

Dynamic Shear Rheometers (DSRs) & Rheological Applications

Georges Mturi, CSIR

Road Pavements Forum, Cape Town, 8-9 May 2018

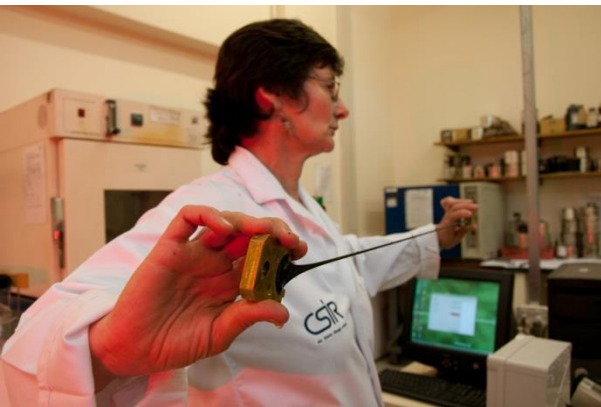
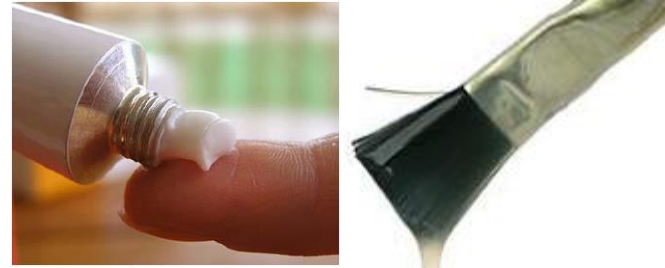
Overview

- Rheology
- Rheometry
- Dynamic Shear Rheometers
- SASOR

Rheology

- Rheology is literally Greek for “flow science”
- The technical definition is **the science of deformation and flow.**
- Rheology is a branch of physics and physical chemistry.

Rheology



Rheology

- In practice, rheology is used as a problem solving tool to answer the questions:
 - Will the material **pour out**?
 - Will it be **stable**?
 - Will it **spray**?
 - Will it **settle**?
 - Will it **crack**?
 - Will it **deform**?

Different industries...
...different questions?

Rheology

- Testing
 - Typically, testing can either be in terms of **flow** (viscosity) and/or **deformation** (oscillation).
 - Flow – mimics processing conditions
 - Deformation – quantifies viscoelasticity (performance)

Rheometry

- Measuring technology used to determine rheological data:
 - Instruments – flow cups, capillary viscometers, rotational/oscillatory viscometers/rheometers, etc.
 - Measuring systems
 - Tests
 - Analysis methods

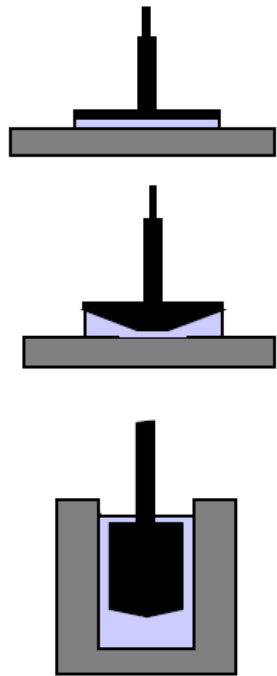
Dynamic Shear Rheometer

- Measures fundamental material rheological properties.



Dynamic Shear Rheometer

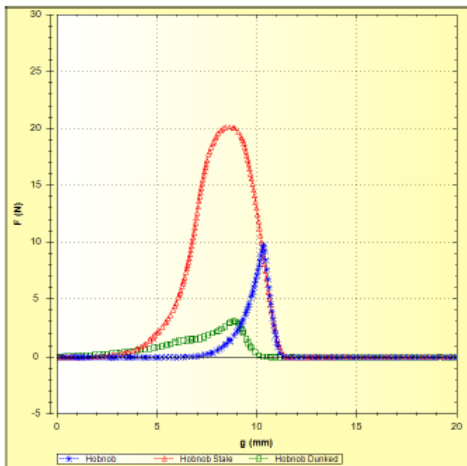
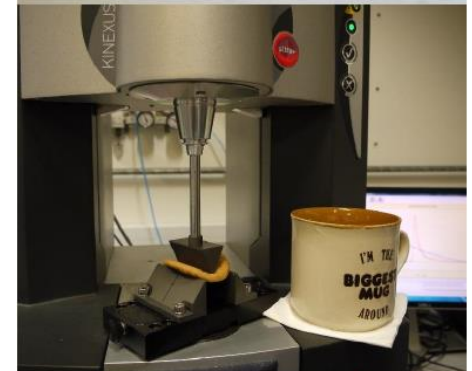
- Measures material rheology



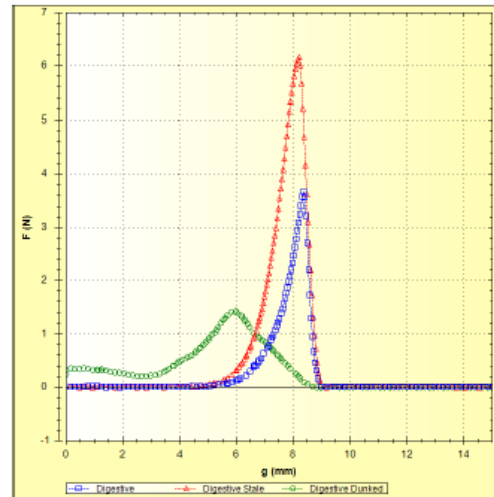
Polymers
Coatings
Food
Cosmetics
Pharmaceuticals
Petrochemicals
Bitumen
Automotive
Adhesives/sealants
Building materials
Mining
...etc.

Dynamic Shear Rheometer

- Providing the science of material performance.

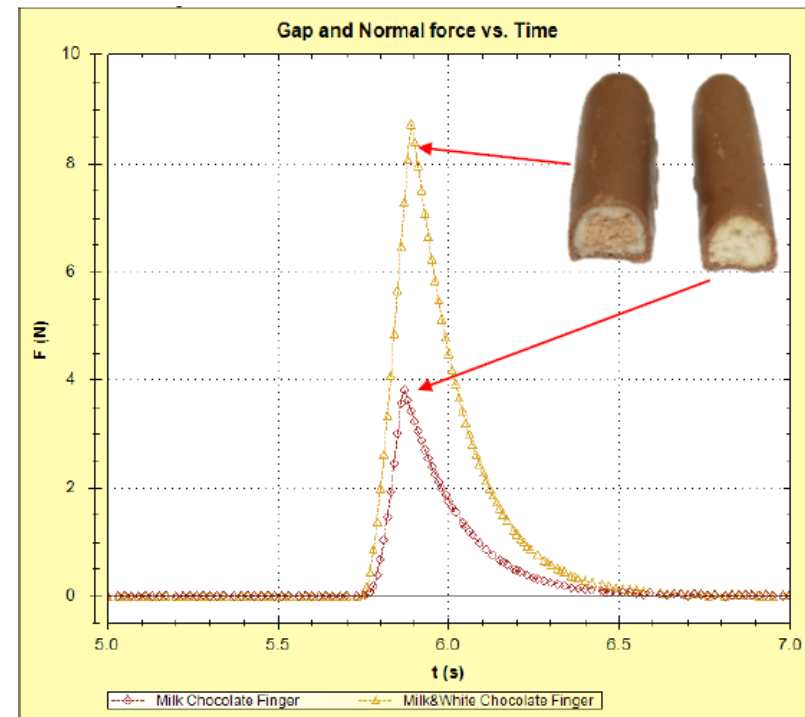
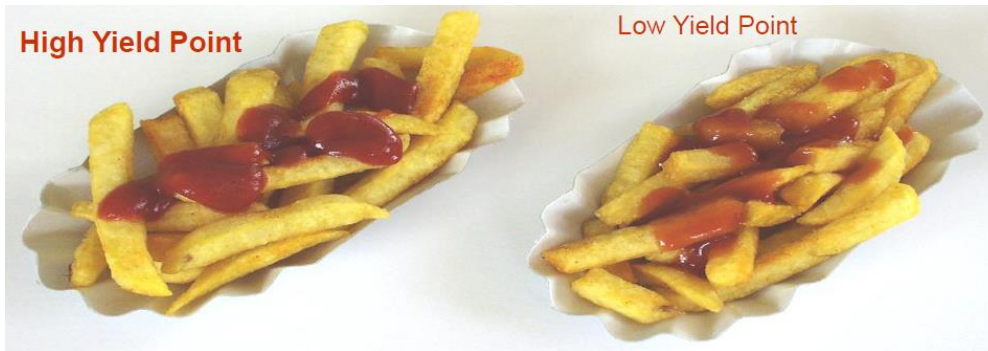


Stale
Fresh
Dunked

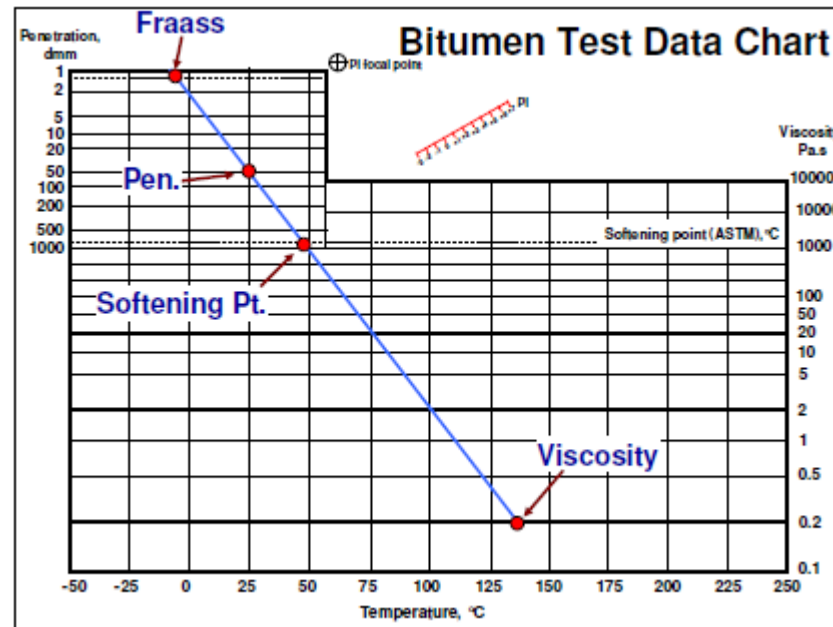
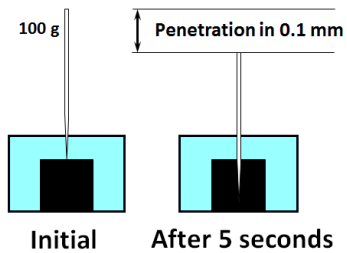


Dynamic Shear Rheometer

- Providing the science of material performance.



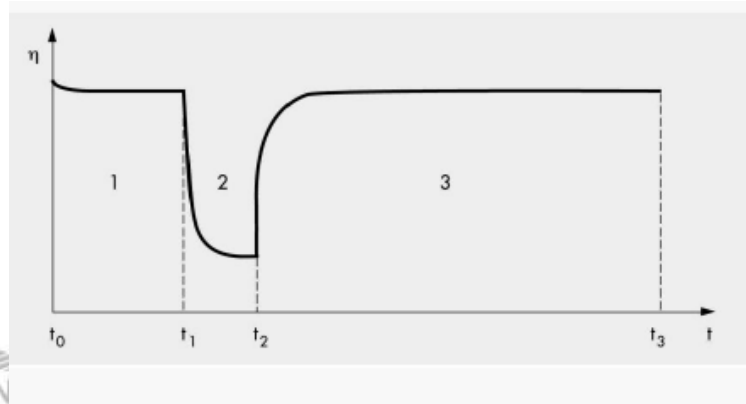
Dynamic Shear Rheometer



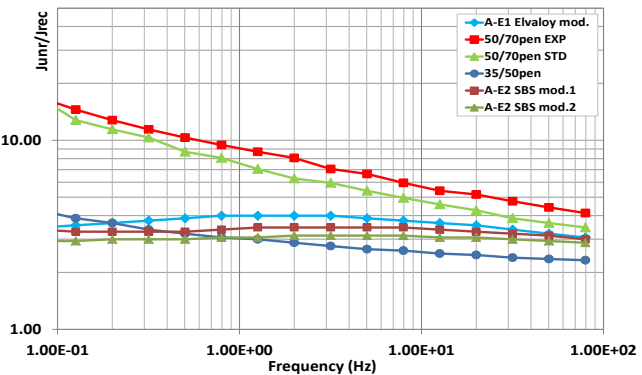
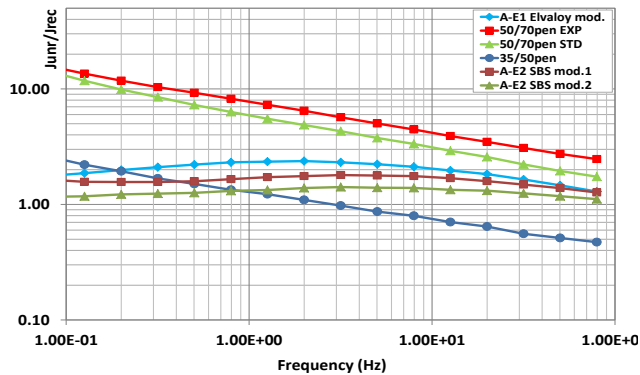
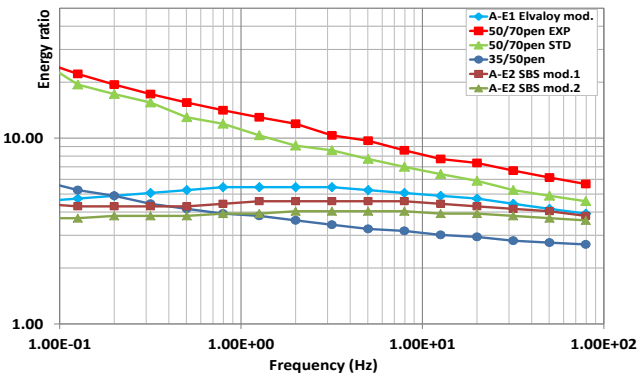
Why pay more?

Dynamic Shear Rheometer

- DSR is not necessarily for replacing traditional tests that work
- DSR is an effective tool to give notably better solutions
 - Instead of waiting days to simulate the drain-out properties of an emulsion, why not do a 30 minute thixotropic test?



Dynamic Shear Rheometer



$$\frac{W_{dis.1/4}}{W_{st.1/4}} = \frac{-(0.5\varepsilon_0\sigma_0 \cos \delta) - (0.25\pi\varepsilon_0\sigma_0 \sin \delta) + (0.5\sigma_0\varepsilon_0 \cos \delta)}{(-0.5\sigma_0\varepsilon_0 \cos \delta)}$$

$$= 0.5\pi \tan \delta$$

$$\% \gamma_{unr} = \frac{100\sigma_0}{|G^*|} \left(1 - \frac{1}{\tan \delta \sin \delta} \right)$$

$$S(t) = 1/D(t) \approx \frac{3G^*(\omega)}{[1 + 0.2 \sin(2\delta)]}$$

$$J_{rec} = G' / (G'')^2$$

$$J' = \cos \delta / G^*$$

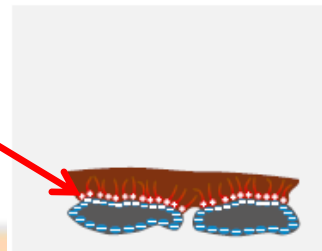
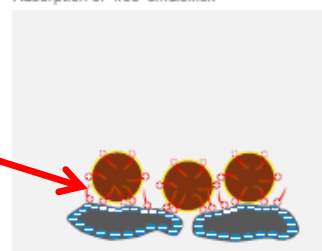
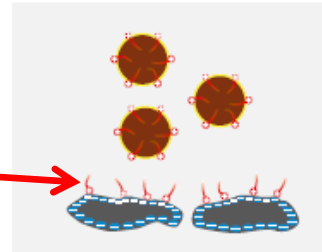
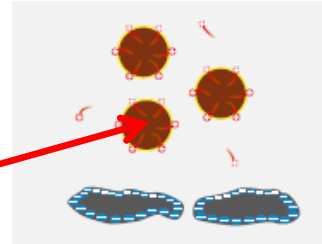
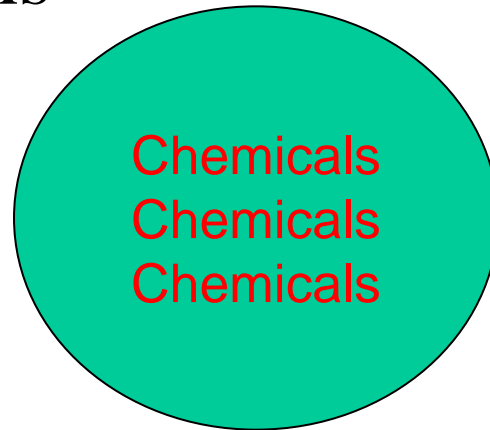
Dissipated:
stored energy
ratio

J_{unr}/J_{rec}

J_{unr}/J_{rec}

Dynamic Shear Rheometer

- Rheology effect from chemical interactions



SASOR

- SASOR was officially launched at the 1st Rheology Conference in September 2006 and was inaugurated as part of European Society of Rheology since 2010.
- Aim is to promote the science within Southern Africa by organising regular meetings
 - academia and industry and international experts in the field
 - demonstrate the advantages of rheology as a tool to improve industrial processes and product performance.

SASOR 2010

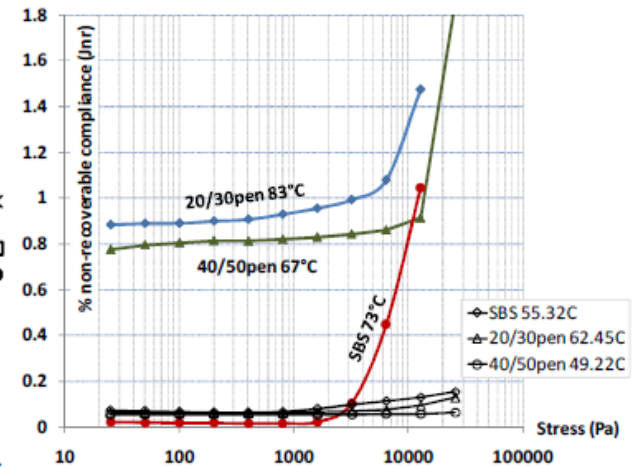
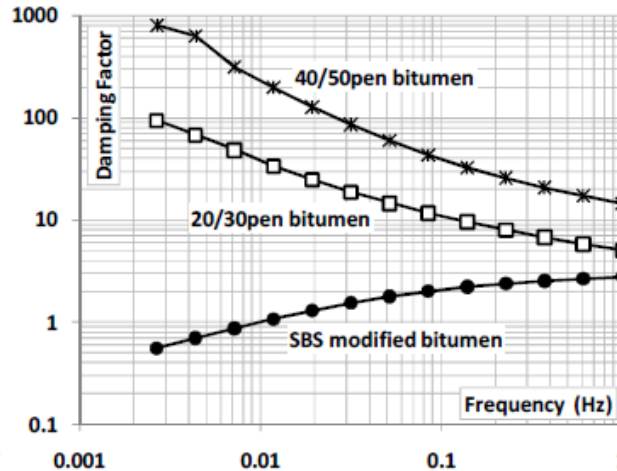
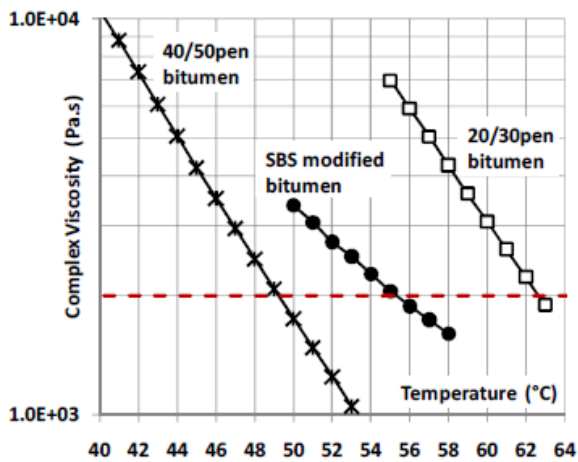


SASOR 2010, CapeTown, 8 – 10 September 2010

CHALLENGES IN RHEOLOGICAL CHARACTERISATION OF ROAD BITUMENS

S.E. Zoorob, G.A.J. Mturi, J. O'Connell

SASOR 2010



SASOR 2016



SASOR Short Courses

2006	Rheology and engineering applications of multi-component materials	Prof Alex Malkin Prof Raj Chhabra
2007	Rheology of food emulsions	Dr Peter Fischer
2008	Rheology of polymers	Prof Raj Chhabra
2009	Rheology of multi-component materials	Prof Alex Malkin Prof Irina Masalova
2011	Rheology of polymers and polymer processing	Prof Jeffrey Giacomin Prof Gerry Fuller Dr Massimo Baiardo Dr Loredana Pop Dr Samir Mukhopadhyay
2013	Application to Polymers, Emulsions and Suspensions: Product formulation – Rheology – Processing	Prof Jan Mewis Mr Peter Goosen



RHEOLOGY
SHORT COURSE 2015

**CAPE PENINSULA UNIVERSITY OF TECHNOLOGY
IN ASSOCIATION WITH SASOR IS PRESENTING A:
CEMENT AND CONCRETE RHEOLOGY SHORT COURSE**

18-19 November 2015

Location: Plastic Federation, 18 Gazelle Ave, Corporate Park South, Midrand



We look forward to see
you at our next event



RHEOLOGY
CONFERENCE 2018

SASOR 2018:

7TH RHEOLOGY CONFERENCE AND SHORT COURSE

25-28 SEPTEMBER 2018,

STIAS (STELLENBOSCH INSTITUTE FOR ADVANCED STUDY)

WALLENBERG RESEARCH CENTRE IN STELLENBOSCH, SOUTH AFRICA.

www.sasor.co.za



We look forward to see
you at our next event

