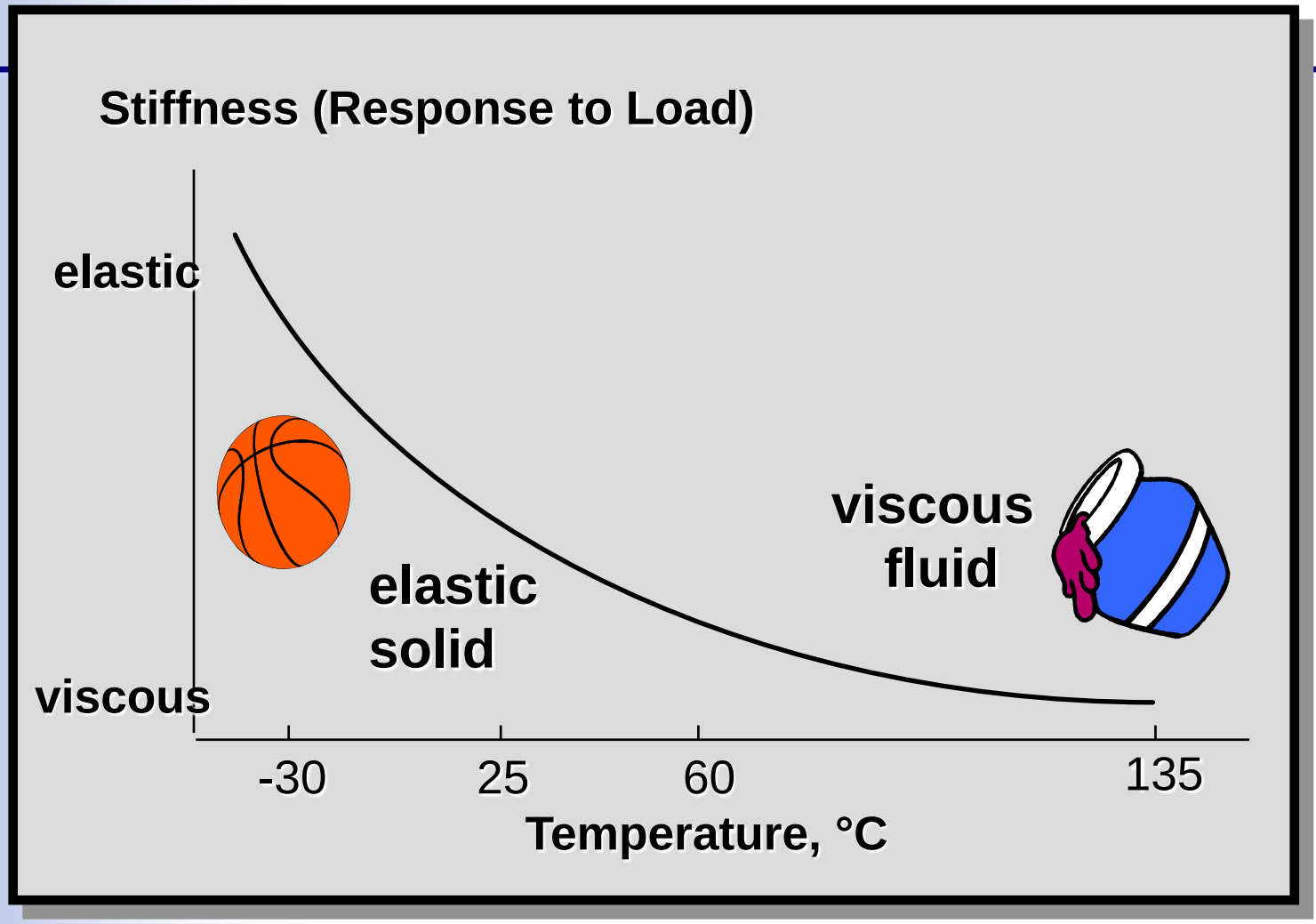
Superpave Asphalt Binders

Aging and what they mean to the specification

John D'Angelo
D'Angelo Consulting, LLC
johndangelo@dangeloconsultingllc.com

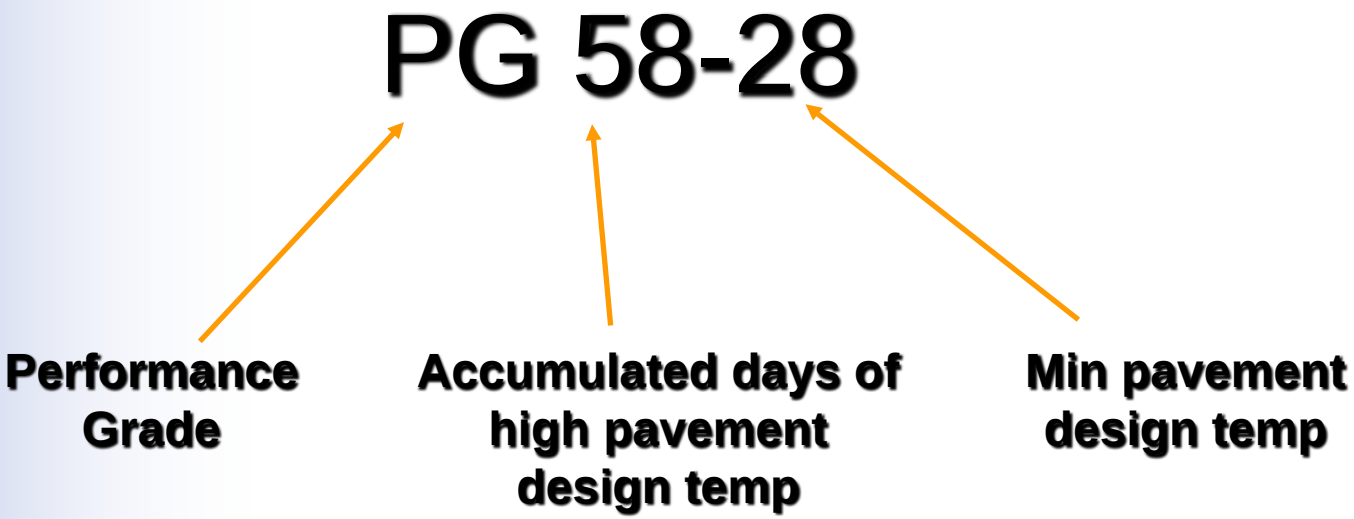


Superpave Asphalt Binder Specifications

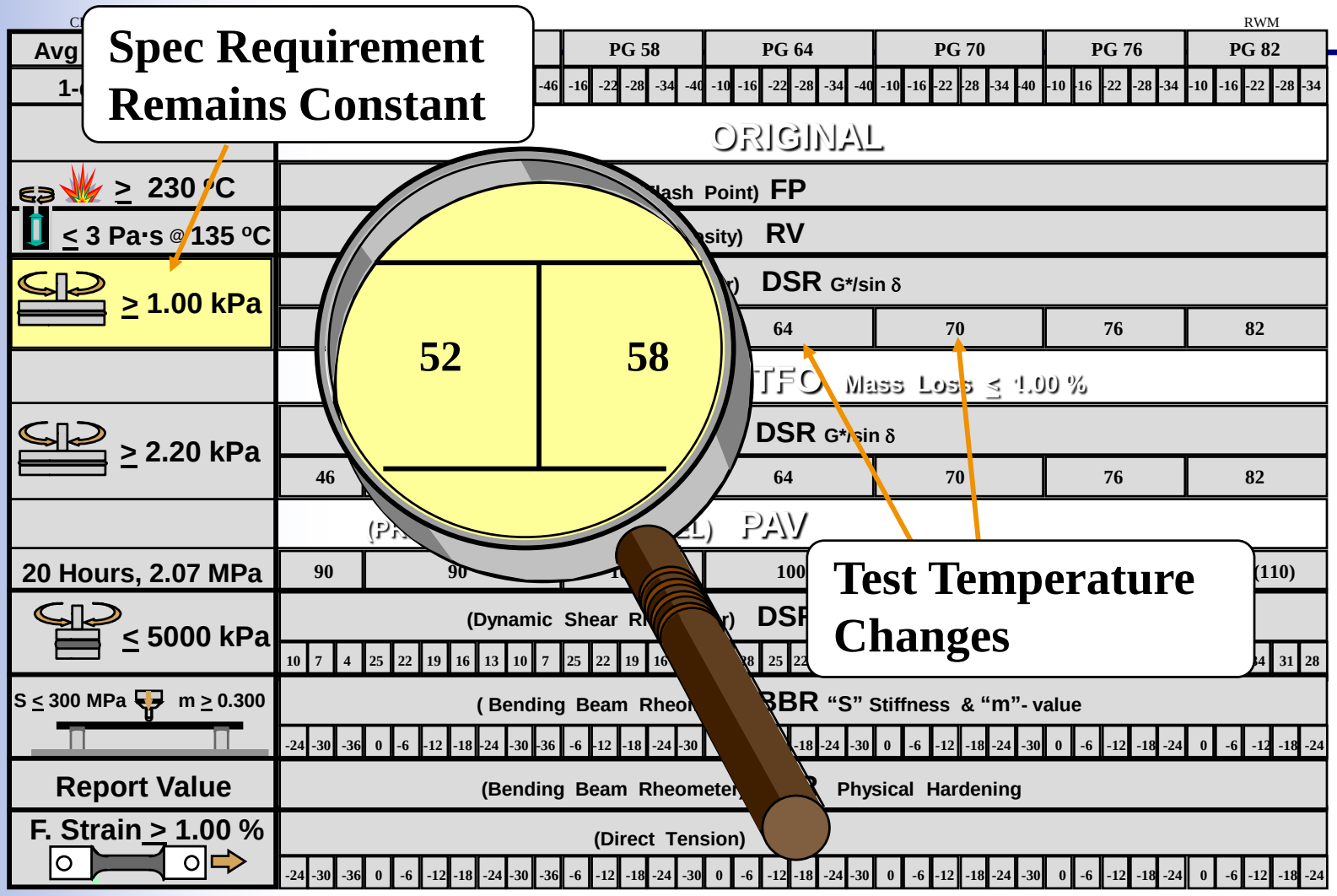
- Performance-Based to minimize
  - permanent deformation (rutting)
  - fatigue cracking (repeated load failure)
  - low temperature cracking or single event cracking
- Physical Properties
  - measured on aged binder

Grading System

- Based on Climate



How the PG Spec Works

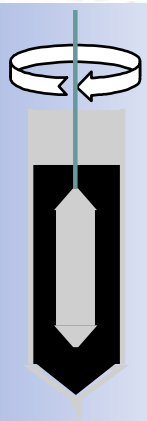


Production

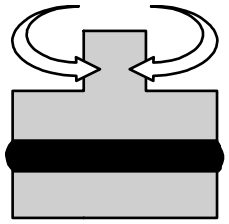
Rutting

Fatigue Cracking

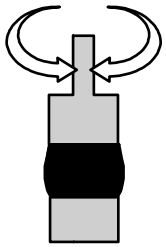
Thermal Cracking



RV

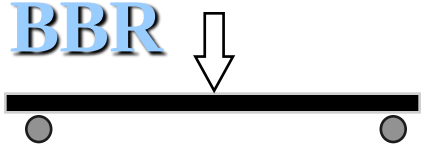


DSR



DTT

BBR



Time

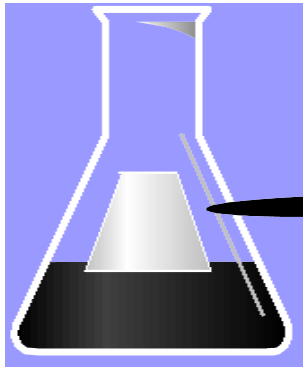
RTFO - aging

No aging

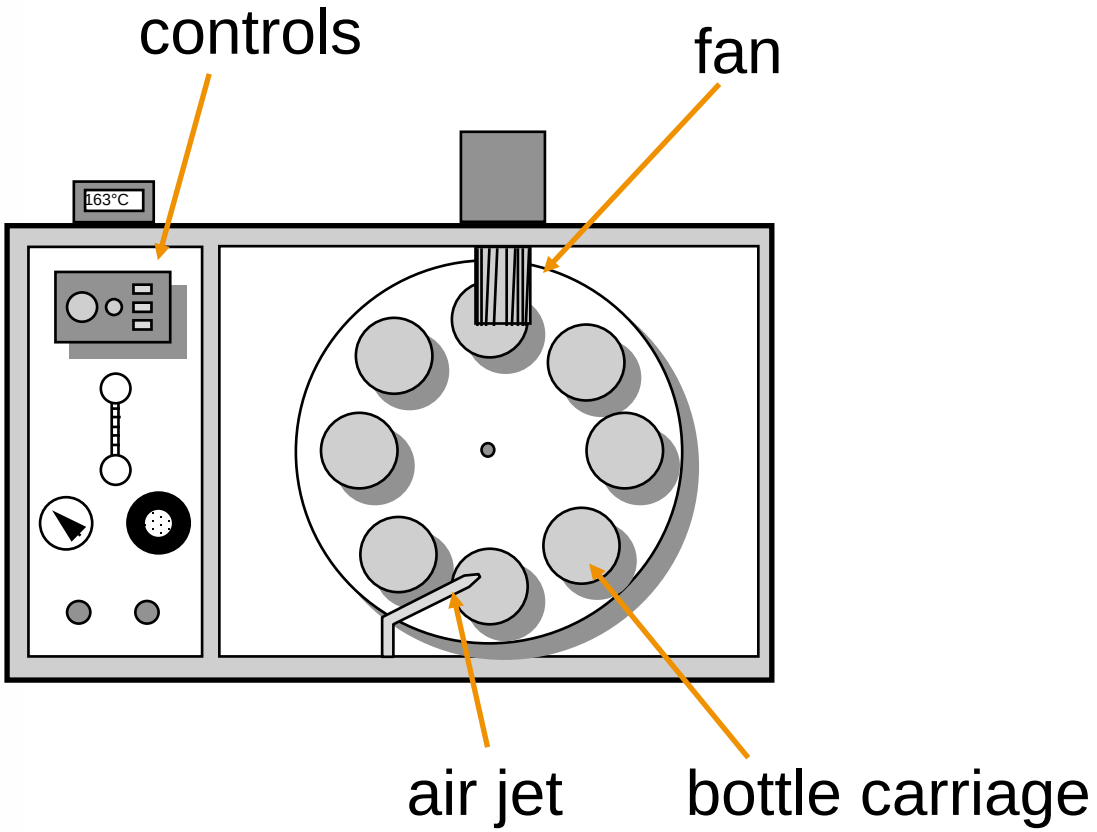
PAV - aging

Aging - How ?

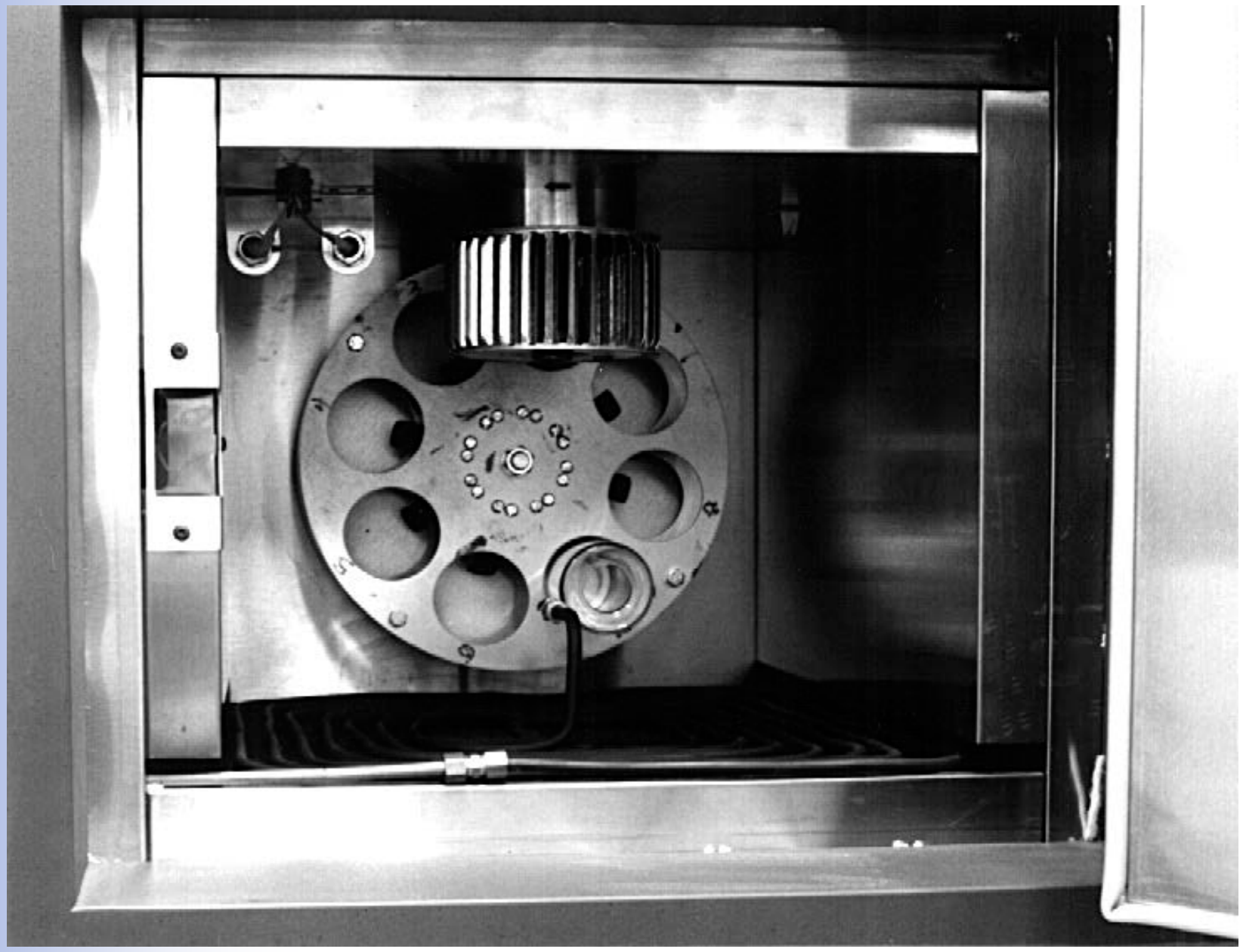
- Early: To simulate the aging that occurs due to construction and initial service, we are going to employ the Rolling Thin-Film Oven *(RTFO)*. This is a standard AASHTO test method, T 240.
  - Spec.: 85 minutes, 163°C, 400 ml of air per minute, 15 rpm



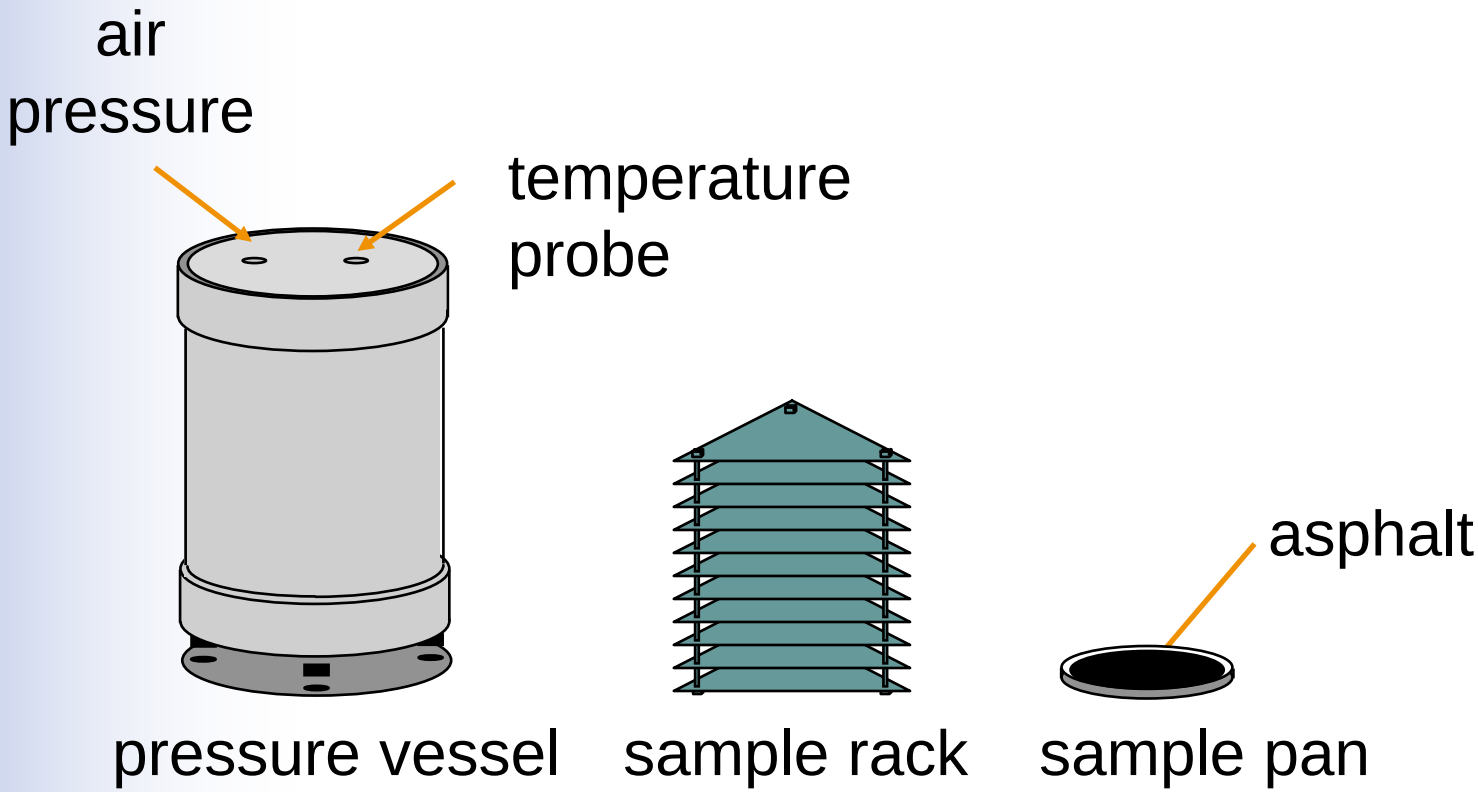
Rolling Thin Film Oven



D'Angelo Consulting

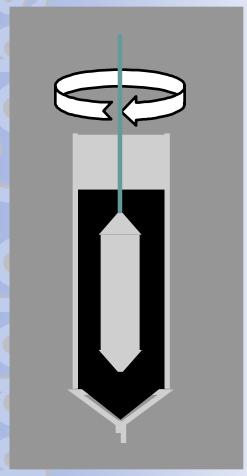


Pressure Aging Vessel

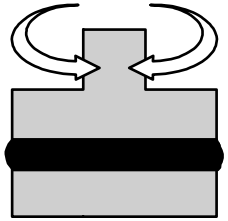


D'Angelo Consulting

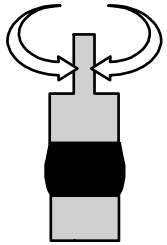
Construction **Rutting** **Fatigue Cracking** **Low Temp Cracking**



[RV]

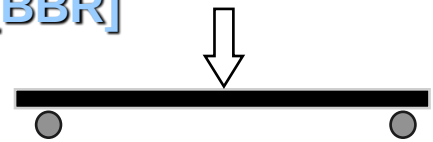


[DSR]



[DTT]

[BBR]



Time

RTFO - aging

No aging

PAV - aging

Grading of Asphalt binder Original

PROPERTY		AASHTO TEST METHOD	SPECS	RESULTS by sample label info below			
				-1	-2	-3	-4
ORIGINAL BINDER							
AASHTO M 320, Table 1 Requirements (DSR's & BBR's reported above and below 'passing'							
Specific Gravity	15.6°C	T 228	Report	1.0146	1.015	1.022	1.018
Flash Point, °C (°F) COC		T 48	230 min.	552 (289)	536 (280)	530 (276)	540 (282)
Viscosity, Pa•s	135°C	T 316	3.0 max.	0.34	0.29	0.375	0.4
Dynamic Shear (G*/sin □10 rad./sec.), kPa	58°C	T 315	1.0 min.	--	1.74	--	--
	64°C			1.07	0.826	1.35	1.52
	70°C			0.529	--	0.657	0.74

Grading of Asphalt binder RTFOT

PROPERTY		AASHTO TEST METHO	SPECS	RESULTS by sample label info below			
RTFOT RESIDUE		D		-1	-2	-3	-4
AASHTO M 320 Requirements							
Mass Change, % (Mass Loss is reported as Negative)		T 240	1.0 max.	-0.065	-0.17	-0.173	-0.109
Dynamic Shear (G*/sin δ, 10 rad./sec.), kPa	58°C	T 315	2.2 min.	--	6.1	--	--
	64°C			4.08	2.91	--	--
	70°C			1.98	1.41	2.62	2.99
	76°C			--	--	1.28	1.46

Grading of Asphalt PAV

PROPERTY			AASHTO TEST METHOD	SPECS	RESULTS by sample label info below			
					-1	-2	-3	-4
Dynamic Shear (G*•sin δ), kPa, 10 rad./sec.		19°C	T 313		4,120	--	4,230	4,480
		16°C			5,790	4,810	5,940	6,210
		13°C			--	6,760	--	--
Creep Stiffness	Stiffness, MPa (60 sec.)	-12°C		300 max.	92	--	102	111
	m Value			0.300 min.	0.322	--	0.317	0.352
	Stiffness, MPa (60 sec.)	-18°C		300 max.	191	157	208	197
	m Value			0.300 min.	0.296	0.311	0.29	0.299
	Stiffness, MPa (60 sec.)	-24°C		300 max.	--	312	--	--
	m Value			0.300 min.	--	0.287	--	--
AASHTO M 320 SUPERPAVE™ Binder Grade, PG:					**64-22**	**58-28**	**64-22**	**64-22**
AASHTO M320, Table 1, Continuous PG:					**64.6-27.1**	**62.5-30.8**	**66.5-25.8**	**67.5-27.9**

PG Continuous Grade

AASHTO M 320 SUPERPAVE™ Binder Grade, PG:	64-22	58-28	64-22	64-22
AASHTO M320, Table 1, Continuous PG:	64.6-27.1	62.5-30.8	66.5-25.8	67.5-27.9

ASTM D 3384 Table 4

PROPERTY		TEST METHOD	SPECS		RESULTS; Sample #			
			AC-10	AC-20	-1	-2	-3	-4
ASTM D 3381-14, Table 4 Requirements: As Received								
Absolute Viscosity, P	60°C	D2171	1,000±200	2,000± 400	1,921	1,452	2,392	2,417
Kinematic Viscosity, cSt, min.	135°C	D2170	250	300	371	313	408	430
Flash Point, COC, °C (°F)		D92	219 (425)	232 (450)	289	280	276	282
Solubility in TCE, %, min.		D2042	99	99	99.95	99.92	99.94	99.94
Specific Gravity	15.°C	D70	Report	Report	1.0146	1.015	1.022	1.018
Penetration (100 g, 5 sec.), dmm	25°C	D5	Report	Report	65	77	62	59
Softening Point, °C (°F)		D36	Report	Report	51.7	50	53.3	52.8
Penetration Index [2]		Annex A	-1.5 to +1.0		-0.142	-0.116	0.121	-0.125

ASTM D 3384 Table 4

PROPERTY		TEST METHOD	SPECS		RESULTS; Sample #			
			AC-10	AC-20	-1	-2	-3	-4
RTFOT Residue:								
Mass Change, %, max.			1		-0.066	-0.062	-0.06	-0.112
Absolute Viscosity, P, Max.	60°C	D2171	5,000	8,000	9,245	8,016	13,513	18,803
Ductility, cm, min (5 cm/min.)	25°C	D113	75	50	29	42.4	25.4	22

Would you want to use this asphalt on your pavement?

No Control of Aging on The RTFOT

PROPERTY		AASHTO TEST METHOD	SPECS	RESULTS by sample label info below			
				-1	-2	-3	-4
ORIGINAL BINDER							
AASHTO M 320, Table 1 Requirements (DSR's & BBR's reported above and below 'passing'							
Specific Gravity	15.6°C	T 228	Report	1.0146	1.015	1.022	1.018
Flash Point, °C (°F) COC		T 48	230 min.	552 (289)	536 (280)	530 (276)	540 (282)
Viscosity, Pa•s	135°C	T 316	3.0 max.	0.34	0.29	0.375	0.4
Dynamic Shear (G*/sin δ, 10 rad./sec.), kPa	58°C	T 315	1.0 min.	--	1.74	--	--
	64°C			1.07	0.826	1.35	1.52
	70°C			0.529	--	0.657	0.74
RTFOT RESIDUE		**D**		**-1**	**-2**	**-3**	**-4**
AASHTO M 320 Requirements	58°C			--	6.1	--	--
Dynamic Shear (G*/sin δ, 10 rad./sec.), kPa	64°C	T 315	2.2 min.	4.08	2.91	--	--
	70°C			1.98	1.41	2.62	2.99
	76°C			--	--	1.28	1.46

Needed Modification to the PG Spec

- PAV aging may not be capturing the aging issues with binders.
- We may need control of aging on RTFOT.

Discussions

THANK YOU