

Bitumen, black or shades of grey?

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ໂດະ Annual Conference 2017

Bitumen, black or shades of grey?

- Bitumen supply & demand in Europe
- Bitumen quality Specification & Performance

Bitumen durability – Long Term Ageing

Bitumen demand Europe





Capacity, kb/d



Energy traders plan to increase their bitumen market share

There is a perception that the world is going to be more disconnected - supply and demand-wise - and we are there to help connect the dots. You can expect our presence and our interest to be where there are significant opportunities and shorts in the market." (Puma Energy)

Source : Bloomberg, July 14, 2016

It used to be mostly a small distribution business. Now it is more of a whole arbitrage business requiring a global reach and shipping capacity." (Vitol)

> "We see a definite upward trend in the number of nautical miles for bitumen." (VALT)

Bitumen grades in Europe

Polymer Modifie

> Industrial 023^{EN} 13304

Paving Grades EN 12591 + EN 13924-1

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FORMAL DEMANDS

Construction Products Regulation (EU) No 305/2011

- Establishes 'Basic Requirements'
 - Mechanical resistance and stability
 - Safety in case of fire
 - Hygiene, health and the environment
 - Safety and accessibility in use
 - Protection against noise
 - Energy economy and heat retention
 - Sustainable use of natural resources
- Must be incorporated into bitumen standards

Bitumen Specifcation – EN 12591

Characteristics	Unit	Test method	Class 0 ^a	20/30	30/45	35/50	40/60	50/70	70/100	100/150	160/220
Penetration at 25°C	0,1 mm	EN 1426	1	20 – 30	30 - 45	35 – 50	40 – 60	50 – 70	70 – 100	100 - 150	160 - 220
Softening point	°C	EN 1427	1	55 – 63	52 – 60	50 – 58	48 – 56	46 - 54	43 – 51	39 – 47	35 – 43
Resistance to hardening at 163°C		EN 12607-1	1								
Retained penetration	%]	1	≥ 55	≥ 53	≥ 53	≥ 50	≥ 50	≥46	≥43	≥37
Increase in softening point, max - Severity 1	°C]		≤8	≤8	≤ 8	≤9	≤9	≤9	≤ 10	≤11
or			1	or							
Increase in softening point, max - Severity 2 ^b	°C			≤ 10	≤ 11	≤ 11	≤ 11	≤ 11	≤ 11	≤ 12	≤ 12
Flash point ^b	°C	EN ISO 2592	1	≥ 240	≥240	≥ 240	≥ 230	≥ 230	≥ 230	≥ 230	≥ 220
Solubility ^b	%	EN 12592	1	≥ 99	≥ 99	≥ 99	≥ 99	≥ 99	≥ 99	≥99	≥ 99
Change of mass after RTFOT ^b	%	EN 12607-1	1	≤ 0,5	≤0,5	≤ 0,5	≤ 0,5	≤ 0,5	≤ 0,8	≤0,8	≤ 1,0
Penetration index	-	Annex A°	NR₫	-1.5 to +0.7							
Kinematic viscosity at 135°C	mm²/s	EN 12595	NR	≥ 530	≥ 400	≥ 370	≥ 325	≥ 295	≥ 230	≥ 175	≥ 135
Dynamic viscosity at 60°C	Pa.s	EN 12596	NR	≥ 440	≥ 260	≥ 225	≥ 175	≥ 145	≥ 90	≥ 55	≥ 30
Fraass breaking point	°C	EN 12593	NR	-	≤ -5	≤ -5	≤ -7	≤ -8	≤ -10	≤ -12	≤ -15

Table 1 — Paving grade bitumen specifications for grades from 20 x 0.1mm to 220 x 0.1mm penetration

a Class 0 can only selected for non-mandated properties. These properties are optional. The decision to apply or not to apply a property is taken by the National Standardisation Body (NSB). If chosen it becomes "required", if not, class 0 is to be selected.

When Severity 2 is selected, it shall be associated with Fraass breaking point and/or penetration index.

Reference to normative Annex A in the present document, dealing with calculation of the penetration index, lp.

NR: "Not Required", this class is used when there is no mandated requirement for a property.

Bitumen specification timeline from empirical to more fundamental performance



- CEN Specifications are to be more performance related based on fundamental properties
- Eurobitume Task Force Performance started in 1999.

Eurobitume Task Force

- completed review of all available perforamcne related test methods.
- proposed to CEN to formally standardise appropriate methods.

CEN/TC 336 publication CEN/TR 15352

Bitumen Validation

- Literature review over suitability, shortcoming and opportunities of propsoed test methods
- Report publised in 2006

Eurobitume Data Collection project started.

Bitumen Quality ...?

Table 1 — Paving grade bitumen specifications for grades from 20 x 0.1mm to 220 x 0.1mm penetr

Characteristics	Unit	Test method	Class 0ª	20/30	30/45	35/50	40/60	50/7
Penetration at 25°C	0,1 mm	EN 1426	1	20 – 30	30 – 45	35 – 50	40 – 60	50 -
Softening point	°C	EN 1427	1	55 – 63	52 – 60	50 – 58	48 – 56	46 –
Resistance to hardening at 163°C		EN 12607-1	1					
Retained penetration	%		1	≥ 55	≥ 53	≥ 53	≥ 50	≥ 50
Increase in softening point, max - Severity 1	°C]		≤8	≤ 8	≤ 8	≤9	≤9
or			1	or	or	or	or	or
Increase in softening point, max - Severity 2 ^b	°C			≤ 10	≤ 11	≤ 11	≤ 11	≤1′
Flash point ^b	°C	EN ISO 2592	/	≥240	≥ 240	≥ 240	≥ 230	≥ 23
Solubility ^b	%	EN 12592	1	≥ 99	≥ 99	≥ 99	≥ 99	≥ 99
Change of mass after RTFOT ^b	%	EN 12607-1	1	≤0,5	≤0,5	≤ 0,5	≤ 0,5	≤0,

Ageing induced cracking:

Observations:

Block cracking can occur on aged pavements without reaching BBR $T_{critical}$ Materials rank differently for block vs. transverse cracking



Two binder parameters have been introduced in 2010

- **ΔTc** from Bending Beam Rheometer
- Glover Rowe from Dynamic Shear Rheometer (G*, δ at T=15°C and $\omega{=}0.005~s^{\text{-1}}$)

Bending Beam Rheometer (EN 14771)

	Α	В	С	D	Ε
Penetration	42	64	52	52	67
Softening Point	51.3	47.7	49.8	49.0	46.8
PI	-1.3	-1.2	-1.2	-1.4	-1.4
Fraass Breaking Point	-15	-14	-17	-14	-17



EN Grade 40/60 50/70 50/70 50/70 50/70

- On RTFOT-PAV aged sample a constant load is applied, the deformation is followed with time.
- Stiffness 'S' and slope of the creep curve 'm' (after 60s)
- To prevent fracture; a low stiffness and/or a large m-value are preferred
- More recently ΔT_c is measured





Ageing is a Process

AN

Fresh

Short Term Aged

Long Term Aged



Short and Long Term Ageing



Short and Long Term Ageing



Eurobitume database 168 bitumen available in the EU market, measured by Eurobitume members,

Nordic data base 38 bitumen available in the Nordic market, measured at SINTEF

Estonia report on 7 bitumens

Nynas data 28 bitumens

Conclusions

- Bitumen "travels further" today than it used to, giving more diversity in source and supply chain operations
- Specifications must reflect performance including the long term durability
- Wide variations observed in ΔT_c of bitumens available Europe
- Long term performance expected to be different, and
- Selection of bitumen all the more impo





Not just black but many shades of grey www.instituteofasphalt.org

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