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Effects of Cutting Fluids on Cemented Carbide and HSS Tools using Transient Thermal Analysis with a K- type Thermocouple and Rockwell Hardness Tester

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Abstract:- Cutting fluids are utilized in machining for a selection of reasons like mitigating work-piece thermal deformation and improving the hardness of the specimen. In this work soluble oil, water and air were used as coolants in turning operations. Cemented carbide (A30 grade) and HSS (M35 grade) cutting tools were employed as cutter with cutting speed of 355rpm and Stainless Steel (SS202 grade) as the specimen. Turning was done under dry condition and also using 2 coolants. Temperature and Hardness values after each cut were recorded. The temperature readings were recorded from the tools at each case using a Digital k-type Thermocouple and the hardness of the specimens were ascertained using Rockwell Hardness test. It was revealed that variation within the Hardness value of the samples with progress in machining time is more with the use of carbide tool compared to the HSS cutter. Samples cooled with water exhibited the very best hardness value. variation within the hardness of the samples with progress in machining time is more just in case of samples machined using Carbide tool compared to HSS tool, the rationale being higher tool tip temperatures generated in carbide tool. However, in both cases, samples machined using different cutting fluids vary significantly in terms of hardness.

Keywords:- *Cutting Fluids, Cemented Carbide, HSS, Stainless Steel, Digital K-type Thermocouple, Rockwell Hardness Test and Soluble Oil.*

INTRODUCTION

Cutting fluids are usually used to lubricate and chill the tool that is utilized for machining a job in a work floor. During the 19th century, it was not obscure to use plain water as a cutting fluid as it was easily accessible and would have been the first preference that would have crossed the mind. As a cutting fluid it did not perform well in the lubrication part but, its cooling aspects were better compared to dry cutting. The biggest demerit using water was its high corrosion factor and to overcome this, soda was inhibited as an alternative. These alternatives are mostly omitted in the modern industrial age as we have amended choices such as palm kernel oil, soluble oil, various vegetable oils etc.

I. OBJECTIVE

To study the effects of cutting fluids such as air, water and a soluble oil on a HSS (M35 grade) and Cemented Carbide (A30 grade) single point cutting tools, and recording their transient heat transfer with the help of a Digital K type thermocouple and their effect on hardness of the samples using Rockwell Hardness test.

II. METHODOLOGY

The research work was carried out at the Machine Shop located in St. Joseph's College of Engineering, Chennai. Two of the cutting fluids with the cutting tools were both obtained from the workshop. The HSS and Carbide tool and the work piece (stainless steel) were commercially available locally. The experiment was carried out on a *center* lathe machine. The work piece was mounted on the 3-jaw chuck. The Cemented Carbide A30 cutting tool was clamped in the tool post and the angle of the tool post was adjusted so that the tool was more or less perpendicular to work piece. The cutting speed was set to the specified value and the machining began with the introduction the coolant using an hand pump. The process was iterated until the required diameter of the sample was achieved. The diameter of the work piece was measured using a vernier caliper before and after the machining. The machining parameters used are given in **Table.1.** The tip tools had no space to accompany the thermocouple probe. So, in order to overcome this issue holes were drilled on the tip of the single point cutting tools using super drilling machine a type of EDM which is shown in **fig**.**1**. this is mainly used for creating microscopic orifices for fuel system components and other applications. The tools after the EDM process is shown in **fig.2.**

III. TESTING METHODS

Transient Thermal Analysis: After the machining of the samples the temperature of the tip of the tool is immediately recorded using a digital K type thermocouple as shown in **fig 3**. and recorded in **Table.2**. the heat energy created from the frictional interaction between the tool and specimen is

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dissipated through the holes introduced in the tip of the tools and is recorded using a thermocouple.

Rockwell Hardness test: The hardness testing was carried out in a KED hardness tester. The hardness test done on the specimen was ROCKWELL HARDNESS TEST. three samples were reserved each for the Cemented Carbide and HSS tools. The intender used was a diamond intender and a V-block was used to support the specimen on the anvil. The readings are noted and recorded in **Table.3**.

IV. CONCLUSION

As cutting fluid is introduced while machining operations, it dissipates heat from the cutting tool/work-piece interface. This prevents the tools from surpassing above their critical temperature where it gets soft and worn out. Fluids conjointly lubricate the cutting tool/work-piece interface, mitigating the amount of heat created by friction. A fluid's cooling and lubrication properties has a crucial role in depreciating tool wear and ameliorate tool life. Soluble oil provides the best lubrication and better cooling capacities. Water, on the contrary, is an efficacious cooling agent, dissipating heat 2.5 times quicker than air. Individually, water acts as a very poor lubricant and initiates rusting.The evaluation of the hardness test together with the graphs reveals the following:

• Variation within the hardness of the samples with progress in machining time is more just in case of samples machined using Cemented Carbide tool compared to HSS tool, the rationale being higher tool tip temperatures generated in carbide tool. However, in both cases, samples machined using different cutting fluids vary significantly in terms of hardness.

• It was be deduced that water when used as a cutting fluid gives the highest hardness of the work piece material than soluble oil or dry cutting.

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EDM Super Drilling Machine

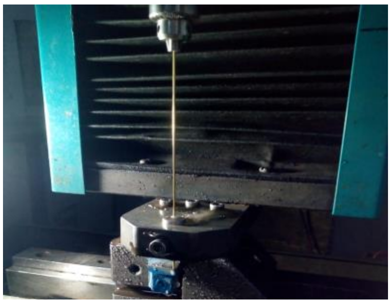


Fig.1

Tools after the EDM process

Fig.2

Table.1

Machining parameters at different lubrication conditions

lubrication	Dry cutting		wet		Soluble oil	
Tool	**HSS**	**CARBIDE**	**HSS**	**CARBIDE**	**HSS**	**CARBIDE**
Spindle speed	355 rpm		355 rpm		355 rpm	
Cutting speed	44.58m/min		44.58m/min		44.58m/min	
Depth of cut	2.5mm		2.5mm		2.5mm	
Feed rate	0.02mm/rev		0.02mm/rev		0.02mm/rev	
Material removal rate	2060.625mm^3/min		2060.625mm^3/min		2060.625mm^3/min	
Dia. of specimen before cutting	40mm		40mm		40mm	
Dia. of specimen after cutting	35mm		35mm		35mm	
Length of the job	35mm		35mm		35mm	

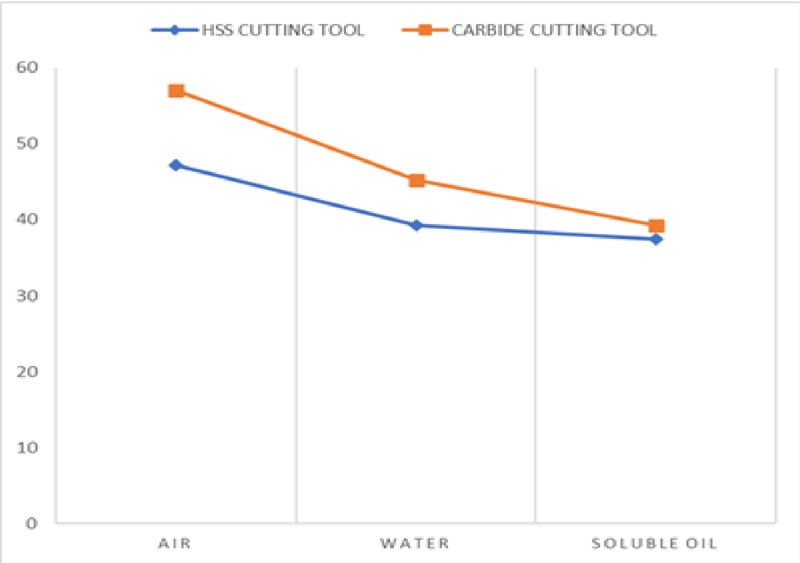
Transient thermal analysis using a k-type thermocouple

Fig.3

Table.2
Transient thermal analysis using the K-type thermocouple

S.no	SPECIMENS	LUBRICATION	SPEED (RPM)	TEMPERATURE BEFORE TURNING (^{O}C)	TEMPERATURE AFTER TURNING (^{O}C)
1	HSS (GRADE M35)	AIR	355	32.5	47.2
2		WATER	355	32.5	39.2
3		SOLUBLE OIL	355	32.5	37.4
4	CEMENTED CARBIDE (GRADE A30)	AIR	355	32.5	57.0
5		WATER	355	32.5	45.2
6		SOLUBLE OIL	355	32.5	39.2

Graph:



Transient thermal analysis result graph

Table.3

S.no	TOOL	LUBRICATION	LOAD APPLIED (150 kgf)	SCALE	HRC VALUE	AVG.MEAN HRC VALUE
1	HSS	DRY	150	C	40	42
2	HSS	DRY	150	C	45	
3	HSS	DRY	150	C	41	
4	HSS	WET	150	C	44	44.34
5	HSS	WET	150	C	46	
6	HSS	WET	150	C	43	
7	HSS	SOLUBLE OIL	150	C	43	43.34
8	HSS	SOLUBLE OIL	150	C	43	
9	HSS	SOLUBLE OIL	150	C	44	
10	CARBIDE	DRY	150	C	35	40.66
11	CARBIDE	DRY	150	C	46	
12	CARBIDE	DRY	150	C	41	
13	CARBIDE	WET	150	C	49	48.34
14	CARBIDE	WET	150	C	48	
15	CARBIDE	WET	150	C	48	
16	CARBIDE	SOLUBLE OIL	150	C	46	46.67
17	CARBIDE	SOLUBLE OIL	150	C	46	
18	CARBIDE	SOLUBLE OIL	150	C	48	

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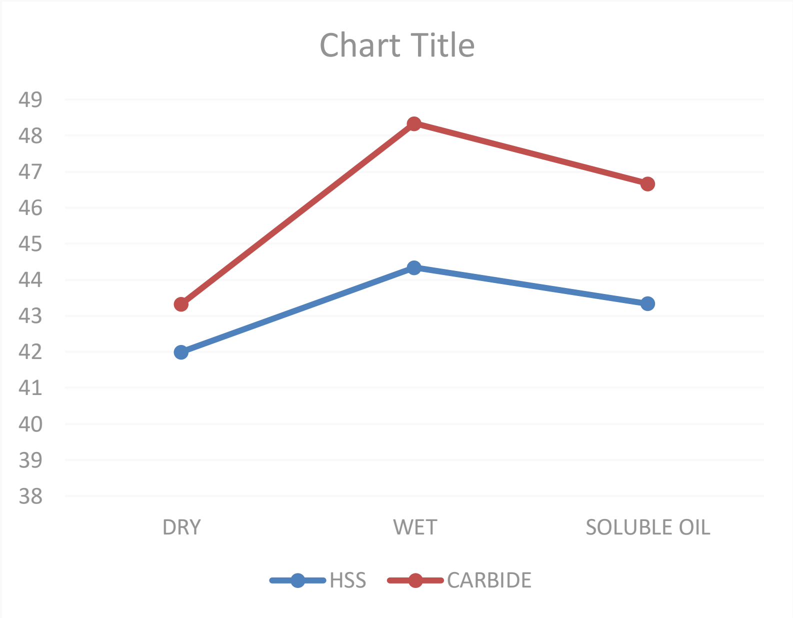
Rockwell Hardness testing values

Graph:



Rockwell Hardness testing result graph