

Tool wear and cost evaluation of face milling grade 5 titanium alloy for sustainable machining

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ABSTRACT

Cutting tool life, its wear rate and machining cost play significant role in a machining process. Effect of these parameters using face milling of titanium alloy is analysed to assess the economic factor of sustainability. Machining sustainability of Ti-6Al-4V hardened to 55 HRC is assessed through a novel technique of iso-response method, in which the response value, i.e. surface finish is taken as criteria for evaluation and comparison among dry, conventional and cryogenic machining. Experiments are designed in DOE for central composite design and performed face milling of Ti-6Al-4V with PVD coated carbide inserts using three conditions of cooling and measured the response values. Feed, speed, and depth of cut were used as input variables. Comparing the average results of tool life and machining cost for iso-response technique, it was found that 47.55 % less electricity cost and 47.59 % less machine operating cost and 10.76 times increased cutting tool life achieved for cryogenically cooled experiments as compared with dry machining. Coolant cost was found 13.33 times cheaper for cryogenic as compared with conventional machining. The results indicate that cryogenic cooling is more sustainable for tool life, having better surface finish of machined part with least energy and machining cost.

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Obraba orodja in stroškovno ovrednotenje čelnega rezkanja titanove zlitine (razred 5) za trajnostno obdelavo

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POVZETEK

Življenjska doba orodja, njegova obraba in stroški obdelave igrajo pomembno vlogo pri obdelovalnih postopkih. V tej raziskavi smo analizirali vpliv teh parametrov na ekonomske dejavnike trajnostne obdelave. Za ocenjevanje stopnje trajnostne obdelave smo obdelovali titanovo zlitino Ti-6Al-4V, utrjeno na 55 HRC, kjer smo za najpomembnejše merilo izbrali površinsko hrapavost, primerjali pa smo tri različne možnosti hlajenja, in sicer hlajenje z zračnim tokom, konvencionalno hlajenje in kriogeno hlajenje. Eksperiment smo izvedli v skladu z metodologijo načrtovanja eksperimentov (angl. DOE). Šlo je za čelno rezkanje titanove zlitine Ti-6Al-4V, kjer smo za orodje uporabili rezkalo s ploščicami, ki so bile prevlečene s PVD karbidno prevleko. Vhodni parametri so bili podajanje, obdelovalna hitrost in globina reza. S primerjanjem povprečnih rezultatov življenjske dobe orodja in stroškov obdelave smo ugotovili, da so primeru kriogenega hlajenja (v primerjavi s hlajenjem z zračnim tokom) stroški električne energije za 47.55 % manjši, za 47.59 % pa so manjši tudi obdelovalno-operacijski stroški, prav tako pa se je za 10.76-krat podaljšala življenjska doba orodja. Stroški kriogenega hlajenja so bili za 13.33-krat nižji kot tedaj, ko smo uporabili konvencionalno hlajenje. Rezultati kažejo, da kriogeno hlajenje podaljšuje življenjsko dobo orodja, omogoča boljšo površinsko kakovost obdelanih kosov, vse to pa dosežemo ob nižjih stroških za vloženo energijo in obdelavo.

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PODATKI O ČLANKU

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