

น้ำมันหล่อลื่นสำหรับฟลูอิดไดนามิกแบริง  
ในมอเตอร์ของฮาร์ดดิสก์ไดรฟ์ขนาด 2.5 นิ้ว

นางสาวสุมิตรา ดวงแก้วมณี

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต  
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**LUBRICATING OIL FOR FLUID DYNAMIC BEARING  
IN 2.5 INCH HARD DISK DRIVE MOTOR**

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สุมิตรา ดวงแก้วมณี : น้ำมันหล่อลื่นสำหรับฟลูอิดไดนามิกแบริงในมอเตอร์ของฮาร์ดดิสก์  
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ในงานวิจัยนี้ได้พัฒนาน้ำมันหล่อลื่น สำหรับใช้ในฟลูอิดไดนามิกแบริงในมอเตอร์ของ  
ฮาร์ดดิสก์ไดร์ฟขนาด 2.5 นิ้ว โดยการศึกษาลักษณะจำเพาะของน้ำมันพื้นฐานที่มีผลต่อการใช้งาน  
จากนั้นจึงเตรียมและศึกษาสมบัติต่างๆของน้ำมันพื้นฐาน สุดท้ายจึงปรับปรุงและศึกษาสมบัติต่างๆ  
ของน้ำมันหล่อลื่นสำเร็จรูป อาทิ จุดวาบไฟ ปริมาณไอระเหย สัมประสิทธิ์แรงเสียดทาน และการ  
ทดสอบการใช้งานจริงเป็นต้น จากผลการทดสอบแสดงให้เห็นว่าน้ำมันหล่อลื่นสำเร็จรูปที่สามารถ  
ใช้ในฟลูอิดไดนามิกแบริงมอเตอร์ของฮาร์ดดิสก์ไดร์ฟขนาด 2.5 นิ้ว เตรียมได้จากการผสม  
ไดออกซิลอดีเพตกับไดออกซิลซีบาเคตในอัตราส่วน 1 : 1 และเติมสารเติมแต่ง 3 ชนิด คือ แอนติ  
ออกซิแดนท์, แอนติแวย์ และเมทัลดีแอกติเวเตอร์ในปริมาณ 2% 1% และ 0.05% โดยน้ำหนัก  
ตามลำดับ น้ำมันดังกล่าวจะมีความหนืด  $9.67 \text{ mm}^2/\text{s}$  ที่  $40^\circ\text{C}$  รอยการสึกหรอ 0.31 มิลลิเมตร  
เปอร์เซ็นต์น้ำหนักที่หายไป 0.289 ( $85^\circ\text{C} \times 3 \text{ ชม.}$ ) ปริมาณไอระเหย 1,394 นาโนกรัมต่อกรัม ( $85^\circ\text{C}$   
 $\times 3 \text{ ชม.}$ ) และสัมประสิทธิ์การเสียดทานโดยเครื่อง SRV 0.097 ( $50^\circ\text{C}$ ) ซึ่งน้ำมันที่เตรียมขึ้นดังกล่าว  
จะมีอายุการใช้งานที่ยาวนาน และมีอัตราการระเหยเป็นไอต่ำเมื่อเทียบกับน้ำมันการค้าที่ใช้ใน  
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In this research, lubricating oil was developed for fluid dynamic bearing (FDB) that can be used in 2.5 inch HDD. The characteristics of base oils that effect on the potential usage of lubricant in fluid dynamic bearing for 2.5 inch HDD were studied. The preparation of base oil samples and properties assessment were performed. Finally, finished lubricants were improved and their properties were assessed such as flash point, outgas, friction coefficient and service life test. The results showed that finished lubricant which could be used in FDB spindle motor of 2.5 inch HDD can be prepared from a mixture of base oils prepared from DOS and DOA (1:1) and then blended with antioxidant additive, antiwear additive and metal deactivator additive at 2%, 1% and 0.05% w/w, respectively. This finished lubricant has kinematic viscosity at 9.67 mm<sup>2</sup>/s at 40°C, wear scar at 0.31 mm., % weight loss at 0.289 (85°C x 3 hrs.), outgas at 1,394 ng/g (85°Cx 3 hrs.) and friction coefficient by SRV at 0.097 (50°C). Moreover, it has excellent long service life and weight loss properties which are better than those of commercial available lubricant.

Field of study Petrochemistry and Polymer Science Student's Signature Sumittra

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### LIST OF ABBREVIATION

HDD	=	hard disk drive
FDB	=	fluid dynamic bearing
NRRO	=	nonrepeatable runout
dB	=	decibel
s	=	second
wt	=	weight
PAO	=	poly alpha olefins
PAG	=	poly alkylene glycols
AN	=	alkylated naphthalenes
DOA	=	dioctyl adipate
DOS	=	dioctyl sebacate
DOZ	=	dioctyl azelate
DOP	=	dioctyl Phthalate
DOTP	=	dioctyl terephthalate
mPa	=	milliPascal
kPa	=	kilogram.Pascal
rpm	=	round per minute
N	=	newton
m	=	meter
cm	=	centimetre
mm	=	millimetre
um	=	micrometre
mv	=	milivolt
cSt	=	centistokes
ml	=	millilitre
ng	=	nanogram
kV	=	kilovolt
g	=	gram
mg	=	milligram
mmHg	=	millimetre of Hg



min	=	minute
psi	=	pound per square inch
kgf	=	kilogram force
Hz	=	hertz
°C	=	degree Celsius
TAN	=	total acid number
KOH	=	potassium hydroxide
ppm	=	part per million
ASTM	=	american standard test method
TG/DTA	=	thermo gravimetric differential thermal analyzer
GC/MS	=	gas chromatography and Mass Spectrometry
SRV	=	oscillation friction and wear testing machine
RBOT	=	rotating bomb oxidation tester
OIT	=	oxidation induction time
IR	=	infrared
FTIR	=	fourier Transform Infrared spectroscopy
SEM/EDX	=	scanning electron microscopy and energy dispersive X-ray spectroscopy
m/z	=	mass to charge ratio
PTFE	=	poly tetra fluoro ethylene
Cu	=	copper
Ag	=	silver
₺	=	Baht
EP	=	extreme pressure additive