LANXESS Corporation

PCMC – The Classic Preservative for Metalworking Fluids and Lubricants

By Dr. Oliver Kretschik, LANXESS Corporation

Parachlorometacresol (PCMC) has been on the market for several decades as a highly effective and safe biocide, and is registered in many regions of the world for use in metalworking fluids and lubricants. LANXESS produces and markets this compound under the trade name PREVENTOL® CMK Preservative (Figure 1).

Over the last decade, PCMC, a phenolic active ingredient, has made a comeback in metalworking fluids due to its tailor-made physico-chemical and microbiological properties that allow for effective and sustainable combat against bacteria, mycobacteria and fungi.

Mode of Action

PCMC is a membrane-active biocide. Phenolic derivatives adsorb (cost) onto the surface of the microbe cell membrane and are more at or less dissolved by liquids. They attach biological membranes and penetrate into the cell, where reactions with the protoplasm and the cellular proteins occur. As a result, enzymes are inhibited. It is known that the oxidoreductases and the enzymes of carboxyl and protein metabolism are particularly sensitive. At low concentrations, there is only reversible adsorption of the phenolic compound at the cytoplasmic membrane and a bacteriostatic or fungistatic effect is observed. At higher concentrations, the cell membrane is penetrated and destroyed, and the action of PCMC is biocidal.

Efficacy

PCMC's solubility in water is fair and increases with increasing pH levels. For most formulas the water solubility is sufficient and higher than the effective concentration. It is its solubility in lipophilic environments that makes PCMC such a powerful molecule in mycobacteria control. Mycobacteria have a more hydrophobic cell wall, caused by the presence of mycolic acid (containing long chain aliphatic hydrocarbons). This distinguishes mycobacteria from other bacteria, and gives a more lipophilic agent like PCMC an advantage at penetrating the cell wall versus other chemistries. Levels of 2000 – 2500 ppm PCMC in the fluid are typically applied to prevent mycobacteria growth; similar levels added tank side can be used to cure mycobacteria infections (Figure 2).

The effectiveness of PREVENTOL® CMK Preservative in metalworking fluids, particularly in soluble oils and semi-synthetic formulas, has been demonstrated repeatedly. Figure 3 displays the result of a 10 week repeated challenge test performed according to ASTM and IBRG protocols. The example illustrates PCMC performance using a mixed inoculum of wild type and IBRG strains of bacteria, yeast and fungi. Plate counts have been carried out weekly before new inoculation.

Biodegradability

A topic that is surprisingly frequently overlooked is how the solubility is bio-degradable. Certainly not all phenols are the same and this holds true for their environmental fate as well. PCMC entering the waste water treatment plants at low concentrations will be biodegraded. PCMC in particular has been tested repeatedly with results that conclude that it is readily biodegradable. Concentrations up to 85 mg/l of PCMC are completely biodegradable and therefore non-toxic to an activated sludge treatment system. A list of experiments performed to demonstrate PCMC biodegradability is shown in Figure 4, page 44.

Registrations and Approvals

In today's global environment, it is crucial to provide manufacturers with the ability to market their products in all regions in which they are interested. As previously mentioned, PREVENTOL® CMK Preservative has been sold for quite some time. As such, a significant number of studies have been conducted, creating a tremendous amount of data. This allows for registrations in all regulated markets, particularly in the United States. E.P.A. registrations, Health Canada PMRA registrations, and

Figure 2

Efficacy Against Mycobacteria

Semi-synthetic Fluid, Mycobacterium Immunogenum, 2003

Figure 3

Challenge Test – 10 Week Results

SOLuble Oil – 5% Ready-to-use Emulsion 2000 ppm PCMC a.i.

Figure 4

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Figure 4

PCMC – Biodegradability

PCMC is Readily Biodegradable

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Biodegradation Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed bottle test</td>
<td>&gt; 84% degradation after 28 days (NIA, 1994)</td>
</tr>
<tr>
<td>OECD confirmatory test</td>
<td>Complete degradation (Voets et al, 1976)</td>
</tr>
<tr>
<td>Water treatment plant</td>
<td>&gt; 100% elimination (unpublished data)</td>
</tr>
<tr>
<td>River simulation test</td>
<td>Complete elimination (Fritsch, 1998)</td>
</tr>
<tr>
<td>Bio-reactor study</td>
<td>&gt; Degradation &gt;&gt; 99% (Cerneck, 2000)</td>
</tr>
</tbody>
</table>

PCMC at proper use presents no risk to the environment.

Biodegradability of Parachlorometacresol (PCMC).

Figure 5

PCMC – Registrations and Approvals

- U.S. EPA No.: 39967-08 (manufacturing use registration)
- U.S. EPA No.: 39967-12 (end use registration)
- U.S. FDA Approval as a Food Contact Substance
- Canada PCP No.: 20818
- Biocidal Products Directive (BiP), supported PT's 1, 2, 3, 6, 9, 13
- BPR Recommendation 37V – polymer dispersions (food contact)
- European Pharmacopoeia
- European Community Cosmetics Directive
- MITI No.: 3-900

BIT = (German) Federal Institute for Risk Assessment
MITI = (Japanese) Ministry of International Trade and Industry

Registrations and approvals in regulated markets.

Product Type listings under the Biocidal Product Directive (BPD) in Europe (Figure 5).

The latest approval for PREVENTOL® CMK Preservative is for use in incidental food contact lubricants (11 lubricants). Approvals have been earned from the U.S. FDA and NSF:
- FDA 21 CFR § 178.3570 FCN No. 560
- NSF Registration No. 138991

U.S. EPA Registered PCMC Grades

PCMC is available in several delivery forms to provide formulators and users the flexibility they need.

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREVENTOL® CMK Preservative</td>
<td>Solid, pellets</td>
</tr>
<tr>
<td>PREVENTOL® CMK-Na Preservative</td>
<td>Solid, flakes</td>
</tr>
<tr>
<td>PREVENTOL® CMK 30</td>
<td>Liquid, solution</td>
</tr>
<tr>
<td>PREVENTOL® CMK 40</td>
<td>Liquid, solution</td>
</tr>
</tbody>
</table>

In summary, PCMC is a formaldehyde-free, properly registered, safe biocide that is effective against bacteria, fungi and mycobacteria. It is fast-acting and provides long term efficacy due to its excellent chemical and thermal stability. PCMC is soluble in non-polar media as well as in water, giving formulators additional flexibility.

New EPA, FDA and NSF Approved Biocide For Lubricant Applications

Biocide for lubricant applications — The FDA has approved PREVENTOL® CMK PRESERVATIVE as a Food Contact Substance with intended use at levels up to 1 percent as an antimicrobial preservative in lubricants that may have incidental contact with food. Additionally, the EPA and NSF have approved this product for use in industrial lubricants. For customers requiring these approvals, this is a new choice for a labile preservative that is effective against bacteria, yeast, and mold fungi.

Biocides for metalworking fluids — effective and economical fluid control. LANXESS Material Protection offers biocides based on PCMC, OIP, IPBC, BIT and Bronopol.

Corrosion inhibitors for aqueous and non-aqueous metal working fluids. LANXESS corrosion inhibitors are based on tolyltriazole and benzotriazole. They offer thermal stability, resistance to atmospheric oxidation, low toxicity and non-irritation to skin.

LANXESS Material Protection – Flexible solutions you can always trust

PREVENTOL® is a registered trademark of LANXESS Deutschland GmbH.