



**Effect of Heat Treatment on  
Hardness and Wear Properties of an  
Aluminum Alloy of Motorcycle Piston**

by

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**LIST OF ABBREVIATIONS**

AA 2xx.x	Aluminum Alloys Series 2000
AA 3xx.x	Aluminum Alloys Series 3000
AA 4xx.x	Aluminum Alloys Series 4000
AA	Aluminum Alloy
Al	Aluminum
Al <sub>2</sub> Cu	Aluminum Copper
Al-Si	Aluminum Silicon
ASTM	American Standard Testing Materials
Cu	Copper
EDS	Energy Dispersive X-Ray Spectroscopy
Fe	Iron
g/cm <sup>3</sup>	Gram per Centimeter Cubic
GPa	Giga Pascal
h	Hours
HF	Hydrofluoric Acid
H <sub>v</sub>	Vickers hardness value
K	Wear Coefficient

kg/cm <sup>3</sup>	Kilogram per Centimeter Cubic
kg/m <sup>3</sup>	Kilogram per Meter Cubic
km	Kilometre
kN	Kilo Newton
L	Liquid
Mg <sub>2</sub> Si	Magnesium Silicide
mm <sup>3</sup> /min	Milimeter Cubic per Minute
MODENAS	Motosikal dan Enjin Nasional
MPa	Mega Pascal
N/m <sup>2</sup>	Newton per Meter Square
NASA	National Aeronautics & Space Administration
Ni	Nickel
NPH	New Piston Head
NPS	New Piston Sidewall
P	Phosphorus
Q	Quaternary Intermediate Phase
rps	Revolutions per Second
SEM	Scanning Electron Microscope
Si	Silicon

SiC	Silicon Carbide
UPH	Used Piston Head
UPS	Used Piston Sidewall
V	Vanadium
Zn	Zink

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## LIST OF SYMBOLS

%wt	Weight Percent
$\mu\text{m}$	Micron
$^{\circ}\text{C}$	Degree Celsius
E	Modulus Young
$\text{N}/\text{m}^2$	Newton per Meter Square
$\delta$	Delta
$\epsilon$	Epsilon
$\theta$	Theta

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**LIST OF CONFERENCE AND PUBLICATIONS**

1. **M.Z. Fizam**<sup>1</sup>, K.A. Rafezi<sup>2</sup>, M.Z. Ruhiyuddin<sup>2</sup>, D. Ruslizam<sup>1</sup>” *Effect of Heat Treatment on Aluminum Alloy: A Study of Motorcycle Piston*”. Engineering Postgraduate Conference (2009).
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## Abstrak

Kajian dilakukan untuk menyelidik kesan rawatan haba terhadap mikrostruktur, kekerasan dan haus omboh aloi aluminium dan juga bertujuan meningkatkan sifat kekerasan dan ketahanan haus bagi omboh aloi aluminium melalui kaedah perawatan haba. Bahan ujikaji terdiri daripada omboh aloi aluminium yang dihasilkan oleh sebuah syarikat pengeluar omboh dan digunakan oleh enjin empat lejang "Motosikal Nasional". Unsur – unsur aloian seperti Al, Si, Cu, Mg, Ni dan Fe dikesan pada sampel asal dengan 8% kandungan silika. Rawatan larutan dilakukan pada suhu 500°C selama 5 jam dan dilindap kejut di dalam air pada suhu bilik. Rawatan penuaan dilakukan pada suhu 130°C, 170°C dan 210°C untuk tempoh 1 hingga 6 jam bagi pemerhatian kesan penuaan ke atas sifat mekanikal dan mikrostruktur. Analisis mikrostruktur dijalankan dengan menggunakan mikroskop optik dilengkapi dengan kamera digital dan Mikroskop Elektron Imbasan (SEM). Pengukuran kekerasan dijalankan dengan menggunakan penguji mikrokekerasan Vickers. Ujian gelongsor kering telah dijalankan dengan menggunakan kaedah ujikaji pin di atas cakera. Kehilangan isipadu, kadar haus dan pekali haus di nilai melalui kaedah tanpa pelinciran dengan pemberat 10 N, kelajuan gelongsor 1.0 m/s, dan jarak gelongsoran 0.1, 0.25, 0.5, 1 dan 2 km. Keputusan menunjukkan, selepas rawatan haba lengkap, mikrostruktur didapati mempunyai mendakan lebih keras seperti  $Al_6Cu_3Ni$ ,  $\beta$  ( $Al_5FeSi$ ) dan  $Mg_2Si$ . Di dapati struktur zarah silika berbentuk plat asikular (bentuk bulat). Keputusan mikrokekerasan pada sampel penuaan 130°C menunjukkan kenaikan di antara 12.67% hingga 34% berbanding dengan sampel asal. Sementara itu, mikrokekerasan untuk sampel penuaan 170°C menunjukkan peningkatan dari 28.06% hingga 46% dan sampel penuaan 210°C turut menunjukkan peningkatan di antara 25.29% hingga 44.36%. Ujian haus untuk sampel penuaan menunjukkan penurunan kadar haus diantara 14.01% hingga 56.63% apabila dibandingkan dengan sampel asal. Selain itu, nilai pekali haus untuk sampel yang ditua turut menurun di antara 3.09% hingga 42.15% daripada sampel asal. Keputusan daripada pemerhatian menunjukkan sampel penuaan pada 170°C bagi tempoh penuaan 2 jam telah meningkatkan sifat kekerasan dan ketahanan haus pada omboh aloi aluminium.