Environmental Alternatives on Cutting Fluid- A Review

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Abstract- *Most metalworking and machining processes can benefit from the use of cutting fluid, depending on work piece material. Owing to environmental concerns and growing regulations over contamination and pollution, the demand for renewable and biodegradable cutting fluids is rising. In this review paper, an attempt is made regarding of green machining including the cutting fluid type as well as the methods to apply the cutting fluids in machining process. Knowledge of the cutting fluid types and its machining conditions are critically important in order to maximize the efficiency of cutting fluids in any machining process. Generally, heat generation at the cutting zone due to the friction at tool-chip interface, and friction between the clearance face of the tool and work-piece is always the decisive factor on the surface quality of the work-piece. A good understanding of the methods to apply cutting fluid at the cutting zone may significantly reduce the heat generation in machining and thus improve the surface roughness. Surface roughness and tool wear are always used as a quality indicator of a finished or semi-finished product. This paper reviews the developments in bio-based cutting fluids by using various vegetable oils and their performances in machining. Undoubtedly, these bio-based cutting fluids have significantly reduced the ecological problems caused by mineral-based cutting fluids. An overview of the cleaner application techniques of dry cutting, minimum quantity lubrication (MQL), and cryogenic cooling is also well presented. These techniques largely minimized the amount of cutting fluids used in machining while providing similar or even better cutting performances compared to wet cooling methods.*

Keywords- VEGETABLE OIL, CUTTING FLUID, MACHINE APPLICATION

I. INTRODUCTION

Cuttingfluid is a type of COOLANT and lubricantdesigned specifically for metal working processes, such as machining and stamping. There are various kinds of cutting fluids, which include oils, oil-water emulsion, pastes, gels, aerosols (mists), and air or other gases. They may be made from petroleum distillates, animal fats, plant oils water and air, or other raw ingredients. Depending on context and on which type of cutting fluid is being considered, it may be referred to as cutting fluid, cutting oil, cutting compound, coolant, or lubricant.

Most metalworking and machining processes can benefit from the use of cutting fluid, depending on workpiece material. Common exceptions to this are cast iron and brass which may be machined dry (though this is not true of all brasses, and any machining of brass will likely benefit from the presence of a cutting fluid)

The use of vegetable oils may allow this mixture, to make possible the development of a new generation of cutting fluid where high performance in machining combined with good environment compatibility could be achieved. Interest in vegetable oil-based cutting fluids is growing. Compared to mineral oil, vegetable oil can even enhance the cutting performance, extend tool life and improve the surface finishing according to some recent analysis from industry. Though, they have many environmental benefits, vegetable oils are more susceptible to degradation by oxidation or hydrolytic reactions. Therefore, the correct selection of the vegetable substance, the pH of the resulting solution and its control are important issues. This work proposes a development of a vegetable based emulsion that can be used in grinding process to replace the commonly used mineral oil based emulsion. This product was tested in grinding process in order to verify the performance and environmental requirements for CBN grinding.

II. PROPERTIES OF VEGETABLE OILS

Vegetable oils comprise of primarily triglycerides, that is, tri-esters of long chain carboxylic acids (fatty acids) combined with glycerol. Most of these oils contain at least four and sometimes as many as twelve different fatty acids. The proportion of each fatty acids depend not only on the type of the plant, but also on the geo-climate and the weather available. The triglyceride structure of the vegetable oils provides desirable qualities of boundary lubrication; A sustainable environmental development is achieved considering some important factors like biodegradability and toxicity of lubricants. On the other hand, the lubricants should

be stable during usage under different operating conditions Cutting fluids are consisting of base fluids and additives. Mineral oil, rapeseed oil and synthetic or native esters can be used as base fluids. If biodegradability should be considered, esters and vegetable oils are more indicate to formulate cutting fluids, because they are readily biodegradable in contrast to mineral oil. Also, the additive concentrations usually are below 10% w/w, this concentration is tolerated for eco-label "blue angel" [6]. In the use vegetable oil have some problems due to inadequate oxidative stability and problems associated with use in high or low temperature observed in this oil. The problem of poor oxidative stability can be mitigated by the structural modification of vegetable oil by chemical reactions.

The oxidation stability of vegetable oils depends on the level of unsaturated products present. The lower the unsaturation, the better the oxidative Stability, but higher the melting point. Excess of certain poly unsaturated fatty acids leads to unfavorable oxidation behavior and resignation at high temperatures. The long and polar fattyacid chains produce oriented molecular films that interact strongly with the metallic surfaces, reducing both friction and wear. In general, vegetable oils have a poor oxidative and thermal stability when compared to mineral oils and this issue can be addressed by various methods such as reformulation of additives, chemical modification of vegetable oils and genetic modification of oil seed crop.

Properties of vegetable oil is shown in table

Vegetable oil	Kinematics viscosity (mm^2/s)	Flash point (°C)	Density (kg/l)
Rapseed	37	246	0.911
Castor	227	230	0.961
Palm	36	164	0.880
Peanut	39.6	271	0.902
Soybean	32.6	254	0.914
Sunflower	33.9	174	0.916

III. DEVELOPMENT OF CUTTING FLUID

Cutting fluids are consisting of base fluids and additives. Mineral oil, rapeseed oil and synthetic or native esters can be used as base fluids. If biodegradability should be considered,esters and vegetable oils are more indicate to formulate cutting fluids, because they are readily biodegradable in contrast to mineral oil. Also, the additive concentrations usually are below 10% w/w, this concentration is tolerated for eco-label "blue angel".

The use of vegetable oil in cutting fluid applications may alleviate problems faced by workers, such as skin cancer andinhalation of toxic mist in the work environments. This will also help to add value to a farm commodity, such as soy oil and other similar vegetable based oil. The most important characteristic of vegetable oil is its biodegradability. According to Willing biodegradability is the most important aspect with regard to the environmental fate of a substance. Biodegradability means that a substance is susceptible to biochemical breakdown by the action of microorganism

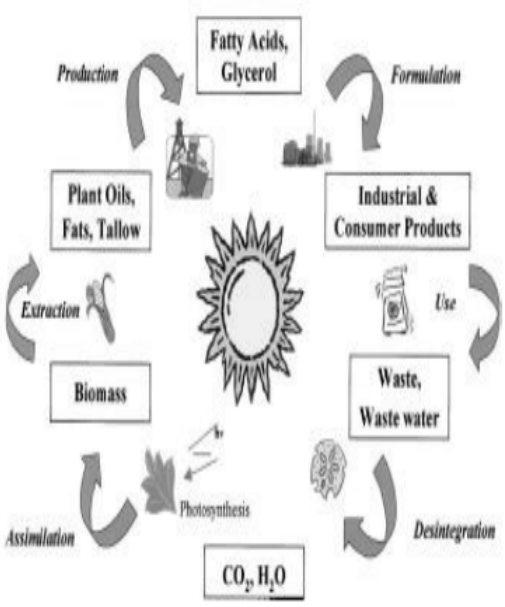


Fig- life cycle of chemical product based on renewable processes

IV. TYPES OF CUTTING FLUID

Based on their composition: synthetics, semi-synthetics, soluble oil and straight oil. The oil that is used in these fluids is either mineral or synthetic oil and each fluid has its own distinct properties. Mineral oils are naphthenic and paraffinic hydrocarbons that are refined from crude oil. The function of these molecules is to provide a base for other additive molecules to attach themselves to refine and hone specific characteristics of the fluid. These oils should be hydrogenated so that most of the carcinogenic polycyclic aromatics can be destroyed or naturalized. A common disadvantage of soluble oils is their poor emulsion stability, meaning they are prone to the oilseparating out of the solution. Semi-synthetics possess good lubrication for moderate and heavy-duty grinding. Moreover, they consist of less mineral oil than soluble cutting fluids, but they require high-quality

water and tend to foam very easily. Foam can inhibit the heat transfer because it limits the amount of fluid in contact with the wheel and work piece. Synthetic oils do not contain mineral oil and are often recognized by their water-like appearance.

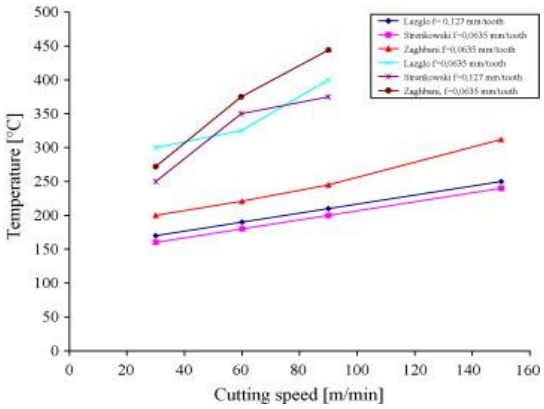
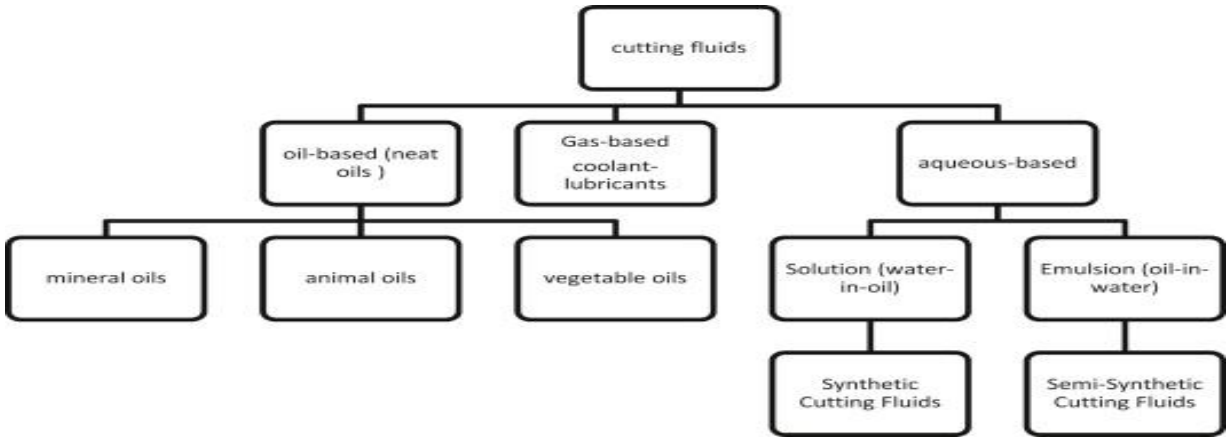


Fig- variation in cutting temperature and cutting Speed.



V. CONCLUSION

The proposed vegetable oil based soluble grindingfluid provided good results in the grinding tests similar to the obtained with the neat oil. Wheel wear, grinding forces and surface roughness were reduced when the new cutting fluid diluted at 45% was used. Vegetable oil is useful and it reduces the deformation of metal corrosion property is also decrease

In this review paper , the types of cutting fluid, vegetable based cutting fluid are more resist able then the other cutting fluid fluid proposed in this work has filled all environmental requirements and provided a good grinding performance.Several review papers have already provided indications on the scope of vegetable based oils effectively replacing the mineral oils as MWFs and further research efforts are in progress confirming this hope. In this review paper, an effort has been undertaken to provide highlights on the vegetable oils that have shown promising scope of their emergence as metal working fluids.

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