

Nomenclature

A	point, area of cross section
A(), B()	substitutional variables, Eq. (2b)
F	force in drawing or extrusion
F _o () , F(), f(), g()	functions
g	acceleration of gravity
H	lubricant film thickness, see Eq. (8)
I ₁ , I ₂	definite integrals, Eq. (30)
J [*] , J [*] ()	upper-bound on energy consumption, applied power
k _{II}	constant defined by Eq. (k) of Sec. {9.2.2.2}
K	number of the order of approximation: 1,2,3 ...Eq. (b) of Sec. {9.2.3.1}
L	length of land of die
L	lower-bound approach
L.B.	lower-bound
l ₁	distance in geometry, see Fig. <63>, Eqs. (e) & (f) of Sec. {9.2.2.1}
l ₂	distance in geometry, see Fig. <74>
M, m	constant friction factor (0≤m≤1)
n	number of triangles: 1,2,...i, j, ...n, see Fig. <63>
o	apex of cone, origin of coordinate system
p	pressure
p _b	extrusion pressure
p _a	drawing pressure
R	instantaneous radius, radius
R _d	distance defined by Eqs. (a) and (b) of Sec. {9.2.2.1}, See Fig. <62>
R _γ	radius associated with minimal net drawing stress, Fig. <62>
R.A.%, r%	percent reduction in cross-section area
r	radial distance (independent on θ)
r _o [*] , r _f [*]	radial distance (dependent on θ) of the point entering, exiting deformation region
r,θ,Z	axis in cylindrical coordinates
r,θ,φ	axis in spherical coordinates
S	Sommerfeld number, spherical field designator
T	Triangular field designator
t	thickness
U	upper-bound approach
Ū, v	velocity
Ū _r , Ū _θ , Ū _φ	velocity components in the spherical coordinate system
U _{II} , v _{II}	velocity components in the zone of deformation, Eqs. (i), (j) and (k) for Sec. {9.2.2.2}
W _f	power associated with friction
W _i	internal power of deformation
W _s	redundant power associated with shear
W _t	total power (work per unit time)
w _k	inertial force, Eqs. (h) and (i) of Section {3.9}

Z, Z'	relative axial displacement (maximal, intermediate) within the deformed product, see Eq. (25)
α	semi-cone angle of the die
α_1	dead-zone semi-cone angle
α_2	semi-cone angle of the die at which pure shaving begins
α_{opt}	optimal semi-cone angle of the die for which power expenditure is minimized
β	inclination on true stress - true strain curve, measure of ability to strain harden, angle in geometry, Fig. <74>
β_1, β_2	angles in geometry, Fig. <62>
Γ_i	surfaces of velocity discontinuity
γ	substitutional variable, see Eq. (27)
Δ	difference
Δv	measure of change in velocity (velocity discontinuity)
$\delta \bullet$	pressure coefficient of viscosity
δ	very small portion of \bullet
ϵ	thickness of the lubricant
η	viscosity
η_o	viscosity at atmospheric pressure
θ	angular position in coordinate system, Figs. <12> & <74>
λ	substitutional variable, see Sec. {9.2.3.2}
μ	Coulomb's coefficient of friction
ζ	substitutional variable, see Eq. (26)
π	ratio of the circumference of a circle to its diameter
ρ	density
σ_o	effective flow stress
σ_R	radial stress
σ_x	longitudinal stress
σ_{xb}	back tension, extrusion stress
σ_{xf}	front tension, drawing stress
τ	friction stress, shear stress
ϕ, ϕ'	functions defined in Sec. {9.2.3.1}
ϕ_{eff}	effective (logarithmic) strain
$\tilde{\omega}$	angular velocity, see Fig. <24>

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<>	Symbol for figures as in Fig. <1>
()	Symbol for equations as in Eq. (1)
[]	Symbol for references as in Ref. [1]
{ }	Symbol for sections as in Sec. {1.1}

Symbols

o	spherical velocity field
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\triangle	uni-triangular velocity field
$\triangle\triangle\triangle$	multi-triangular velocity field
$\begin{array}{c} \text{---} \\ / \quad \backslash \\ \text{---} \end{array}$	trapezoidal velocity field

Subscripts

a	front (drawing)
b	back (extrusion)
cr	critical value
eff	effective
f	final; friction; front
i	index: 1,2,3 ...; inner; internal
ideal	ideal (maximum possible)
L.B.	lower-bound
max	maximum
o	original; outer
opt	optimal value
R	radial
r, θ	spherical coordinate components
r, θ , Z	cylindrical coordinate components
S	redundant (shear)
t	total
X	longitudinal
I, II, III	zone designators

Superscripts

\bullet^*	asterisk denotes that \bullet is kinematically admissible
\bullet	dot denotes time derivative
\bullet'	intermediate; derivative of \bullet
$\overline{\bullet}$	average value of \bullet

Prefixes

$\delta\bullet$	very small portion of \square
\triangle	difference
A(b)	A is function of b. A can be any symbol; b can be a series of variables and constants