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reaching new frontiers



Durability of Bituminous Binders

Johan Muller

22nd Road Pavements Forum,

CSIR International Convention Centre, Pretoria, Gauteng, 9 November 2011

OVERVIEW

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- ACKNOWLEDGEMENT / DEDICATION
- INTRODUCTION
- DEVELOPMENT OF A SOUTH AFRICAN ACCELERATED AGEING TEST
- EXPERIMENTAL
- RESULTS AND DISCUSSION
- CONCLUSION
- RECOMMENDATION

Acknowledgement

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- Dedication to the LEADERS
 - *LK Davidson (1928-2011)*
 - *DE Sadler*
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 - *Dr J Oliver*
 - *Me Esbé van Assen*

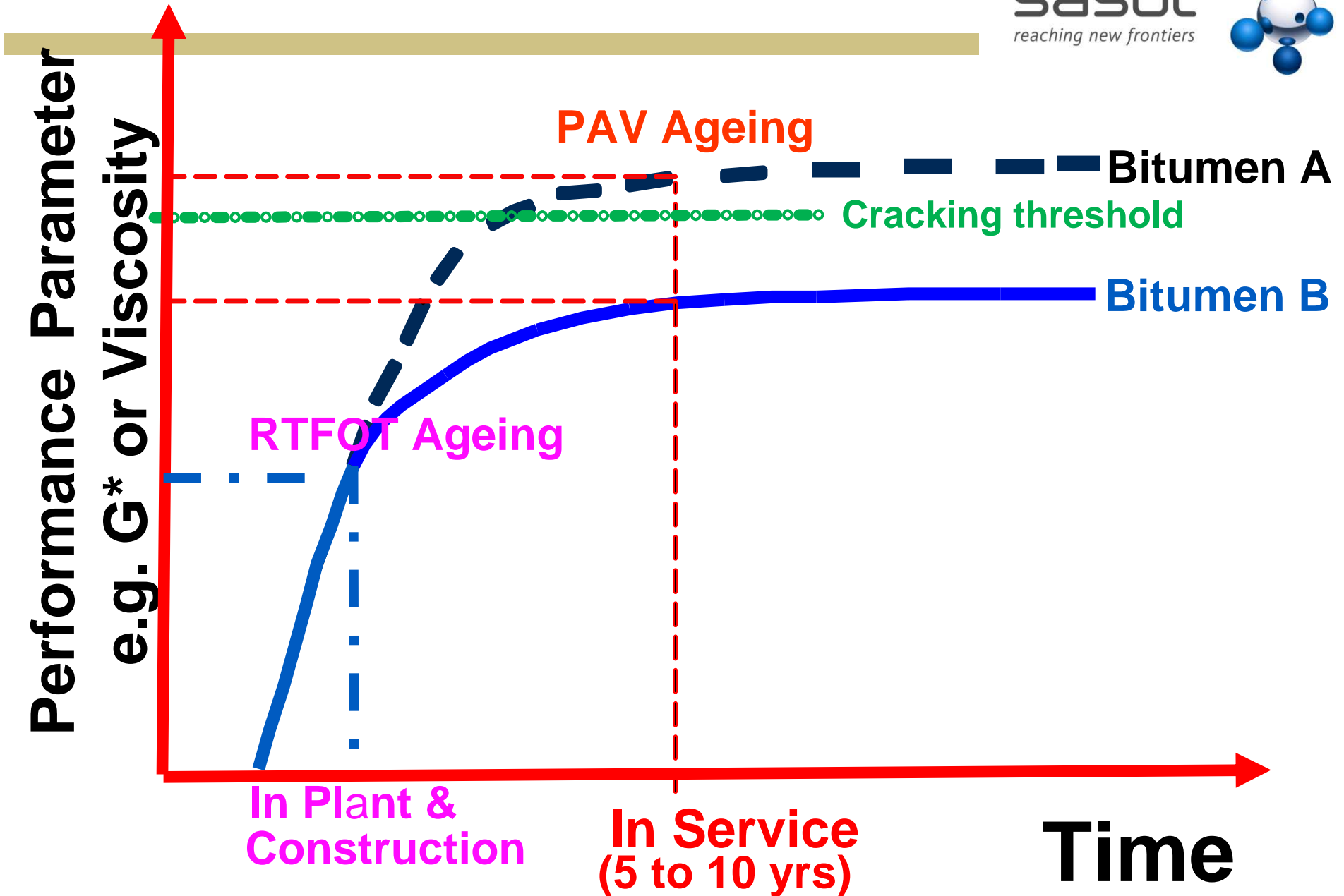


INTRODUCTION

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- Bitumen
Durability
- South African
Bitumen Specification
Development
- Accelerated
Binder Ageing
Requirement
for South Africa



COMPARISON OF ACCELERATED AGEING METHODS



Test Method	Ageing	Reference
RTFOT (Rolling Thin Film Oven)	Short Term Ageing	EN 12607-1 / ASTM 2872
TFOT (Thin Film Oven)		EN 12607-1 / ASTM 1754
RFT (Rotating Flask Test)		EN 12607-1
Modified RTFOT*		Await New Developments
PAV (Pressurised Ageing Vessel)	Long Term Ageing	prEN14679 / AASHTO PP1-98
HiPAT (High Pressure Ageing Test)		Covered by PAV
RCAT (Rotating Cylinder Ageing Test)*		prEN 15323
LTRFT (Long Term Rotating Flask Test)		Development work shelved
ERTFOT163 (Extended RTFOT at 163°C) ERTFOT100 (Extended RTFOT at 100°C)*		New proposed protocol

- (steel rod assisted)
- Source CEN TC 336 (2005) and BiTVaI Report 2006

COMPARISON OF ACCELERATED AGEING METHODS

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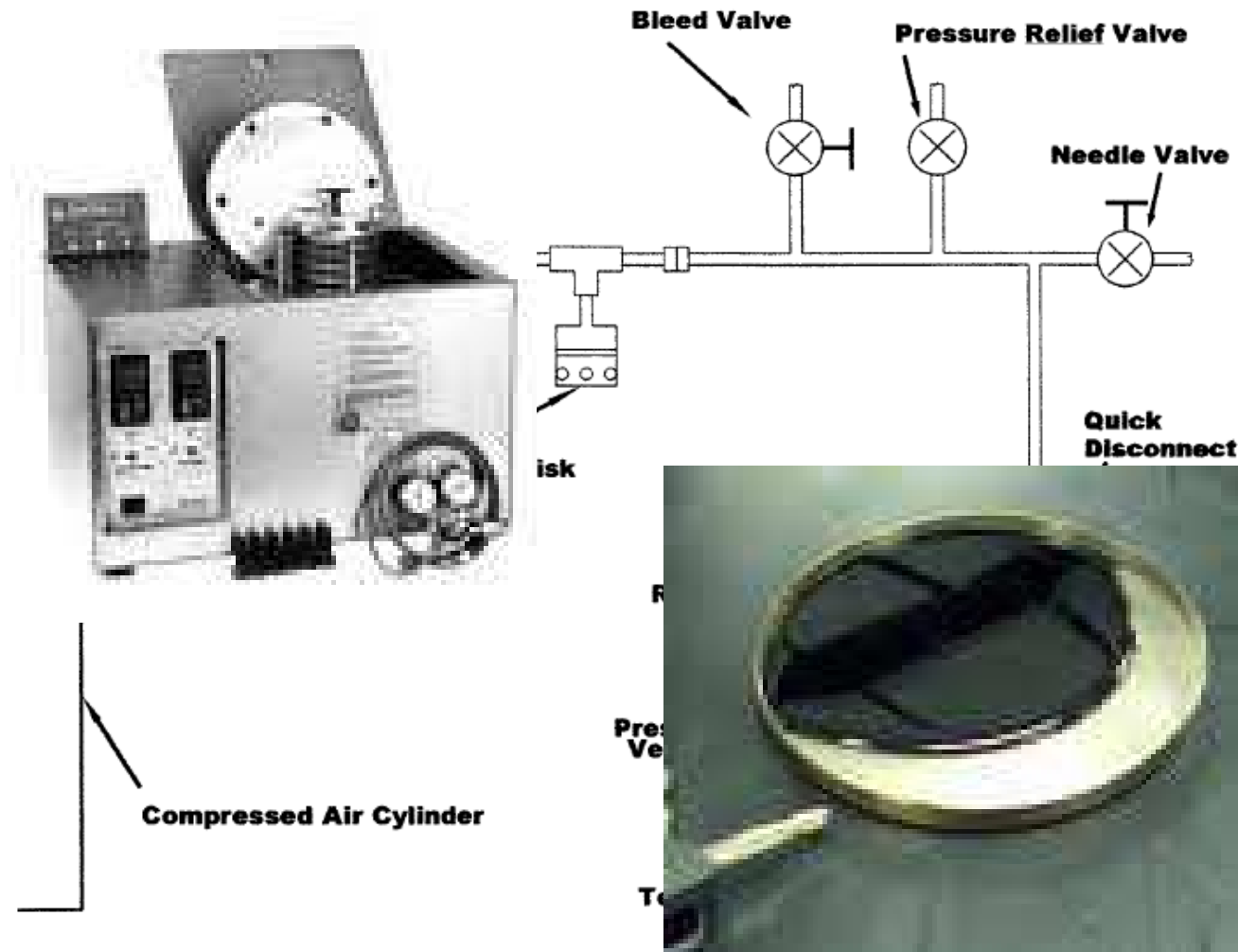
- Rolling Thin Film Oven Testing – Short Term Ageing



COMPARISON OF ACCELERATED AGEING METHODS



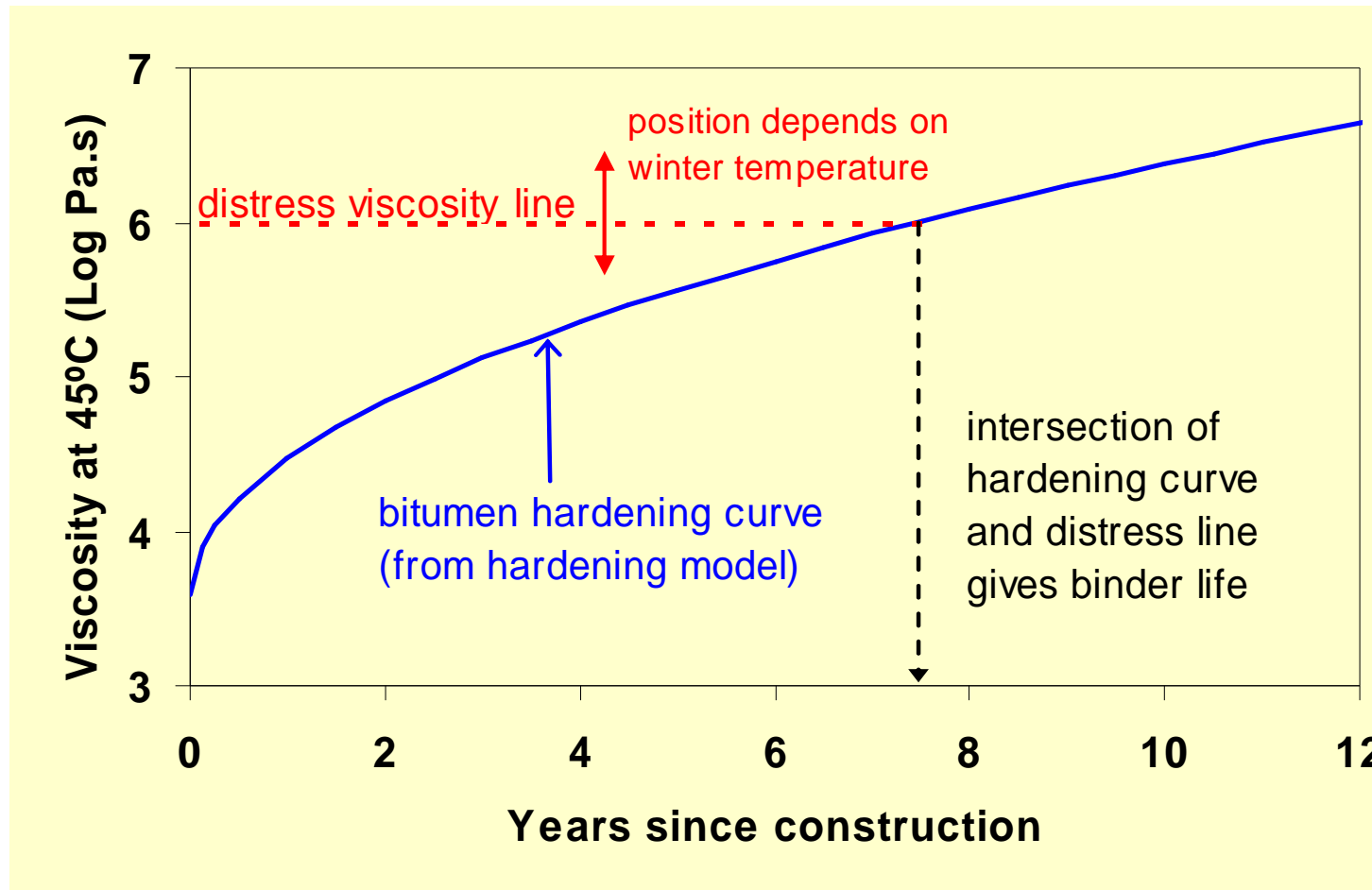
- Pressurised Ageing Vessel – Long Term Ageing



COMPARISON OF ACCELERATED AGEING METHODS



- ARRB Durability Test
 - Long Term Ageing
 - Sprayed Seals



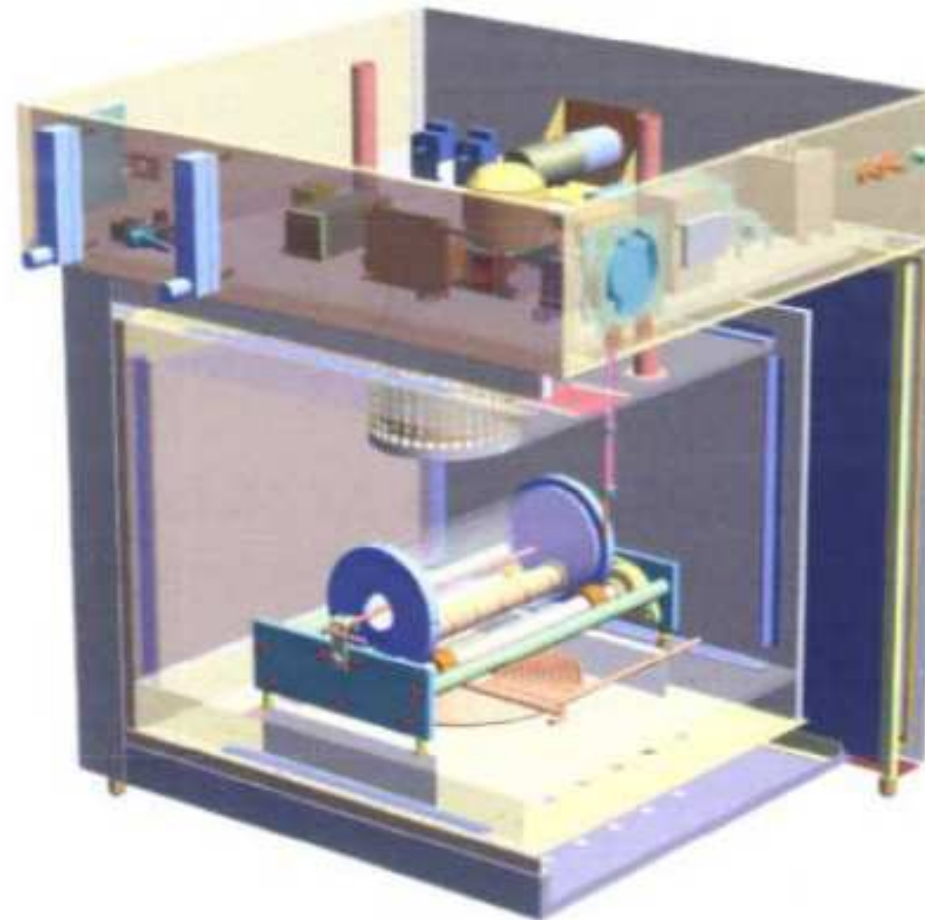
Courtesy: Dr. John Oliver Australian Road Research Board

COMPARISON OF ACCELERATED AGEING METHODS

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- Rotating Cylinder Asphalt Tester – Long Term Ageing



DEVELOPMENT OF A SOUTH AFRICAN ACCELERATED AGEING TEST

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- **Developing a LTA for RSA**
 - ***Readily available***
 - ***Reliable (repeatable & reproducible)***
 - ***Easy to use and interpretation***
 - ***Relevant***
 - ***Comparable***
 - ***PAV, ARRB Durability, RCAT***
- **Simulate Field Ageing**
- **Applicable for Seals and HMA**



- **Samples population**
 - *60 /70 binders ex RSA refineries*
- **Properties**
 - *Empirical tests*
 - *Dynamic Shear Rheometer*
 - *Bending Beam Rheometer*
- **Comparison before and after Ageing**
 - *Virgin – unaged*
 - *RTFOT at 163°C*
 - *PAV 100°C, 2,1kPa air pressure*
 - *ERTFOT163 (Extended RTFOT at 163°C)*
 - *ERTFOT100 (Extended RTFOT at 100°C)**



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 - *ERTFOT100 (Extended RTFOT at 100°C)**

EXPERIMENTAL



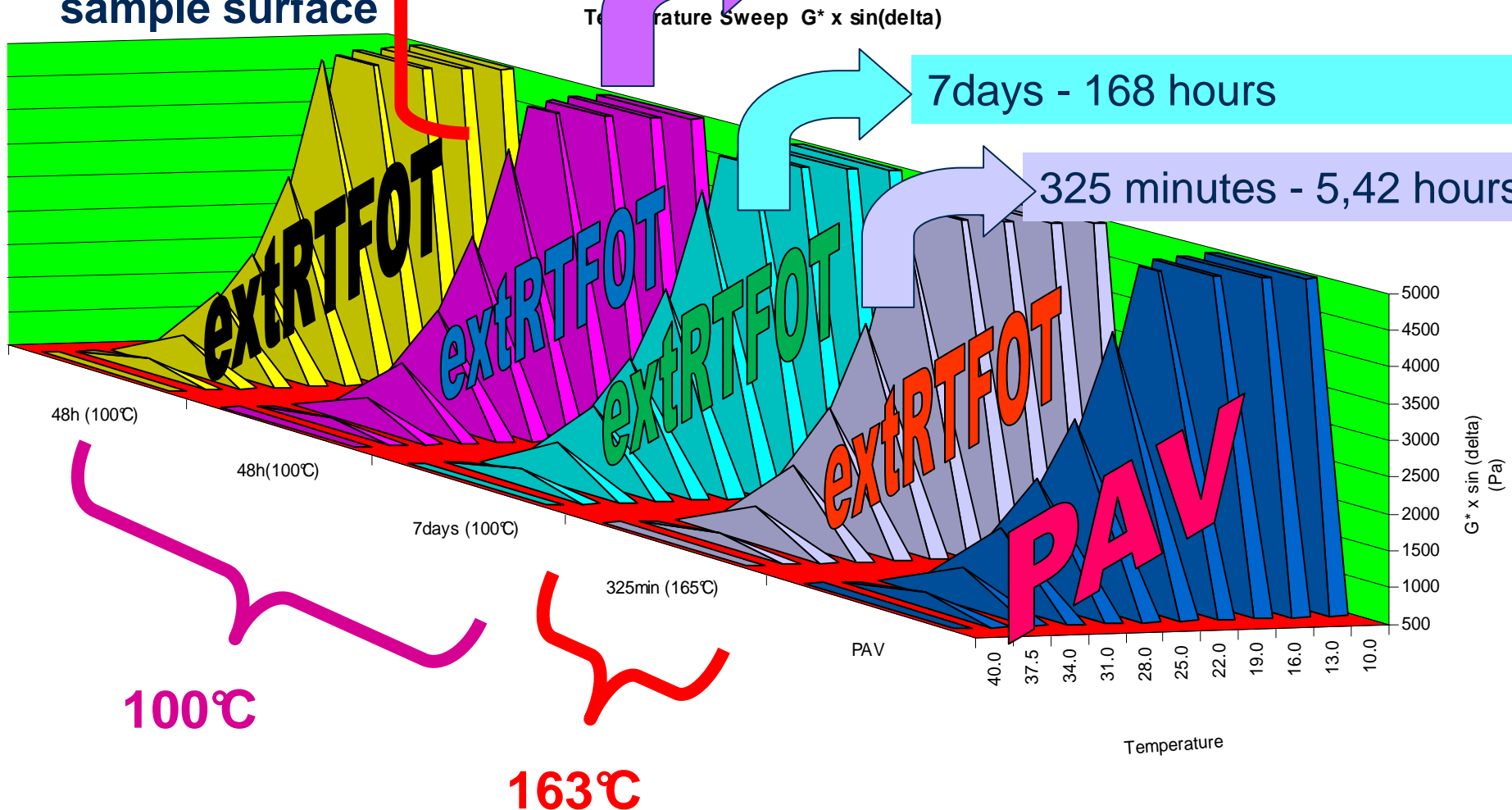
Continuously generates new exposed sample surface

8mm electroplated steel rod 48hours

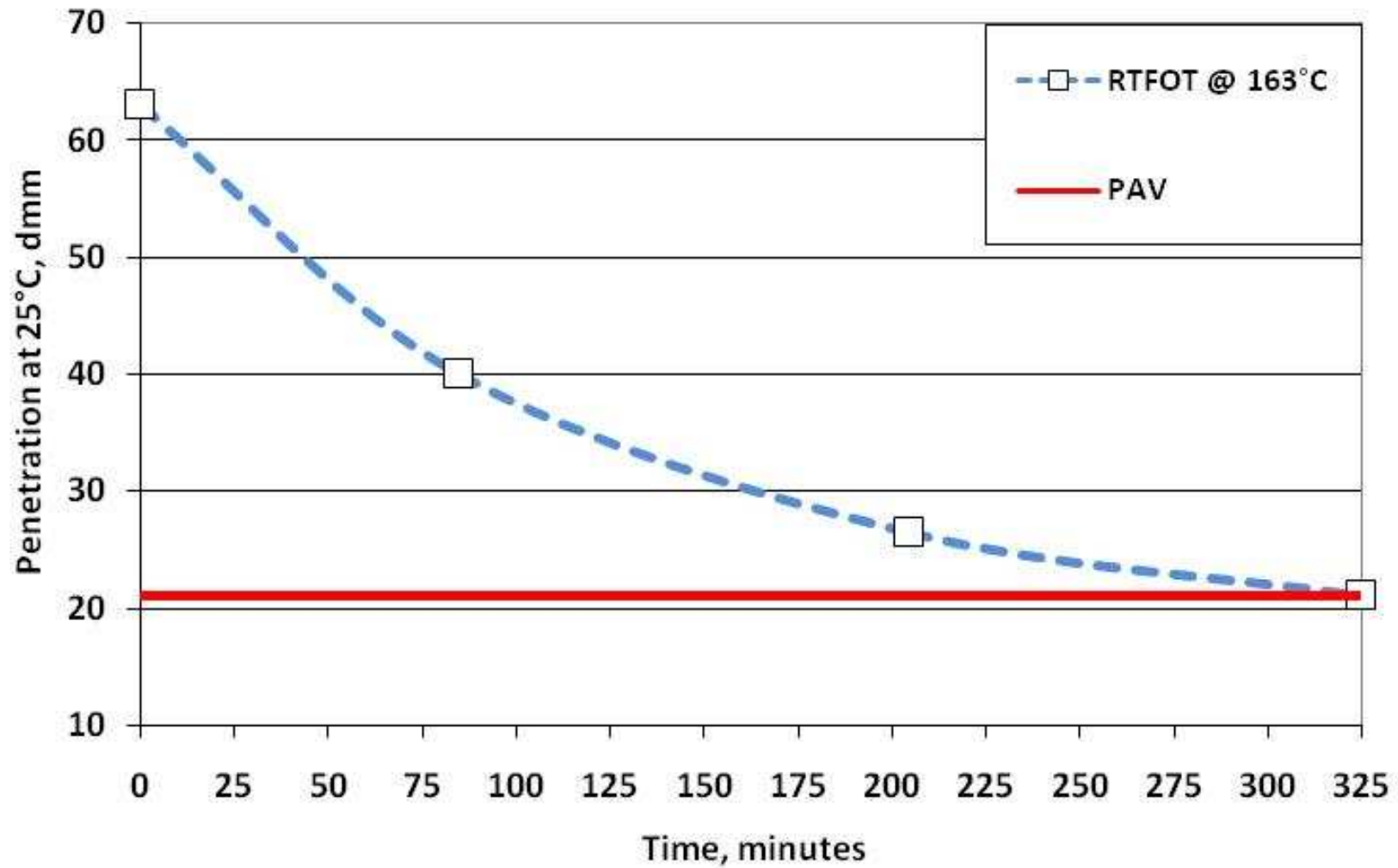
8 x 9mm steel ball bearing 48 hours

7days - 168 hours

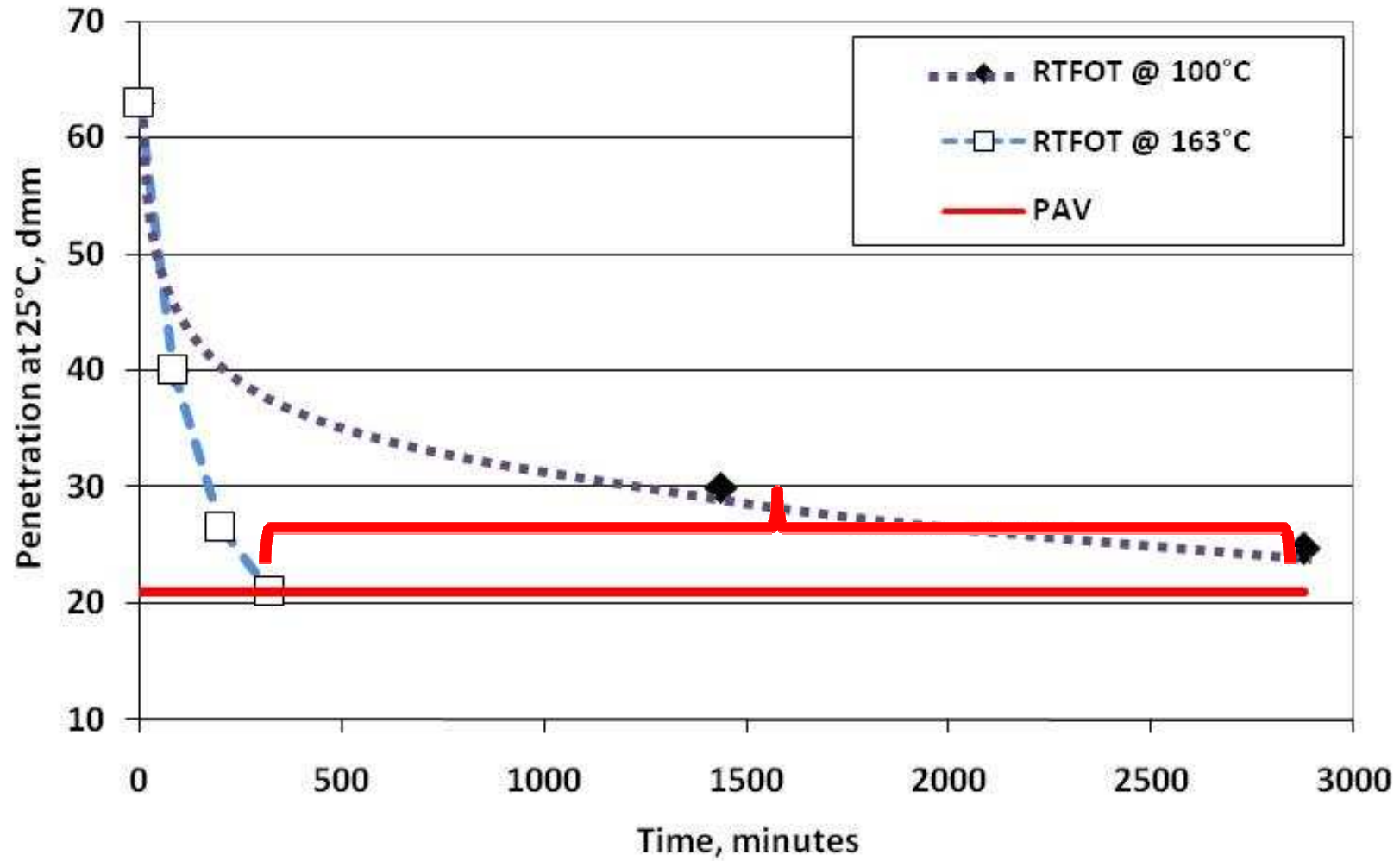
325 minutes - 5,42 hours



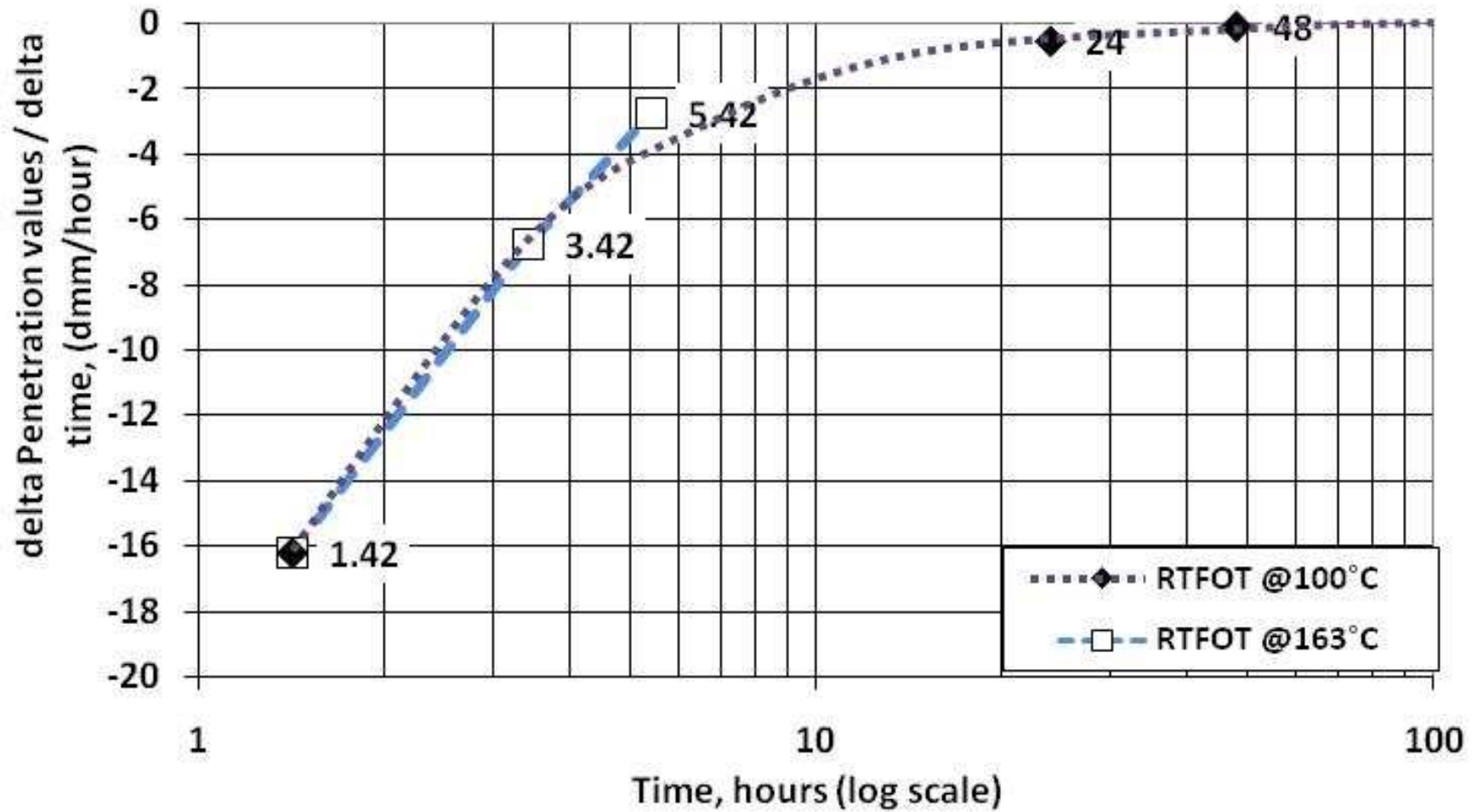
RESULTS AND DISCUSSION



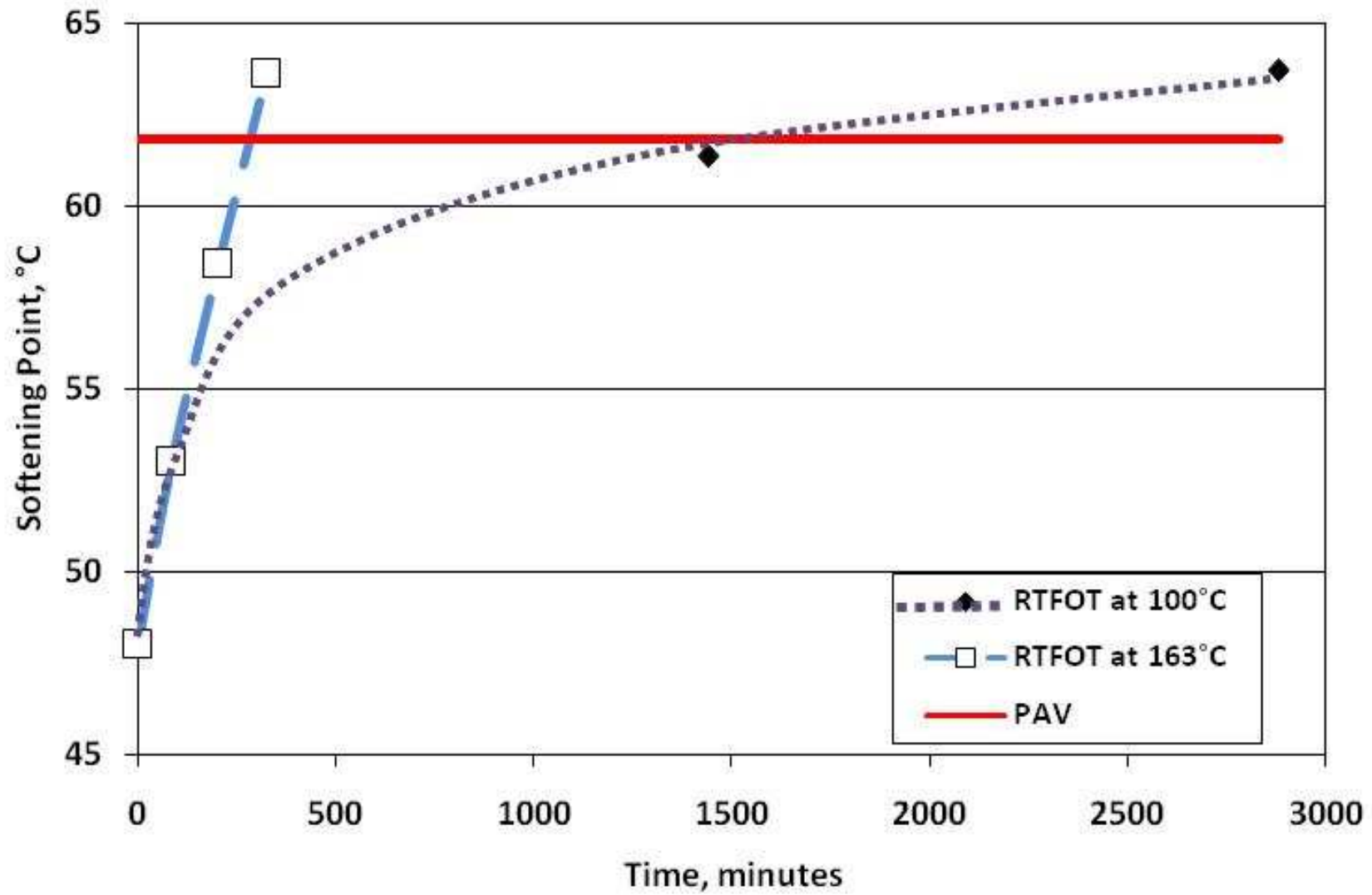
RESULTS AND DISCUSSION



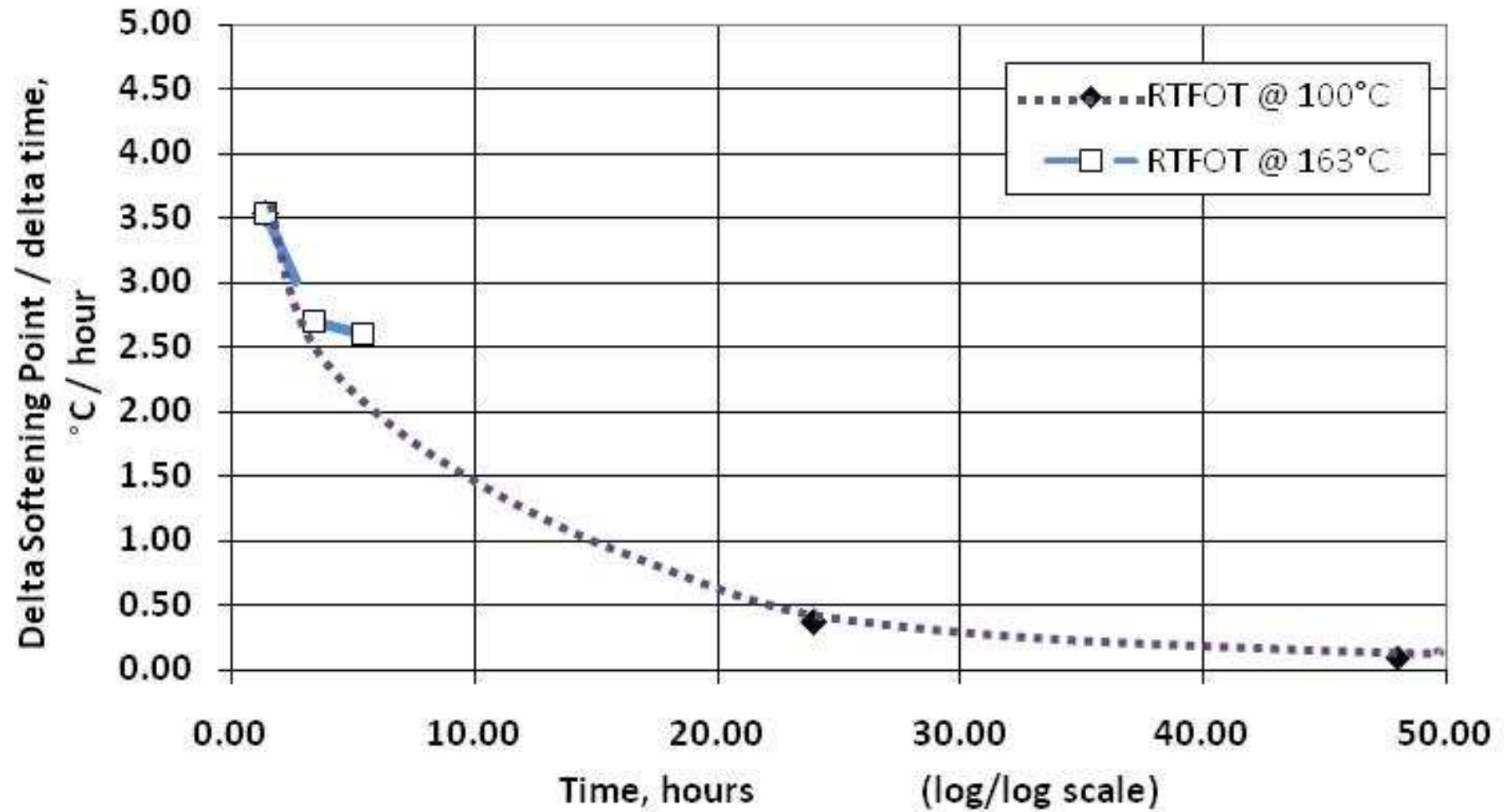
RESULTS AND DISCUSSION



RESULTS AND DISCUSSION



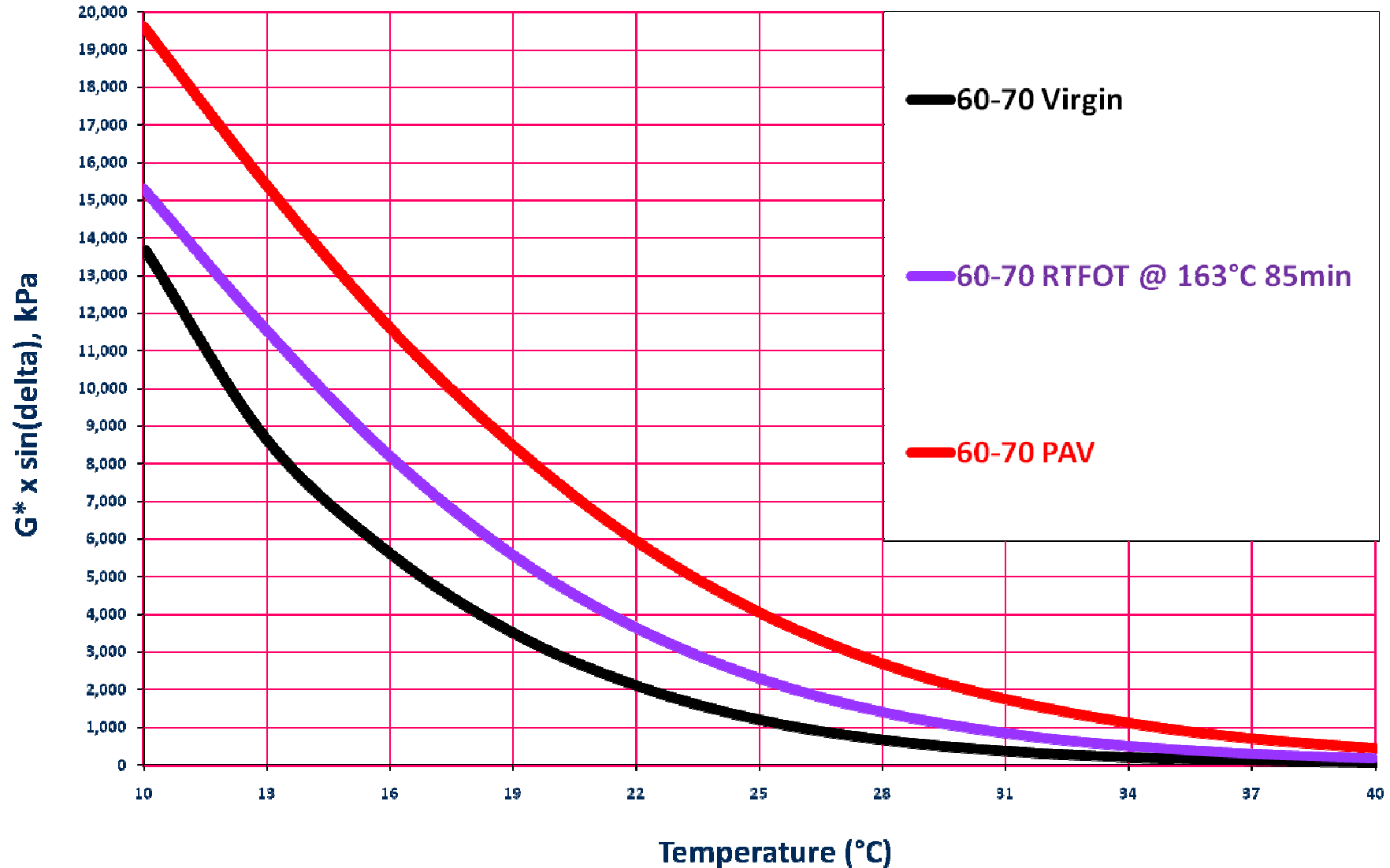
RESULTS AND DISCUSSION



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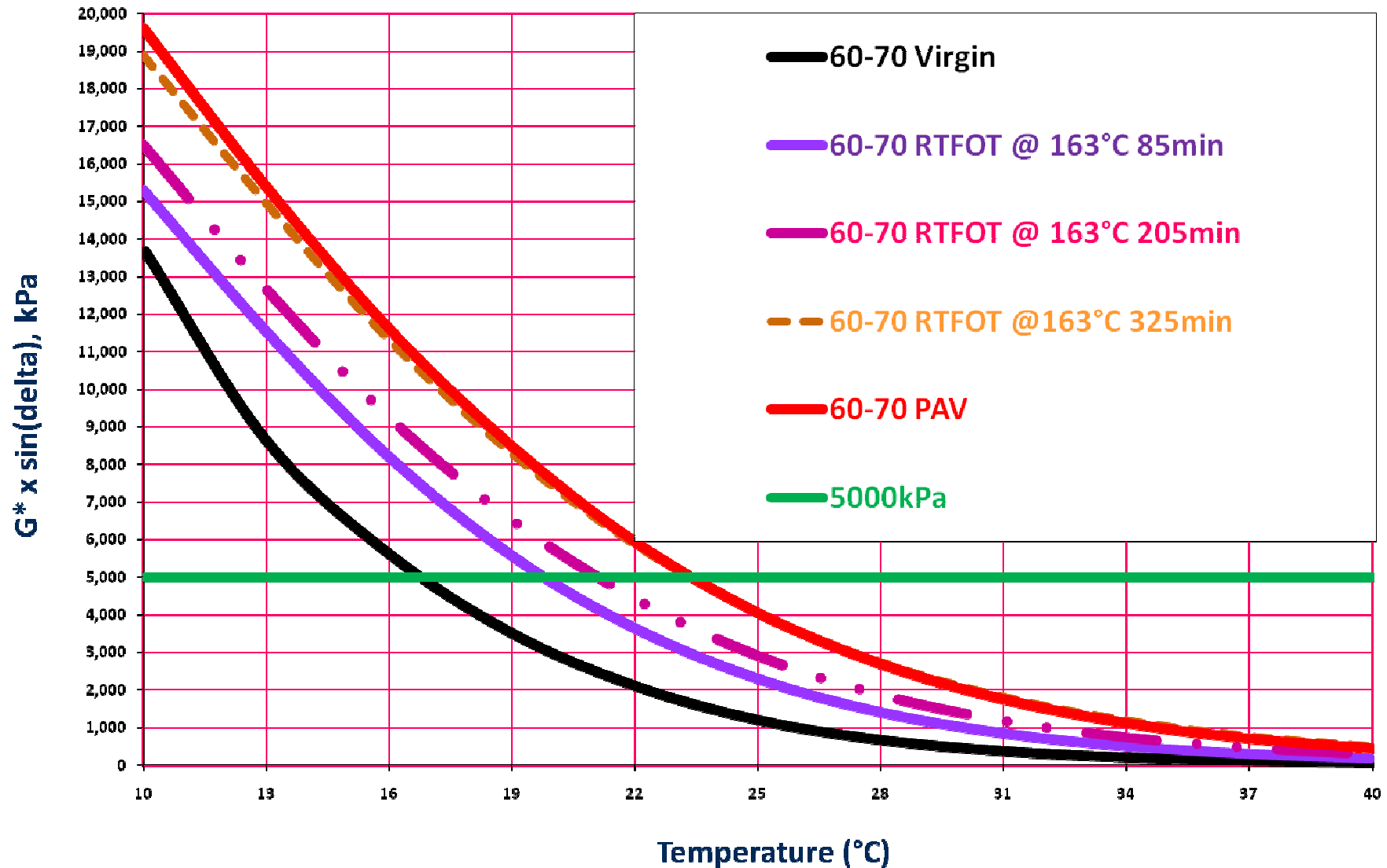
Virgin vs. RTFOT₁₆₃ vs. PAV



RESULTS AND DISCUSSION



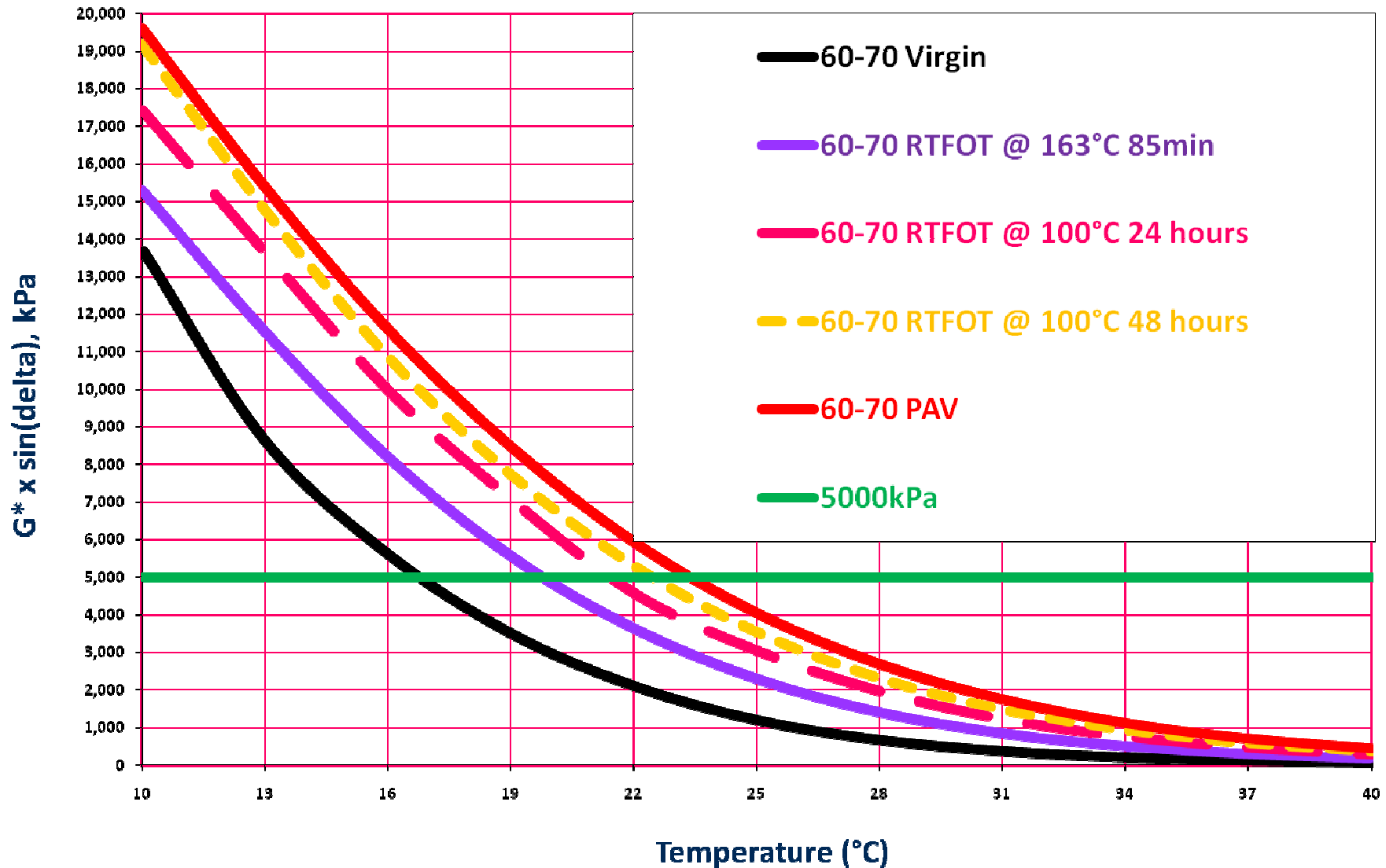
Extended RTFOT163 vs. PAV



RESULTS AND DISCUSSION



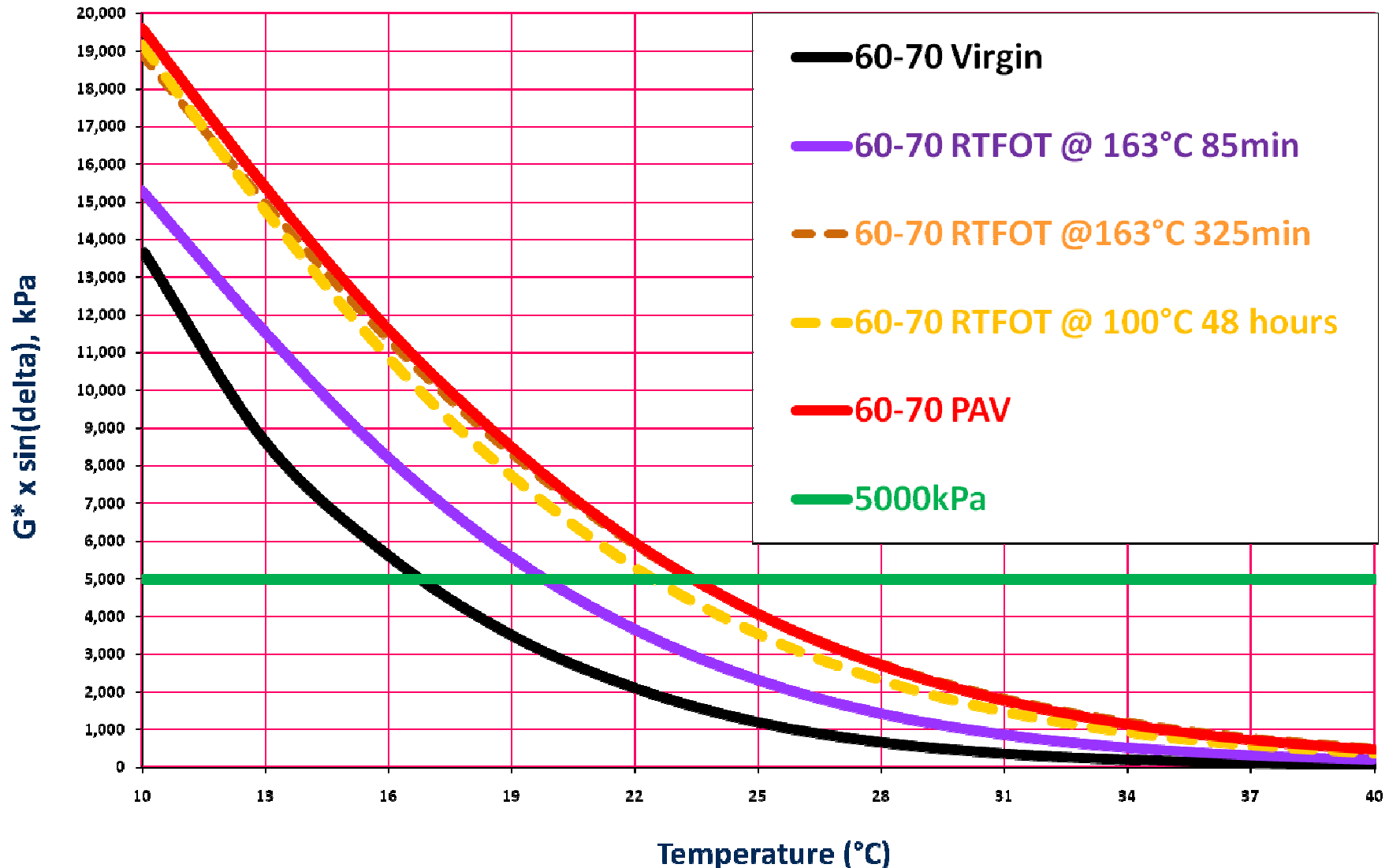
extRTFOT100 vs. PAV



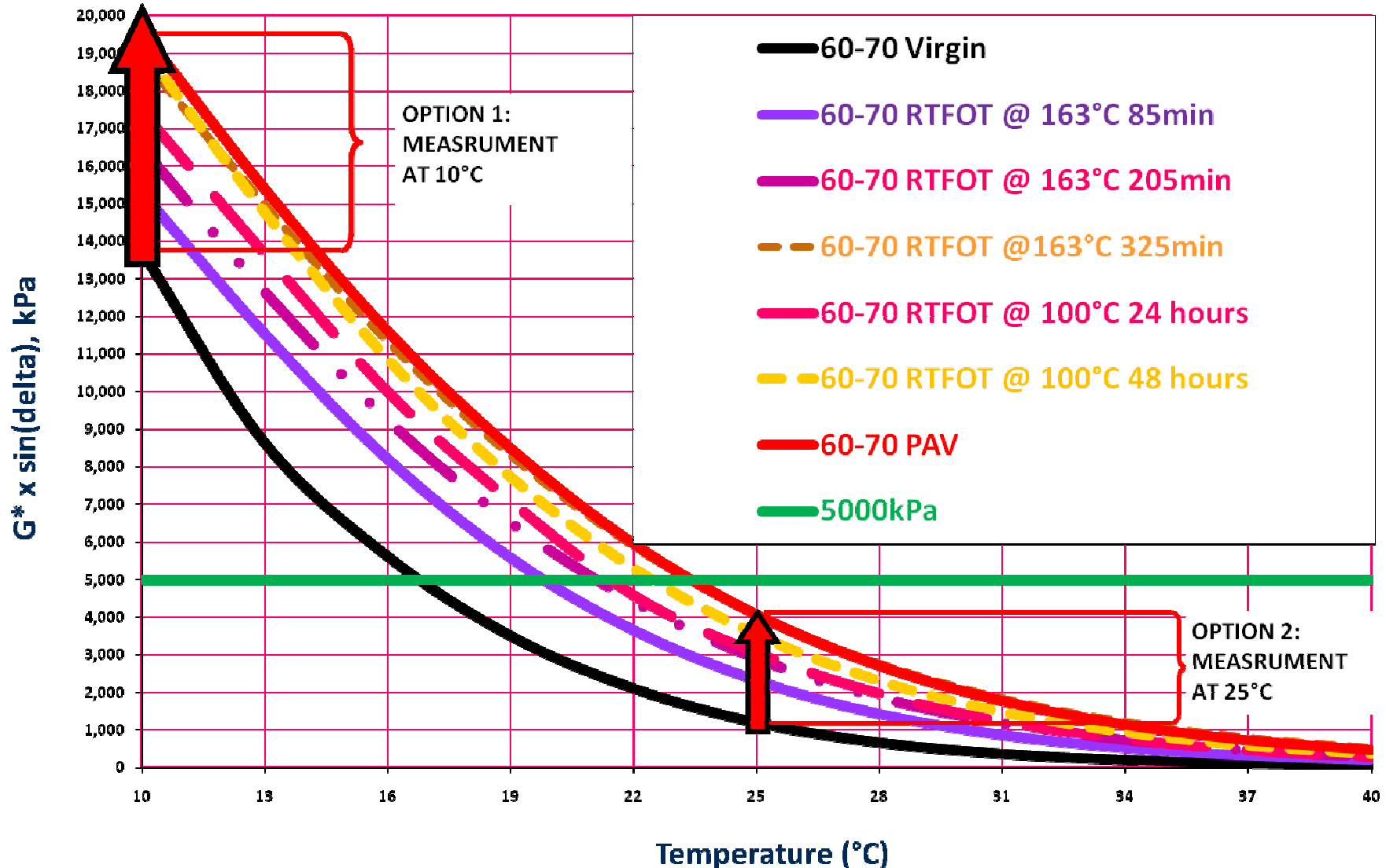
RESULTS AND DISCUSSION



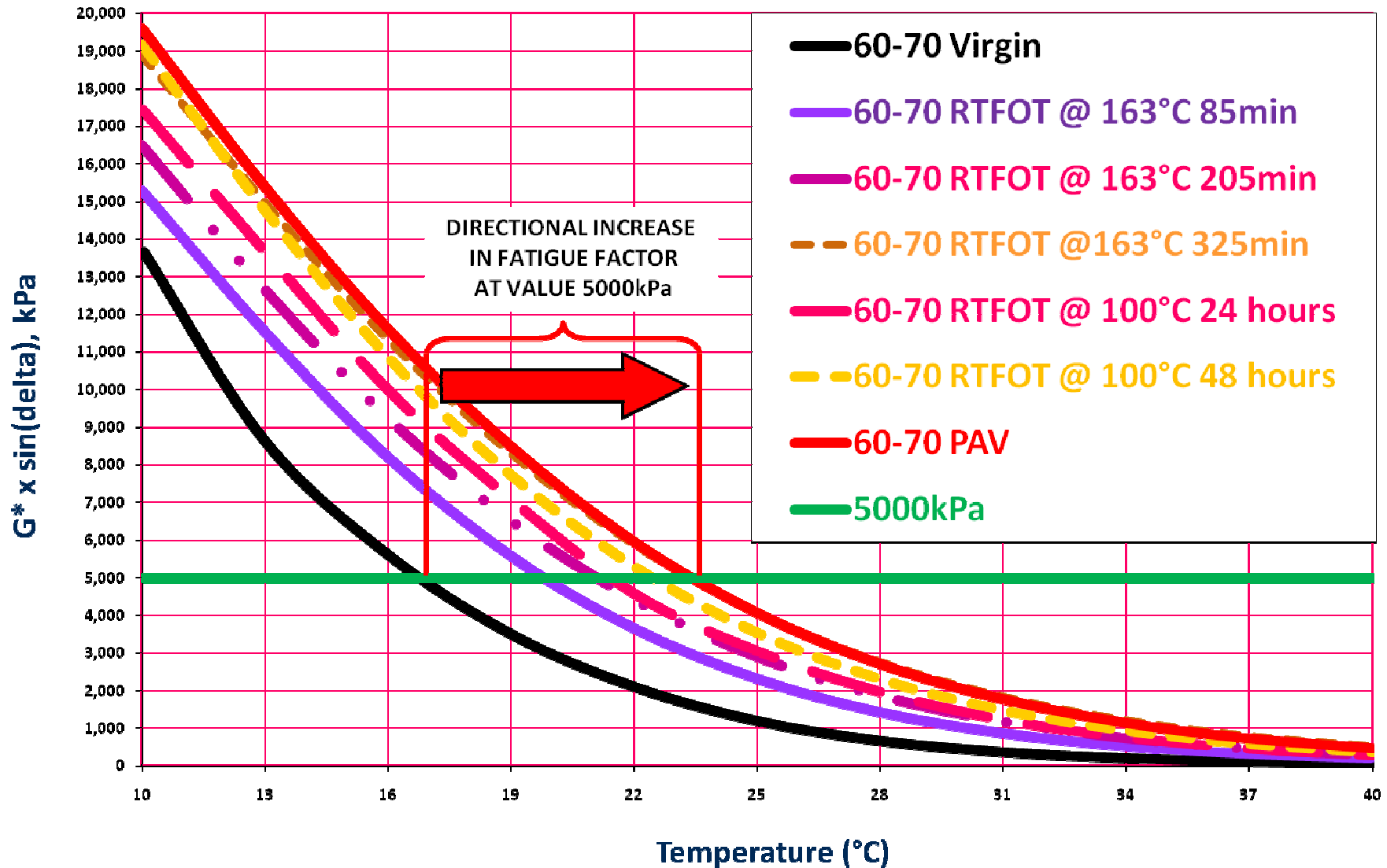
extRTFOT163 vs. extRTFOT100 vs. PAV



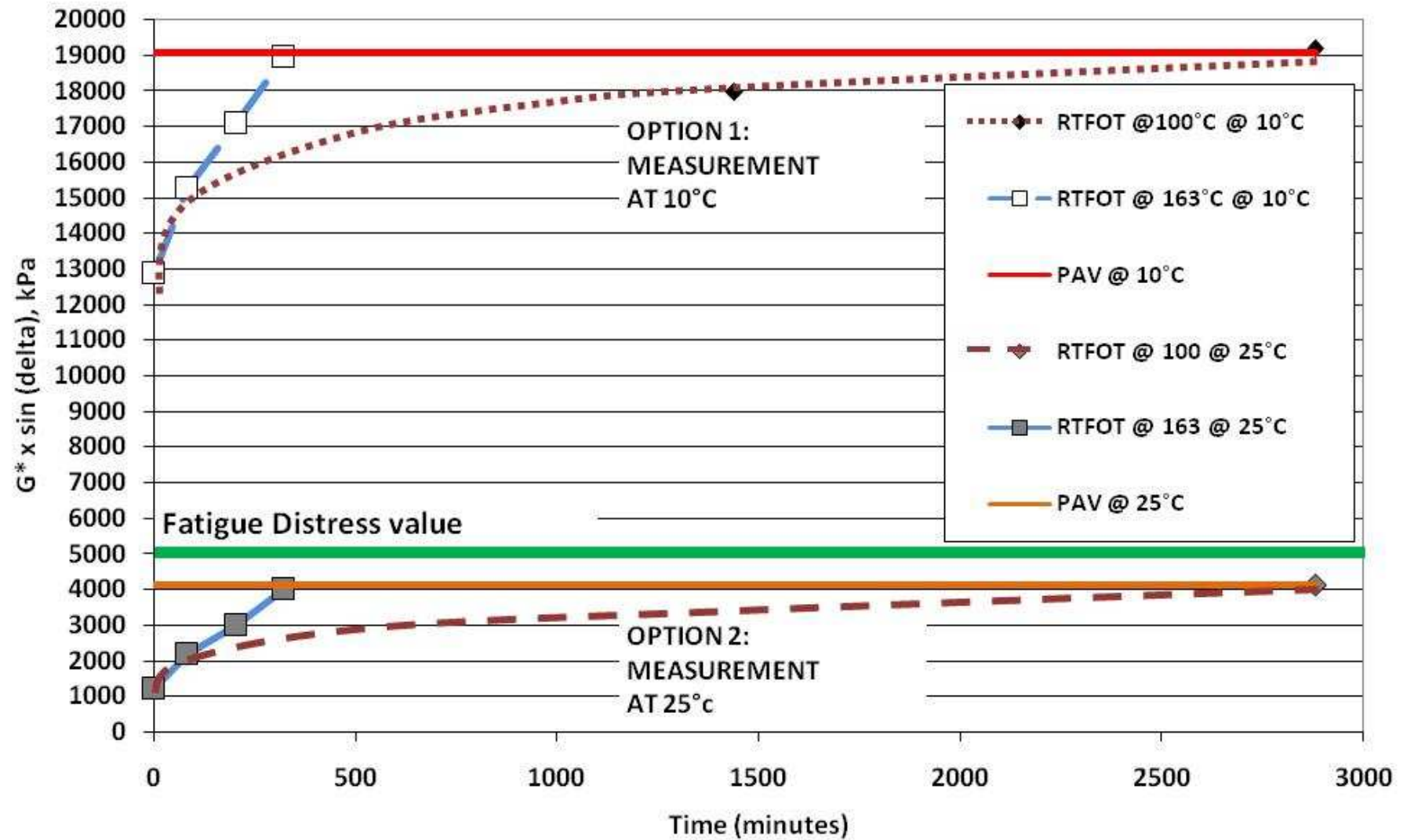
RESULTS AND DISCUSSION



RESULTS AND DISCUSSION



RESULTS AND DISCUSSION



CONCLUSION

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Not one but potentially two methods

Protocol 1:

- Virgin
- RTFOT at 163°C at 85 minutes
- RTFOT at 163°C “extended” till 325 minutes / PAV

Protocol 2:

- Virgin
- RTFOT at 163°C at 85 minutes
- RTFOT at 100°C “extended” till 48 hours / PAV
- (Steel Rod assisted)

CONCLUSION



- Extended RTFOT (proposal 1)
- Temperature 163°C
- Pressure ~0.1MPa (Atmospheric Pressure)

RTFOT Time		Sample Conditioning	Ageing Simulation
Min	hours		
	0	Virgin	Unaged
85 (75)*	1.42	RTFOT	Short-term ageing
145	2.42	RTFOT + 1 hour	
205	3.42	RTFOT + 2 hours	
265	4.42	RTFOT + 3 hours	
325	5.42	RTFOT + 4 hours	Long-term ageing

CONCLUSION



- Alternative Extended RTFOT (proposal 2)
- Temperature 100°C
- Pressure ~0.1MPa (Atmospheric Pressure)

RTFOT Time		Sample Conditioning	Ageing Simulation
Min	hours		
	0	Virgin	Unaged
85 (75)*	1.42	RTFOT @ 163°C	Short-term ageing
1440	24	RTFOT@ 100°C	
2880	48	RTFOT @ 100°C	Long-term ageing

RECOMMENDATION

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- **Validation of the laboratory ageing**
- **Samples obtained from the field**
- **Prediction tool**
- **South African Pavement Design Manual (SAPDM).**
- **Potential application of the proposed ext RTFOT**
 - ***Additional norm***
 - ***Assist the South African Roads Industry***
 - ***Quality Assurance***
 - ***Performance Prediction***
 - ***Binder Selection during Design and Construction***

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THANK YOU