INVESTIGATION OF INCLUSION CASTING, SAND BLASTING AND EMBOSSING METHODS TO PREPARE ENGINE CYLINDER BORE SURFACE FOR FRICTIONAL AND WEAR IMPROVEMENT

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We hereby declare that We have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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In memory of my Grandparents who thought me my ABC's and took care of me during my formative years

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ABSTRAK

Kehilangan tenaga akibat geseran di antara gelang omboh dan permukaan silinder enjin adalah satu sumber utama kehilangan tenaga mekanikal dalam enjin pembakaran dalaman (ICE). Plateau honing menghasilkan permukaan silinder yang agak kasar dengan banyak lembah untuk penyimpanan minyak dan permukaan mendatar untuk bertindak sebagai permukaan galas yang biasanya mempunyai kekasaran mikro yang menyebabkan geseran mekanikal. Sebaliknya permukaan yang licin digilap dengan lekuk kecil adalah lebih sesuai untuk mencapai geseran dan kadar hausan rendah dalam ICE. Objektif kajian ini adalah untuk menghasilkan sampel yang mempunyai permukaan yang licin dengan lekuk kecil untuk pengekalan minyak melalui kaedah sandblast, emboss dan tuangan inklusi. Kemudian sampel ini dicirikan untuk mengkaji kesan saiz serbuk pasir, emboss dan grafit keatas permukaan sampel yang dihasilkan. Akhirnya sampel dengan ciri permukaan terbaik dipilih untuk ujian keausan dan hasilnya dibandingkan dengan sampel pleateau honing. Sampel aluminium hipereutektik SC114A disediakan dengan emboss mengunnakan kertas pasir, sandblast menggunakan pasir silika dan tuangan inklusi dengan serbuk grafit pelbagai ukuran. Sampel ini disangga dan digilap untuk menghasilkan permukaan rata yang licin dan kemudian geseran dan keausan dinilai dalam kajian ini menggunakan penguji haus berayun (OWT). Sampel juga dicirikan menggunakan profilometer permukaan dan mikroskop elektron pengimbasan (SEM). Dari pencirian permukaan, ditentukan bahawa sampel emboss dengan kertas pasir # 480 grit, sampel disandblast dengan pasir silika # 320 grit dan tuangan inklusi dengan serbuk grafit # 270 grit mempunyai sifat yang diingini untuk diuji dengan lebih lanjut. Hasil kajian mendapati bahawa pekali geseran (μ) dikurangkan dengan 18% pada 300 RPM dan 6% pada 1200 RPM untuk permukaan sampel sandblast # 320 grit. Walaupun selepas 900,000 kitaran ujian kehausan tinggi, sampel sanblast # 320 tetap menunjukkan μ 5% lebih rendah daripada sampel pleateau honing. Ini menunjukkan bahawa permukaan dengan geseran yang lebih rendah dan kehausan yang lebih baik dapat dihasilkan menggunakan salah satu kaedah alternatif yang diteliti dalam kajian ini.

ABSTRACT

Frictional losses between the piston rings to cylinder bore surface is one of the major sources of mechanical losses in internal combustion engines (ICE). Traditional plateau honing produces a relatively rough cylinder bore surface with many valleys for oil retention and plateaued surfaces that usually have micro roughness that cause mechanical friction to act as a bearing surface. A smooth polished dimpled surface is more ideal to achieve low friction and wear in an ICE. The objectives of this study are to produce samples that have smooth plateau surfaces and have oil retaining dimples via sandblasting, embossing and inclusion casting. Then these samples were characterized to study the results of variable grit sizes of the sandblast, emboss and graphite powder to the size of the dimples as a result of the roughness of the samples produced. Finally, the samples with the best surface characteristics are selected for wear testing and the results are compared to a conventional plateau honed sample. Hypereutectic aluminium SC114A samples were prepared by embossing with sandpaper, sandblasting with silica sand and inclusion cast with graphite powder of varying sizes. The samples are then buffed and polished to create smooth flat plateaus and the friction and wear are evaluated in this study using an oscillating wear tester (OWT). The samples were also characterized using a surface profilometer and Scanning Electron Microscope (SEM). From the surface characterization, it was determined that the samples embossed with #480 grit sandpaper, sandblasted with #320 sieve silica sand and inclusion cast with #270 grit graphite powder had the desired properties to be tested further. It was found that surface sandblasted with #320 silica sand with a reduced coefficient of friction (μ) of 18% at 300 RPM and 6% at 1200 RPM. Even after 900,000 cycles of accelerated wear testing, the μ of #320 sandblasted sample remains 5% lower than the conventional plateau honed sample. This shows that a surface with lower friction and improved wear can be produced using one of the alternative methods investigated in this study.

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