



MODIFIED
ASPHALT
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CENTER



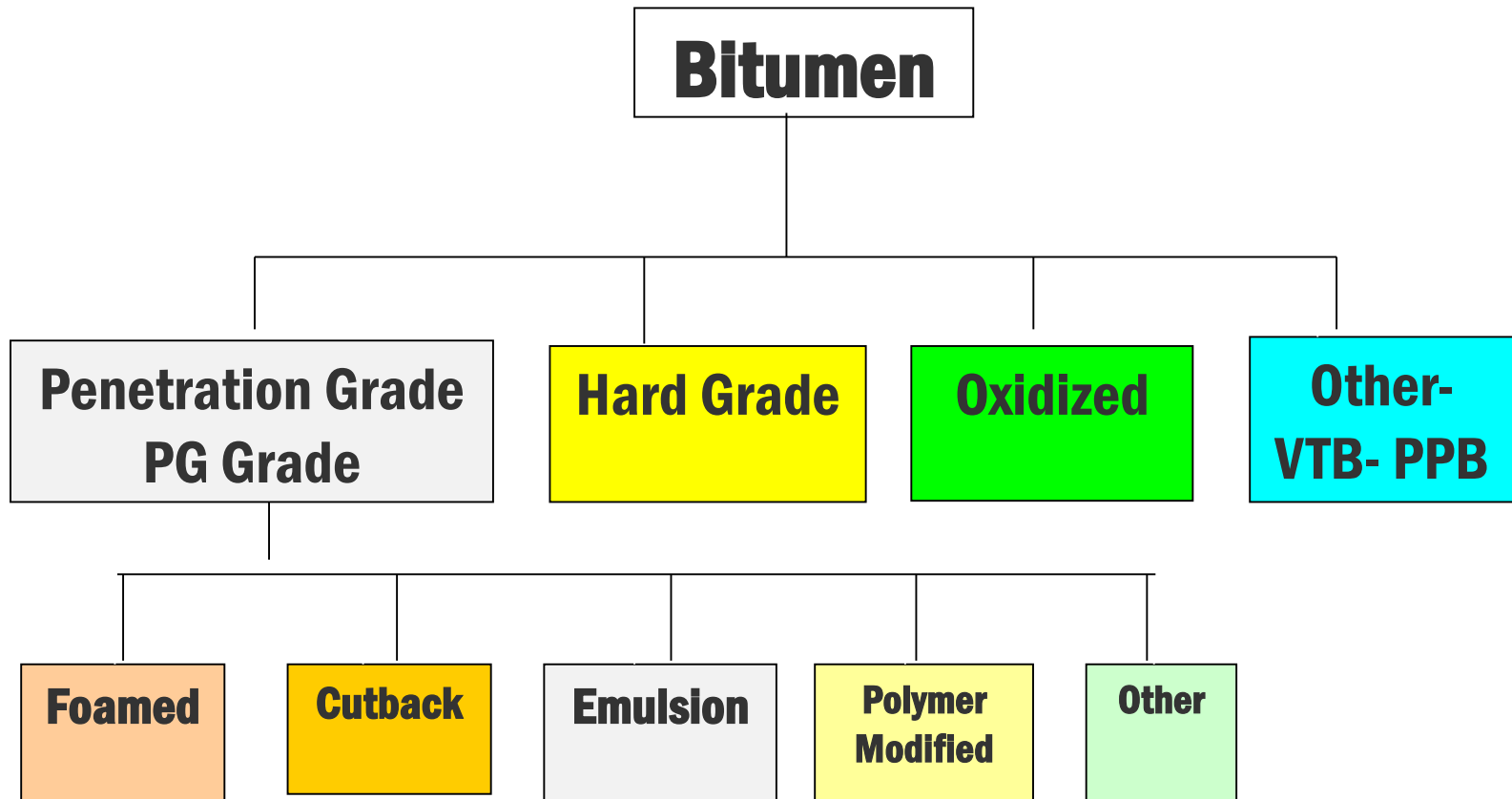
Bitumen Blending, Oxidation, and Quality Requirements

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Latest Technological Advances in Bitumen Testing and Evaluation

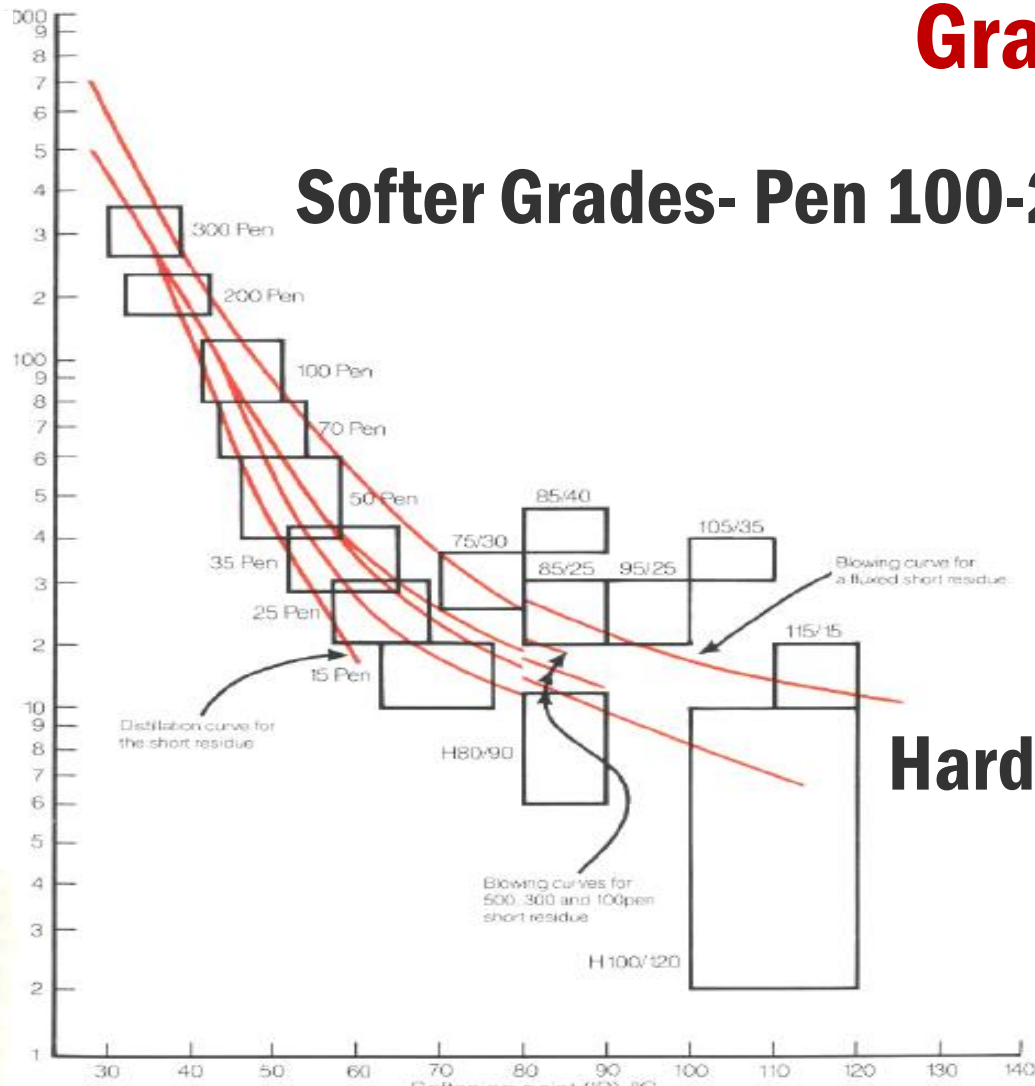
- **Bitumen sources and chemistry**
- **What is the risk in blending sources**
- **What is the risk in blending grades**
- **How can we control quality of blended bitumen**

Bitumen Types



Production of Pen and Roofing Grades

Penetration at 25 C

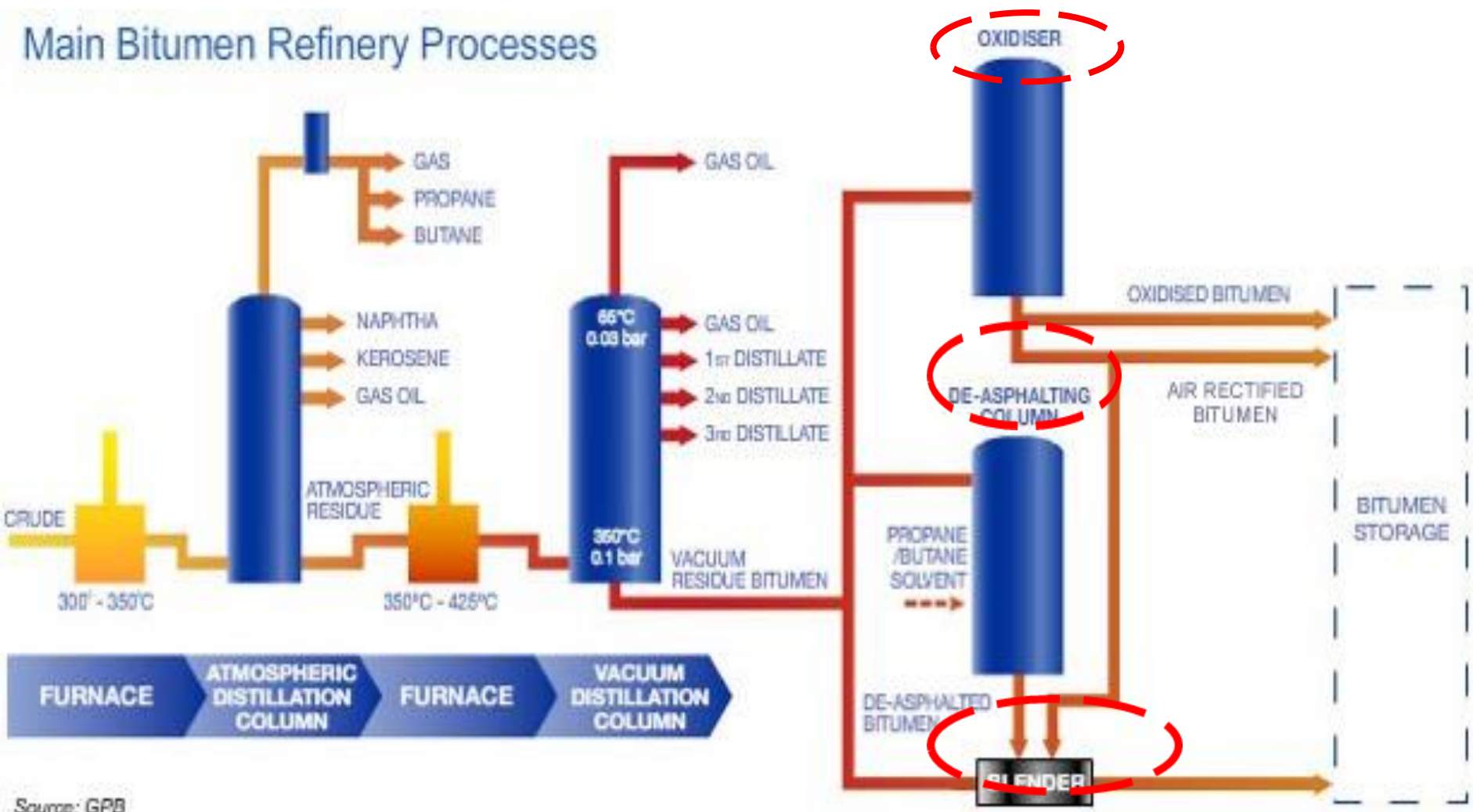


Softer Grades- Pen 100-200

Harder Grades - Pen 10-20

Softening Point, C

Main Bitumen Refinery Processes



Source: GPB

<http://www.eurobitume.eu/bitumen/production-process>

The Three Main Processes of Bitumen Production

Distillation

The most common refining process is **straight reduction** from crude or a crude blend, **using atmospheric and vacuum distillation**. To remove the last traces of the lighter fractions and avoid heat transformation of the molecules. Vacuum distillation is for pressure reduction to lower boiling temperatures and unwanted thermal cracking of the molecules can be avoided.

Solvent de-asphalting

Specific solvents can also be used to **separate the lubricant and bitumen components** of crude, without damaging their chemical structure. Along with finely controlled variations in the vacuum distillation process, these processes permit the production of bitumens with varying levels of penetration.

Oxidation

Bitumen can be further processed by blowing air through it at elevated temperatures (280°C on average) to alter its physical properties for commercial applications. Oxidised bitumen covers two distinct types depending on the degree of oxidation: **air rectified and oxidised**. Varying the length of the oxidation or air blowing process varies the extent of the reaction and produces distinctive end products. Oxidised bitumen is used in roofing applications, while air rectified bitumen is used in paving applications and some roofing applications.

Pitch- Cracking of Petroleum Fractions

- Bitumen is sometimes **confused with petroleum pitch** which is also derived from crude oil.
- Pitch is the **residue from the extreme heat treatment or “cracking”** of petroleum fractions.
- The properties and chemical composition are **quite different from those of bitumen**.
- Pitch blending could be **high risk for bitumen quality**.

The Blending of Bitumen Products

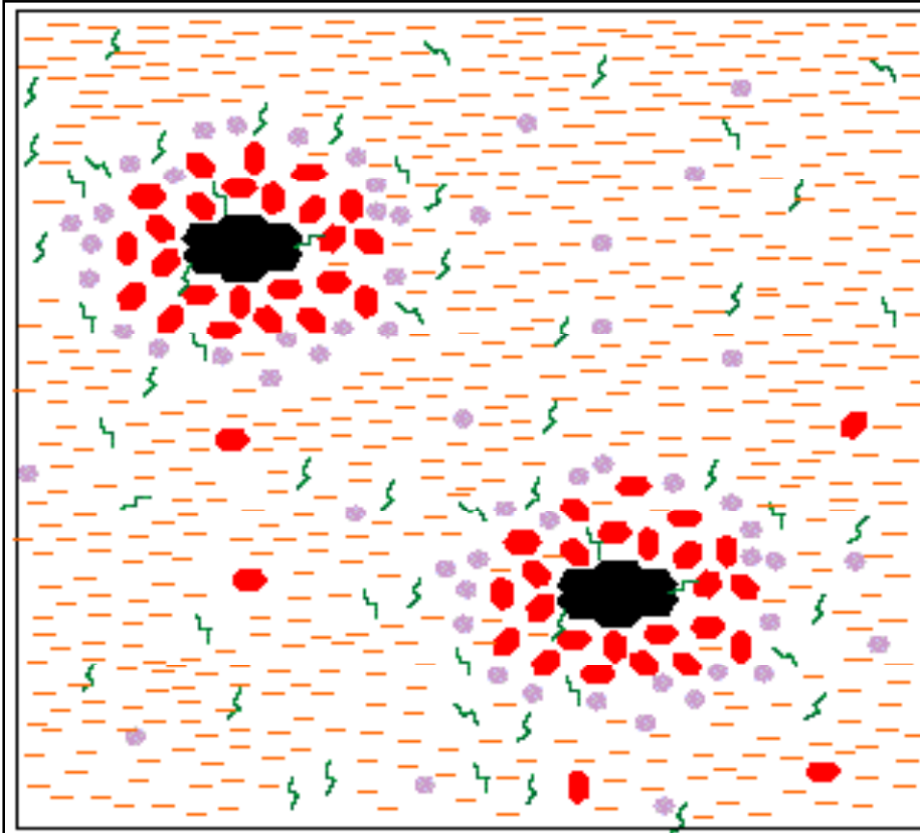
The final bitumen product can be produced to technical specification either:

1. **Directly in the refining process** or by blending bitumens with different physical properties.
2. **Blending of higher and lower viscosity residues** in the required proportions.
3. The blending **may take place at the refinery, at terminals or at a third party facility.**

Finished products can be easily transported and distributed for use.

Asphalt Molecular Structure

A Delicate Balance of Chemistry



Asphaltenes



Resin



Naphthenic Aromatic

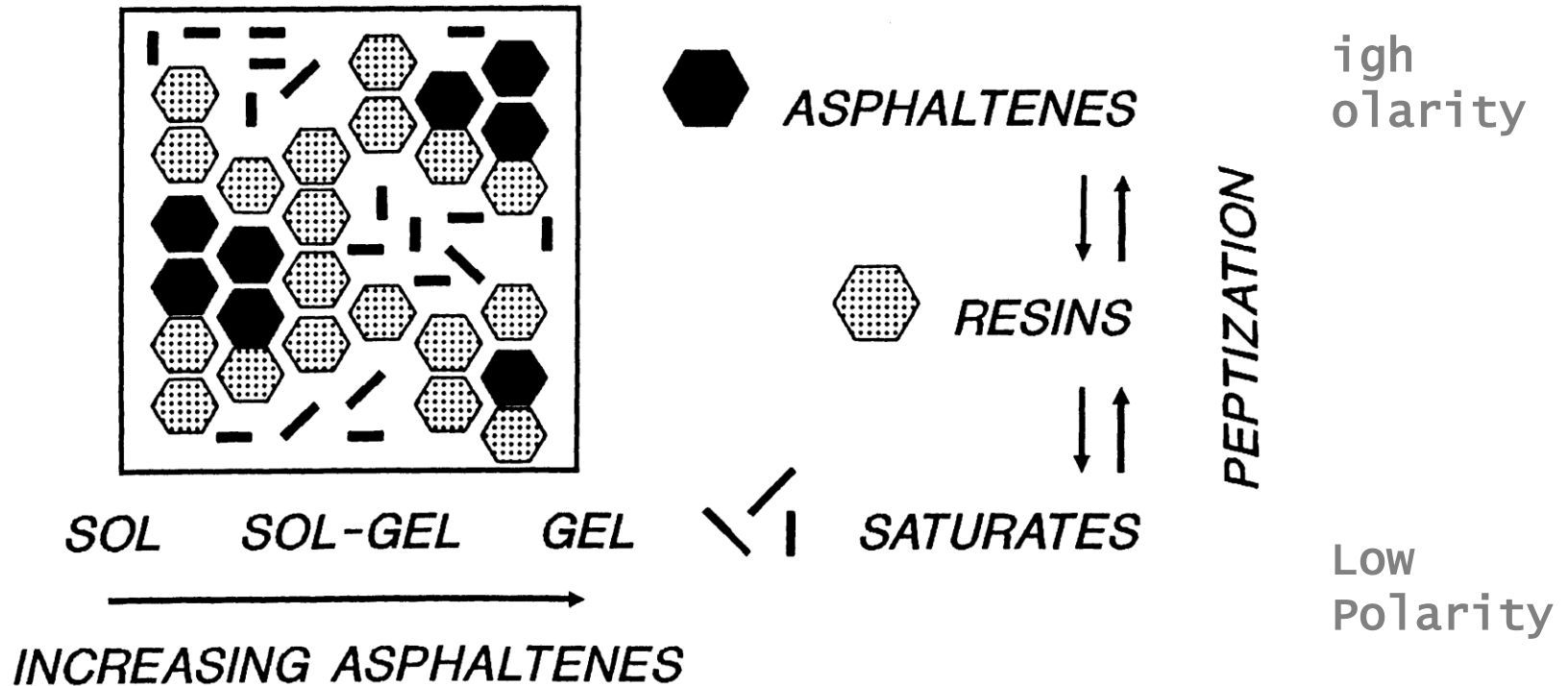


Naphthenic Aliphatic



Aliphatic- Saturates

Asphalt Molecular Structure Hypothesis



Risks to Quality

- **Blending from different sources** could be a problem. Not all chemistries are similar.
- **Oxidation changes chemistry**, molecular weight, and could upset balance of bitumen.
- **De-asphalted bitumen** is not really a paving grade material.
- **It is very hard to tell when Pitch** is used in bitumen production
- Soft bitumen-Vacuum Tower Bottoms (VBTs) are abundant.

Examples of VTB based feed stock in the GCC region

Property	Source 1	Source 2	Source 3
Pen at 25 C, dmm	119	169	60
R&B Softening Pt, °C	43	34	51
Ductility, cm	84	>125	>125
Flash point , C	321	328	346
R. Vis at 135C	212	100	388

Asphalt Molecular Structure

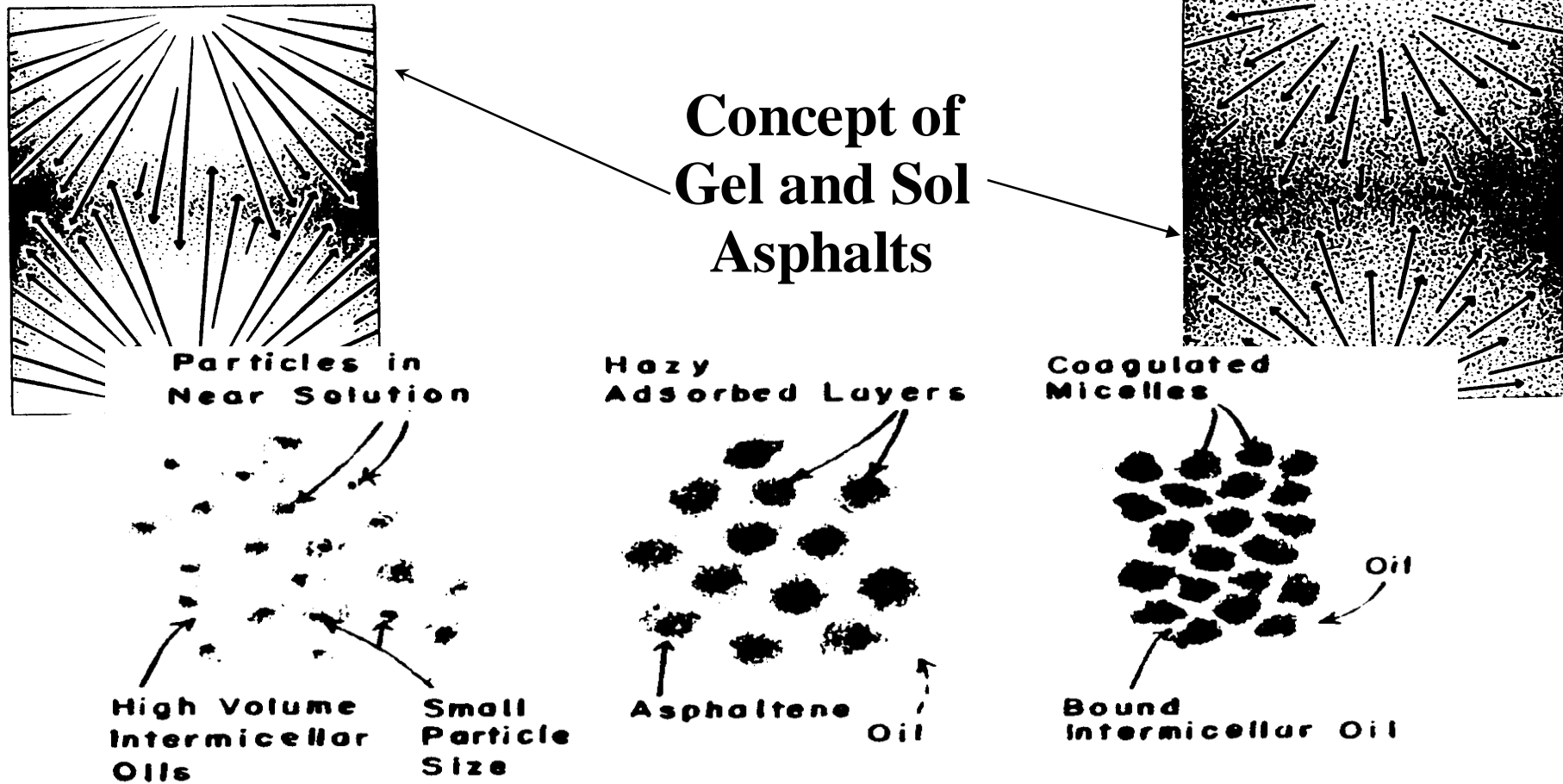
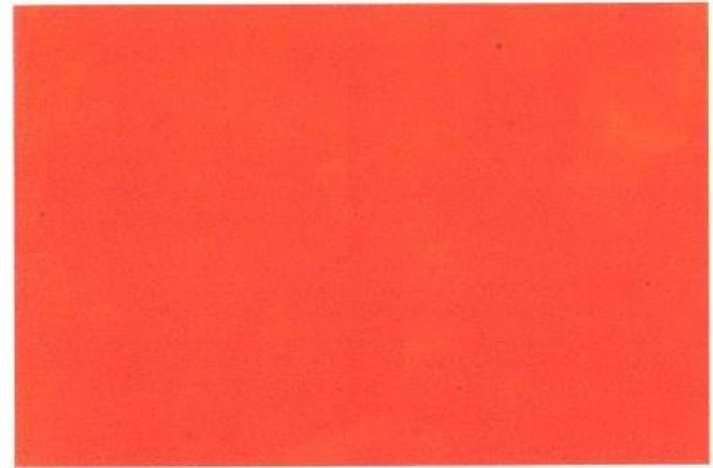


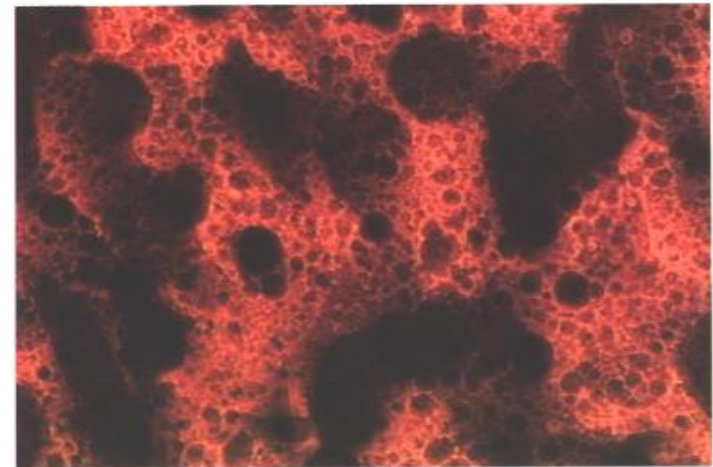
Fig. 4. Diagrammatic sketch of particles in asphalt types: (a) sol asphaltene; (b) sol-gel asphaltene; (c) gel asphaltene.

Bitumen Compatibility

- **Highly related to production**
- **Best is straight run**
- **All blending steps impose risks**
- **Within a refinery is the least risk**
- **Too hard + too soft is the highest risk**



Photograph 5.8a — Compatible bitumen

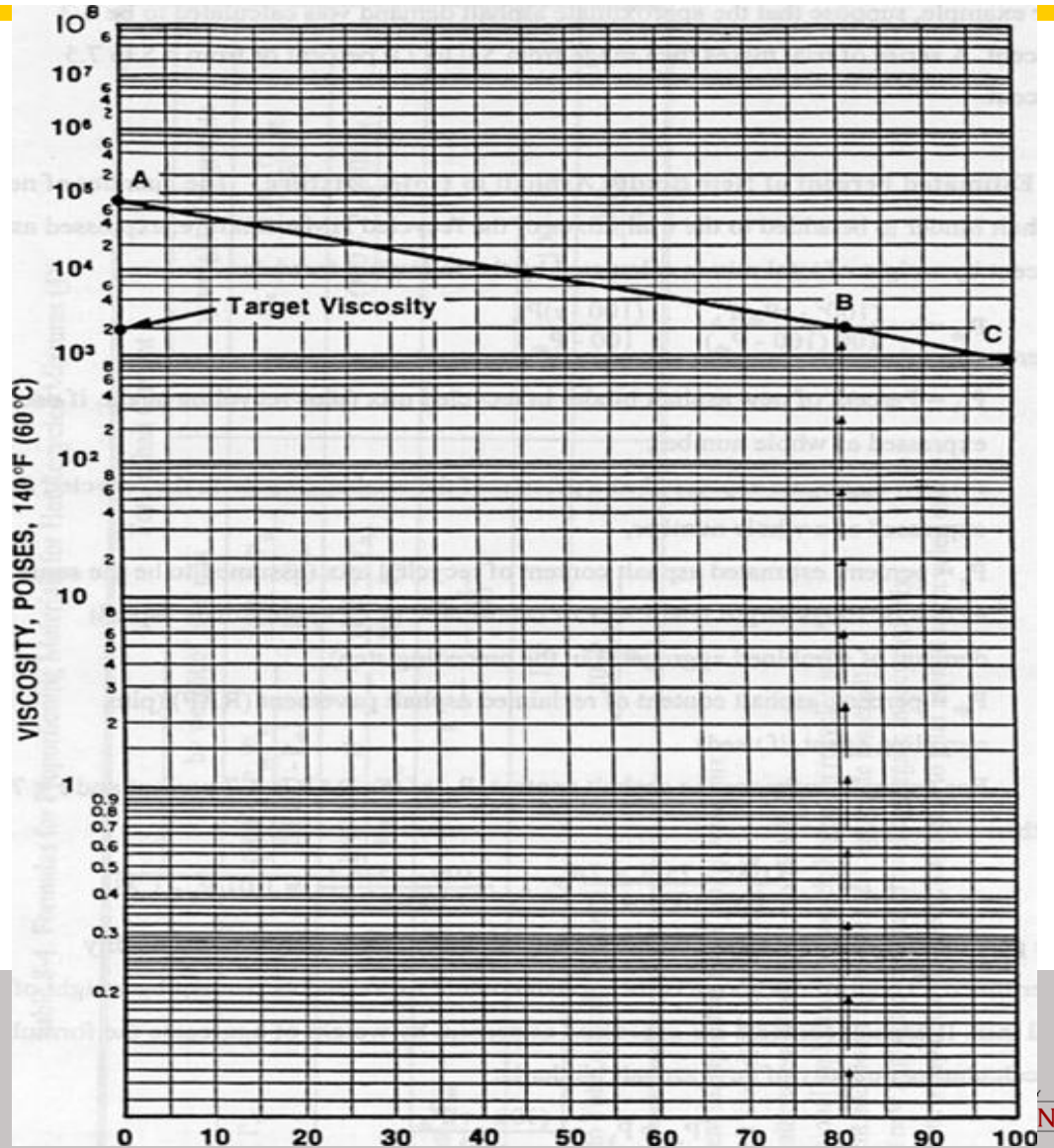


Photograph 5.8b — Incompatible bitumen

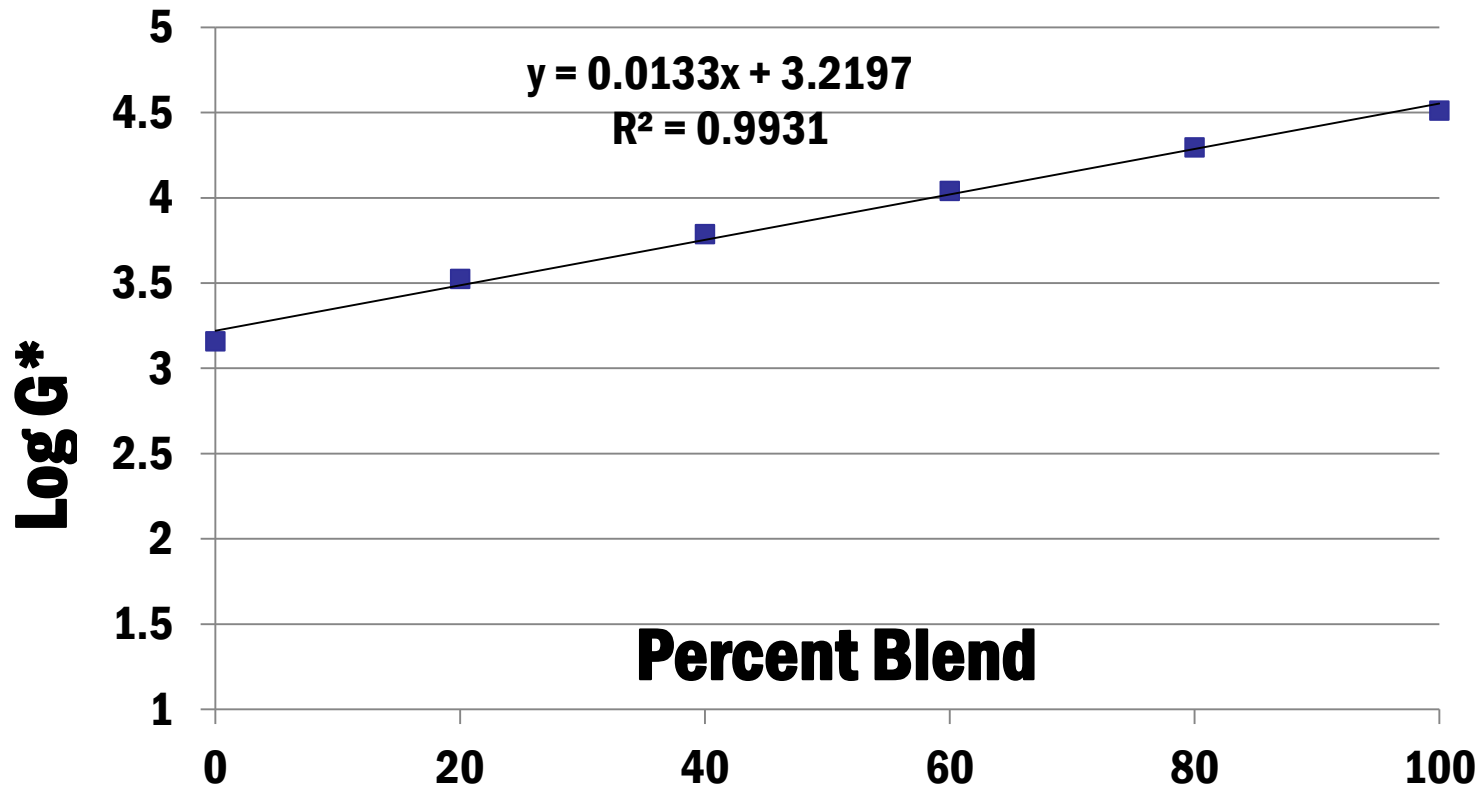
Source: Shell Handbook

Viscosity Blending Chart

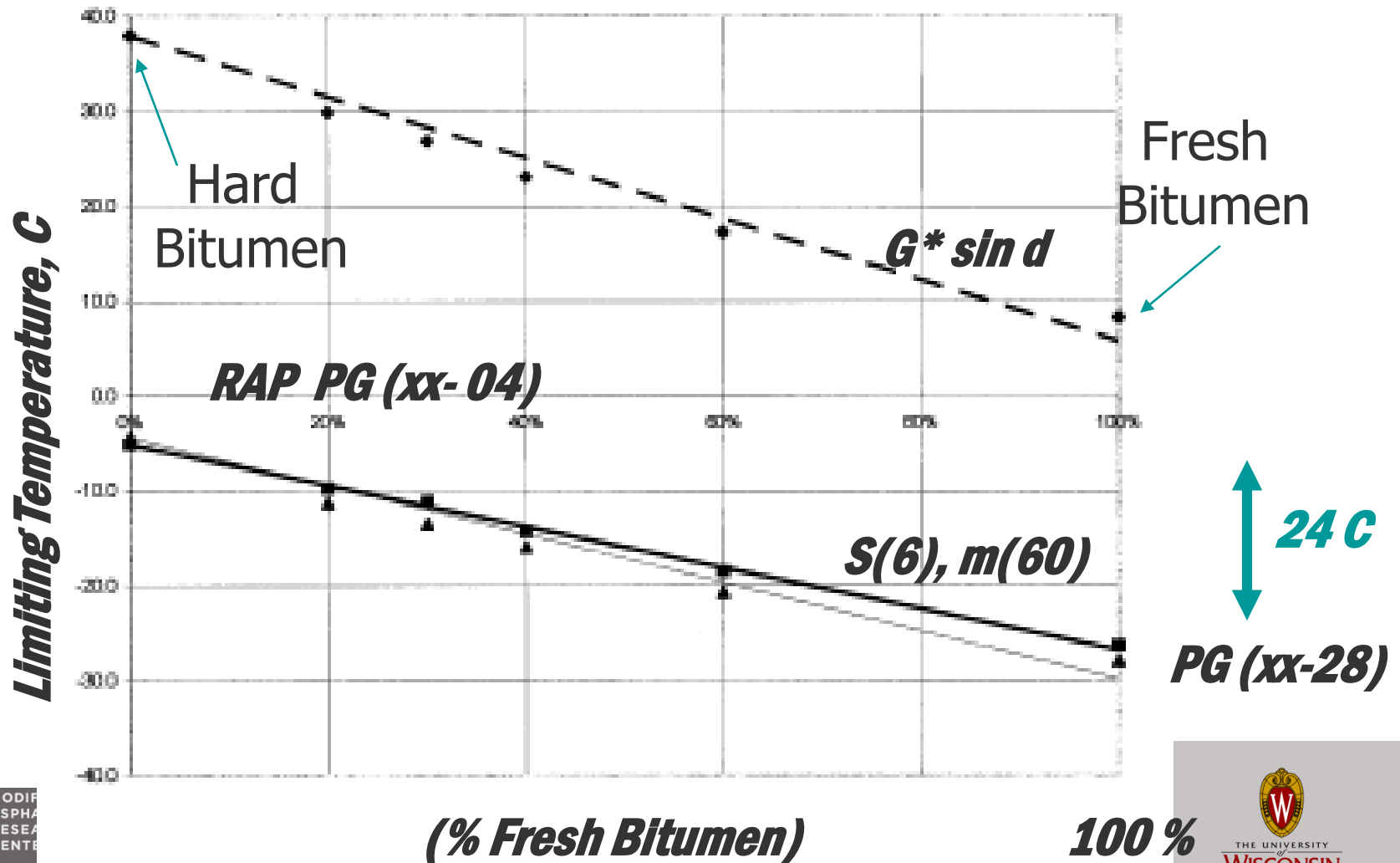
- Blend A- Hard
- Blend C- Soft
- Log Viscosity versus % blend



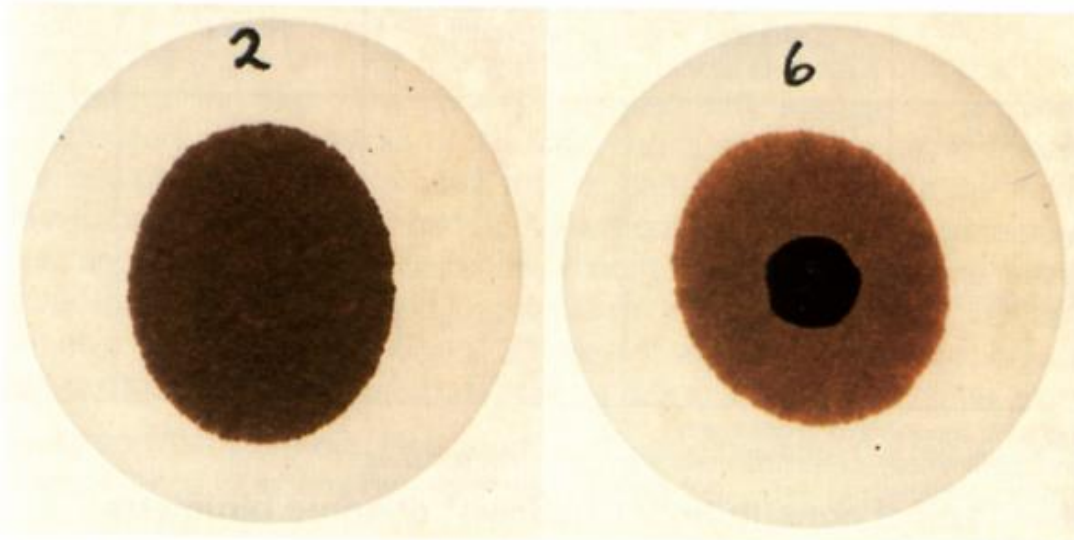
Development a simple blend chart



Example for Blending of PG Binders with different Grades



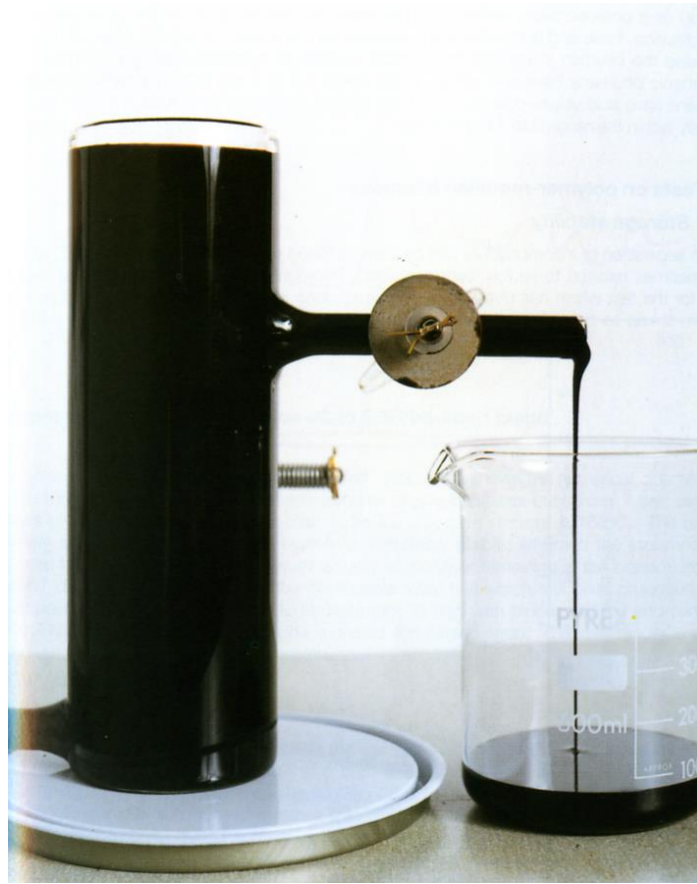
Checking Quality of Blends- Spot Test



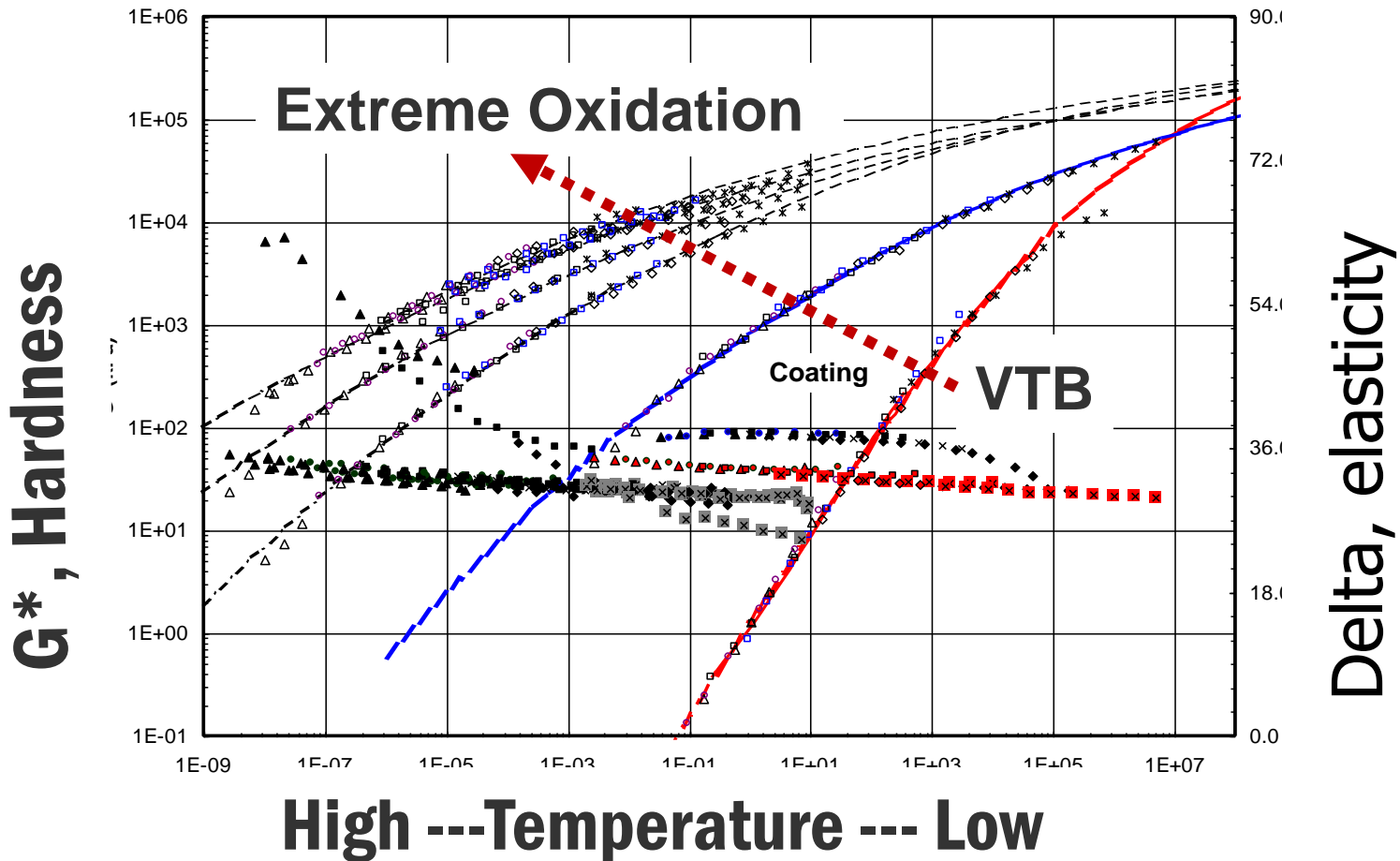
A spot of bitumen is placed on a filter paper and several drops of a special solvent are washed over the sample. After a short time the solvent is seen to form a brown ring around the bitumen drop. If a black ring develops within the brown ring the test is deemed to be positive, otherwise it is negative.

This test was developed to detect cracked petroleum residues in bitumen formed during excessive heating of the bitumen. However, it is now known that some crudes produce bitumens which give positive results in this test.

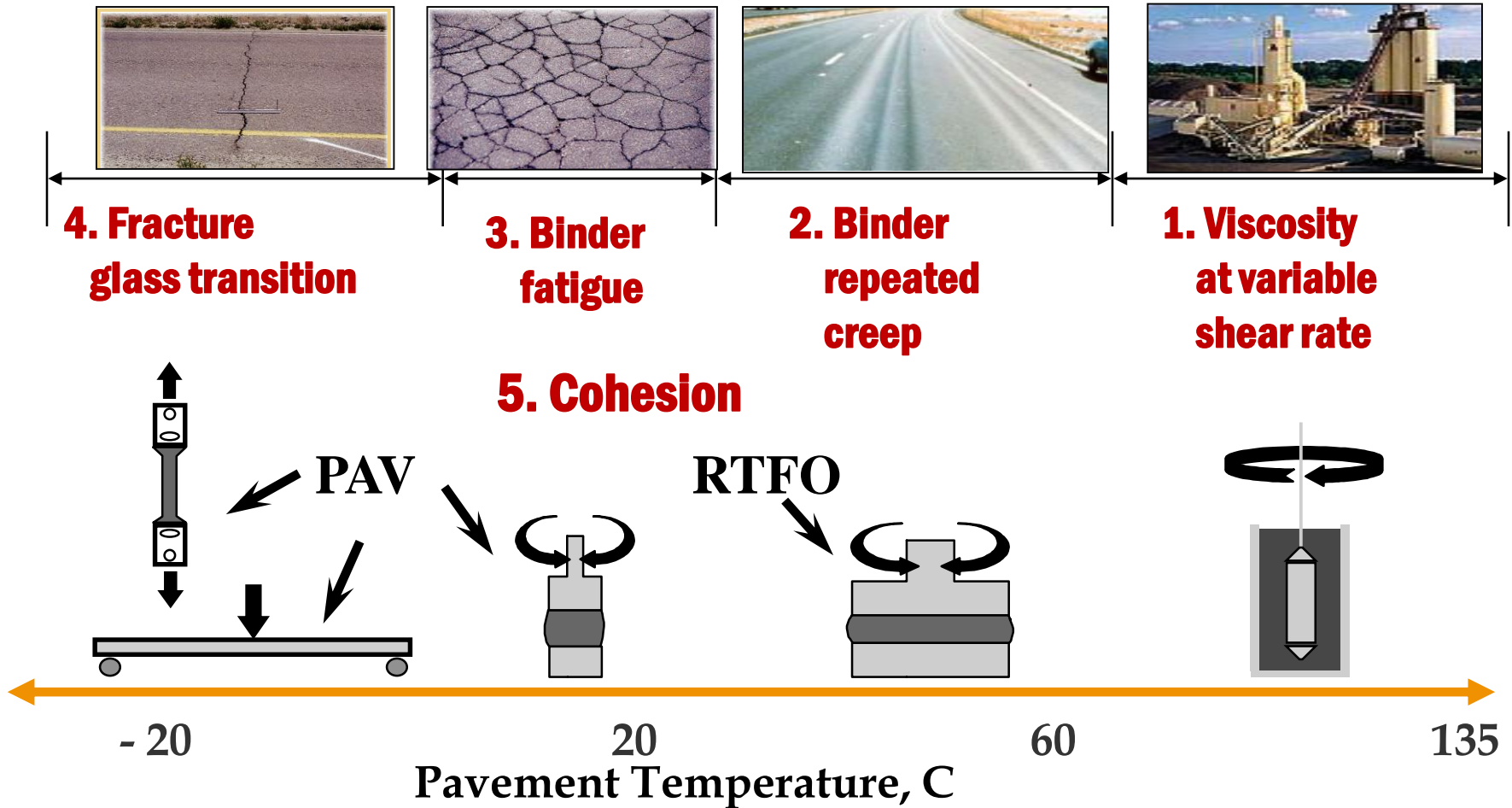
Hot Storage Test- Poor blends will Separate



Rheology can be used to detect problems and establish consistency

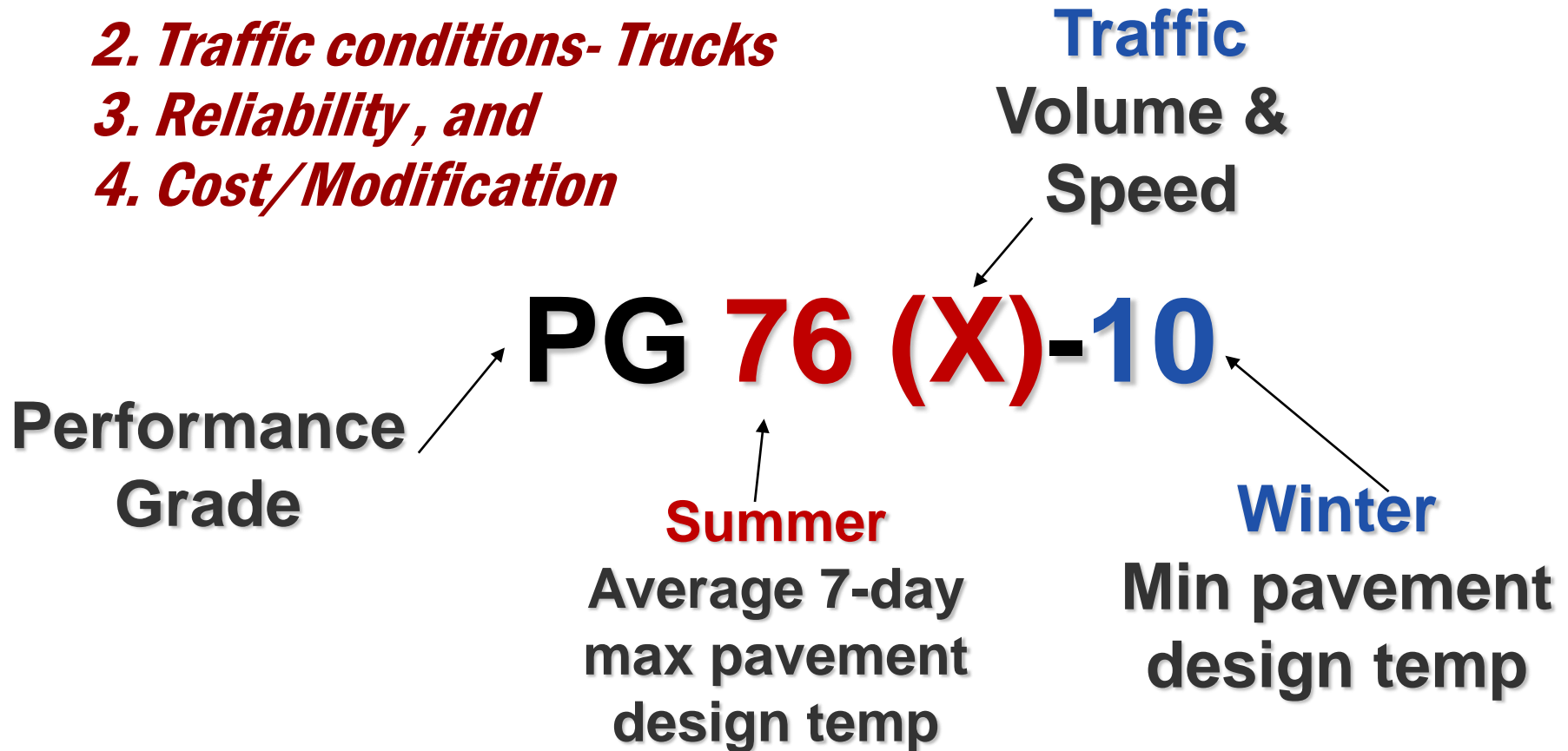


New / advanced testing proposed for modified bitumens

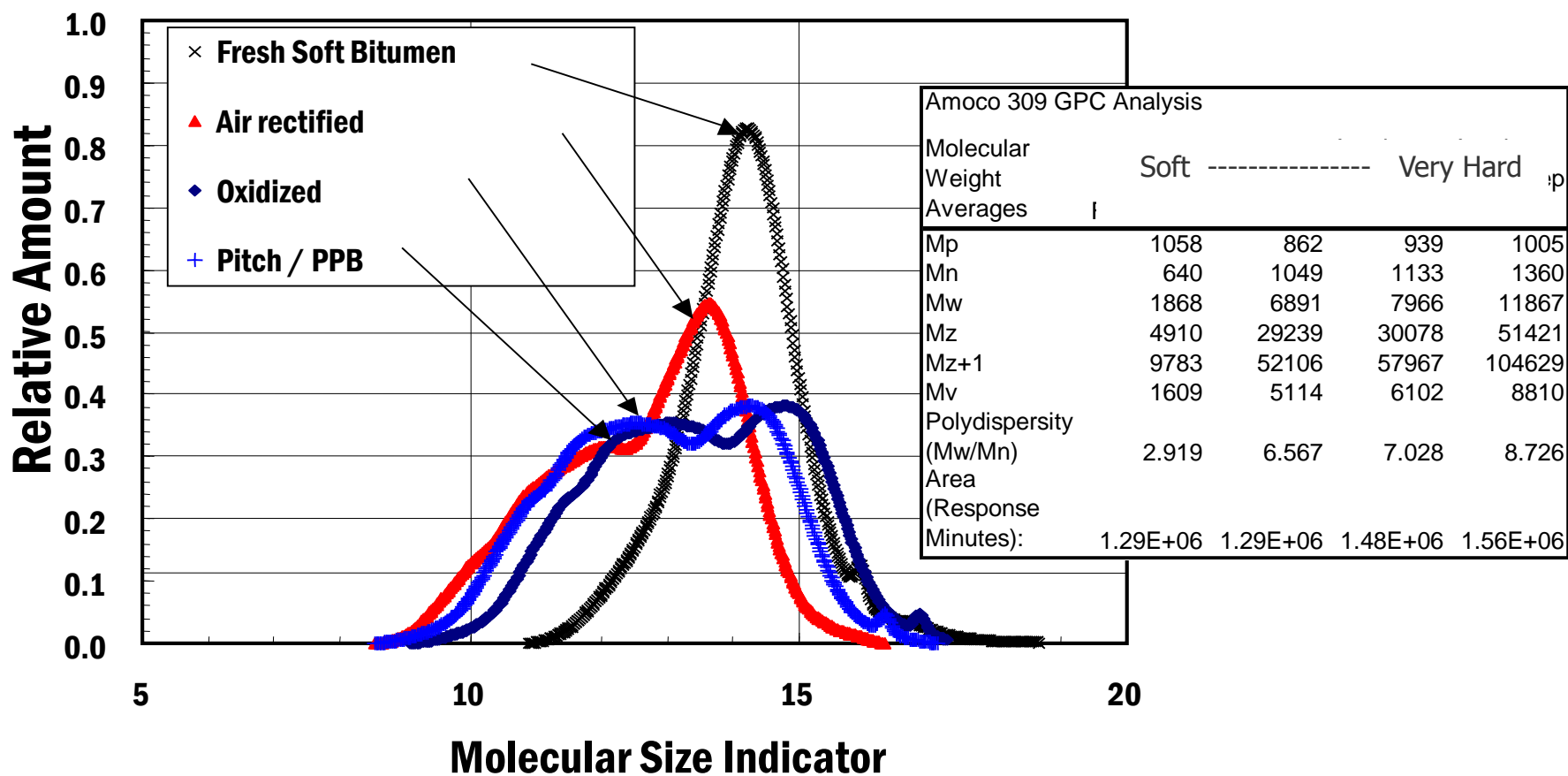


Bitumen Grading System- PG

- 1. Climate*
- 2. Traffic conditions- Trucks*
- 3. Reliability, and*
- 4. Cost/Modification*



Measuring Molecular Structure – Chromatography (GPC)



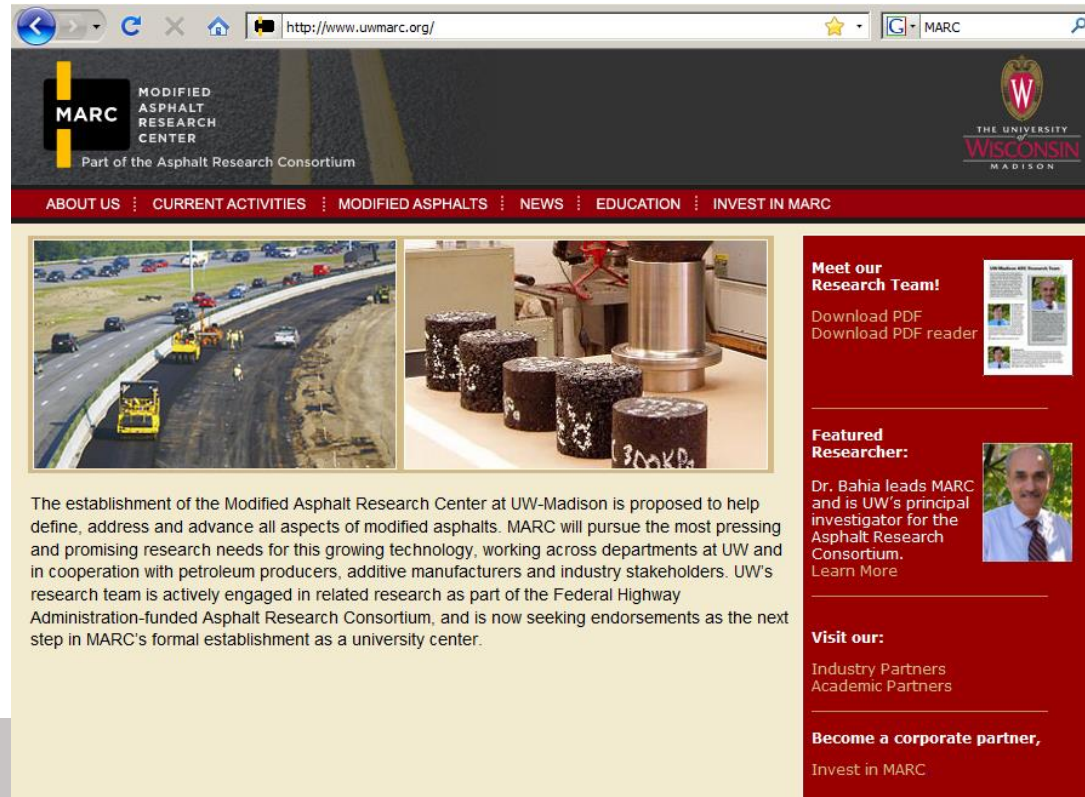
Concluding Remarks- Bitumen Blending

- **Straight-run bitumen** is simplest and most consistent
- **Oxidation, rectification, de-asphalting and cracking** are common refinery practices that present risk to quality
- **Blending will continue** to be used to provide bitumen, **Mixing of sources** is very risky
- Measures to check quality and prevent poor quality need to be practiced
- Chemical, **rheology and GPC** are potential quality control tools
- **Performance grading (PG)** is one of the good tools

Thank You

- Organizers of the conference
- Sponsors / partners of MARC

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The screenshot shows the website for the Modified Asphalt Research Center (MARC) at the University of Wisconsin-Madison. The browser address bar displays <http://www.uwmarc.org/>. The website header includes the MARC logo, the text "MODIFIED ASPHALT RESEARCH CENTER Part of the Asphalt Research Consortium", and the University of Wisconsin-Madison logo. A navigation menu lists: ABOUT US :: CURRENT ACTIVITIES :: MODIFIED ASPHALTS :: NEWS :: EDUCATION :: INVEST IN MARC. The main content area features two images: a highway construction site and laboratory asphalt samples. Below the images is a text block: "The establishment of the Modified Asphalt Research Center at UW-Madison is proposed to help define, address and advance all aspects of modified asphalts. MARC will pursue the most pressing and promising research needs for this growing technology, working across departments at UW and in cooperation with petroleum producers, additive manufacturers and industry stakeholders. UW's research team is actively engaged in related research as part of the Federal Highway Administration-funded Asphalt Research Consortium, and is now seeking endorsements as the next step in MARC's formal establishment as a university center." To the right, a red sidebar contains the following sections: "Meet our Research Team!" with links to "Download PDF" and "Download PDF reader"; "Featured Researcher:" with a photo of Dr. Hussain U. Bahia and text stating "Dr. Bahia leads MARC and is UW's principal investigator for the Asphalt Research Consortium. Learn More"; "Visit our:" with links for "Industry Partners" and "Academic Partners"; and "Become a corporate partner, Invest in MARC".