TRANSACTIONS OF THE SOCIETY OF RHEOLOGY 20:2, 311–317 (1976)

Proposed Nomenclature for Steady Shear Flow and Linear Viscoelastic Behavior

C. L. SIEGLAFF, *Diamond Shamrock Co., Painesville, Ohio 44077*

Eighteen years ago Leaderman [*Trans. Soc. Rheol.*, **I**, 213 (1957)] published a nomenclature for linear viscoelasticity. Since that time the science of rheology has matured and its use in other disciplines has grown. In order to facilitate communication between these diverse disciplines, a systematic organization of names and symbols is very desirable.

In 1970, F. R. Eirich, as vice-president of the Society of Rheology, formed an ad hoc committee to review the status of rheological nomenclature. This committee first convened at the Princeton Annual Society meeting. The committee then agreed that a uniform system of nomenclature for material properties, such as moduli, viscosities, etc., was needed. It was also agreed that the existing prevalent usages should serve as guide lines for proposed nomenclature.

Subsequent to the original meeting, several approaches to a uniform system of nomenclature were explored. The results were distilled down to the nomenclature list proposed in the *Rheology Bulletin, Vol. 43*. Several corrections and comments have been included in the final nomenclature published in this report. A major addition is the use of SI units, as well as the cgs system.

The committee recommends that the Society of Rheology members adopt this nomenclature in their communications to the Society. The committee expressly recommends standardization of those symbols and notations representing material constants, material functions, and notations for the directions of shearing flow.

The present committee did not consider it necessary or advisable to develop a dictionary of (phenomenological) behavior. A dictionary of this type by M. Reiner and G. W. Scott Blair is currently

© 1976 by The Society of Rheology, Inc.
Published by John Wiley & Sons, Inc.

Nomenclature for Simple Steady Shear Flow
$v_x = f(y)$ or $v_1 = f(x_2)$

			Units				
			SI System			cgs System	
Symbol	Name	Definition	Name	Symbol	Dimensions	Name	Units
x,1	geometric direction of flow	—	—	—	—	—	—
y,2	direction of velocity change	—	—	—	—	—	—
z,3	neutral direction	—	—	—	—	—	—
$\sigma \equiv \sigma_{21}$	shear stress in simple steady shear flow	—	Pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$ or (N/m^2)	—	dyne cm^{-2}
$\dot{\gamma}$	shear rate	dv_x/dy	s^{-1}	s^{-1}	s^{-1}	—	s^{-1}
η	viscosity	$\sigma/\dot{\gamma}$	Pascal second	Pa·s	$m^{-1} \cdot kg \cdot s^{-1}$ or $(N \cdot s/m^2)$	Poise	$dyne \cdot s \cdot cm^{-2}$
N_1	first normal stress function	$\sigma_{11} - \sigma_{22}$	Pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$ or (N/m^2)	—	dyne cm^{-2}
N_2	second normal stress function	$\sigma_{22} - \sigma_{33}$	Pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$ or (N/m)	—	dyne cm^{-2}

Ψ_1	first normal stress coefficient	$N_1/\dot{\gamma}^2$	—	$Pa \cdot s^2$	$m^{-1} \cdot kg$	—	$dyne \cdot s^2 \cdot cm^{-2}$
Ψ_2	second normal stress coefficient	—	—	$Pa \cdot s^2$	$m^{-1} \cdot kg$	—	$dyne \cdot s^2 \cdot cm^{-2}$
η_0	limiting viscosity at zero shear rate	$\lim_{\dot{\gamma} \to 0} (\sigma/\dot{\gamma})$	Pascal second	$Pa \cdot s$	$m^{-1} \cdot kg \cdot s^{-1}$	Poise	$dyne \cdot s \cdot cm^{-2}$
η_∞	limiting viscosity at infinite shear rate	$\lim_{\dot{\gamma} \to \infty} (\sigma/\dot{\gamma})$	Pascal second	$Pa \cdot s$	$m^{-1} \cdot kg \cdot s^{-1}$	Poise	$dyne \cdot s \cdot cm^{-2}$
η_s	viscosity of solvent or continuous medium	—	Pascal second	$Pa \cdot s$	$m^{-1} \cdot kg \cdot s^{-1}$	Poise	$dyne \cdot s \cdot cm^{-2}$
η_r	relative viscosity	η/η_s	dimensionless			dimensionless	
η_{sp}	specific viscosity	$\eta_r - 1$	dimensionless			dimensionless	
$[\eta]$	intrinsic viscosity	$\lim_{c \to 0} \left(\frac{\eta_r - 1}{c}\right)$	—	—	$m^3 \cdot kg^{-1}$	—	$g^{-1} \cdot cm^3$ or specified units of concentration

Nomenclature for Small Amplitude Oscillatory Motion

		Units				
		SI System			cgs System	
Symbol	Name	Name	Symbol	Dimensions	Name	Units
ω	angular frequency	hertz or radians per second	Hz rad/s	s^{-1}	—	s^{-1}
t	time	second	s	—	second	s
τ	relaxation time or retardation time	second	s	—	second	s
η^*	complex dynamic shear viscosity	Pascal second	Pa·s	$m^{-1}\cdot kg\cdot s^{-2}$ or $N\cdot s/m^2$	poise	$dyne\cdot s\cdot cm^{-2}$
η'	dynamic viscosity					
η''	out-of-phase component of η^*					
B^*	bulk dynamic complex compliance	—	Pa^{-1}	$m\cdot kg^{-1}\cdot s^2$ or (m^2/N)	—	$cm^2\ dyne^{-1}$
B'	bulk storage compliance					
B''	bulk loss compliance					
$B(t)$	bulk creep compliance					
D^*	tensile dynamic complex compliance	—	Pa^{-1}	$m\cdot kg^{-1}\cdot s^2$ or (m^2/N)	—	$cm^2\ dyne^{-1}$
D'	tensile storage compliance					
D''	tensile loss compliance					
$D(t)$	tensile creep compliance					

E^*	tensile dynamic complex modulus	Pascal	Pa	$m^{-1}\cdot kg\cdot s^{-2}$ or (N/m^2)	—	dyne cm^{-2}
E'	tensile storage modulus					
E''	tensile loss modulus					
$E(t)$	tensile relaxation modulus					
G^*	complex dynamic shear modulus	Pascal	Pa	$m^{-1}\cdot kg\cdot s^{-2}$ or (N/m^2)	—	dyne cm^{-2}
G'	shear storage modulus					
G''	shear loss modulus					
$G(t)$	shear relaxation modulus					
J^*	complex dynamic shear compliance	—	Pa^{-1}	$m\cdot kg^{-1}\cdot s^2$ or (m^2/N)	—	cm^2 $dyne^{-1}$
J'	shear storage compliance					
J''	shear loss compliance					
$J(t)$	shear creep compliance					
K^*	bulk dynamic complex modulus	Pascal	Pa	$m^{-1}\cdot kg\cdot s^{-2}$ or (N/m^2)	—	dyne cm^{-2}
K'	bulk storage modulus					
K''	bulk loss modulus					
$K(t)$	bulk relaxation modulus					
μ^*	complex dynamic Poisson's ratio		dimensionless		—	—
μ'	in-phase component of μ^*					
μ''	out-of-phase component of μ^*					

Nomenclature for Small Deformation Linear Elasticity

		Units				
		SI System			cgs System	
Symbol	Name	Name	Symbol	Dimensions	Name	Units
		Simple Shear				
G	shear modulus; modulus of rigidity	Pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$ or (N/m^2)	—	dyne cm^{-2}
J	shear compliance	—	Pa^{-1}	$m \cdot kg^{-1} \cdot s^2$ or (m^2/N)	—	cm^2 $dyne^{-1}$
		Bulk (Isotropic) Compression				
K	bulk modulus	Pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$ or (N/m^2)	—	dyne cm^{-2}
B	bulk compliance	—	Pa^{-1}	$m \cdot kg^{-1} \cdot s^2$ or (m^2/N)	—	cm^2 $dyne^{-1}$
		Tensile Extension				
E	Young's modulus (tensile modulus)	Pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$ or (N/m^2)	—	dyne cm^{-2}
D	tensile compliance	—	Pa^{-1}	$m \cdot kg^{-1} \cdot s^2$ or (m^2/N)	—	cm^2 $dyne^{-1}$
μ	Poisson's ratio		dimensionless		—	—

available (*Rheology, Vol. 4,* Academic Press, New York, 1967). Also, the systemization of non-linear nomenclature was considered to be premature. A future committee should be organized to consider this vital area of rheology.

The chairman wished to thank the committee members:

R. B. Bird	F. R. Eirich	R. R. Myers
R. A. Dickie	H. Markovitz	

for their diligent efforts in compiling the nomenclature list. Also, the committee wishes to express its gratitude to the Society members who made many thoughtful inputs to this endeavor.