*Research Journal of Engineering Sciences* ISSN 2278 – 9472
Vol. **3(2),** 12-16, February **(2014)** *Res. J. Engineering Sci.*

# Evaluation of Microbial Contamination of Cutting Fluids with Nano Graphite Inclusions

**Prasad M.M.S.[1] and Srikant R.R.[2]**
[1]Dept of Mechanical Engg, Regency Institute of Technology, Yanam-U T of Puducherry, INDIA
[2]Dept of Mechanical Engg, GIT, GITAM University, Visakhapatnam, AP, INDIA

**Available online at: www.isca.in, www.isca.me**
Received 28th December 2013, revised 11th January 2014, accepted 20th February 2014

## Abstract

The purpose of the cutting fluids is to minimize the friction and heat apart from flush away the chips that are generated during machining operation. Further, these fluids are the mixtures of various synthetic, semi –synthetics, straight oils, emulsifiers, additives and biocides. There is also a possibility of contamination of the fluids in any manufacturing concern because of tramp oils, particulate matter etc. Apart from this a serious problem involves with these water based metal working fluids is the development of microbial contamination and its related other products like exo and endotoxins. Foul odor generation, appearance as a sticky substance and unpleasant nature to touch the fluids causes severe health effects to the workers involved in machining operations. In this paper, samples of graphite nano particle suspended fluids prepared with different weight percentages meant to be used in Minimum Quantity Lubrication. These samples stored for one month and then tested during this period to find the type of bacteria present in the cutting fluids and the growth of microorganisms.

**Keywords:** Minimum Quantity lubrication, microorganism, cutting fluids, petri plates.

## Introduction

Cutting fluids are the best choice to serve as both cooling and lubrication to improve the quality of the operations involved in machining and thereby the productivity[1].

The cutting fluids reduce the thermal expansion of the work piece in turn there is an enhancement of the tool life and improvement in the surface finish of the product apart from flushing away the chips, reduce the adhesion wear , friction between the tool and work piece and tool and chip interface. Some of the benefits brought the existence of the metal cutting fluids for different manufacturing operations for the last 200 years[2].

In spite of all these advantages, the major concern with these cutting fluids is degrading its quality day by day while in use, its disposal and consequently the pollution to the environment, mist generation and health hazards to the workers[3]. As the cutting are fully contaminated with the microorganisms, workers are exposed to skin deceases which include dermatitis, folliculate, oil acne and trauma[4,5].

The microorganisms growth in water based cutting fluids will cause fluid properties deterioration, work piece corrosion and choking of fluid flow lines[6,7]. These will also cause severe health problems to the workers in any manufacturing concerns due to bad appearance like a sticky substance and unpleasant nature to touch the fluids and also formation of foul. Microbial contamination accumulated in cutting fluids because of improper plant sanitation in housekeeping and workers hygienity[6]. The bacteria found in the cutting fluids is of aerobic nature which is mostly oxidative.

There are three types of Microbial namely Bacteria, yeast and Molds. Bacteria are basically three shapes which include Treponema palladium of spiral in shape, Cocci of round in shape and Bacilli of rod shaped cause for deterioration of the cutting fluids[8]. Again this bacteria is classified as Aerobic and Anaerobic. The Aerobic bacteria is dominated by Pseudomonas species, highly oxidative and adapt extremely week to the wide variety of organic molecules found in cutting fluids. The growth of these bacteria will lead to loss of lubricity, corrosion and emulsion separation[9]. Among the group of microorganisms, pseudomonas spices are difficult to kill and have maximum appetite and need least nutrients[10].

In this work, samples of the Nano graphite suspended cutting fluids were taken and stored in sterilized bottles and tested once in a week to study the microbial contamination.

## Methodology

Cutting fluid samples (figure-1) with 0%,0.1%,0.3% and 0.5% weight nano graphite inclusions are prepared to be used in Minimum Quantity Lubrication. These samples are stored for a month and are tested weekly once to find the microbial growth. Standard plate count which is conventional method for monitoring microbial levels in Cutting fluids is used[11]. In the present work, Petri plates (figure-2) duly sterilized were taken and filled with nutrient Agar HIMEDIA-M001-500G (figure-3) which is liquid and the temperature is above 45°C[12]. Upon on

cooling of this to the room temperature, it will be dried and hardened like a gel. Considering the aerobic nature of the bacteria 0.1 ml of samples were collected every week and transferring the fluid to the Petri plates. As both agar media and fluids are easily attacked by the bacteria present in the air, in order to prevent the contamination, the Laminar Air Flow chamber (figure-4) is used to transfer the fluid samples to the Petri plates in the presence of blue flame.

The samples were then kept in the Incubator (figure-5) for incubation kept at 37°C for 24 hours, the bacteria formed is known as colonies. These colonies (figure-6) are visible for naked eye and counted which presented in this paper.

**Figure-1**
**Cutting fluid samples**

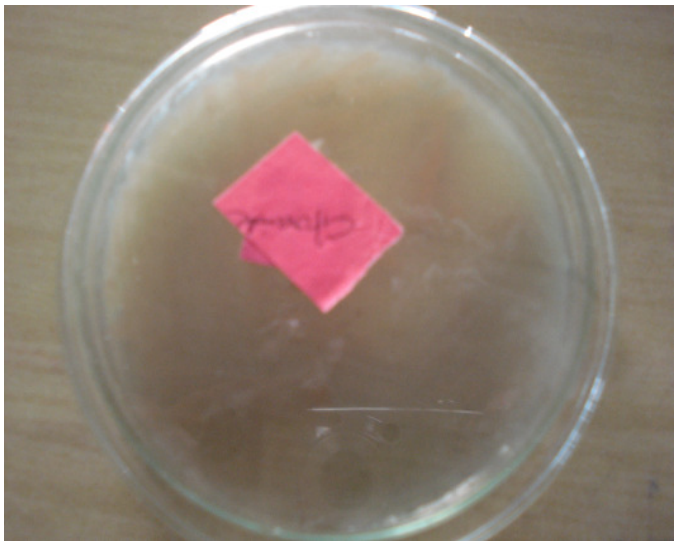

**Figure-2**
**Petri plates**

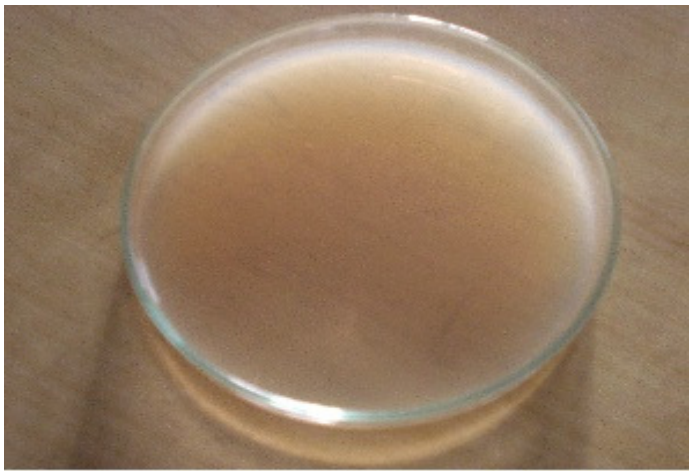

**Figure-3**
**Petri plate with nutrient agar**

**Figure-4**
**Laminar Air flow chamber with samples**

**Figure-5**
**Incubator with fluid samples**

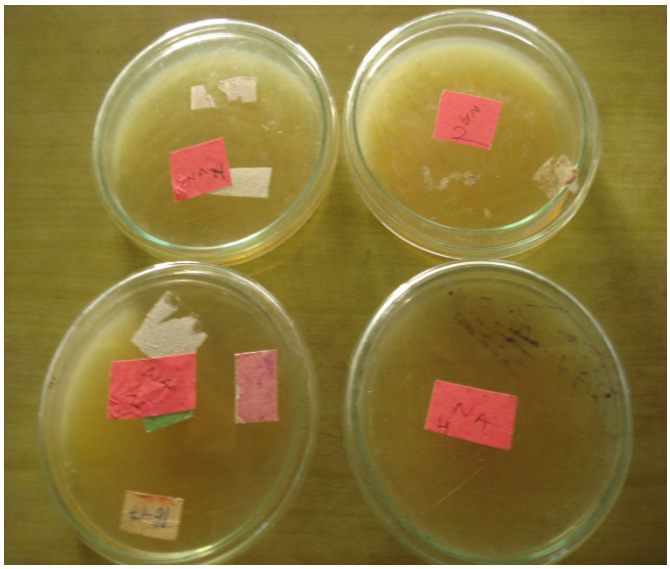

**Figure-6**
**Growth of Colonies**

## Results and Discussion

A major limitation in the usage of cutting fluids in machining processes mainly because of microbial contamination which directly affect the workers of the concern by way of skin diseases result in folliculated, mechanical trauma, infections and allergic dermatitis[13]. The colony growth observed and colony count was recorded in the samples collected in every week and like for four weeks. The observations were shown in figure-7 from plate count of stored samples with varying weight percentages of nano graphite inclusions.

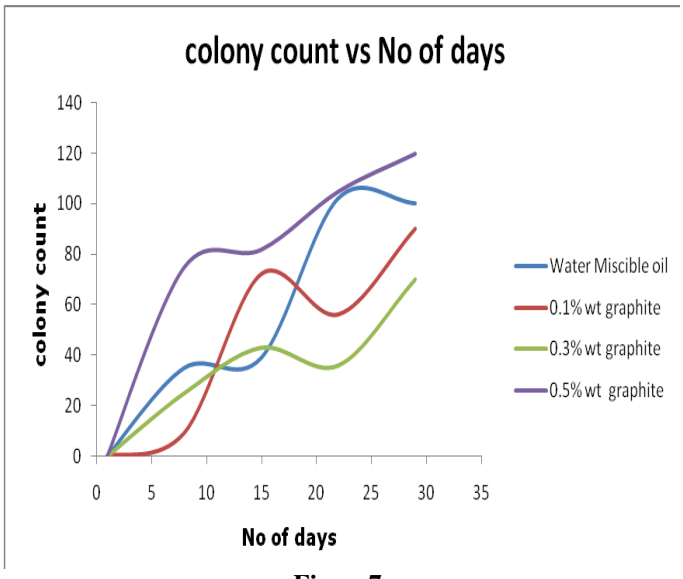


**Figure7**
**Growth of Colonies with Time**

There are no fixed levels of microbes to say that exactly the cutting fluids become deteriorated, some of the factors like pH, color, odor and appearance are to be considered in assessing bio deterioration[4].

It was evident from above graph, the growth was least in sample with 0.3% wt graphite Nano particle inclusion as the pH value of 0.3% Nano graphite inclusion is more hostile to the bacteria compared to 0%, 0.1% and 0.5% Nano graphite inclusion cutting fluids. Graphite being a reducing medium does not support the growth of aerobic bacteria.

However, lower contents of graphite do not produce the effect to the desired levels. Further, excess percentage of Nano graphite inclusions do not disperse well as the fluid becomes saturated; it does not affect the growth of the microorganisms. Hence, 0.3% inclusion appears to be optimal.

Identification of the microorganisms was carried out to estimate the organism effect present in the cutting fluid in order to decide the remedial actions. Tested for type of organism in different culture media by doing isolation and represented in table-1.

Growth was observed in only Cetrimide agar medium which showed the organism present as Pseudomonas genus in the cutting fluid samples. Pseudomonas genus is almost an invincible bacterium that can be present even in biocides. Hence the only way to hamper its growth is by tuning the composition of the fluids, i.e. the content of Nanoparticles, in the present case.

**Figure-8**
**Cetrimide on Petri plate**

**Table-1**
**Identification of Bacterial Species**

| S.NO | Experimental Procedure | Observations | Inference |
|---|---|---|---|
| 01 | Gram Stain | Pink colored rod shaped bacteria observed | Negative rods. May be Pseudomonas |
| 02 | Agar slant cultural characteristics | Abundant growth and spreading light bluish colored colonies observed | ---- |
| 03 | Fermentation | Lactose-Non fermented (No gas, no acid). Glucose- Non fermented (No acid, no gas). Sucrose- Non fermented (No gas, no acid). | No fermentation occurred. |
| 04 | IMVIC test | Indole- observed no cherry red ring. | Tryptophanate enzyme not observed. Indole-Negative |
| | | Methyl red-Red color observed | Methyl red-Positive |
| | | VP-No light red color | VP-Negative |
| | | Citrate-Blue color observed | Citrate utilized. Citrate-Positive. |
| 05 | $H_2S$ test | SulphateIndole Motility test-No black color observed. | No $H_2S$ Production. $H_2S$-Negative. |
| 06 | Catalase test | Bubble formation was observed when $H_2O_2$ added | Catalyze-Positive |
| 07 | Oxidase test | Violate/black color observed | Oxidase-Positive. |
| 08 | Gelatin liquefaction | No liquefaction | No gelatinize production. Gelatin-Negative. |
| 09 | Growth in Mac conkey medium | Growth observed which is colorless. | Non lactose fermented. |
| 10 | Growth in Mannitol salt agar | No growth observed. | ---- |
| 11 | Growth in Cetrimide agar | Growth was observed (Figure8) | Specific for Pseudomonas. |

## Conclusions

i. From the above, bio-chemical and staining characteristics, the organism present in the nano cutting fluids was confirmed as Pseudomonas species. ii. It was observed least growth of microorganisms in sample with 0.3 % wt graphite inclusions to the reason that the pH value of 0.3 % inclusion is more hostile to the bacteria compared to other 0.1 %, 0.5 % wt graphite and W M oil. iii. The bacterial growth was found less in the cutting fluids with Nano graphite Inclusions. iv. It is suggested to optimize the content of nano graphite inclusions to minimize and control the growth of the microorganisms. v. Further research can be done to choose the cutting fluids with additives to have minimal amount of bacterium.

## References

**1.** Julieb Z Andres F, Kimf H, Steven J. design of hard water stable emulsifier systems from petroleum and bio based semi synthetic metal working fluids. Environ SciTechnol, **37,** 5278-88 **(2003)**

**2.** Shaw M.C., Metal cutting principles, 2nd edition, (Oxford University Press, USA) **(2004)**

**3.** Applicability of cutting fluids with nanoparticle inclusion as coolant s in machining by

**4.** Srikant R.R., Rao D.N., Subrahmanyam M.S. and Vamsi Krishan P., in IMechEvik 223 Part I, *Journal of Engineering Tribology*

**5.** Roosemore H.W., Evaluation Techniques for Bio-deterioration of Water Miscible Metal working fluids, *Bio-deterioration Research Techniques, I,* 227-242 **(1976)**

**6.** Rossmoore H.W., Microbial causes of cutting fluid deterioration, *Society of Manufacturing engineers, MI,* **(1974)**

**7.** Benett EO, The biology of metal working fluids, *Lubrication engineering,* **28,** 237-247 **(1972)**

**8.** Rossmoore H.W. and Rossmoore L.A., The identification of defined microbial inoculums for the evaluation of biocides in water based metal working fluids, *Lubrication engg.,* **36,** 16-20 **(1980)**

**9.** Rosmoore L.A. and Rosmoore H.W., Metal working Microbiology, Buers, J P (Ed.),Metal working Fluids New York: Marcel Dekker, Inc., 247-247 **(1994)**

**10.** Rosemoore H.W., Evaluation Techniques for Bio-deterioration of water Miscible Metal working fluids, Bio-deterioration Research.

**11.** Rosemoore H.W., Antimicrobial agents for water-based metal working fluids, journal of Occupational medicine, **23(4),** 147-254 **(1981)**

**12.** American Society for Testing and Materials (ASTM) Designation D 3946-92 in annual book of ASTM standards, vol 5.03, ASTM Philadelphia **(1992)**

**13.** John P Harley, Microbiology lab manual McGraw Hill Asia, **(2007)**

**14.** Narayana Rao S., Satyanarayana B. and Venkatasubbaiah K., Experimental investigation of microbial contamination of nano cutting fluids with cnt inclusion, Global journal of Research in Engineering, **11(4),** 1.0, **(2011)**