4th Symposium on Metal Removal Fluids: Global challenges

Barcelona | Spain
14-16 September 2011

COMPENDIUM of ABSTRACTS
AUTHOR: STEVEN ANDERSON

ORGANIZATION NAME: AFTON CHEMICAL

TITLE: ADDITIVES TO REPLACE MEDIUM CHAIN CHLORINATED PARAFFINS

ABSTRACT:

The use of chlorinated paraffins in metalworking applications is coming under growing pressure, with North America leading the way to restrict their use. Afton Chemical’s metalworking fluid solutions provider, Polartech, has taken a lead in evaluating additives which can be used as alternates to these chlorinated paraffins.

This study has preferentially focused on additives which are derived from renewable vegetable sources. The additives have been evaluated using a wide range of applications tests, including wear, extreme pressure and forming applications using a broad selection of industrially important alloys covering the main automotive and aerospace usage.

The results of this evaluation have identified a number of additives that can be used to replace chlorinated paraffins, providing both superior performance and an enhanced environmental profile.
ABSTRACT:

The talk presents results of a comprehensive evaluation programme for cutting fluid efficiency, when machining the aerospace 'superalloy', Inconel 718. The machining methods used were milling, drilling, tapping and VIPER grinding.

Results from different cutting fluids were evaluated (e.g. semi-synthetic, synthetic, high-oil emulsion). Cutting forces, torque and spindle power were acquired during machining, while geometrical accuracy, surface texture and surface integrity of the workpiece were analysed afterwards.

The experimental results demonstrate the difficulty of identifying the 'best' cutting fluid, especially when several different machining methods are to be employed on the same machine tool. It is unlikely that a single fluid will show the best performance on all machining trials and output measures. Therefore, prioritization of the output measures and specification of the relative importance of each machining operation becomes essential, in order to evaluate and rank the cutting fluid efficiencies.

A flexible multicriteria model for the evaluation of cutting fluid efficiency, relative to the performance of a benchmark fluid, is proposed and described. The advantage of the model consists in its flexibility and capability to compare the efficiency of cutting fluids across different machining methods and output criteria. An application of the evaluation model is provided, using results from the tested cutting fluids.
ABSTRACT:

Key to success in selling lubricants, namely metalworking fluids, is product performance aside of good technical service, but also health and safety aspects aside of environmental issues becomes more important. Customers often look for products which are not labelled as “dangerous”. Especially high performing metalworking fluids can be hardly sold “label free” in the future, this needs to be explained to customers.

The new hazard labelling system CLP and new law like REACH leads to an increased number of products labelled as “dangerous” and limits the number of ingredients available for lubricants. Lubricant users are confronted with new hazard descriptions, symbols, phrases etc.

In addition, the new safety data sheets required by REACH contain a high number of “exposure scenarios” explaining exactly how to handle mixtures to avoid H&S risks.

Explaining the new rules and helping the customer to fulfil the requirements given by law becomes an additional part of marketing and service. This presentation highlights some aspects of the new hazard communication system with focus on lubricants.
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ORGANIZATION NAME: CENTER FOR CHEMICAL TOXICOLOGY RESEARCH AND PHARMACOKINETICS (CCTR), NORTH CAROLINA STATE UNIVERSITY, RALEIGH, NC USA

TITLE: QUANTITATIVE DETERMINATION OF MWF ADDITIVES PERMEATION IN SKIN

ABSTRACT:

Skin exposure to metal working fluids (MWF) can potentially cause local skin effects or systemic effects if absorbed into the general circulation. As it is impossible to measure skin permeation of all MWF components, the focus of this presentation is to describe the permeability of additives important to the industry especially those additives that may cause adverse health effects.

Skin permeability data for several biocides (e.g., phenols, triazines) and amines (e.g., dicyclohexylamine, DCHA) will be presented to illustrate the influence of various classes of MWF formulations on the skin permeability of these additives.

This discussion will also focus on the various experimental approaches used in my research center (CCTR) in North Carolina to test and validate formulation effects on skin permeability. This includes the use of a flow-through diffusion cell system to measure in vitro permeability in pig skin which is similar physiologically and anatomically to human skin as well as validation of formulation effects using the pig as an in vivo model. Other screening methods such as surrogate skin membranes (e.g., membrane coated fibers) along with quantitative structure permeability relationships (QSPR) using multi-linear regression modeling are currently being used in our center to predict MWF formulation effects on skin permeability with some success.

In summary, the skin permeation of MWF additives can be modulated several fold by specific MWF formulations and these formulation effects can be readily assessed with various methodologies that reflect occupational exposures.
AUTHOR: JOHN BELIEN
ORGANIZATION NAME: QUAKER CHEMICAL CORPORATION
TITLE: EFFECTS ON OVERALL PERFORMANCE OF CHANGING THE pH BUFFER SYSTEM IN EMULSIFIABLE COOLANTS

ABSTRACT

As a result of changes to the labeling legislation in December 2010, more boric acid free coolants are being introduced to the market. Traditionally, boric acid is neutralized with an amine and together provides pH buffering necessary to control numerous physical and chemical processes occurring in coolant concentrates and their final working dilutions.

One of the alternative buffering systems that demonstrate equivalent performance to boric acid without the need for additional hazardous labeling is amine-polyborates. However, research into the pH buffering of boron free and boron-amine free technologies is based on new innovative materials that yield additional performance advantages in lubrication, corrosion inhibition, microbiological-control, and foam control relative to both the traditional boric acid – amine packages now regulated, as well as the amine-polyborates formulated to replace them.

In particular benefits of the new boron and boron-amine free buffering systems are realized during the machining of aluminum alloys. Furthermore, these innovative blends of acids neutralized with alkaline materials create fluid environments which micro-organism will not easily develop and thus reduces the dependence biocidal agents in the end formulations.

The presentation discusses the study and field experience of the aluminum machining properties with boron free formulations as well as the investigation of other coolant properties such as micro-biological control.
ABSTRACT:

Formulators and end users face multiple challenges when working with metal removal fluids. Some of the challenges arise from governmental chemical use restrictions such as chlorinated paraffins, phenolic anti-microbial compounds, formaldehyde, boron, sodium nitrite / secondary amines, as well as specific end user restricted chemicals. End users are challenged with restrictions on oil mist, volatile organic compounds, MYCO bacteria, disposal, and demands from organized labor requiring safer work environments. Supplies of group II base oil are limited in certain markets requiring formulators to seek alternative sources. Some alternative sources are ester derivatives such as from vegetable or animal products. Synthetic esters may also have a place in future formulation strategies. The challenges are further complicated by legal and end user complete formulation disclosures, while suppliers attempt to remain competitive with proprietary formulas. Suppliers of metal removal fluids need to make sufficient sales volumes and profit margins to remain viable businesses while end users require price cuts and fluid recycling strategies to also remain competitive.

This paper will outline in detail these and more challenges and then lay out the likely future for metal removal fluids in the next 10 years.
ABSTRACT

Metalworking fluids (MWFs) are complex mixtures of oils, detergents, surfactants, biocides and anti-corrosion agents. MWFs are widely used as coolants, lubricants, and swarf or metal chip removers during machining operations. They also help to prevent surface corrosion of the machined parts and prolong the life of machine cutting tools. The worldwide usage is approximately more than $2 \times 10^9$ litres annually and the spent MWFs could be more than 10 times the concentrate used since they have to be diluted before use. Discharge of spent MWFs to surface waters and ground waters can be very harmful to the environment if they are not carefully managed.

In the recent years regulations regarding the discharge of industrial wastes, including spent MWFs, have become more stringent. This requires companies to take any and all measures necessary to ensure the safe collection and disposal of waste oils and must, as far as possible, give priority to the processing of waste streams. As a result, businesses need to treat spent MWFs before the waste water component can be discharged to sewers.

Different types of MWFs are currently in use (e.g. macro-emulsions, semi-synthetics, synthetics) and companies can produce varied volumes of waste according to the size of their operations. This guide is concerned with water-mix MWFs since it is these that present the most significant environmental problems once the fluids are spent. This presentation summarises the content of the guide, which is based on findings of a recent research undertaken by Pera to help businesses to decide on the most appropriate disposal system for their needs, taking into consideration the type of waste, the cost of treatment and the advantages and disadvantages of the techniques reported. Treatment and disposal options applicable to water-mix MWFs depend on type and volume of waste, so treatment solutions, which include primary, secondary and tertiary treatment options, are often difficult to determine. It is therefore the aim of the guide to help engineering companies to select the most suitable technologies available in terms of cost and performance.
ABSTRACT

The aim of this study is to describe exposure of bacteria in inhalable MWF aerosols in machine shops and the effect on airways.

Personal full-shift air samples of inhalable aerosol sampled on PAS-6 and endotoxin sampled on Sioutas Cascade Impactor (5 fractions) were collected on operators in different machine shops. The PAS-6 filters were then analysed gravimetrically for MWF aerosol and the filters from the impactor were analysed for endotoxin. Personal continuous dust measurements were performed with a real-time instrument (DataRAM) during working shift, using one-minute average values. Before and after shift the workers the fraction of exhaled NO (FENO) was measured by a chemiluminescence analyzer (NIOX, Aerocrine AB, Sweden). Bacteria quantification was done by colony counts, total bacteria counts and analyzed by MALDI-TOF.

Endotoxins were found on all 5 fractions in the impactor from personal air samples. With Data-RAM peak exposures were identified during certain work tasks. New bacteria were identified with MALDI-TOF.

With new information about the bacteria content in MWF and exposure of MWF aerosols more targeted engineering control can be developed.
ABSTRACT

Introduction:

Amines and aminoalcohols have been used for many years in water dilutable metalworking fluids (MWF). Their primary functions are neutralization of acid-functional components and development and maintenance of alkaline pH. They also provide other benefits such as longer fluid life, corrosion control etc. The performance of amines in formulation is influenced by structural variables such as carbon number, molecular arrangement and presence or absence of hydroxyl groups. Similar variables also affect formulation stability and need to be considered to achieve optimum performance. The paper outlines hydrophile-lipophile balance (HLB) based strategies to effectively formulate various amine structures in metalworking fluid (MWF) formulations. We will also present structure-property evaluations for several amines focusing on the effect of amine structure on microbiological and corrosion performance of metalworking fluids.

MWF Formulation and Performance Testing:

MWFs contain a variety of components, which in the case of soluble oils and semi-synthetic fluids, are formulated to form stable emulsions. This is achieved by employing the surface active components called surfactants or emulsifiers. The emulsifiers keep the lipophilic (oil-loving) components in an emulsified form in the continuous medium, typically water. The HLB technique was developed specifically for nonionic surfactants and it is a measure of the degree to which the surfactant is hydrophilic or lipophilic, determined by calculating values for the different regions of the molecule. Effective formulation strategy is to balance the required HLB of the MWF formulation using HLB values of the emulsifiers to obtain a stable emulsion [1-2]. The experimental techniques described here are quick, effective and can help achieve the best use of time and resources.

We will also present performance evaluation data for several amine compounds. The microbiological and corrosion performance was tested using ASTM E2275 and ASTM D4627 procedures, respectively. The testing was conducted on a wide range of aliphatic and cycloaliphatic molecules varying in carbon chain length, branching as well as the number of hydrophilic groups. Two common biocides, triazine and benzisothiazolinone (BIT), were tested. Results indicated that the amine molecular size and structural configuration influence the performance synergy with the biocides. Several studies have indicated that certain amine structures can enhance the performance of registered antimicrobials [3-4]. The same variables are also seen to affect the corrosion control provided by the amines. Having an understanding of the structure-property relationships is helpful in making conscious choices to formulate MWF fluids that are globally acceptable. This is an important criterion in light of the restrictions on use of secondary amines and the scrutiny of Triazine biocide.
AUTHOR: HEINZ DWULETZKI

ORGANIZATION NAME: CARL BECHEM GmbH,

TITLE: A NEW COOLANT CONCEPT FOR THE MINERAL OIL-FREE MANUFACTURING OF TOMORROW- A PLEA FOR ECOLOGICALLY SUSTAINABLE MODERN PRODUCTION BEYOND PETROLEUM

ABSTRACT

1. Resources for lubricants
Mineral oil is the long-term used base fluid of nearly all lubricants and has already reached peak-oil in 2006. Due to availability and general ecological reasons the replacement of this raw material is of fundamental interest and more than a question for today. Technically and chemically water offers so many positive characteristics that it could act as an everlasting, never ending base fluid for lubricants and could help to solve many problems in future.

2. Pros and Cons of non-water miscible and water miscible coolants: Classical, state-of-the-art types of coolants used in metalworking applications
Mineral oil based lubricants offer mainly well-known typical advantages like viscosity, lubricity, corrosion protection and simplicity in handling. On the other hand severe disadvantages like poor cooling power, inflammability, necessity of fire and explosion protection, strong health and safety impacts on the working place surroundings, etc. become more obvious. The dominant aspect of water diluted coolants derives from the thermodynamic data of the base fluid water. In principle this helps to master those processes where cooling requirements dominate lubricational aspects. In addition, cleaning and chip removal are getting more and more relevant in practise of highly automatic production sequences und need the use of water-diluted coolants.

3. New viscous, water-based lubricants: A new approach to old problems which opens a new horizon of manufacturing
Within the light of sustainability and climate protection a new strategic approach for the design of lubricants becomes more likely: LCA’s of formulations, carbon-footprints and global warming potential become more important for a lubricant whose technical potentials remains unchanged on highest performance level. Viscous water-based lubricant systems merge the positive aspects of both classical base fluids from mineral oil and from water as well: Lubricity, viscosity, fire-resistance and cooling-power mix into the new class of lubricants. Tribological data and a large bunch of results from the field clearly demonstrate the high level of performance of these newly developed lubricants.

4. Experiences from the field
So far a broad spectrum of technical applications had been reported and is presented in detail. Positive results from metal removal applications by grinding and cutting as well from metal forming processes show an enormous potential for future.

5. Conclusion
Based upon examples from practise the ecological-safe pathway of a modern manufacturing is described. The replacement of mineral oil by viscous water let a dream come true and offers technical and ecological benefits with the highest possible sustainability of any type of base-fluid.
ABSTRACT

Respiratory intake of living organisms including dead bacterial cell wall constituents such as Gram-negative lipopolysaccharides (LPS, endotoxins) is common. Such pyrogens are proinflammatory active substances and eventually induce fever or even shock, i.e. life threatening reactions. Established test methods for controlling the absence of pyrogens are the rabbit pyrogen test and the limulus amoebocyte lysate (LAL) assay (an endotoxin assay), both based on animal sources. In metalworking fluids, the standard test method for detection of endotoxins is the LAL assay, although his limitations are known.

The novel PyroDetect is specific for pyrogen exposure of man, because it uses the immune response of human blood, i.e. the white cell population monocytes/macrophages, to pyrogens. They release proinflammatory cytokines upon exposure to any pyrogen which can be easily assessed by an immunological ELISA assay. Based on an international validation study, the procedure, named Monocyte-Activation Test (MAT), was introduced into the European Pharmacopoeia (EP 6.7, Chapter 2.6.30, 2010) as alternative to the rabbit test.

In its developed and standardized form, the PyroDetect based on the measurement Interleukin-1β (IL-1β) is commercially available and in use by Biotest. The detection spectrum covers bacterial Gram-negative or Gram-positive or fungal pyrogens in parenteral (injectable drugs, solutions) und medical devices, including even air borne contaminations.

In pilot studies the PyroDetect was adapted for measuring air borne pyrogens in farm houses. An ongoing study adjusts this method to metal working fluids and aerosols in order to adopt it as a robust method seems for assessing the health risk for workers in metal working industry.
The metalworking industry has recently been impacted by a number of emerging HES regulations and directives. These include programs aimed at the elimination of formaldehyde and boric acid use, the reduction of overall biocide usage and an accounting for the contribution of metalworking fluids to the atmospheric VOC burden.

Government agencies and other organizations are working to develop these new regulations with attainable goals which are beneficial for the environment and at the same time feasible for industry. In order to conform to these new directives, metalworking fluid formulators are rethinking traditional metalworking formulation strategies.

The use of additives with ancillary colloid stabilizing and bio-stabilizing properties and low total VOC contribution are being considered. This talk will describe the use of off-diagonal additive optimization as a means of producing stable and low VOC contributing fluids.
ICCA Global Product Strategy (GPS) is the industry commitment to the Strategic International Chemicals Management (SAICM) and was launched in 2006 in Dubai.

GPS aims for safe chemicals management throughout its life cycle by making available hazard and risk data to all interested stakeholders in a transparent way. GPS is implemented at global level and in the EU it follows the implementation of REACH. This presentation will briefly explain the GPS project and elaborate on the implementation of it in EU countries.

Exposure scenarios are the result of the REACH exposure assessments and describe all uses with its the risk management measures and operational conditions to use the substance in a safe way. ES will be part of the eSDS and need to be communicated down the supply chain.

Communication of ES can be supported by harmonised IT systems. For that a IT standard and standard phrases need to be developed. Industry has started a project to develop these phrases and to set an IT standard. This presentation will give information on the industry project and how this standard can be used.

Dec 201 ECHA published an updated Guidance on Intermediates. This guidance changed the definition of intermediates significantly. The conditions for Strictly Controlled Conditions Strategies were changed as well, with severe consequences for industry. This presentations deals with the changes in the new guidance, the consequences for industry and the position Cefic has taken.
ABSTRACT

Formaldehyde has been used for many years as an intermediate in the production of resins and glues for wood panels (for construction and furnishings), as well as in the manufacture of plastics, resins and coatings for automotive and aerospace use. Formaldehyde also has found application as a biocide and along with formaldehyde releasers has been used in metalworking fluids.

However there are currently a number of regulatory challenges facing formaldehyde in Europe, including potential re-classification under the CLP legislation, which would have implications under REACH, and the Biocides Directive. These are outlined and Formacare’s advocacy programme is described.
AUTHOR: BRIAN K. HOVIK

ORGANIZATION NAME: BOEING

TITLE: BOEING COMPANY METAL WORKING FLUID QUALIFICATION PROCESS

ABSTRACT

In the process of fabricating some of the most sophisticated aircraft in the world, Boeing obtains parts from all around the globe. To maintain the structural integrity of all parts, whether fabricated within Boeing factories or acquired from sub-contractors, Boeing has established a testing regime to assess a metal working fluid’s affect on machined parts. These tests are part of a Process Specification which Engineers and production personnel reference when fabricating parts. These tests assess whether a MRF contributes to various types of corrosion, creates any stress, weakens sealants, hampers paint adhesion & the MRF’s general compatibility to the substrate. The coolant supplier pays for these tests.

To reduce cost and time Boeing has developed a four-step process for evaluating new coolant candidates for inclusion in the specification and approved product list (APL). In a nutshell, the four steps are:

1) A pre-screening machinability test wherein a MRF is subjected to a standard test to evaluate how well it performs.
2) Toxicology, compatibility with cleaning methods, sump longevity (bio-stability), waste treatment and foaming.
3) BAC specification testing; Up to eight different tests depending on the substrate that the fluid will be used on. This step also includes a three phase testing protocol to reduce testing cost based on the substrate.
4) Shop trials. Most trials are for a 90 day period after which the product will be included on the approved product list.

This four step process has been very successful in weeding out coolants that are sub-standard performers. It has also helped coolant manufacturers by giving them some quantifiable targets when approaching Boeing with new coolants. This reduces cost and laboratory time for both the supplier and Boeing.
The work described in this paper is part of the European Project IBIOLAB, trying to find suitable metalworking fluids from a type of vegetable oils such as high oleic sunflower oil (HOSO). In this presentation, it is compared the performance of the IBIOLAB water based formulations, in comparison with Mineral and Synthetic fluids.

Innovative characterization tests at laboratory scale (3 ball abrasion tests, grinding simulation tests, Tapping torque and tests) and in real grinding machines and advanced techniques (residual stress measurements monitored by RX to predict formation of cracks), have been combined for screening the performance of the emulsions.

The main conclusions achieved have been the following:

- From efficiency point of view characterized by low friction & torque, Synthetic fluid has the better performance followed by vegetal fluid A, and C and these better than mineral oil, but lower temperature was detected when using vegetable. Good prediction was achieved using the 3 ball abrasion tests and tapping torque tests.

- From Wheel durability point of view, Synthetic fluid is better than vegetal A & C, and this better than mineral oil. Good prediction was achieved using the grinding simulation tests.

- In the case of F114 steel, using M1 machining conditions, the vegetal fluid C or A emulsions are more beneficial than the reference synthetic & mineral fluid since it is possible to avoid the tensile stress protecting the surface integrity and avoiding crack generation.

- In the case of F522 steel, using M1 machining conditions, the synthetic fluid allows to reach a minimum surface residual stresses in the part.

- When using M2 Machining conditions, tensile stress that increased with the hardness of the material were found, with small differences between lubricants.
The European Ecolabel for Lubricants (EEL) was designed to unify several national ecolabels for products in loss and high-risk lubrication. The EEL identifies products, meeting minimum requirements for technical performance, with only a limited hazard to the aquatic environment and a high fraction of renewable raw materials. It sets well-founded, strict and clear criteria that require detailed information on any substance intentionally added to the product. This creates market opportunities that challenge producers of lubricants and components to develop new products. The EEL was launched in 2005. Its first revision, started in 2009, aims to harmonize the criteria with developments in European legislation and regulations, improve clarity on the requirements and open perspectives for innovative entrepreneurs that focus their R&D and marketing strategies on green purchasing policies. Together, these should stimulate market supply and demand of sustainable products for use in sensitive environments.

In this presentation the development and role of the ecolabel in several other areas will be presented. Attention is given how in the revision CBI has been considered. Currently Metal Working Fluids are not included in one of the defined categories. Some ideas will be presented how this might be achieved.
Volatile organic compound (VOC) regulations require an innovative approach to formulating heavy duty and moderate duty rust preventives. Solvent born rust preventive coatings provide excellent part coverage, fast drying times and can be tailored to achieve a variety of film characteristics and protection needs.

Water based products require different approaches to application and formulating. This presentation will cover regulatory drivers impacting the rust preventive market and how the use of innovative water-based rust preventives enable formulators to meet heavy duty long term indoor and outdoor protection requirements, during storage and shipping, while meeting VOC regulatory demands.
**AUTHOR:** INGO KRULL  
**ORGANIZATION NAME:** SCHÜLKE & MAYR GMBH  
**TITLE:** NEW TRENDS IN THE PRESERVATION OF METALWORKING-FLUIDS  

**ABSTRACT**

Due to the increasing legislative pressure (BPD and IFRA) and the decreasing number of available biocides the preservation and composition of metalworking fluids are changing.

Today the formulator of a metalworking fluid has to consider first of all for which market/region the product is dedicated: EU, USA, Canada, Turkey etc. A lot of countries have already introduced legislative regulations for biocides or are working on it. The technical performance of a product is becoming secondary.

Furthermore the customer expectation is to get less harmful formulations from their mwf-supplier. Therefore they are open for “preservative free” metalworking fluids.

In this presentation schülke wants to give an overview about the “global” legislative situation for biocides in metalworking fluids as well as about current preservation trends and biocide discussions in the metalworking industry like:

- the status of the formaldehyde discussion  
- concepts for formaldehyde free metalworking fluids  
- limitations for HHT in the USA  
- preservative free metalworking fluid concepts  
- etc.
ABSTRACT

Over the past few years there has been considerable regulatory scrutiny regarding formaldehyde. Regulators in the U.S., Canada and EU are reviewing formaldehyde and formaldehyde donor chemistries in parallel using the most current science and their subsequent actions will affect preservatives used in the metalworking fluid market.

The evaluation by a number of research and government institutions is key to the continued use of formaldehyde donor chemistries throughout the world. In the U.S. for example, the National Academy of Sciences (NAS) conducted a scientific evaluation of the EPA’s IRIS (Integrated Risk Information System) Assessment of Formaldehyde. Their peer review of this assessment is key to subsequent evaluations by other U.S. based institutions such as the National Toxicology Program (NTP) as well as the development of new regulatory parameters by both the U.S. EPA’s Pesticides Program, and Canada’s Pest Management Regulatory Agency.

Likewise in the EU there is the ongoing evaluation of formaldehyde donor chemistries under the Biocidal Products Directive (BPD) by a number of key EU member states as well as separate actions by the French under the REACH regulation which will have implications on this market. Actions by regulators on both sides of the Atlantic highlight the differences in the evaluation of formaldehyde exposure which is either by hazard or risk. With the implementation of GHS globally, it remains to be seen how these approaches are reconciled in future regulation of products for the metalworking and other industries.
Metal removal fluids (metal working fluids) consist of a large variety of different chemical compounds. Each of them provides a specific feature essential for the overall performance of the metal removal fluid. It is well known that these fluids are very often highly contaminated by microorganisms (in general bacteria and fungi) which will use many of these compounds as a food source. The impact of microbial growth can lead to a degradation of specific compounds and to several transformations of their chemical characteristics. Often these microorganisms are feeding highly selective only on a few chemicals. As a consequence, the performance of the metal removal fluid will be changed dramatically and this event is difficult to monitor. To obtain realistic numbers for the microorganisms involved is hindered by the use of improper media for cultivation. The same is true for a rapid identification of the most abundant microorganisms present in the metal removal fluids because some of them can represent a health risk for the employee. Here we summarize some of the major problems related to microbial contamination of metal removal fluids and represent a new state of the art method for their rapid identification.
AUTHOR: UWE LANDAU

ORGANIZATION NAME: LARGENTEC VERTRIEBS GMBH

TITLE: AgXX - A NEW CONTACT CATALYST FOR DESINFECTION OF WATER-BASED LUBRICANTS

ABSTRACT

The interdisciplinary research of scientists from surface technology, chemistry, applied engineering and microbiology generated the new antimicrobial contact catalyst AgXX. To this aim a specially structured precious metal coating is conditioned and activated by a finishing treatment. The result is a new, highly efficient antimicrobial surface. The inactivation of microorganisms mainly takes place at or in close contact with the AgXX surface by depolarisation of biological membranes thereby inducing lysis of microbial cells. This allows new solutions for the decontamination of many different aqueous systems. Functioning as a physical contact catalyst AgXX works especially well in newly developed reactors, cartridges and filter cassettes. In practical applications as well as in different tests AgXX already demonstrated the successful microbial decontamination of lubricants and cooling liquids. Because AgXX does not depend on the release of toxic chemicals into liquids, AgXX is not harmful for humans. Therefore additional applications for pharmacy, food industry, biomedicine and drinking water have already been started.

To cover the constantly increasing demand of AgXX for industrial applications a first reel-to-reel mass production process has been established. Meanwhile AgXX can be produced in the form of foil, membrane, net or powder. Coating of many different materials like steel, plastic, glass, ceramic etc. is possible. The coating thickness determines the time of antimicrobial activity which can be adjusted for applications of months or several years.

Because of its special properties AgXX is also resistant against most chemical agents and especially against activated sulfur components that normally are highly problematic for conventional silver surfaces. AgXX works nearly free of any maintenance and can easily be cleaned or regenerated if necessary.
Twist compression is a bench test that is used by metalworking lubricant and additive manufacturers, as well as end-users, to compare the frictional performance of fluids under various conditions. Combinations of work piece and tool materials may be evaluated under various pressures. During the test, an annular specimen is rotated while in contact with a lubricated flat piece under pressure, while the normal force and torque transmitted through the lubricant film are monitored. This test geometry forms a squeeze film and the test reaches boundary conditions quickly. Extreme pressure additives are activated under these severe conditions and lubricants may be compared based on how long they can resist breakdown and metal-metal contact. The test creates lubricant starvation, a condition that is common to many metalworking operations when lubricant failure occurs. This is one reason the test correlates well with a variety of metalworking applications. Additionally, coefficient of friction is calculated using the monitored forces, allowing one to compare friction levels of lubricants while the films persist and are performing well. The presentation will describe the test in detail. Variations of the test will be described and methods of data interpretation explained as they relate to metalworking applications.
ABSTRACT

In literature, significant changes regarding the physical, chemical and microbial properties of MWFs over their lifetime are extensively reported. The deterioration leads to decreased performance of the MWF, which may result in higher tool wear, poor workpiece quality and damage of machine tool components. Conventional methods for the monitoring of the MWF’s condition are time consuming and in some cases show poor accuracy.

An innovative approach to allow for online monitoring of the chemical and microbial state of MWFs within the machine tool is currently developed at the IWT Bremen in collaboration with the Center for Environmental Research and Sustainable Technology (UFT Bremen). An array of semiconducting metal oxide sensors is integrated into the MWF tank of the machine tool and continuously measures the concentration of several volatile substances.

This so called electronic nose performs a relative correlation between the measured substances and therefore works independent from external effects. Initial results demonstrate the system’s potential to detect both, changes of the chemical composition as well as the development of the microbial load.

The latter causes metabolization of specific additives and leads inter alia to the presence of volatile substances within the MWF, which can be detected by the electronic nose. The testing time is superior to the conventional methods and allows for control measures (e.g. refilling of additives or addition of biocides) in a very early stage.
ABSTRACT

The South Coast Air Quality Management District (AQMD) is the local air pollution regulatory agency serving the South Coast Air Basin (Basin) consisting of portions of Los Angeles, Riverside, Orange and San Bernardino counties in California. The air quality in the Basin has been designated as extreme non-attainment by the U.S. Environmental Protection Agency (EPA). For that reason, the AQMD often finds itself at the forefront of the nation’s emission reduction efforts. As part of these efforts, the AQMD has been investigating volatile organic compounds (VOC) emissions from metalworking fluid use. One of the primary challenges has been to find a reliable test method to determine VOC content. EPA Method 24 Determination of Volatile Matter Content, Water Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coating failed to provide reproducible results. The lack of precision is due to many metalworking fluids being semi-volatile fluids. In cooperation, Independent Lubricant Manufacturers Association (ILMA) and AQMD developed a thermogravimetric test method that mimicked the results from a six month, low temperature evaporation study of naphthenic oils. After being validated using ASTM E691-05 Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method, this method was incorporated into ASTM E 1868-10 Standard Test Method for Loss-On-Drying by Thermogravimetry. Using this reliable, low-cost methodology, the AQMD adopted a regulation for metalworking fluids to reduce air emissions from solvents and light naphthenic oils (C12-C16) which will result in a reduction of over 3.5 tons per day of VOC emissions from the Basin. In early 2012, AQMD and ILMA will sponsor a joint symposium on emerging low-VOC technologies, including water-dilutable, bio-based and paraffinic products, to further explore emission reduction opportunities.
The large share of human errors causing accidents in aviation suggested the - at first sight brilliant - solution to replace the fallible human being by an “infallible” digitally operating computer. However, we learned that complex tasks involving quick and difficult decisions cannot be controlled entirely by machines. We need optimum human performance.

Since a single person is always “highly error-prone”, the principle solution of the problem is optimum team interaction. The probability that two persons make exactly the same mistake at the same point within an operating process is relatively low, as long as the two “thought machines” collect and evaluate the available facts independently from each other before discussing and clarifying the further steps. The independent work of mind results in a safety network that is able to cushion human errors.

A comprehensive survey showed the following result: Far and away the most frequent safety-critical situation (37.8% of all events) consists of the following combination of risk factors:

1. A complication develops
2. In this situation of increased stress a human error occurs.
3. The negative effects of the error cannot be corrected or eased because there are deficiencies in team interaction on the flight deck.

This means that for example a negative social climate has the effect of a “turbocharger” when a human error occurs: It needs to be pointed out that a negative social climate is not identical with a dispute. In many cases the working climate is burdened without the person responsible noticing it: A first negative impression, too much or too little respect, contempt, misunderstandings, not expressing unclear concern, lack of motivation, etc. can reduce the efficiency of a team considerably.

It is almost a paradox of human history: Man’s efforts to develop machines that compensate human weaknesses have lead to the situation where now the "inherently human" abilities of social competence are of utmost importance when dealing with HITEC.
AUTHOR: MILIND PHADKE  

ORGANIZATION NAME: KLINE & COMPANY, INC.  

TITLE: GLOBAL METALWORKING FLUIDS – A REVIEW OF MARKET OPPORTUNITIES AND CHALLENGES  

ABSTRACT  

This presentation outlines the top line findings from Kline’s recently completed studies “Metalworking Fluids 2010: Market Analysis and Opportunities” and “Global Lubricant Additives 2010: Market Analysis and Opportunities”.  

The global metalworking fluids market in 2010 is estimated at 2.2 million tons. Asia is the largest region accounting for over 40% of this volume. Removal fluids account for nearly 50% of the total volume. Compared to 2007, Asia grew by 3% per year despite the recession. Europe and North America on the other hand declined by 2% and 8% per year respectively. The decline in Europe was not as severe as North America, mainly because key metalworking fluid markets like Germany and Russia exhibited a fairly robust recovery. Besides strong regional demand, demand growth in Asia is aided by production shifting from North America and Europe to Asia.  

The consumption of additives to formulated metalworking fluids accounts for about 0.6 million tons. Corrosion inhibitors, emulsifiers, and friction modifiers are the leading function classes consumed accounting for 65% of the total additive demand.  

The supplier base for metalworking fluids is extremely fragmented in all three regions with the top 10 suppliers accounting for 45% to 65% of the total market. The situation can differ for individual countries. Similarly, there is a wide variety of metalworking fluid product offerings. This variety is driven by formulator and user preferences, machining conditions, materials involved, performance objectives, regulations, and other such factors. This makes the market rich in niche opportunities, helping margins, but making growth a challenge.
AUTHOR: MENK K. PRINSEN

ORGANIZATION NAME: TNO TRISKELION

TITLE: IN VITRO SKIN AND EYE IRRITATION TESTING OF WATER-MISCIBLE METALWORKING FLUIDS

ABSTRACT

Water miscible metalworking fluids (MWF) are formulated with a varying number of acids and bases, both organic and inorganic. These acids and bases will undergo simple neutralization reactions in situ to form salts, resulting in an equilibrium mixture in the product as supplied to customers. Nearly 100 acids and bases can be used in MWF and approximately 2,500 neutralisation salts can be formed. Assigning a hazard classification to this number of salts on an individual basis is impractical, and therefore a pragmatic approach by grouping and read-across process was performed to reduce to a number of salts and to identify sentinel neutralization salt(s) from representative groups that could be examined for skin and eye irritating properties. This grouping resulted into 9 neutralization salts.

In the in vitro skin irritation test with EpiDermTM reconstructed skin membranes, the undiluted samples were applied topically for 60 min. After a 42-hour incubation period, the effect on the tissue viability was determined, based on the reduction of MTT to a purple formazan precipitate by mitochondrial dehydrogenase activity.

In the in vitro eye irritation test with Isolated Chicken Eyes (ICE), the undiluted samples were applied topically to the cornea for 10 sec. With a Haag-Streit slit lamp microscope, corneal effects, i.e. corneal thickness (as a percentage swelling), corneal opacity and fluorescein staining of damaged corneal epithelium were determined at regular intervals up to 4 hours after treatment.

Using these tests, 9 neutralization salts were tested as well as 3 theoretical typical metalworking fluid samples. The presentation will give the results of these tests.
Part 1: Definitions and review of Machine Operator's Lung cases: Hypersensitivity pneumonitis (HP) is an inflammatory disease of the lung due to repeated inhalation of antigens (fungi, bacteria, proteins). Fever arises 6 to 8 hours after exposure. The main symptoms are: dyspnea, cough, loss of weight, fatigue, breathlessness and improvement during eviction periods (1). Occupational exposure to Metalworking fluids (MWFs) through inhalation of aerosols has been associated with HP known as “Machine operator’s lung” (MOL) related to microorganisms that frequently contaminate MWFs, especially Mycobacterium immunogenum (Mi). Since 1993, most cases of MOL have been described in the USA automotive industry. The first European case clusters were recently reported in automotive plants in Great Britain and in France (2).

Part 2: Sampling and analyze tools: Culture on 7H10 medium and quantitative Polymerase Chain reaction are useful to obtain MWFs Mi concentration. By serological analyze, presence of specific Mi precipitins provide arguments to the diagnosis of MOL cases.

Part 3: First French cluster cases of MOL and new serological tests: 13 workers at a car-engine manufacturing plant were suspected of MWF-HP. Microbial analysis of 83 used MWF was carried out. Sera from 13 MOL cases, 12 exposed unhealthy- and 18 healthy unexposed controls were tested to determine their immunological responses to three Ag including Mi. Mi was identified in 40% of used fluids. The threshold to differentiate cases from controls was five arcs of precipitation (Sensitivity (Se) 77%, specificity (Sp) 92%) as determined by electrosyneresis (2-3). Recombinant antigens (RAg) were product and tested again the same sera. Two RAg (Dihydrolipoyl DH; AcetylCoA DH) gave good results with respectively Se 93%, 100% and Sp 67%, 83% and a very high antigen standardisation (4-5).

Part 4: A case of MOL, a survey, a cost: Financial consequences of the contamination of 8 MWF installations in a big French automobile factory and the arisen of a case of MOL are analyzed. The immediate cost is more than 400 K€ for a new MWFs management, but a complete restructuring of temperature and ventilation regulation is needed (unpublished data).

Part 5: Comparison of microbial MWFs contamination in automobile- vs micromechanic plants (6): 180 MWF samples from non automotive plants, and 165 samples from automotive plants in which cases of MOL had been proven were microbiologically analyzed. Our results revealed two types of microbial floras: the first one was from the non-automotive industry, showed predominantly gram-negative rods and was associated with a low risk of MOL; the second one came from the automotive industry, that was affected by cases of MOL and showed predominantly gram-positive rods. Traces of M. immunogenenum were sporadically detected in the first type, while it was highly prevalent in the automotive sector, with up to 38% of samples testing positive. The use of chromium, nickel or iron was associated with growth of gram-negative rods; conversely, growth of gram-positive rods was associated with the absence of these metals. Our results suggest that metal types play a part in MWF contamination (7).


4th Symposium on "Metal Removal Fluids: Global challenges" - Barcelona, 14-16 September 2011
Metal working fluids (MWF) are multi-component-mixtures of very complex constitution and there may be a number of dangerous substances as ingredients. Due to the constant change of the composition while using the MWF it is almost impossible to perform a risk assessment and to plan risk management measures (RMM) based on one or several components.

With the almost same reason neither specialists in occupational medicine and toxicologists could derive a threshold limit. The convention “The higher the exposition, the higher the hazard” does not help without limit for intervention.

The employers mutual insurance association (in Germany: DGUV, [www.dguv.de](http://www.dguv.de) and BGHM, [www.bghm.de](http://www.bghm.de)) therefore decided, on the basis of measurements realized during the last 15 years, to adjust a “technically based threshold limit” as state of the art in their regulations.

The “DGUV-Regel 143” (issue December 2010) describes evaluation and assessment of risks at typical workplaces with MWF and resulting safety measures.

This lecture will give an actual overview about latest development.
ABSTRACT

1. Background
The Health & Safety Executive (HSE), the UK regulatory body for health & safety in the workplace has funded a three year programme of research into the health effects of metalworking fluids. Following the outbreak of respiratory ill health at the Powertrain plant in Longbridge in 2003-2004, one area that HSE has focussed its attention on MWF mists as a risk factor for respiratory disease. The use of compressed airlines for removing residual MWF has raised concerns about generation of respirable MWF mist.

2. Methodology
The impact of compressed air on generation of MWF mist was investigated using an experimental test chamber in which the background levels of respirable sized particles were lowered to facilitate measurement of mist generation. A workplace study was also undertaken to ensure that the experimental findings reflected real working practice. Mist generation was quantified using particle counters and personal sampling (boron marker methods MHDS 95/2) to determine respirable exposure to MWF. The formation of mist was visualised using backlighting and its distribution onto surfaces was visualised using a UV fluorescent dye. The study investigated parameters such as airline pressure; the impact of microbial contamination of the MWF, and the risk for dermal exposure.

3. Results
The greater risk from the use of compressed air was for dermal exposure due to formation of large droplets of MWF coating the workers torso and operating arm. Only under the experimental conditions with lower background of particles in the air was it possible to demonstrate formation of respirable mist. Visual demonstration of mist using backlighting was not reproducible and levels of MWF by personal sampling were at the lower limits of detection of the boron marker. Microbial contamination of MWF (either intact or lysed bacteria) did not affect the formation of mist. Background levels of airborne particles in the ‘well managed’ workshop visited were sufficiently high to mask any increase in respirable particles caused by the use of compressed air. Furthermore backlighting was unable to demonstrate reproducible mist formation during the use of compressed airlines and the majority of the fluid was forced away as larger droplets some of which fell onto the arms and torso of the operator.

4. Conclusions
Dermal exposure to used MWFs is a greater risk than inhalation of respirable mist particles when compressed air is used to clean MWFs from surfaces. There is a potential risk for formation of respirable mists when compressed airlines are used at high pressures but good principles of hygiene and control should minimise this risk (e.g., use of airlines at lower pressure).
Precision forging is a process which enables a very high dimensional and shape accuracy and also surface finish. In aircraft construction, for example, many parts (e.g. turbine blades or window frames) are precision-forged to minimize subsequent machining.

A precision forging process naturally has extremely high demands on a forging lubricant. Also the forging of special alloys such as titanium, nickel-base alloys and special steels requires the application of special lubricant coatings at the workpiece.

One way to fulfill the requirements is to use special glasses as high temperature lubricants. These glasses are ideally mixed as a powder in the form of a suspension in water and are applied by spraying, dipping or painting to the workpiece which has to be forged. After drying of the suspension, the workpiece is heated up to forging temperature and then the glass becomes liquid and covers the workpiece completely. By this effect the melted glass layer works as a lubricant and insulating layer during the subsequent forging process.

Glasses do not melt at a specific temperature but soften gradually, ie, a glassy solid converts continuously through a plastic state into a molten glass when heated. The optimum temperature window of a lubricant based on glass is located in an area where the viscosity of the molten glass is low enough for an even distribution of the glass film on the workpiece surface and on the other hand high enough to form a pressure-resistant lubrication film.

A suitable composition of the glass layer can significantly reduce the heat dissipation. Thus the heat distribution in the workpiece is more homogeneous and therefore it can be maintained over a longer period of time in an optimum temperature window.

Additionally the glass layer as a melt forms a seamlessly protecting film around the piece, which prevents the admission of hydrogen, oxygen and other corrosive gases. Thus the surface remains in its original metallic form.

The use of high temperature lubricants on the basis of glasses can effectively solve the problems that occur in the hot forging of special alloys.

By adjusting the glass formulation to the requirements of the individual forging process and material, in addition to the described properties other parameters such as the application method of the glass suspension on the forged part, the adhesion of the coating after the first forming step or the achievable surface quality of the workpiece can be selectively influenced. This results in a variety of different lubricant formulations, each with very specific properties.
ABSTRACT

The continuous checkup of the properties of metalworking fluids is a routine task for a supplier. In case of an incident or to be able to search for specific ingredients or impurities, modern high-performance instruments are of great use to find the cause and offer solutions. The combined use of chromatographic and spectrographic methods can be used to identify even small amounts of foreign substances and quantify certain ingredients very precisely. Several examples will be presented to describe different methods and their usefulness in monitoring metalworking fluids.
This paper will examine the history of the issues relating to the use of boric acid in metalworking fluids over the last twenty years leading up to the current regulatory status of the material and the implications beyond 2011. There will be a review of the science behind the labelling requirements, an update on the programme carried out by UEIL related to the handling of boric acid and further data on the potential presence of ‘free’ boric acid in metalworking fluid concentrates. The author will ultimately look to the future market position of ‘boron’ containing fluids and the potential longer term future of this key formulatory raw material.
AUTHOR: EUGENE M. WHITE

ORGANIZATION NAME: MILACRON LLC/CIMCOOL GLOBAL INDUSTRIAL FLUIDS

TITLE: GLOBAL REGULATORY TRENDS FOR MRF PRODUCTS: A U.S. PERSPECTIVE OF CHALLENGES AND OPPORTUNITIES

ABSTRACT

The regulation of metal removal fluid (MRF) industries has primarily been implemented within national boundaries. Regulatory agencies promulgate and enforce environmental, safety and health (EHS) requirements that influence the qualitative and quantitative aspects of chemicals utilized in the manufacture of products, and the subsequent application of these products by end-users. Until recently, regulatory requirements in one country have had little influence on industries in another. However, due to the rapid expansion of global commerce, companies that export products and their multinational counterparts must be both vigilant and cognizant of established and emerging EHS requirements emanating from various geographic regions. This presentation will offer a U.S. perspective of EHS regulations on international MRF industries with an emphasis on concerns and potential opportunities posed by present global regulatory trends.
ABSTRACT

In his presentation he shows the results of a Chemical Management project, started 15 years ago and its development on a global level within ZF-Group.

With the extension on filters and services an additional value for process improvements and product quality could be provided on top of raising delivery performance and cost savings.