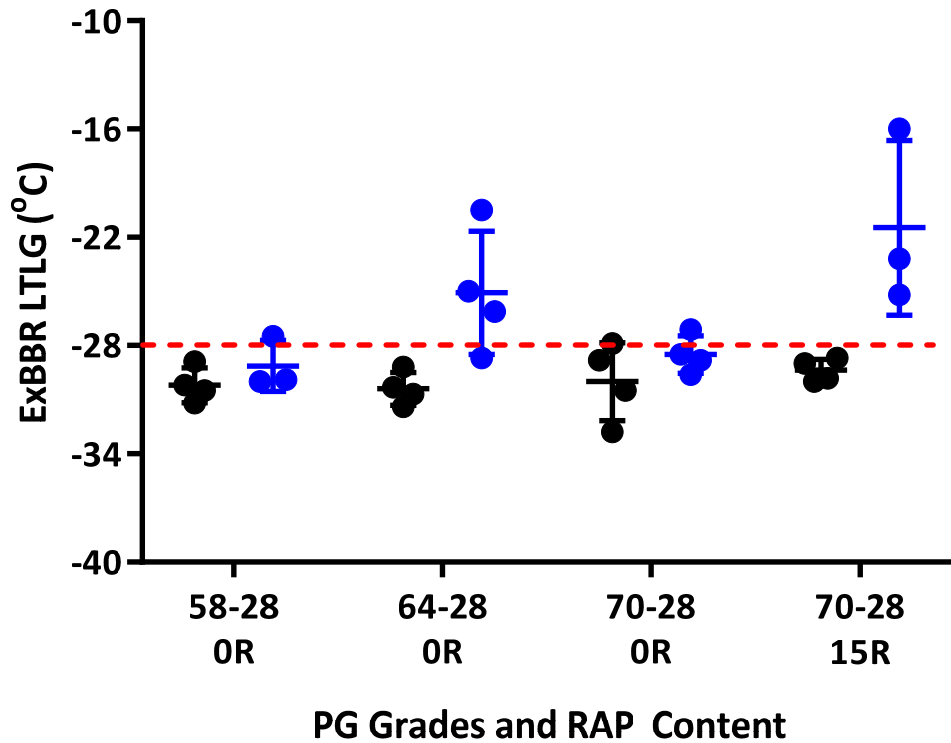
Tank Asphalt and Recovered Asphalt PG Low Temp (PG XX-34)



- Recovered Asphalt
- Tank Asphalt
- - - Specification ≤ -34

0% of tank samples failed
11% recovered asphalt failed

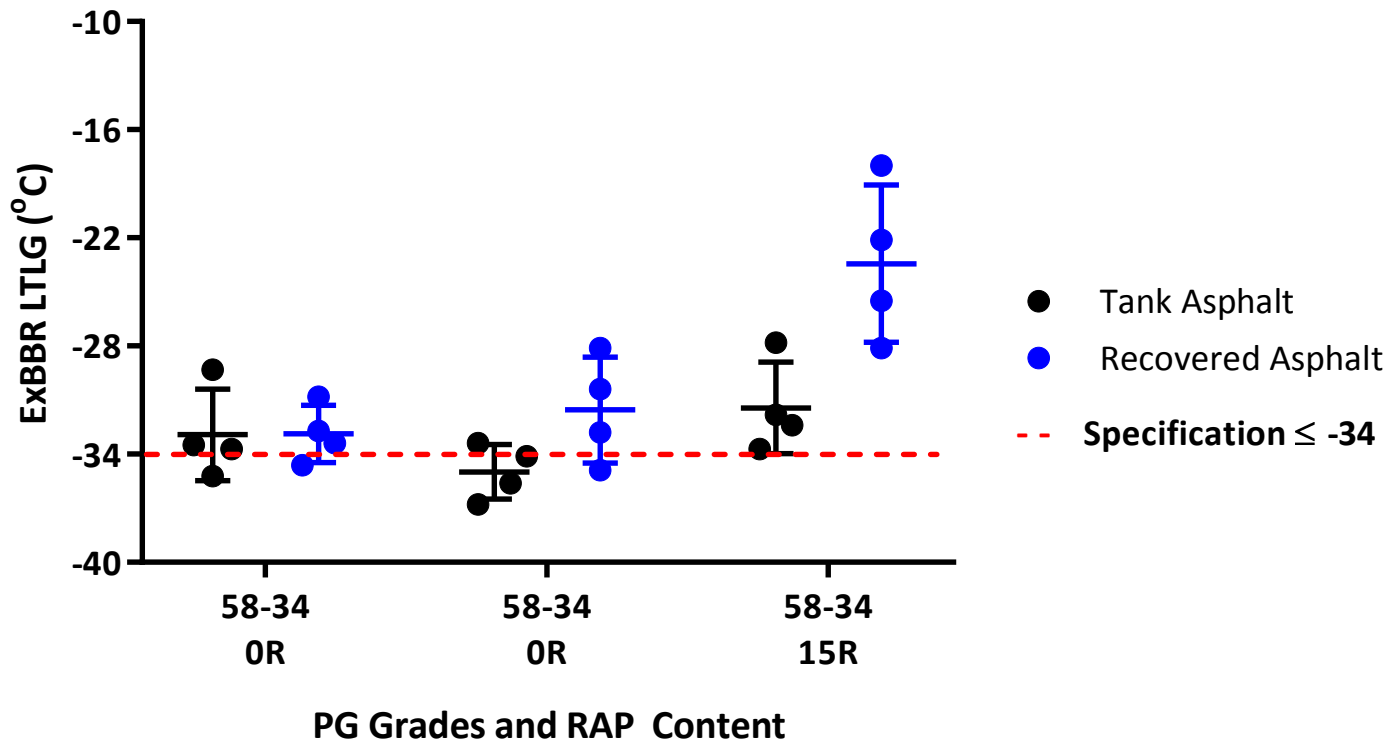
Tank Asphalt and Recovered Asphalt ExBBR Low Temperature Limiting Grade



- Tank Asphalt
- Recovered Asphalt
- - - Specification ≤ -28

6% of tank samples failed
57% recovered samples failed

Tank Asphalt and Recovered Asphalt ExBBR Low Temperature Limiting Grade



67% of tank samples failed
83% recovered samples failed

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Extraction-Recovery and Polymer Modified Asphalt

Research in Europe:

Belgium

- Different highly modified binders (SBS polymers)
 - Some polymer modified asphalt **lost their elasticity after recovery**



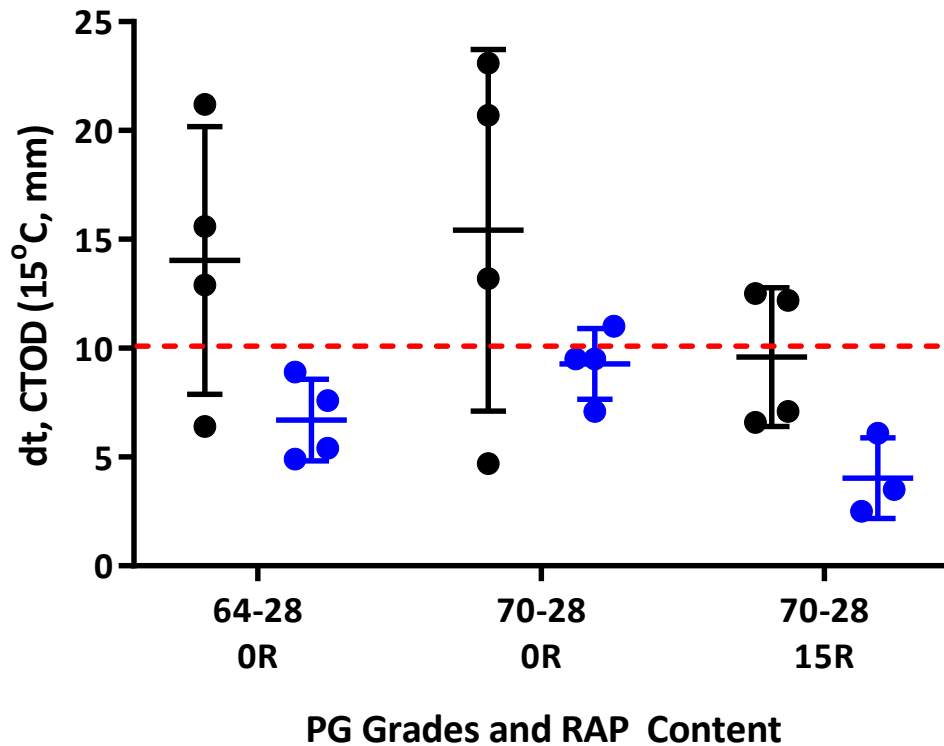
Extraction-Recovery and Polymer Modified Asphalt

Belgium

- 19 polymer modified binders and several solvents
 - Most deviations within the limits of the repeatability for dichloromethane and toluene solvents
 - **TCE resulted in higher variability in test results**



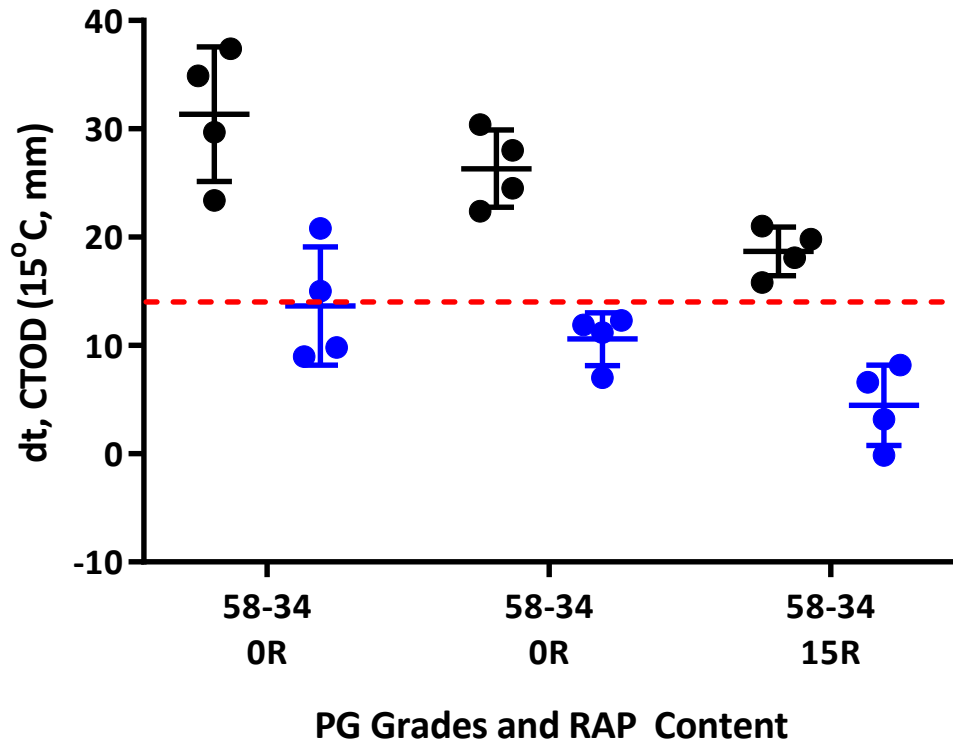
Tank Asphalt and Recovered Asphalt Critical Tip Opening Displacement



- Tank Asphalt
- Recovered Asphalt
- - - Specification ≥ 10

33% of tank samples failed
90% recovered samples failed

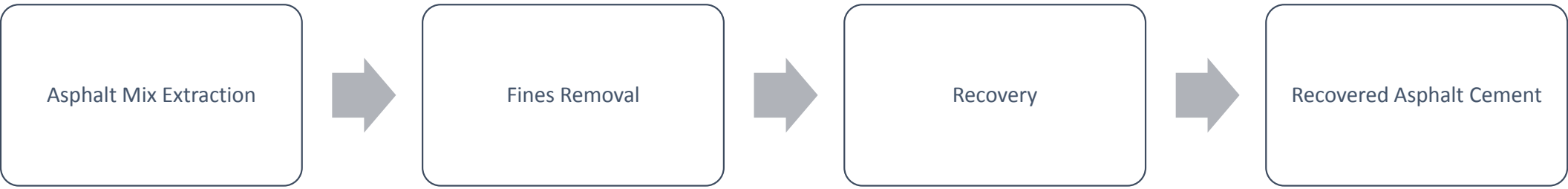
Tank Asphalt and Recovered Asphalt Critical Tip Opening Displacement



- Tank Asphalt
- Recovered Asphalt
- - - Specification ≥ 14

0% of tank samples failed
83% recovered samples failed

Options and Precautions for Users



Centrifuge Extractor



Highspeed Centrifuge



Rotary Evaporator



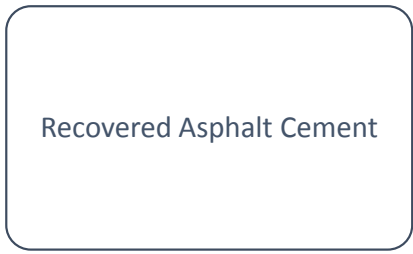
SHRP Extractor

Industry is aware we need to get to a place where we can evaluate the properties of the final mix without extraction.

Performance asphalt testing is where we're going but, in the meantime,, owners want more confidence that what they are asking for is what they are receiving.

More important is we want to ensure that what is specified will perform as intended.

Options and Precautions for Users



Centrifuge Extractor



SHRP Extractor



Highspeed Centrifuge



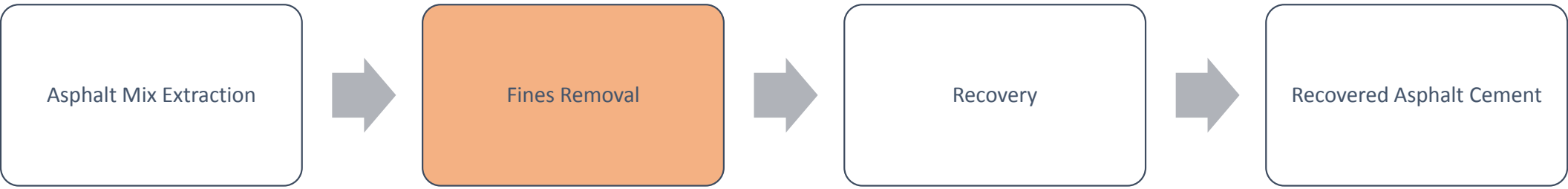
Rotary Evaporator

Ensure the solvent used is consistent. Request the type of solvent used to be reported.

In this study the solvent used was controlled, using only reagent grade TCE.

Other variables such as the effect of aggregate fines, the possibility of residual solvent from the recovery, the process of plant production, and the inclusion of RAP in some mixes are all still variables that can significantly impact the properties of the recovered asphalt.

Options and Precautions for Users



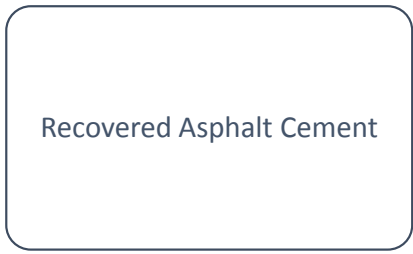
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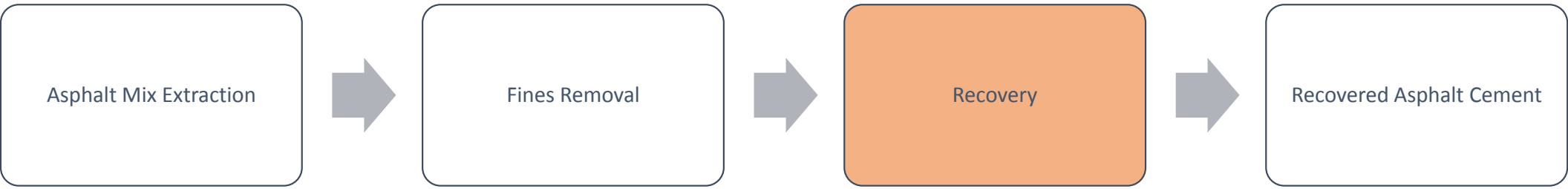
SHRP Extractor

We saw a significant increase in ash content, in the recovered asphalt (up to 100% increase compared to tank asphalt) which we understand impact the properties.

Limit the amount of fines. Although they cannot be completely removed, limiting fines reduces the impact on the resultant properties.

Other factors to consider is the difference in oxidation due to lab aging versus plant production that produced rheological properties.

Options and Precautions for Users



Centrifuge Extractor



Hightspeed Centrifuge



Rotary Evaporator

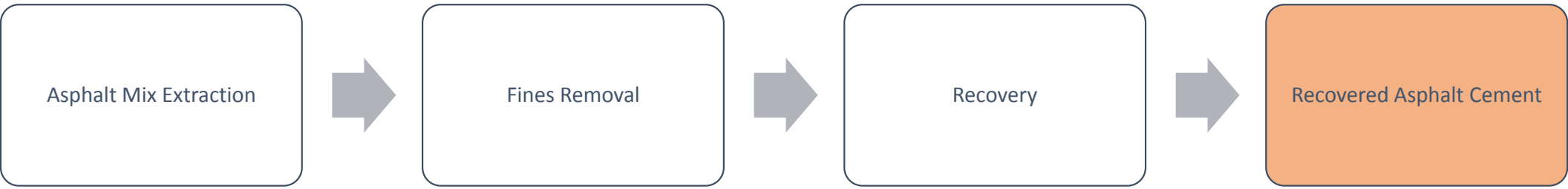


SHRP Extractor

At the recovery stage, a precaution is to avoid the use of Abson. This has been shown the leave residual solvent in the recovered asphalt.

Rotary Evaporator is less likely to leave residual solvent.

Options and Precautions for Users



Centrifuge Extractor



Hightspeed Centrifuge



Rotary Evaporator



SHRP Extractor

The purpose of testing asphalt and other materials is to measure their characteristics and behavior, to determine their suitability for various applications.

In the case of measurements obtained for recovered asphalt, the research shows that the process of recovering an asphalt binder from solution results in physical properties with much higher variability than experienced if performing the same physical property tests on unrecovered (i.e. virgin) asphalt binder.

Thank you.

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