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Asphalt Re-Recycling

Impact on Rheology & Chemistry

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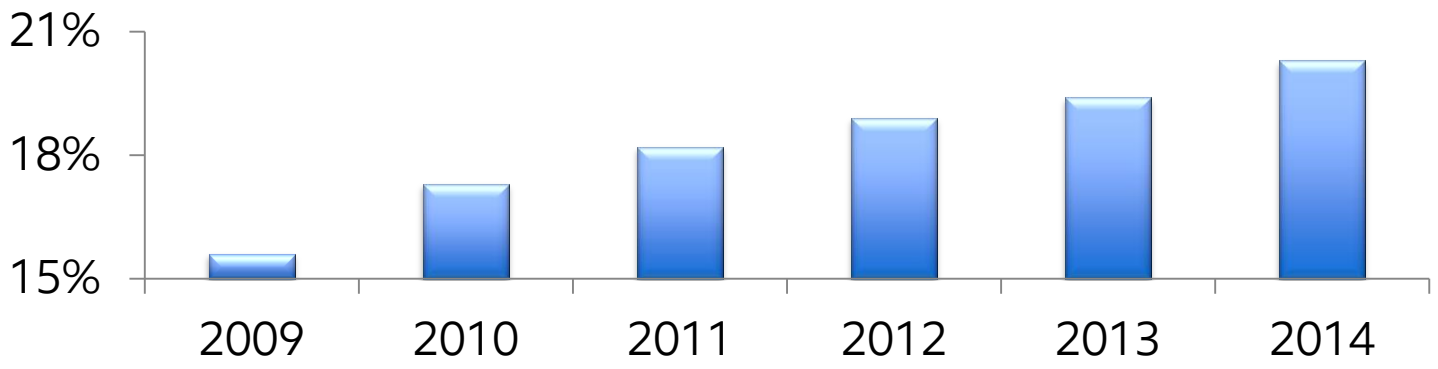
Sarnia Technology Applications & Research

Continuously Recycled Asphalt Pavement = Industry Sustainability

- Rate of recycling is growing
- Re-Recycling is occurring
- Do we understand the implications?

Average Percent Recycled Asphalt Pavement (RAP) Used in the USA*

*http://www.asphaltpavement.org/PDFs/IS138/IS138-2014_RAP-RAS-WMA_Survey_Final.pdf



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How Much Re-Recycling is Viable?

- Aging → Stiffening/Embrittlement → Road failure
- Irreversible changes in chemistry → Is this sustainable long term?
- Softeners? Asphalts, REOB, bio-oils, refinery oils – paraffinic, aromatic etc.

Stockpiling
Grading

+ 60-90% Virgin material
(aggregate + softer binder)

Production

Removal

Construction

Life-end

Service

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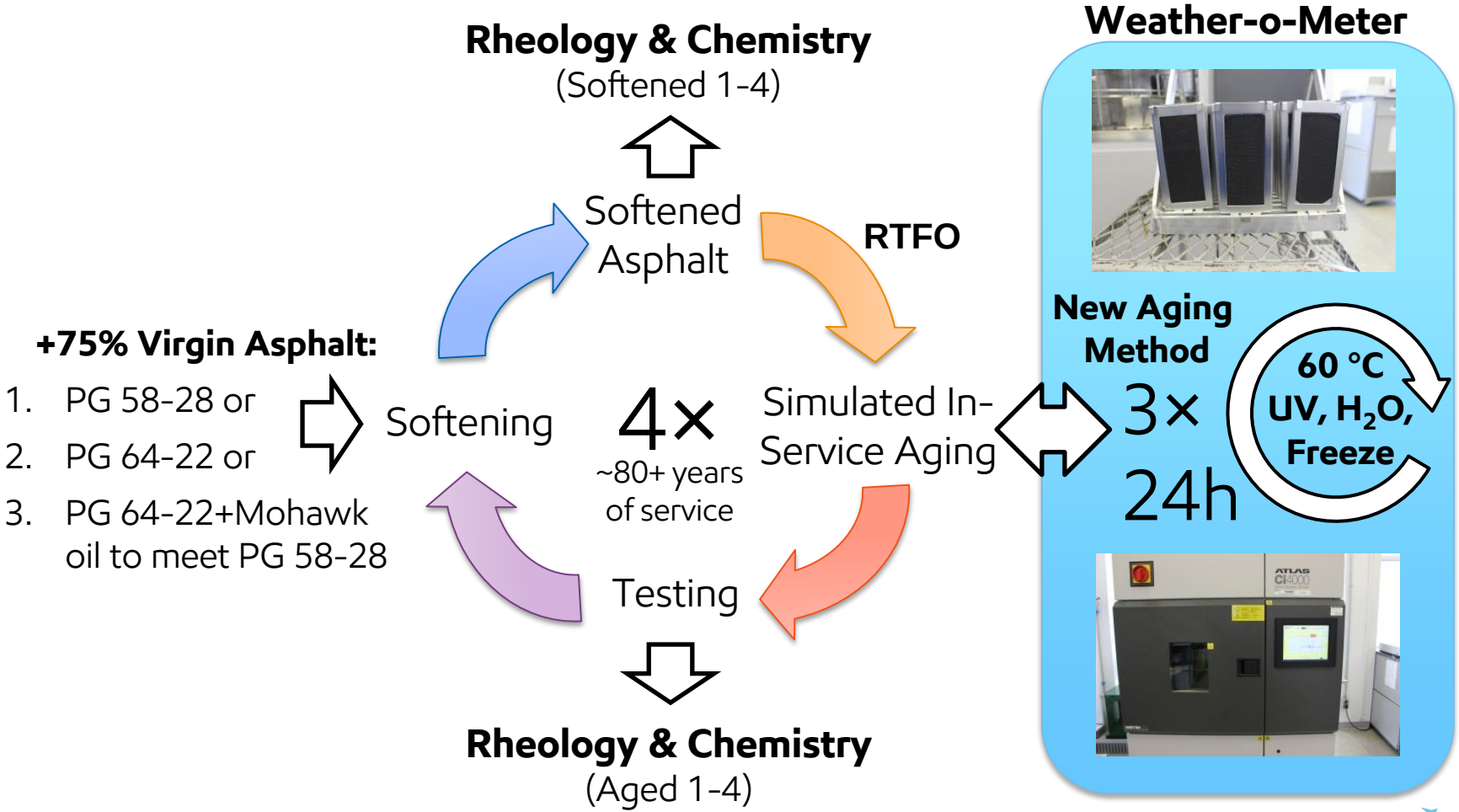
Test Plan Simulated Binder Re-Recycling

- Artificial aging of asphalt binder in Weather-o-Meter (WoM) to better mimic in-service aging



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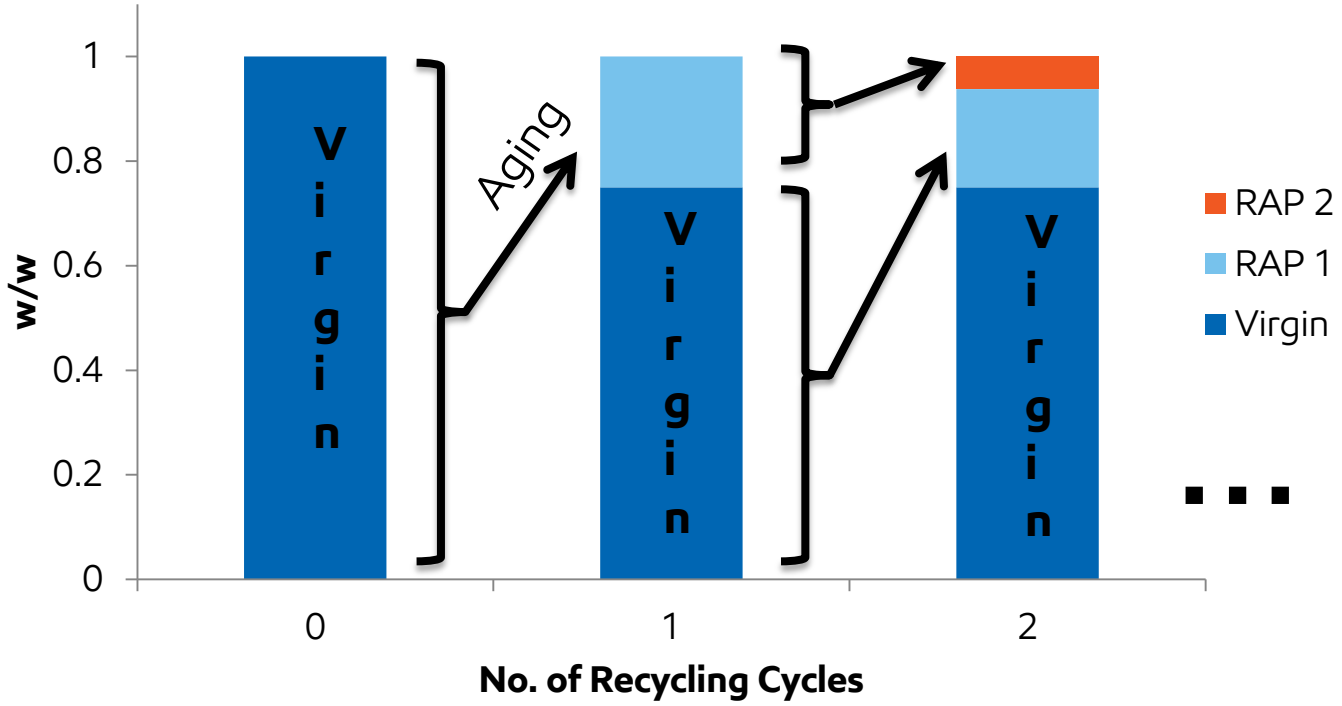
Ratio of Binders in Re-Recycled Materials



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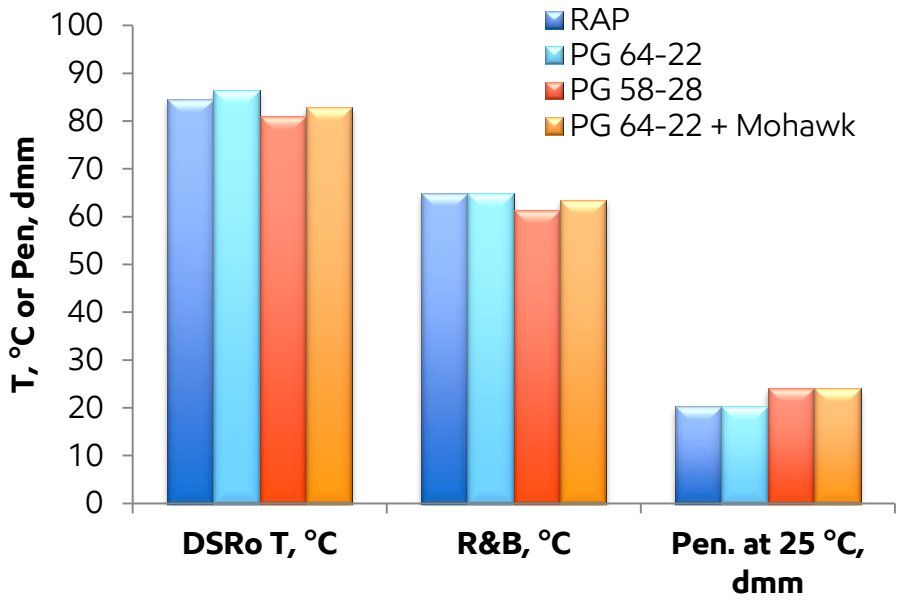
3 Weather-O-Meter Cycles Match RAP Rheology

- Three virgin binders subjected to weather-o-meter aging method
- 3×24 h cycle found suitable to obtain similar rheology to particular RAP

High Temperature Properties
(field RAP vs virgin PG after 3×24h in WoM)



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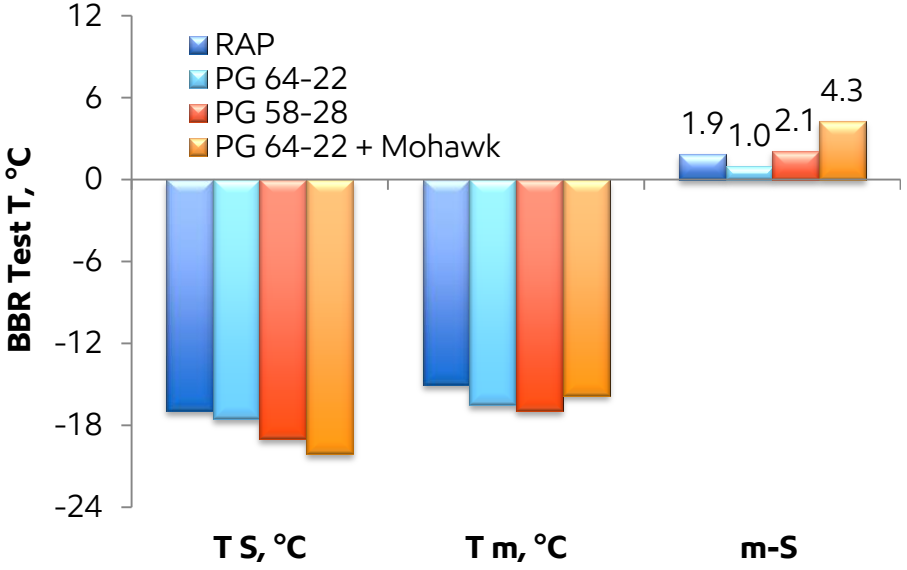

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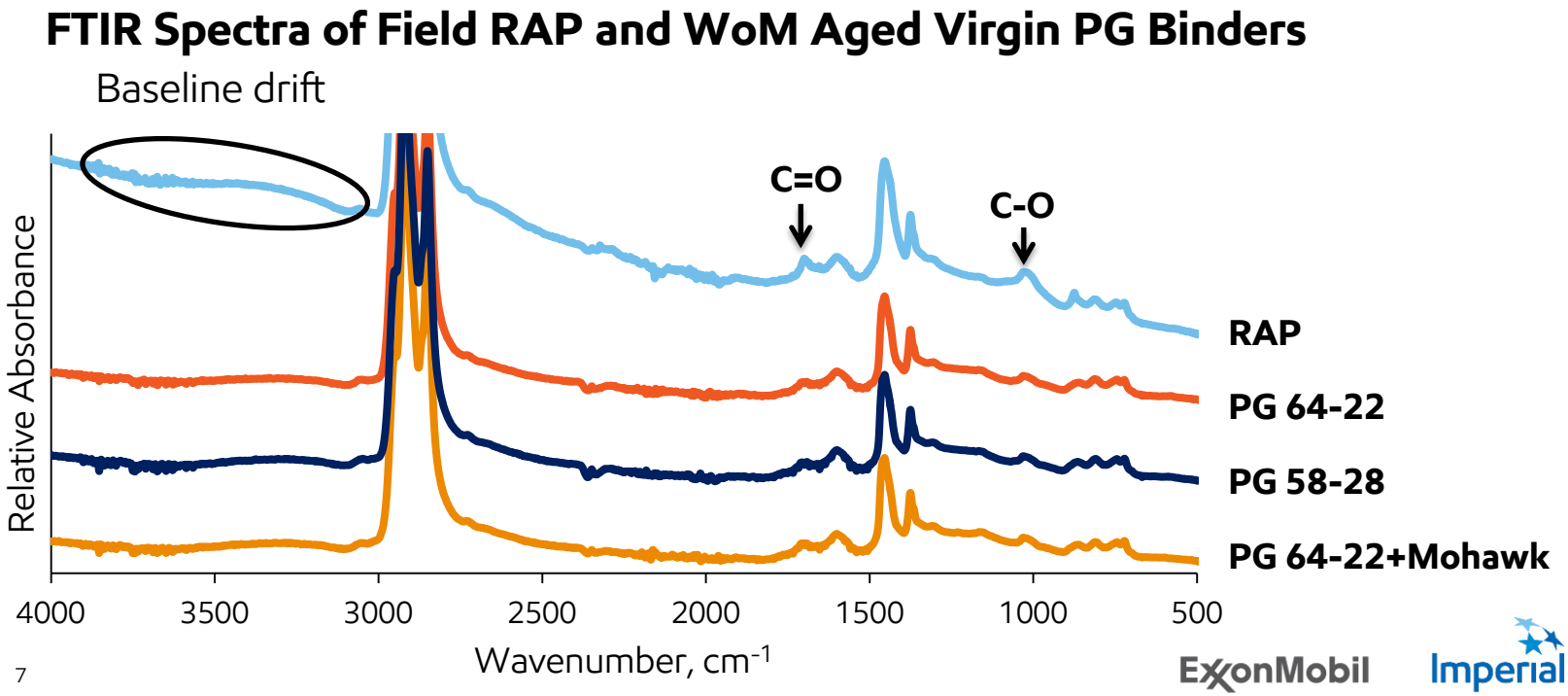
Field Aging Differs From WoM aging in FTIR

- C & O bonds (Carbonyl/Carboxyl/Alcohol/Ether…) more prevalent in RAP
- Baseline drift (presence of condensed aromatic rings) only observed in RAP
- RAP & weather-o-meter aged binders not compositionally equivalent



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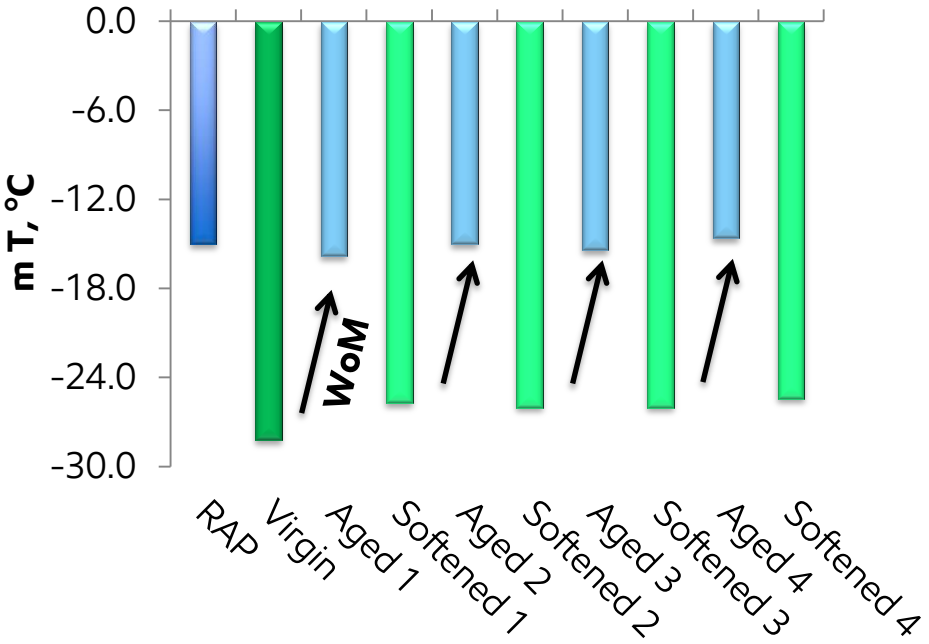
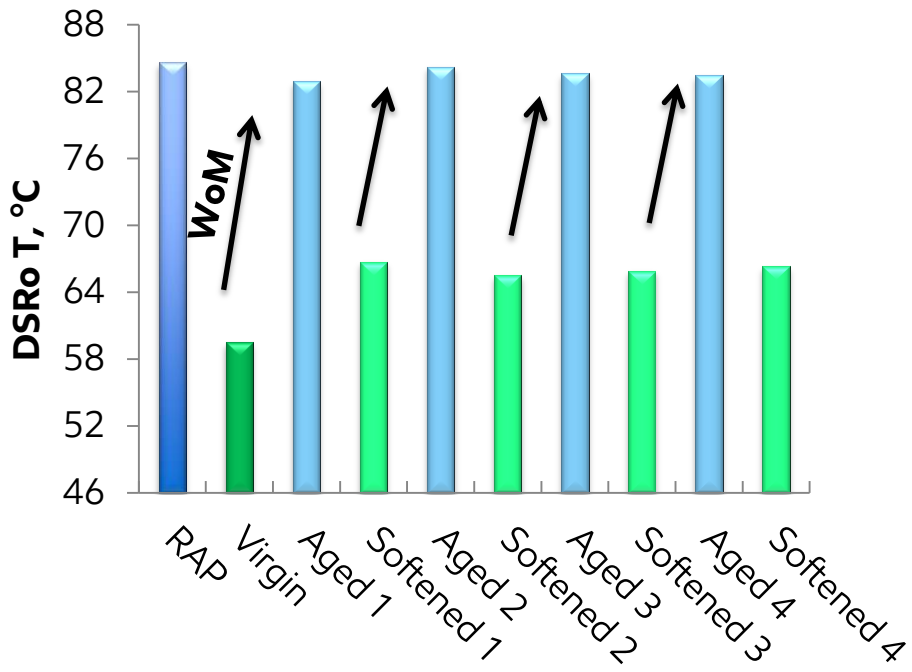
Re-recycling → No Change to PG at 25% Rate

- Re-recycling at 25 %wt. recycling rate showed minimal impact
- Minor increase in m-value temperature noted with each cycle

Example for PG 64-22 + Mohawk Oil Dataset at 25 % Recycling Rate





m T = temperature at BBR m-value = 0.300 MPa/s
DSRo T = temperature at DSR = 1.0 kPa

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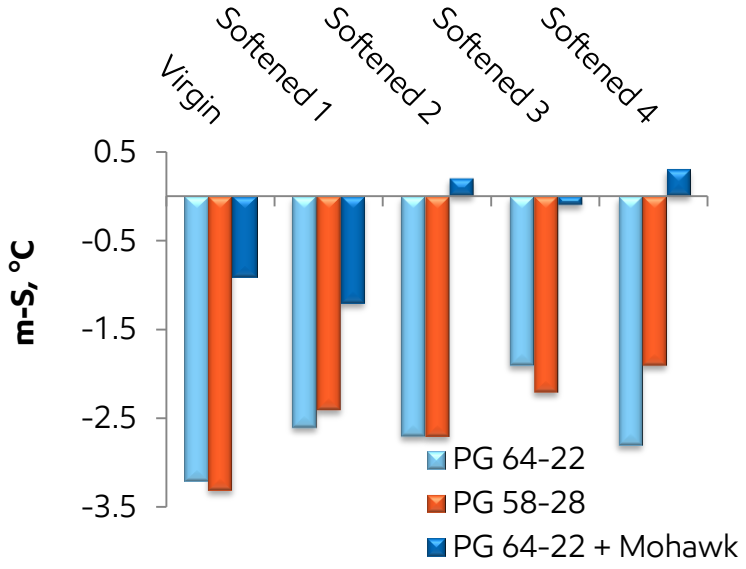
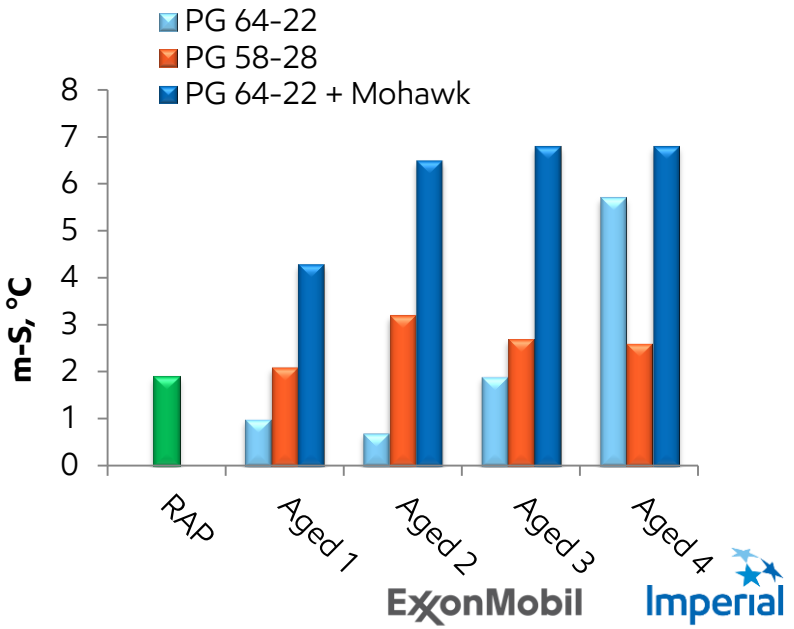
Evolution of BBR m-S with Re-Recycling

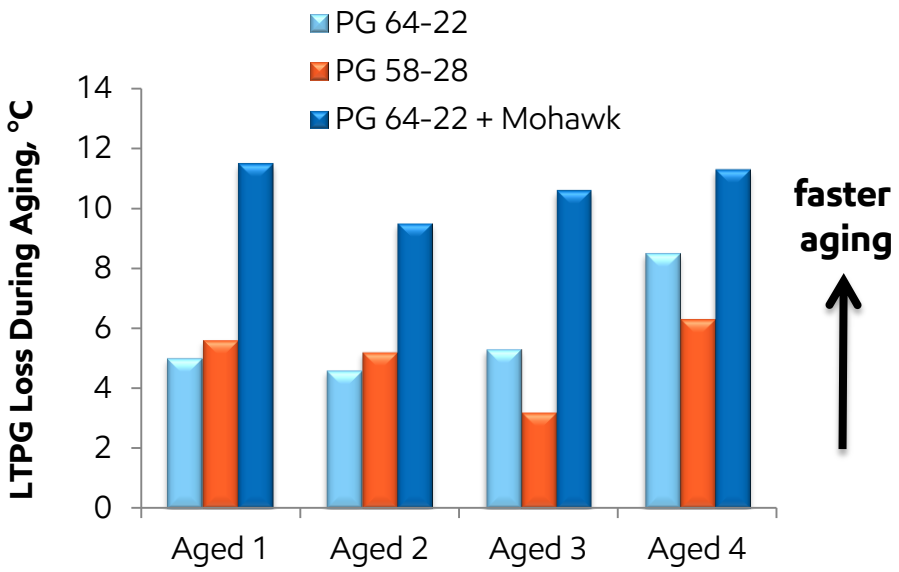
- High quality straight-run asphalts are generally BBR stiffness limited
- Aging increases BBR m limiting T faster than BBR-S T
- Asphalt softened with Mohawk oil is significantly more m-value limited
- Re-Recycling increases BBR m T due to loss of relaxation → back bone rigidity (C-O → C=O etc.) &/or phase incompatibility





Straight-Run Asphalt Outperforms Mohawk Oil

- Both PGs straight-run asphalts showed smaller loss in LTPG during aging
- PG 64-22 softened with Mohawk oil showed faster aging rates
- After 2nd recycling, relaxation properties (m-value) slightly worsen



LTPG = Low Temperature Performance Grade

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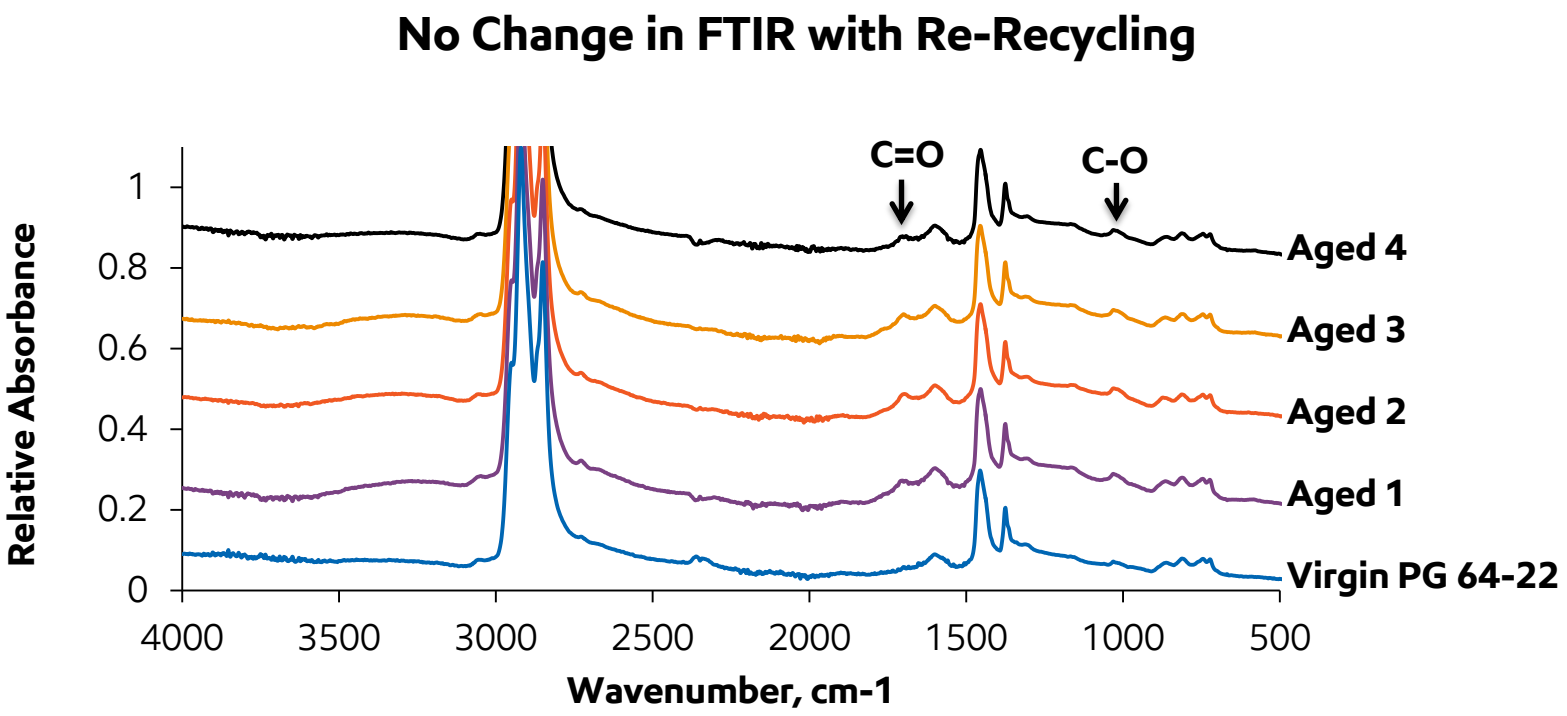
Further Re-Recycling Not Evidenced in FTIR

- No significant change in FTIR spectra with re-recycling
- Oxidation evidenced, but not at a field sample level
- Analysis beyond FTIR, XRF, CHNS necessary for PAHs



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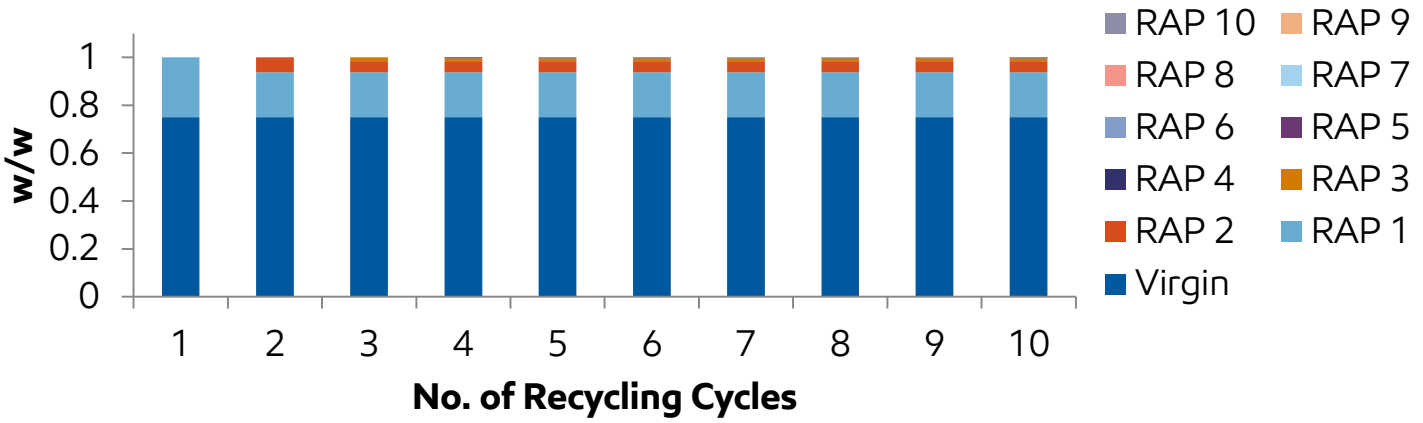
Conclusion: Re-Recycling Viable with Limitations

- Straight-run asphalts outperform oil softeners, that includes harder PG
- Softening with oils does not bring desired effect in improved performance
- At moderate recycling rates (25%) **dilution minimizes impact**

At 25% Recycling Rate, 6.25% Material at 2+ Cycles & 1.56% at 3+ Cycles



Next Steps:

- Enhance understanding of phase stability & formation of condensed aromatic rings and link it to relaxation properties

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Question & Comments?

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