

ABSTRAK

Proses *pocket milling* pada mesin CNC *milling* memerlukan pemilihan strategi *toolpath* dan parameter pemesinan yang tepat untuk memperoleh keseimbangan antara kualitas permukaan dan produktivitas. Penelitian ini bertujuan untuk menganalisis pengaruh strategi *toolpath* dan feed rate terhadap kekasaran permukaan (*surface roughness*) dan *Material Removal Rate* (MRR) pada proses *pocket milling Aluminium 6061*. Strategi *toolpath* yang digunakan terdiri atas zig-zag, spiral, dan one way, sedangkan variasi feed rate yang diterapkan yaitu 0,02 mm/tooth, 0,04 mm/tooth, dan 0,06 mm/tooth. Penelitian menggunakan metode eksperimen dengan rancangan faktorial 3×3 dan tiga kali pengulangan pada setiap kombinasi perlakuan. Parameter respon yang diamati adalah nilai kekasaran permukaan (R_a) menggunakan *surface roughness tester* serta nilai MRR yang dihitung berdasarkan selisih massa benda kerja sebelum dan sesudah pemesinan terhadap waktu pemesinan. Analisis data dilakukan menggunakan uji normalitas, uji homogenitas, dan ANOVA dua arah.

Hasil penelitian menunjukkan bahwa strategi *toolpath*, *feed rate*, dan interaksi keduanya berpengaruh signifikan terhadap kekasaran permukaan maupun MRR ($P\text{-value} < 0,05$). Pada pengujian kekasaran permukaan, feed rate merupakan faktor yang paling dominan dengan kontribusi sebesar 36,28%, diikuti strategi *toolpath* sebesar 29,34% dan interaksi keduanya sebesar 21,36%. Nilai kekasaran permukaan terbaik diperoleh pada strategi one way dengan feed rate 0,02 mm/tooth sebesar 0,1249 μm . Pada pengujian MRR, feed rate memberikan pengaruh terbesar dengan kontribusi 89,96%, sedangkan strategi *toolpath* dan interaksi masing-masing memberikan kontribusi sebesar 4,73% dan 2,54%. Peningkatan feed rate terbukti meningkatkan nilai MRR pada seluruh strategi *toolpath*, sementara strategi zig-zag menghasilkan produktivitas tertinggi. Hasil penelitian ini menunjukkan bahwa pemilihan kombinasi strategi *toolpath* dan feed rate yang tepat dapat meningkatkan produktivitas proses *pocket milling* tanpa mengabaikan kualitas permukaan hasil pemesinan, sehingga dapat menjadi acuan dalam proses manufaktur komponen Aluminium 6061.

Kata Kunci : CNC *milling*, *pocket milling*, strategi *toolpath*, *feed rate*, kekasaran permukaan, *Material Removal Rate* (MRR), Aluminium 6061.

ABSTRACT

The pocket milling process on CNC milling machines requires the appropriate selection of toolpath strategies and machining parameters to achieve an optimal balance between surface quality and productivity. This study aims to analyze the effects of toolpath strategy and feed rate on surface roughness and Material Removal Rate (MRR) in the pocket milling process of Aluminum 6061. The toolpath strategies investigated were zig-zag, spiral, and one-way, while the feed rate levels were 0.02 mm/tooth, 0.04 mm/tooth, and 0.06 mm/tooth. An experimental method employing a 3×3 factorial design with three replications for each treatment combination was used. The response variables observed were surface roughness (R_a), measured using a surface roughness tester, and Material Removal Rate (MRR), calculated based on the difference in workpiece mass before and after machining divided by the machining time. The data were analyzed using normality and homogeneity tests, followed by a two-way Analysis of Variance (ANOVA).

The results indicate that the toolpath strategy, feed rate, and their interaction significantly affect both surface roughness and MRR (P -value < 0.05). For surface roughness, feed rate was identified as the most influential factor, contributing 36.28% of the total variation, followed by toolpath strategy (29.34%) and the interaction between the two factors (21.36%). The lowest surface roughness value of $0.1249 \mu\text{m}$ was obtained using the one-way toolpath strategy with a feed rate of 0.02 mm/tooth. For MRR, feed rate was the dominant factor with a contribution of 89.96%, while toolpath strategy and their interaction contributed 4.73% and 2.54%, respectively. Increasing the feed rate consistently improved the MRR for all toolpath strategies, with the zig-zag strategy producing the highest productivity. These findings demonstrate that the appropriate combination of toolpath strategy and feed rate can enhance the productivity of the pocket milling process while maintaining high surface quality, providing a useful reference for machining Aluminum 6061 components.

Keywords : CNC milling, pocket milling, toolpath strategy, feed rate, surface roughness, Material Removal Rate (MRR), Aluminum 6061.