International Journal of Engineering Technology Research & Management ROLE OF ENVIRONMENTAL FRIENDLY MACHINING: IN PROSPECT TO SUSTAINABLE MANUFACTURING

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ROLE OF ENVIRONMENTAL FRIENDLY MACHINING: IN PROSPECT TO SUSTAINABLE MANUFACTURING

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Abstract
To compete in today's market, any manufacturing industry must strike a balance between environmental, social, and economic factors. Environmentally friendly machining is a new approach that is both cost-effective and environmentally friendly while also improving machinability. The main focus of this essay is on gaining a better grasp of environmentally friendly machining and studying diverse insights from previous literature that can help with its implementation. Some of the categories used to categorise the articles include dry machining, MQL machining, cryogenic machining, and environmentally friendly machining dimensions. Following a research of the literature, it was determined that heat is generated in the cutting zone as a result of tool chip contact in metal cutting operations, resulting in poor surface smoothness and increased tool wear. Surface roughness and tool wear are two characteristics that play a big impact in quality in every manufacturing industry. The review paper's main goals are to investigate and promote environmentally friendly manufacturing. Finally, it was discovered that environmentally friendly machining is both cost-effective and ecologically benign when compared to traditional machining.

Keywords: Surface engineering, Mist-cooling, Sustainable manufacturing, Ti-Alloy, Stainless Steel.

1 Environmental Friendly Machining

1.1 Introduction

Machining is that the most vital producing cycle, involving the transformation of raw materials into the ultimate desired object via a reductive cycle and connection live. The reductive cycle of materials is employed to point machining measures for the foremost half. Because friction is formed between the tool, the work piece, and the equipment chip during machining, a portion of the energy supplied is converted to heat. Figure 1 depicts the heat generated during a metal cutting operation.

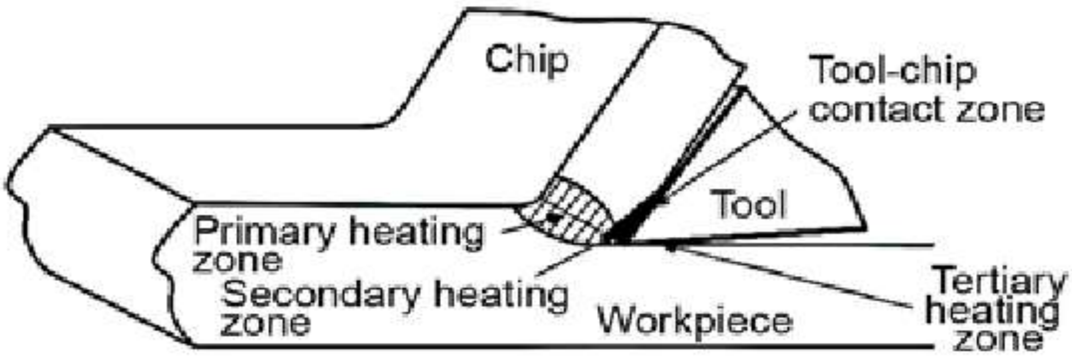

Figure 1: *shown metal cutting process [1]*

If the heat generated is not adequately dissipated, it can affect the finished surface quality, tool life, and overall interaction. Furthermore, these cycles are not environmentally friendly. In the metal cutting cycle, the standard cooling approach is used, which is neither cost-effective nor environmentally friendly [2]. Using normal cutting fluids in metal cutting processes is inflicting increasing environmental and health difficulties, thus environmentally friendly machining techniques are created, that is a cheap and sensible various. These approaches additionally improve surface quality, take away settled edges, lower friction forces, and extend tool life. property machining is appreciating environmental friendliness. The layout of property machining is shown in Figure 2.

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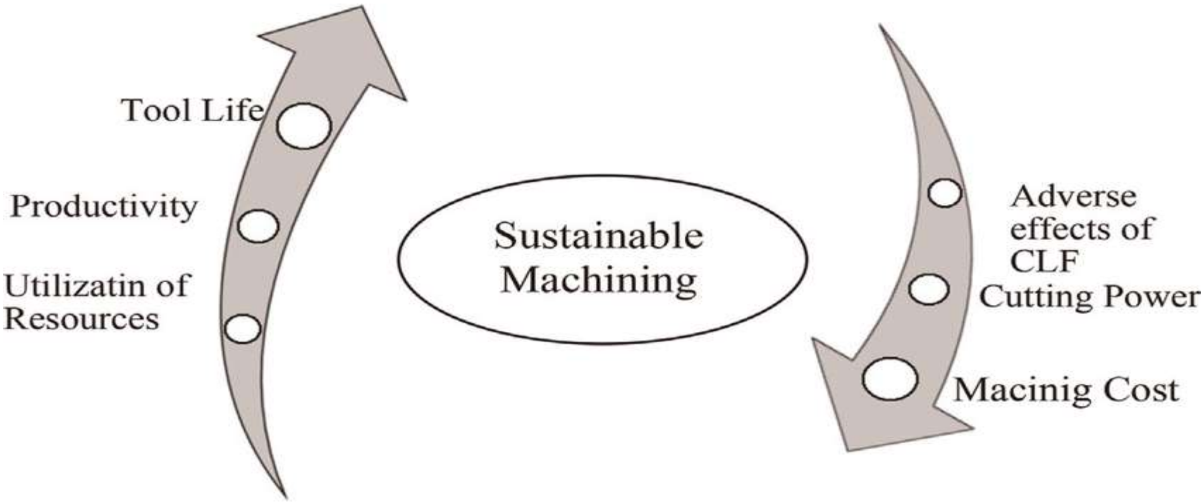

Figure 2: *Showing advantages of environmental friendly machining [3]*

1.1.1 Environmental Friendly Machining Vs Sustainable Machining Process

Manageability terms refer to products and ventures, laws, rules, and arrangements that cause minimal, negligible, or no harm to biological systems or the climate. Environmentally friendly cycles, also known as ecological amicable cycles, are also referred to as eco-friendly, nature-friendly, and green.

Types of Cutting Fluids

Different types of cutting fluids square measure used in industries. Figure 3 showing classifications of cutting fluids.

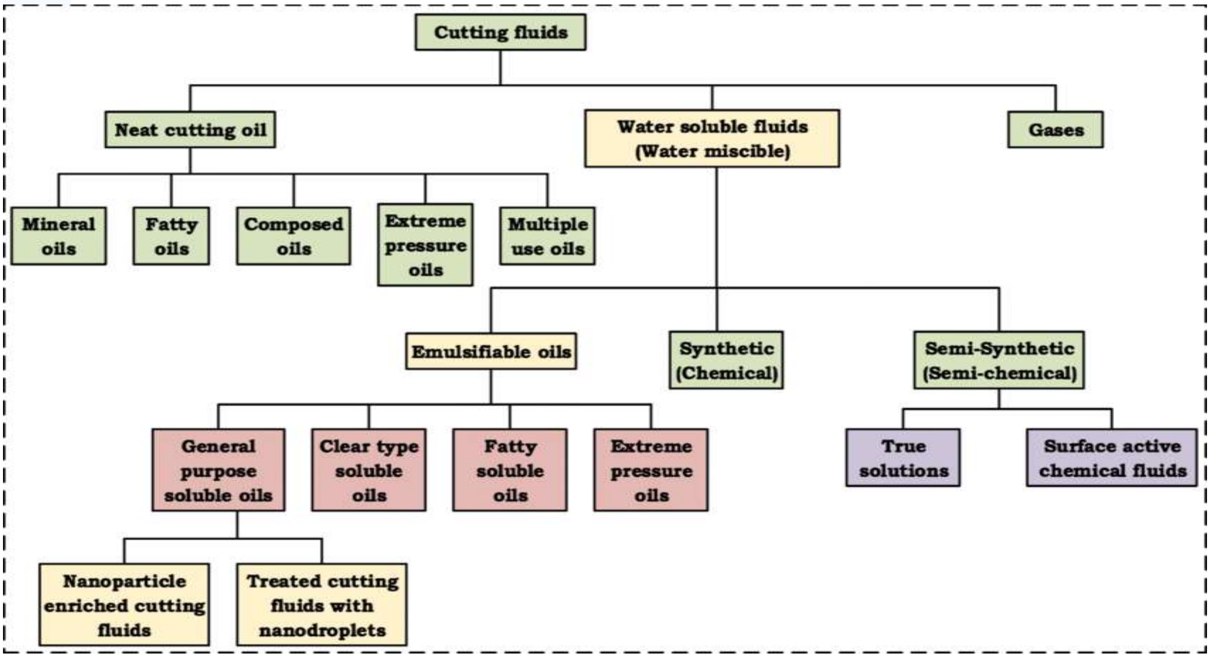

Figure: 3 *Showing types of cutting fluids [4],[5]*

2. Literature Review

This section is a review of the literature on the impact of environmentally friendly machining techniques on the machinability of materials such as titanium alloys, stainless steels, magnesium alloys, aluminum alloys, and Inconel. Based on the materials, this part was separated into four sub-sections. The sections that follow are:

2.1 Literature Review on Ti and its alloy

Titanium alloy offers excellent qualities such as strength retention and corrosion resistance at high temperatures, which make it ideal for use in biomedical, aerospace, petroleum, and automotive applications [6]. Titanium and its blends are delicate to cut accoutrements in comparison to aluminum, carbon, and hardened sword. To

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ameliorate the machinability of delicate- to- cut accoutrements, cryogenic, MQL, and high- pressure machining is used. As a result, these cooling ways are allowed to be a feasible result for machining a variety of delicate- to-cut accoutrements [7]. In terms of face enhancement, [8] observed that when Ti- 6Al- 7Nb was exposed to dry, flood tide, and cryogenic surroundings, face roughness (Ra) bettered by 35 percent, and by6.6 percent when exposed to cryogenic cooling. Figure 4 depicts the microstructure of the workpiece. This is also corroborated by [9], which demonstrated that cryogenic contraction cooling enhanced face roughness and machinability after trials on Ti- 6Al- 4V with oil painting- grounded coolant. likewise, tool wear and tear [10] trial work was carried out on Ti- 6Al- 4V using dry, cryogenic compressed air and set up that tool wear and tear was reduced as compared to dry machining.

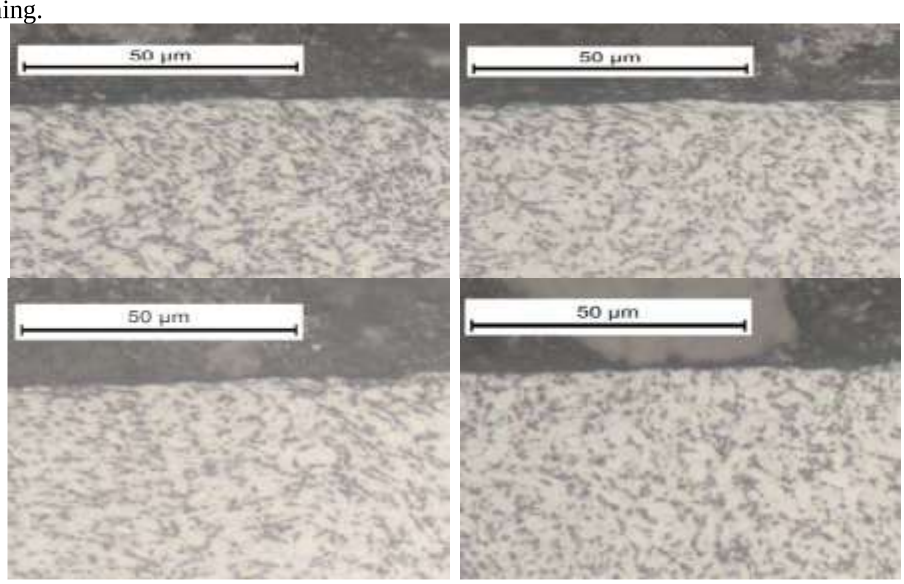

Figure 4: *The microstructures of the machined surface and sub-surface in: (a) cryogenic machining; (b) flood-cooled machining; (c) dry machining; and (d) as received material [7]*

Similarly, environmentally friendly machining offers superior machinability than other methods. [11] describes a trial on Ti- 6Al- 4V with flood tide, ScCO2, and MQL ScCO2. Following this exploration, it was discovered that using ScCO2 MQL at Vc- 60 m/ min and a feed rate of0.5 mm/ tooth bettered machinability. In terms of tool life [12], machining work on Ti- 6Al- 4V with AlCrN tool coating was fulfilled under colorful cooling surroundings, including flood tide, MQL Nano patches, internal cryogenic cooling, MQL external cooling system, and MQL internal cryogenic cooling. In comparison to the traditional flood tide coolant strategy, MQL circular cryogenic cooling system tool wear bettered by 90. MQL circular cryogenic machining setup and tool wear and tear in colorful machining settings are shown in Figure 5(a & b).

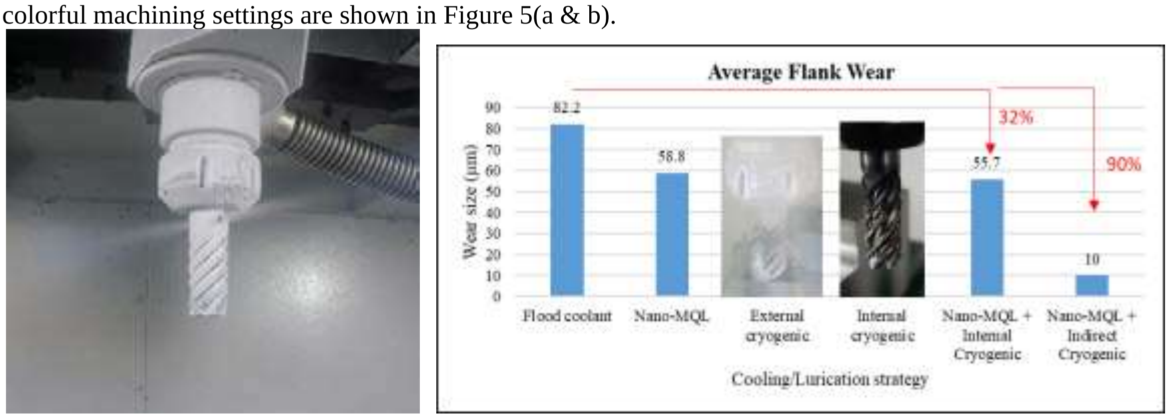

Figure: 5 (a) MQL + indirect machining setup, (b) Tool wear with respect to different cooling system [12]

Figure 5 shows that tool wear and tear is reduced as compared to the flood tide cooling system. As a result, it has been discovered that environmentally friendly machining produces better results. The literature review on titanium amalgamation is included in References 9- 19. These studies are presented in irregular form, with Table 1 displaying a literature review of machining on Ti and its blends under colorful cooling surroundings.

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Table 1 *Literature Review of Ti-alloy*

Paper Title	Cutting Tools	W/P	Environment
[7]	TiAlN Coated inserts	Ti-6Al-7Nb	Dry, flood and Cryogenic machining
[8]	Coated carbide insert CNMG 120,412	Ti-6Al-4V	Oil based coolant, Cryogenic cooling system
[9]	Carbide inserts CNMX120408A2S	Ti-6Al-4V	Dry machining, Machining with compressed air
[10]	SANDVIK 419 R-1405E-MMS407	Ti-6Al-4V	Flood machining, ScCO2 and MQL+ScCO2
[11]	Coated with AlCrN	Ti-6Al-4V	Flood, MQL+ Nano particles, internal cryogenic cooling, MQL+ Internal, MQL+ indirect
[12]	Uncoated carbide inserts CNMG120408	Ti-6Al-4V	UT, CT(12H, 24H, 36H)
[13]	SANDVIK432MM insert with TiCN coating	Ti-5553	Flood machining, MQL, Cryogenic cooling system
[14]	Cemented carbide CNMG120404	Ti-10V-2Fe-3Al	Cryogenic with CO2, emulsion
[15]	Uncoated cemented carbide insert	Ti-6Al-4V	Dry machining, wet with MQL, MQL with 0,-15,-30,-45 degree
[16]	Uncoated microcrystalline ISO K20 insert	Ti-6Al-4V	High pressure cooling approach, conventional cooling approach
[17]	PVD coated tungsten carbide insert	Ti-6Al-4V	Untreated condition, treated condition (24H,48H)
[18]	Cemented carbide with diamond coated insert	Ti-6Al-4V	Dry, ScCO2, ScCO2+WMQL, ScCO2+ O_oWMQL
[19]	Uncoated carbide insert	Ti-6Al-4V, Inconel 718	Cryogenic cooling (CO2), MQL, CMQL

2.2 Literature Review on Stainless steel

Stainless sword [20- 22] is an element of iron- grounded blends having at least 11 percent chromium [23- 25], which prevents rusting and provides heat resistance [23, 24, 27- 30]. The pristine- sword composition is shown in Table 2. Stainless sword contains carbon (ranging from0.03 percent to further than1.00 percent), nitrogen, aluminum, silicon, Sulphur, titanium, nickel, and molybdenum, among other rudiments. Exact kinds of tempered sword are generally assigned a three- number number, similar as 304 good.

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Stainless sword's resistance to ferric oxide conformation is due to the presence of chromium in the complex, which forms a unresisting sub caste that protects the introductory material from corrosion and allows it to tone- form in the presence of oxygen. Stainless sword is generally used in machining measures in this way.

Table 2 *Element of Stainless steel*

Material	**%**
C	0.008
S	0.030
Cr	20
Ni	12
Mg	2.00
P	0.045
Si	0.75
N	0.10
Fe	67-71

In terms of surface roughness [31], experiments were conducted on AISI 4340 steel using a liquid nitrogen chilling method, and the error was found to be just 5.32 percent. Figure 11 shows the percentage contribution of surface roughness control variables. also, all tool life trials [32] were conducted on AISI p20 in dry, flood tide, and cryogenic cooling surroundings. After the trial, it was discovered that machining with cryogenic cooling reduced tool wear and tear by 15- 17 percent when compared to indispensable cooling surroundings.

In terms of face integrity (33- 36), all of the trials were carried out on colorful types of pristine sword under flood tide, dry, and MQL machining, as well as cryogenic machining, and it was discovered that environmentally friendly machining provides better machining performance than conventional cooling ways. Table 3 summarizes the results of the literature review on pristine sword.

Table 3 *Literature Review on Stainless Steel*

Paper Title	Cutting Tools	W/P	Environment
[31]	HSS T-42 S-400 Insert	AISI 4340	LN2
[32]	TiN coated ISO-P30TN450XPDT	AISI p20	Dry machining, flood machining, machining with LN2
[33]	PVD coated Nano-Multilayer TiAlN insert	Duplex stainless steel	Dry environment and machining with cryogenic (LN2)
[34]	CBN TCGW16T304S105MT	AISI52100	Cryogenic (LN) and dry machining
[35]	CVD coated (TiCN/Al_2O_3) carbide insert	AISI 4340	Dry environment machining, cryogenic machining(LN2)
[36]	TiN coated carbide DNMG150608 MM	AISI304	Dry machining, machining with liquid nitrogen, MQL machining, MQL+LN2, MQL+ CO2 (Cryo.)
[37]	AlTiN PVD coated KC 5010 tungsten carbide insert	17-4 HSS	Dry machining, wet machining, MQL machining, machining with liquid nitrogen
[38]	HSS twist drill	SS310	Untreated condition, cryogenic treated condition

[39]	TiN & TiAlN coated insert	AISI D2	Dry machining, wet machining and LN2 machining
[40]	TiCN/Al_2O_3/TiN coated tungsten carbide insert	AISI H11	Dry machining, Liquid nitrogen cooling untreated condition
[41]	Uncoated SNGA 120408 TO1020AB30	AISI D2	CHT, DCH (36) & DCTT (36)

2.3 Literature Review on Magnesium alloy, nickel alloy, Inconel and aluminum alloy
Table 4 showing literature review on Magnesium alloy, nickel alloy, Inconel alloy and aluminum alloy.
Table 4 *Literature review on Magnesium alloy, nickel alloy, Inconel alloy and aluminum alloy*

Paper Title	Cutting Tools	W/P	Environment
[42]	Carbide insert	AA6063 aluminum alloy	Machining with dry & machining with LN2
[43]	Carbide insert CNMG	Inconel 718	Dry machining, LN2 machining, MQL machining and MQL+LN2 machining
[44]	Two flute helical PVD	AZ31 magnesium alloy	Dry machining, liquid nitrogen machining
[45]	PVD TiAl/AlCrN grade ACK 300	Inconel 718	Cryogenic cooling system and dry machining
[46]	PVD TiAlN/TiN coated carbide tool	Nickel based alloy	Cryogenic machining, MQL machining and MQL + Cryogenic machining
[47]	Uncoated carbide tool	AZ31B magnesium alloy	Dry machining & machining with LN2
[48]	AlTiN coated tungsten insert	Nickel based alloy	Machining with liquid nitrogen & machining with MQL + Nano particles
[49]	Coated carbide tool	Inconel 625	Dry machining, MQL machining, Cryogenic machining (by LN2), MQL machining + LN2 machining, NMQL + LN2
[50]	PVD coated tool	Inconel 718	Machining with dry and cryogenic machining (Through CO2)

3. Summary of Literature Review
This section summarizes all literature reviews based on two criteria: quantity of papers per kind of material and comparative investigation of machining performance and environmental issues under various cooling-lubrication settings.

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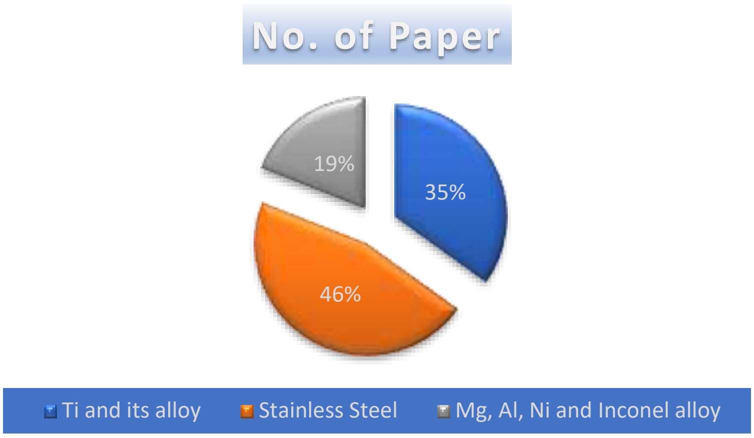

Figure. 6: *literature review between No. of paper to types of materials*

Comparative analysis of machining performance and environmental issues under various cooling-lubrication circumstances. These analyses are shown in Table 5.

Table 5 *Comparative analysis for performance and ecological aspects of machining under different cooling-lubrication conditions*

Parameters	Dry Machining	MQL Machining	Cryogenic Machining
Tool Life	2	4	5
Surface Quality	2	4	5
Cost	3	5	4
Sustainability	3	4	5

4. Conclusion

The current study emphasized how environmental friendly machining exploration has progressed in the former ten times by conducting a comprehensive descriptive study through a methodical literature review of chosen papers. The conclusions of composition are following;

- In utmost machining operations, standard slice fluids are used. still, these approaches aren't ideal for machining operations due to environmental and health enterprises. Because these styles are neither cost-effective nor environmentally salutary [51]. Following a review of the literature, it was discovered that environmentally friendly machining styles similar as dry machining, high- pressure cooling, MQL machining, and cryogenic machining are both environmentally and bring-effective.
- Dry machining is less harmful to the environment and enhances machinability [52]. However, there are significant limitations to dry machining in the drilling machining process because drilling generates greater heat in the cutting zone, reducing machining performance.

The current essay is a comprehensive examination of environmentally friendly machining and its impact on industrial industries.

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