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The Identification of Desirable Parameters for Aluminium Cutting Using Various Cutting Fluids and Limited Volume Lubrication

B.E.Meister

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by

B.E.Meister

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Author:	Bernhard Meister
Mentor:	Prof. P.L. de Vaal
Department:	Chemical Engineering University of Pretoria
Degree:	Master of Engineering

Synopsis:

Standard equipment to determine friction and wear properties of lubricants cannot be used to determine the performance of cutting fluids. In addition, a technique was required that would enable characterisation of cutting fluids applied in limited volumes.

To address these requirements, a standard shaper was instrumented and served as a test bench for the evaluation of cutting fluid performance.

The parameters that were measured in the tests were assigned weights and were used to rank the cutting fluids that were tested. The most important parameters when comparing the different cutting fluids are:

- 1) the smooth fraction on the underside of the chip - this is related to the distance that can be cut until the built-up edge forms.
- 2) the distance cut to formation of the built-up edge.
- 3) the chip shape, specifically the chip radius.
- 4) the distance cut to first break.
- 5) the ease of chip flow.
- 6) the temperature at the quarter way mark at 52mm length of cut.
- 7) the temperature at which the built-up edge forms.

Results obtained, making use of a variety of cutting fluids, indicated that the methodology that had been developed to evaluate performance of cutting fluids enabled ranking of the cutting fluids according to their performance with respect to the above-mentioned parameters.

The performance ranking methodolgy developed can be adapted, depending on the application, resulting in a useful technique with direct practical possibilities.

Keywords
Cutting fluids, limited volume lubrication, metal cutting, performance testing.

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Die Identifisering van Wenslike Parameters vir die Sny van Aluminium by die Gebruik van Verskillende Sny-olies

Outeur:	Bernhard Meister
Studieleier:	Prof. P.L. de Vaal
Departement:	Chemiese Ingenieurswese Universiteit van Pretoria
Graad:	Magister in Ingenieurswese

Sinopsis:

Standaard toerusting om die wrywing- en slytasie-eienskappe van smeerolies te bepaal kan nie gebruik word om die werkverrigting van sny-olies te bepaal nie. Bykomend was dit ook nodig om 'n tegniek te ontwikkel om die karakterisering van sny-olies wat in beperkte volume smering gebruik word, moontlik te maak.

Om hierdie bykomende tegniek te ontwikkel is 'n standaard sterkarmskaaf geinstrumenteer. Die skaaf is gebruik as 'n toetsbank vir die evaluering van die werkverrigting van 'n verteenwoordigende reeks sny-olies.

Daar is gewigte toegeken aan die parameters wat in die sny-proses gemeet is, wat toe gebruik is om die sny-olies te rangskik volgens hulle werkverrigtingsvermoë. Die belangrikste parameters ter sprake was:

- 1) die gladde fraksie aan die onderkant van die spaander - 'n direkte verwantskap tussen die fraksie en die afstand wat gesny kan word tot waar die opgeboude rif vorm, is waargeneem.
- 2) die afstand wat gesny word tot waar die opgeboude rif vorm.
- 3) die spaander vorm, spesifiek die spaanderradius.
- 4) die afstand wat gesny word tot waar die spaander die eerste keer breek.
- 5) die gemak waarmee die spaander vorm.
- 6) die temperatuur by die kwartpadmerk (52 mm) van die snit.
- 7) die temperatuur waarby die opgeboude rif vorm.

Die resultate wat behaal is, vir 'n verskeidenheid van sny-olies, het aangetoon dat die metode wat ontwikkel is om die werkverrigting van die sny-olies te evalueer, dit moontlik maak om die sny-olies volgens hulle werkverrigting te rangskik.

Die rangskikkingsmetode volgens werkverrigting kan aangepas word, afhangende van watter gewigte aan die parameters toegeken word. Die gevolg is 'n bruikbare tegniek met direkte praktiese toepassing.

Sleutelwoorde
Sny-olies, beperkte volume smering, metaal-snyprosesse, werkverrigtingstoetse

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Table of contents

Nomenclature List

Symbol	Description	Units of measurement
C	heat capacity	kJ/kg.K
	constant in Taylor equation	m/min.
F	cutting force	N
J	mechanical equivalent of heat	kJ
k	shear flow stress	N/m^2
l	length	mm
M	mass	g
n	gradient of slope log-log plot of Taylor equation	m/min^2
	constant in chip temperature equation	J
Q	work rate	W
R	rate of metal removal	cm^3/min
	overall performance ranking	
T	temperature	°C
	tool life	min
t_1	depth of cut	mm
t_2	mean chip thickness	mm
v	cutting speed / velociy	m/min
W	work	J
w	width of cut	mm

Greek

α	rake face angle	°
β	clearance angle	°
γ	chip shear strain	dimensionless length per length
ν	cutting speed	m/s
ρ	density	g/cm^3
Ø or Φ	shear plane angle.	°
ω	parameter	

Subscripts

c	chip, cutting
f	feed
i	the i-th parameter
r	rake face
s	shear plane

Definitions:

BUE - built-up edge, it is a greatly strain hardened lump of work-piece material that has welded to the rake face of the tool

LVL – limited volume lubrication

Peening - surface hardening technique
Swarf - metal debris/chips from the cutting process