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Standard materials
i. IUPAC-LDPE – J.Meissner 1975 Pure & Applied Chemistry

# Standard Materials – M1

ii. The M1 fluid T.Sridhar (1990) JNNFM 35

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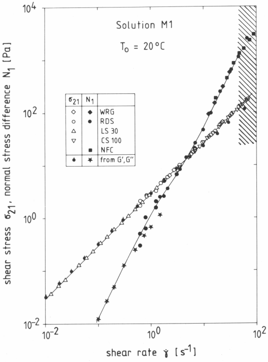


## Steady shear

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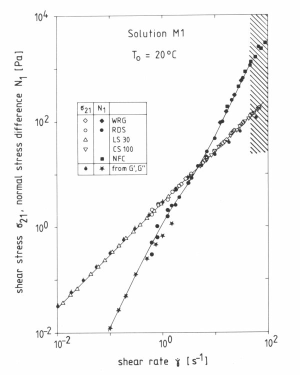



Steady shear

Laun & Hingham (1990) JNNFM 35

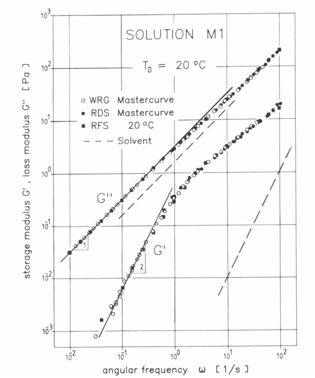
Boger fluid:

$\mu(\dot{\gamma}) \approx \mathrm{const},$

$N_1 \propto \dot{\gamma}^2$

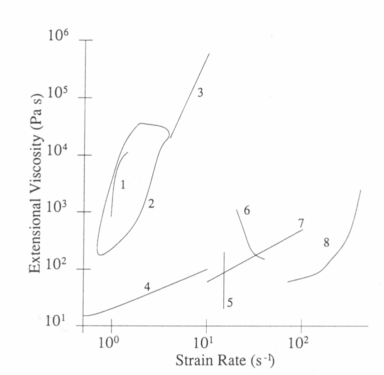
## Oscillating shear

Laun & Hingham (1990) JNNFM 35



# Standard Materials 3 – M1 continued

Extensional viscosity




M1 data collected by Keiller (1992) JNNFM 42

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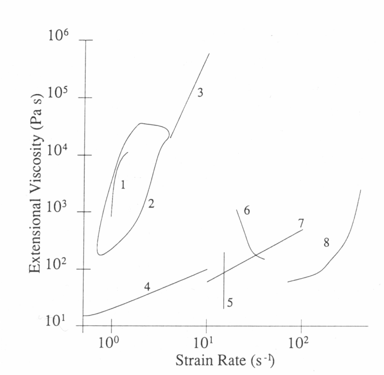


M1 data collected by Keiller (1992) JNNFM 42

Confusion, but very large stresses

# Standard Materials 4 – S1

iii. The S1 fluid N.Hudson (1994) JNNFM 52

5% polyisobutylene in decalin

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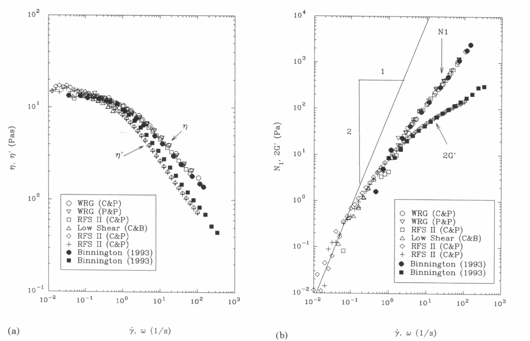
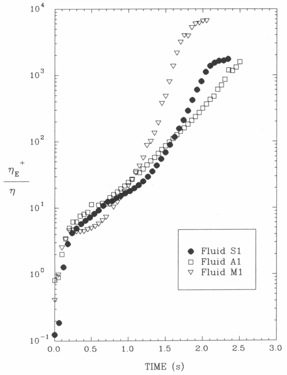
## Shear   Ooi & Sridhar (1994) JNNFM 52




Shear-thinning

# Standard Materials 5

Extension of S1, A1 & M1 Ooi & Sridhar (1994) JNNFM 52




as function of time

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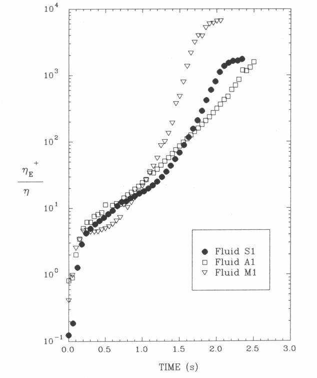


as function of time

– all solutions of similar high molecular weight polymer

# Observations

- Volume flow, Visualisation, LVA, PIV, NMR

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- $\Delta p$
  - but large entry loss
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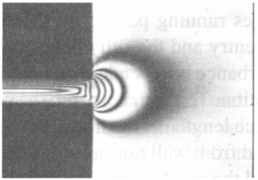
- Birefringence: assume stress-optical law

$$\sigma = C\Delta n$$

# Birefringence

## Observed birefringence

Martyn, Nakason & Coates (2000) JNNFM 91



(b) slit wall shear rate = 255 $s^{-1}$

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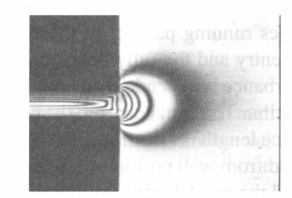

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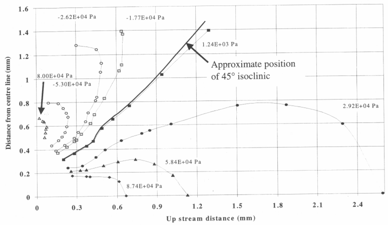
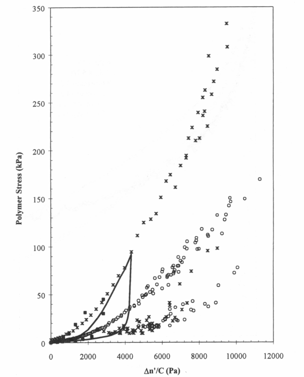
## deduced stress contours



# Birefringence 2

## Start up of extensional flow at different strain-rates




Sridhar (2000) JNNFM 90

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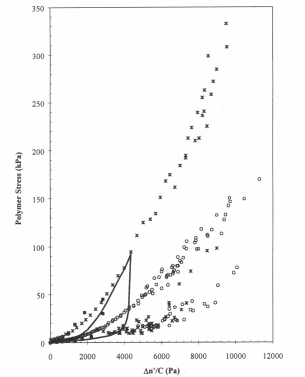


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Failure of stress-optical law

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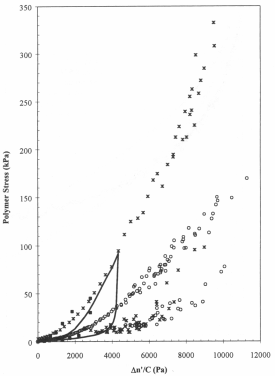


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Failure of stress-optical law

– bond alignment vs overall deformation

# Practical problems

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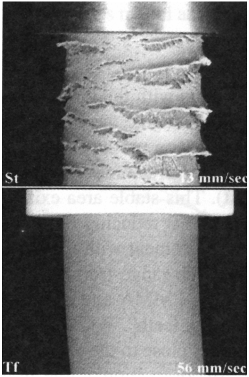
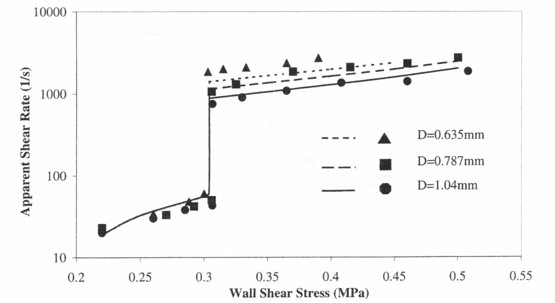
- Viscous heating with $\mu(T, p, \dot{\gamma})$
- Phase separation/crystallisation
- Degradation – light, UV, bio, mechanical

# Practical problems – wall slip

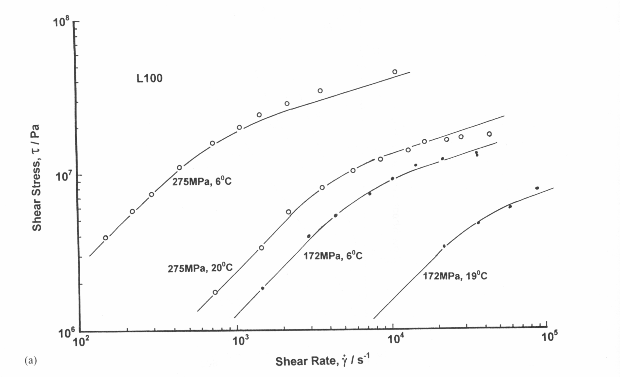



Kulikov (2001) JNNFM 98




Joshi (2000) JNNFM 94

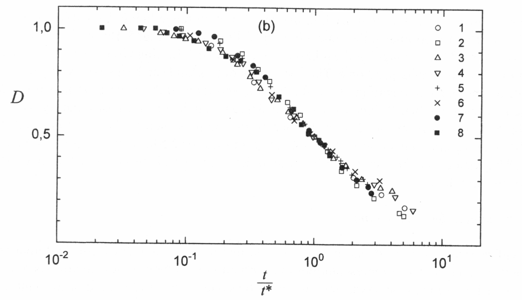
# Practical problems – $\mu(T, p, \dot{\gamma})$




Blair (2001) JNNFM

# Practical problems – mechanical degradation

## Drag reduction decrease in time




Kalashnikov (2002) JNNFM 103

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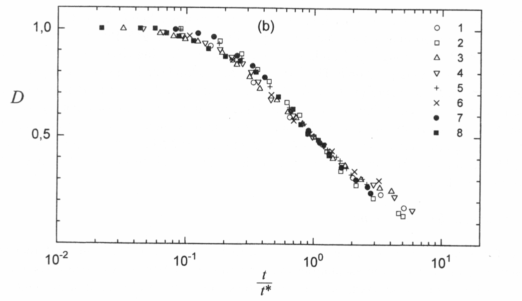


Kalashnikov (2002) JNNFM 103

Theory: residence time in wall layer $t_*(Q, d, L, c, \mu_0)$.