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ALTERNATIVE COOLANT TO SOLUBLE OIL MACHINING A MILD STEEL MATERIAL

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ABSTRACT

This paper presents the use of soybean as an alternative to soluble oil in machining a mild steel material. A detailed comparison of soluble oil and soybean oil as coolants was carried out. The coefficient of correlation (r) of soybean oil when computed was found to be 0.5, a value that fall in the range of moderate correlation. The performance of the coolant-lubricant was evaluated from its effects on mild steel. In this regard the performance of soybean oil was found to be moderate and may, in the alternative, be used as a cutting fluid.

Keywords: Coolant, Lubricant, Machining and correlation

INTRODUCTION

Oils, fat and waxes are very important to man and their use date back to pre-historic times. For example, Chinese and Hindus extracted vegetable oils from oil-bearing plants. It is also recorded that Chinese oil presses were driven by manpower in the olden days while Indian Ghani, Ohekku (Kolhu) were driven by bullocks (Samba Murty et al, 1998).

Oils and fats are of great importance to the economic, industrial and domestic life of man. They are known as fixed or expressed oils, and they are essential raw materials required for the manufacturing of several domestic and industrial High local temperatures and high friction at the chip-tool interface often accompany the process of performing these functions. Any lubricant for machining operations is thus expected to reduce the high friction in metal cutting involving chemically clean unoxidized surfaces. This high value of friction often leads to complete welding as exemplified by the formation of built-up edge on cutting tools (Chisholm, 1959; Evans et al., and Oyinlola, 1996).

The efficiency of the lubricant is dependent on is oiliness which refers to the ability of certain long-chain molecules to attach themselves either physically or chemically to metal in a regular orientated fashion. The presence of these polar molecules considerably reduces the friction and wears in metal cutting operations (Oyinlola, 1996).

The efficiency of fatty oils as metal cutting lubricants is attributed to their high content of free fatty acids, which react with certain metal surface to form metallic soap. The effectiveness of fatty acids to promote boundary lubrication is also being influenced by the chain length. The

products. These oils are of various usage and effect, which have stimulated little exploration and exploitation. The above scenario makes it imperative for man to make an intimate study of the usage and effect of vegetable oil (Adejuyigbe et all, 1997).

The primary functions of any effective cutting fluid include among others the reduction of power consumption, opportunity of using higher cutting speed or longer tool life and improvement in surface finish. The secondary functions confer additional desirable features such as ease of application, corrosion prevention with other system of lubrication (Chisholm, 1959 and Oyinlola, 1996).
problems such as high cost, scarcity and biodegradability of soluble oil makes it imperative for researches to be carried out in local oils as alternative coolant for machining operations.

This paper therefore is aimed at investigating the use of soybean oil as an alternative coolant-lubricant to soluble oil in machining mild steel.

MATERIALS AND METHODS

The principal experimental materials used are a turned solid mild steel bar of initial dimension of 16.0mm diameter and 50mm long, soybean oil, Dumos (soluble oil) and a mixture of soybean and palm oil in ratio 1:1. The Dumos oil serves as the metal cutting fluid that formed the basis for

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comparison of the effectiveness of the fatty base local oils as cutting fluids.

The machining operation (turning) was carried out using a Lathe machine having a feed rate of 114 rpm (revolution per minute) and the cutting tool is a high speed steel with 19mm shank which was grounded to appropriate tool geometry using a tool and a cutter grinder with a constant angle for each turning operation.

Different test pieces of the steel rod were kept intact throughout the test by chucking it at one end of the lathe, and supporting it with a tail stock centre at the other end, while the rod was turned from an initial diameter of 16mm to a final diameter of 10mm.

The turning was done separately with each of the oils as cutting fluid up to a length of 50mm of the workpiece. The lubricant used on the first two pieces is the soluble oil while soybean oil is used on another two. A mixture of soybean oil and palm oil in ratio 1:1 was used on the last two pieces.

After turning with each lubricant, the metals were left in an open place at room temperature. Each of the workpieces was observed daily and the weight recorded for twenty days.

The method adopted in analyzing the result is a simple statistical method of calculating the mean, and the method of least square regression by the use of computer.

RESULTS AND DISCUSIONS

The operational observation of the performance of crude oil as cutting fluid was highly commendable. While the machining operation was in progress, smoke was observed in the

TABLE 1: Weights of the first three workpieces using soluble oil (x_{sol}), soybean oil (x_{soy}) and mixture of soybean & palm oil (x_{sop}) as lubricants respectively.

Number of Days	X_{sol} (g)	Y_{soy}(g)	Y_{sop}(g)
1	29.80	29.00	30.00
2	30.00	29.00	30.00
3	30.00	28.80	29.70
4	30.00	28.90	29.70
5	30.00	28.90	29.70
6	30.00	28.90	29.70
7	30.00	28.90	29.70
[illegible]	30.00	28.90	29.70
9	30.00	28.90	29.70
10	30.00	28.90	29.70
11	30.00	28.90	29.70
12	30.00	28.90	29.70
13	30.00	28.90	29.70
14	30.00	28.90	29.70
15	30.00	28.90	29.70
16	30.00	28.90	29.70
17	30.00	29.90	29.70
18	30.00	28.90	29.70
19	30.00	28.90	29.70
20	30.00	28.90	29.70

Table 2: Weights of the second three workpieces using soluble oil (x_{sol}), soybean oil (y_{soy}) and mixture of soybean & palm oil (y_{sop}) as lubricants respectively.

Number of days	X_{sol}(g)	Y_{soy}(g)	Y_{sop}(g)
1	29.80	29.00	30.00
2	30.00	29.00	30.00
3	30.00	28.80	29.75
4	30.00	28.90	29.70
5	30.00	28.90	29.70
6	30.00	28.90	29.70
7	30.00	28.90	29.70
8	30.00	28.90	29.70
9	30.00	28.90	29.70
10	30.00	28.90	29.70
11	30.00	28.90	29.70
12	30.00	28.90	29.70
13	30.00	28.90	29.70
14	30.00	28.90	29.70
15	30.00	28.90	29.70
16	30.00	28.90	29.70
17	30.00	28.90	29.70
18	30.00	28.90	29.70
19	30.00	28.90	29.70
20	30.00	28.90	29.70

zones of plastic deformation of the chip being removed accompanied by a mild and irritating odour. The unmixed crude oil had a moderate cooling effect on the tool and the workpieces. It also considerably reduced boundary friction during test. Effusion of smoke increased with the use of a mixture of soybean oil and palm oil as cutting fluid.

The results obtained are based on the effect of the lubricants on the machined mild steel material due to the corrosiveness and increment in weight. The result was analyzed to indicate the increase, decrease and the unpermanent stability of the weight of the metal, due to the reactions of oxygen on the surface of the mild steel material to cause oxidation which in turn lead to corrosion of the metal.

Tables 1 and 2 show the weights of the first and second three workpieces of mild steel using soluble oil (x_{sol}), soybean oil (y_{soy}) and mixture of soybean oil and palm oil (y_{sop}) as lubricants respectively.

The mean weight of the mild steel when soluble oil, soybean oil and mixture of soybean and palm oil were used, as lubricants are 29.985g, 28.905g and 29.73 respectively.

The use of least square regression analysis helps to establish the trend for the manufacturing yield and describe the relationship between the variables. The experimental data as presented in Tables 1 and 2 were used in our computations. Coefficient of correlation (r) of soybean oil with soluble oil and mixture of soybean and palm oil with soluble oil are 0.50 and

0.59 respectively. The method adopted in analyzing the result is a simple statistical method of calculating the mean and the method of least square regression coefficient. The calculation of coefficient of correlation, r was also evaluated using the equation below (Adejuyigbe, 1997)

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{n\sum x^2 - (\sum x)^2}\sqrt{n\sum y^2 - (\sum y)^2}}$$

Where y is the projected trend or calculated value of the dependent variable whose value is to be predicted x is the economic indicator being used for prediction and n is he number of days, in this case 20.

The physio-chemical analysis or the local oil under investigation by (Oyinlola, 1998) had revealed the fact that their structure and composition consists of long-chain polar molecules in varying degree. This therefore enhances their performance in preventing wear and tears of machine parts and consequently extends the life span of the cutting tool when used as coolant-lubricant in machining. This is evident in the evaluation of its correlation to fall in the range of moderate correlation.

The proportion of mixture of soybean oil and palmoil used in the study gave a correlation of 0.59 when compared with performance of soluble oil in machining a mild steel material. This is found to be a little higher than the independent correlation between either palm oil and soluble oil (Adejuyigbe et al, 1997) or soybean oil and soluble oil (this paper).

CONCLUSION.

We have attempted in this work to compare the performance of soybean oil as an alternative coolant-lubricant to soluble oil in machining mild steel. The performance evaluation of local oil as presented in this work has also been of interest to scientists and engineers in developing countries especially Nigeria. The result obtained in this work showed that soybean oil is not only a suitable protein supplement but also an effective coolant for machining operation.

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