Industrial *product* preservation
BASF Biocides - protecting the world
The biocide business for Specialty Chemicals, BASF AG

BASF is one of the world’s leading suppliers of specialty biocides. We create products that make life safer, simpler and more comfortable for millions of people worldwide.

Our high performance biocides are used in every aspect of life. From toiletries, to air-conditioners used in both industry and home, from Iceland to Ecuador our technology spans the globe in preservation and disinfection. We help to protect the lives of millions of people across the world every day.

Through our product range, marketing expertise, technical and regulatory knowledge, BASF’s innovative biocides approach positions the business at the very forefront of antimicrobial technology. The marketing, technical and research and development headquarters for BASF’s specialty biocide business is located in Nottingham.

Our products are made in ‘state of the art’ manufacturing facilities at Cramlington, England and Ludwigshafen, Germany. In each of our plants, the expert integration of process and energy requirements leads to manufacturing efficiencies and quality production.

To demonstrate our commitment to our customers, we have made significant investment in long term dedicated biocide resources within Europe, Asia Pacific and the USA.

In 2000, we established a direct presence in the USA with a new dedicated marketing and technical centre based at BASF Corporation headquarters in Mount Olive, New Jersey. Product is supplied through an integrated BASF warehousing facility in Charlotte, North Carolina. Our US operation is part of BASF Corporation’s Chemical Division, situated in Mount Olive, New Jersey.

How we work for you
BASF’s biocides are sold through BASF’s established network of sales offices worldwide. In this way, we aim to offer valuable local support and the highest standards of customer excellence.

Working with BASF provides access to many essential regulatory approvals. For example our EPA registrations allow products and customer formulations to be sold in the USA and our approvals ensure supply to the paper industry in the Nordic area. We are also well positioned to support our actives under the European Biocidal Products Directive.

We believe in long-term commitment to our products and customers and this is reflected in our substantial registrations and the data required to obtain them. To this end many of our products are supported with extensive safety and environmental data packages.

In addition, BASF is committed to providing the highest standard of health, safety and environmental protection as part of our commitment to the Responsible Care® programme. We continually research and innovate to produce the most advanced products on the market.

At BASF, we are also constantly reviewing ways in which we can improve our products and services to ensure that we keep pace with the rapidly changing developments in information technology. BASF is harnessing these changes and ensuring that we are aligned with our customer’s requirements, making it more efficient and convenient for you to do business with us.

BASF’s specialty biocide products are marketed under the Myacide™ and Protectol™ trade names.
Introduction to Industrial product preservation

The preservation of industrial products covers a wide range of application areas and involves the protection of intermediate components as well as final products. As an added benefit the preservative may contribute to the process or the manufacturing conditions.

The types of industrial products in which biocides play an important role can be very diverse indeed. Consider the preservation of water-based paints, adhesives and polymer dispersions as well as dynamic systems such as metal working fluids and leather soak liquors or the more aesthetic applications such as the protection of fresh cut flowers. The criteria for each of the above industrial uses can be very demanding and the biocide must fulfill the majority if not all of the desired needs.

The biocide will encounter different conditions during its use either as an in-can preservative or as part of the production process. Hence, the demands of each industrial application will place certain constraints on the biocide in terms of its physical and chemical properties, compatibility and stability as well as its efficacy.

Consider in-can preservation, where the main function of the biocide is to protect the product during its shelf life, for example polymer dispersions that are stored as produced before being used for downstream purposes as a formulation ingredient in paints or adhesives. The biocide must be compatible with all the components of the polymer dispersion during its manufacture including any physical and chemical conditions such as temperature and pH. Providing the biocide is stable, it can be expected to protect the polymer dispersion from microbial contamination. It is also expected that the biocide from the polymer dispersion should add to the overall preservation of the final formulation to avoid any possible problems of microbial spoilage.

Similarly, the biocide can be used in dynamic systems such as metal working fluids or leather soak liquors where the same parameters of temperature, pH and ingredient compatibility are important. Metal working fluids are themselves preserved with an in-can biocide but the biocide can also contribute to the pH modification in the metal working tank itself. In leather soak liquors the biocide may give a secondary effect from the preserved emulsion when added to the liquor. However in both cases, the primary purpose of the biocide is to inhibit any possible microbial problems.

Industrial applications such as the protection of fresh cut flowers show the benefit of a biocide that may be used to preserve the nutrient mixture or solution into which the fresh flowers are placed. Hence preservation of the solution will prolong the life of the flowers by protection from bacteria. This same principle can also be applied to plants as well.

The occurrence of these contamination and spoilage problems creates a demand for antimicrobial products that can be ideally satisfied by products from the BASF’s specialty chemicals biocide range.

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Myacide™ AS biocide is the industrial grade of 2-Bromo-2-nitropropane-1,3-diol or Bronopol and is supplied as a crystalline solid or as the liquid formulations, Myacide S2, S15 or S30. This choice provides the formulator with the means of an optimised approach to the treatment of microbiological problems in raw materials and also in finished formulations.

In this wide-ranging application area, Bronopol can be used alone or in combination with other actives to preserve water-based paints, polymer dispersions and adhesives plus many other industrial fluids. This flexibility allows the formulator to maximise the strengths of each biocide, as well as reducing the risk of developing tolerant or resistant bacteria.

Bronopol offers highly effective antimicrobial activity in diverse and demanding industrial products, combining well-proven efficacy with important safety characteristics. It has also been shown to be effective against organisms that have developed tolerance or resistance to other biocides.

QUALITY

Myacide AS
Myacide AS is a white to pale yellow, free flowing, crystalline solid. The product contains a minimum 98% 2-Bromo-2-nitropropane-1,3-diol. As supplied it is stable for a minimum of 3 years when kept under good storage conditions.

Myacide AS Plus is marketed only in the USA as an EPA end-use product. Its technical specification and product quality are the same as Myacide AS.

Liquid Formulations
A range of liquid formulations is commercially available. These allow for ease of handling and are ideal for use in systems where automatic dosing is practised.

Myacide S2 is a 50% (w/v) solution of Bronopol in dipropylene glycol and water.

Myacide S30 is a 30% (w/w) solution of Bronopol in propylene glycol and water.

Liquid formulations have a shelf life of 2 years.

ANTIMICROBIAL ACTIVITY

The key to the success of Bronopol has been in its effectiveness as a powerful broad-spectrum antibacterial agent for industrial formulators.

The Minimum Inhibitory Concentrations (M.I.C.) of Bronopol are typically 12.5 –25ppm for a wide range of Gram negative and Gram positive spoilage bacteria, including Pseudomonas aeruginosa, Enterobacter aerogenes, Escherichia cloacae and Escherichia coli.

The following table lists M.I.C.’s of Bronopol against some key organisms. M.I.C. data has been generated according to in-house methodology.

<table>
<thead>
<tr>
<th>Test Organism</th>
<th>M.I.C. (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micrococcus spp.</td>
<td>12.5 - 25.0</td>
</tr>
<tr>
<td>Staphylococcus spp.</td>
<td>12.5 - 25.0</td>
</tr>
<tr>
<td>Streptococcus spp.</td>
<td>12.5 - 25.0</td>
</tr>
<tr>
<td>Escherichia spp.</td>
<td>12.5 - 25.0</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>12.5 - 25.0</td>
</tr>
<tr>
<td>Proteus spp.</td>
<td>12.5 - 25.0</td>
</tr>
<tr>
<td>Pseudomonas spp.</td>
<td>12.5 - 25.0</td>
</tr>
<tr>
<td>Serratia spp.</td>
<td>12.5</td>
</tr>
</tbody>
</table>

In-house and published data also confirm the ability of Bronopol to control bacteria that have become tolerant or resistant to other biocides based on Formaldehyde or formaldehyde-release chemistries, Isothiazolinones (CIT/MIT) and Benzisothiazolone (BIT).
The performance of Bronopol has been assessed in a range of formulation types. Using preservative efficacy tests, it has been proven that Bronopol can offer excellent long-term microbiological control.

Where control of yeasts and moulds is required, Bronopol can be combined with antimicrobials that offer fungicidal activity.

**USAGE RECOMMENDATIONS**

**Solubility, Stability, Compatibility.**

Bronopol is readily water-soluble and solutions containing up to 28% w/v are possible at ambient temperature. The compound also shows a high affinity for polar solvents (e.g. propylene glycol 50% w/v) which allows a flexible approach to formulating solution concentrates for ease of application. In emulsion systems, Bronopol partitions preferentially into the polar (usually aqueous) phase. Since microorganisms grow primarily in the aqueous phase, Bronopol can exert maximum effect at the site of contamination.

Bronopol’s stability makes it an excellent long-term preservative for most industrial products. It shows optimum pH stability in the acidic range with excellent efficacy. At alkaline pH, Bronopol is less stable but still provides effective control. In this case, Bronopol reaches equilibrium with its breakdown products, which are also microbiologically active. This self-stabilisation means that preservative efficacy can be maintained over an extended shelf-life even within aggressive, more alkaline formulations.

Bronopol is compatible with a wide range of materials used in industrial products. In typical formulations such as surface coatings, polymer dispersions, adhesives, printing inks and pigment suspensions, there are no known incompatibilities with surfactants, dispersants, rheology modifiers, or other biocides.

In many systems Bronopol can be used alone to provide effective antibacterial preservation. However, a major benefit is its ability to work in combination with other biocides to give superior performance. An example of this is the widely recommended blend with 5-Chloro-2-methyl-4-isothiazolin-3-one and 2-Methyl-4-isothiazolin-3-one (CIT/MIT). This particular combination brings benefits in terms of reducing the overall biocide loading required as well as controlling organisms that may have developed tolerance or resistance to CIT/MIT, BIT or other chemistries.

In common with other biocides, strong oxidising and reducing agents should be avoided.

Bronopol or its concentrated solutions can be corrosive to mild steel, cast iron, galvanised iron and aluminium.
Myacide™ AS / Myacide™ S2, S15, S30
Industrial Biocides

Recommended Dose Rates.
Myacide AS or an associated formulation can be used as an ideal preservative for many industrial products. These include polymer dispersions, paper coatings, water-based paints, printing inks and adhesives. When used alone it can be dosed at 50-500ppm active based on final product volume. However, where antifungal activity is required or where control of resistant or tolerant organisms is indicated, the performance of Myacide AS as a combination biocide is outstanding. Dosage recommendations for these combination systems range from 60ppm Bronopol + 10ppm CIT/MIT to 200ppm Bronopol + 33ppm CIT/MIT depending on the severity of the contamination and the substrate. A typical dose would be 90ppm Bronopol + 15ppm CIT/MIT. The optimum ratio is around 6:1 Bronopol : CIT/MIT although other combinations can be used.

Where liquid formulations of Bronopol are used, the dose level should be calculated on a pro-rata basis.

CASE STUDY 1
A laboratory study was initiated to assess the ability of Myacide AS to control microbial contamination in a water-based emulsion paint. Myacide AS was dosed at 200ppm into an unpreserved emulsion paint and its performance was assessed by three different methods - the ASTM: D2574-94 test method, the International Biodeterioration Research Group (IBRG) test method and the UK Paint Research Association method. Myacide AS successfully passed all three standard tests.

In further trials, paint samples dosed with Myacide AS were contaminated with a mixed bacterial inoculum and stored at 32°C for 14 days. The number of surviving organisms was determined at suitable time intervals over the storage period. All treatment levels down to 10ppm controlled the bacterial challenge. The test was repeated on further paint samples that were stored at ambient and challenged at regular intervals up to 12 months. At the twelve-month sampling point Myacide AS at 100 and 200ppm successfully controlled the challenge within 7 days after inoculation.

CASE STUDY 2
The following example demonstrates advantages to be gained from using combinations of Bronopol and CIT/MIT in a polymer dispersion system. In this case an acrylic dispersion was used as the test substrate. Treatments of Bronopol and CIT/MIT alone were made as well as combinations of both actives. The test organisms used and the test procedure are described below.

Test Organisms:
- *Pseudomonas aeruginosa* ATCC 9027 (NCIMB 8626)
- *Staphylococcus aureus* NCIMB 9518
- *Candida albicans* ATCC 10231
- *Aspergillus niger* ATCC 19404 (IMI 149007)

Multiple Challenge Test Procedure.
50ml of the test preparation was placed into 100ml wide neck containers, inoculated with 0.5ml of either the mixed bacterial or fungal inocula and shaken for 5 minutes at 250rpm on a rotary shaker. The inoculated test preparation was stored in the dark at 25 ± 2°C.

After 7 days the test preparation was again shaken for 5 minutes at 250rpm. A semi-quantitative determination of colony forming units (cfu) was carried out by streaking 10µl onto the surface of a plate of the relevant agar.

The inoculation and cfu determinations were carried out as above until the test preparation had either three consecutive strong growth results from the cfu determination or had six inoculations and cfu determinations.

The semi-quantitative determination involved the following scoring system:

- 0 No visible growth
- 1 Slight Growth (individual colonies)
2 Good Growth (colonies merging/confluent growth)

3 Sample Terminated (due to 3 consecutive 2 results)

The scores recorded over the six challenges were summed and plotted to assess comparative performance of the treatments. High cumulative scores meant poorer performance. The results are shown in Figure 1 and clearly demonstrate the benefits of the combination over the individual preservatives acting alone. This improved performance can lead to a reduction in the overall quantity of biocide needed and can also allow the levels of CIT/MIT to be reduced below any threshold that might be of concern to regulatory authorities.

Figure 1: Activity of Bronopol and CIT/MIT in an Acrylate Dispersion

BNPD 60 = Bronopol at 60ppm; CIT/MIT 10 = Isothiazolinones at 10ppm

SAFETY CHARACTERISTICS
A considerable data package has been assembled on Bronopol, to support a wide range of end-use applications, covering both mammalian and environmental toxicity. This provides the information needed to obtain and retain registrations worldwide. Bronopol is moderately toxic by ingestion. In concentrated form it is irritant to the skin but not irritant at normal use levels. Bronopol is one of the least sensitising of all commonly used biocides and sensitisation is unlikely to occur in people with normal healthy skin. Both acute and chronic studies have shown Bronopol to be non-carcinogenic, non-mutagenic, non-embryotoxic and non-teratogenic.

Bronopol is toxic to some algal species and is therefore potentially dangerous for the environment. However, its inherent biodegradability, rapid hydrolysis and photolysis in water and low bioaccumulation characteristics indicate that it is unlikely to cause significant, long term adverse effects in the aquatic environment.

Bronopol is officially classified in the EU Council directive - 67/548/EEC as harmful, irritant and dangerous for the environment.

REGISTRATIONS

NORTH AMERICA
USA
BASF’s Bronopol products are approved by the US EPA for use in metal working fluids, adhesives, paints, latex and antifoam emulsions, water-based printing inks and print solutions.
175.105 – Indirect food contact use in adhesives.
176.170 – components of paperboard in contact with aqueous and fatty foods at a level not to exceed 0.01% by weight of those components.

CANADA
Health Canada has granted a letter of ‘no objection’ for use in food contact paper.

EUROPE (EU)
FRANCE
BASF’s Bronopol is approved for use as a preservative under the Repression des Fraudes (July 1988).
GERMANY
BgVV XIV, 2f – substances added to dispersions to prevent microbial attack.
Meets the Blue Angel approval for low pollutant paints (RAL U2 12a).
Protectol PE biocide (2-Phenoxyethanol) can be used as a preservative in industrial products such as metalworking fluids, printing inks, and adhesives. This biocidal alcohol has well known antibacterial and antifungal properties as well as being a common co-formulant due to its excellent solvent properties.

QUALITY
Protectol PE is a clear colourless liquid of minimum 99% w/w purity.

ANTIMICROBIAL ACTIVITY
Protectol PE is a well-established antimicrobial agent, being active against a broad range of microorganisms. Minimum Inhibitory Concentrations (M.I.C.) of Protectol PE are as follows:

<table>
<thead>
<tr>
<th>Test Organism</th>
<th>M.I.C. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>0.75</td>
</tr>
<tr>
<td>Staphylococcus epidermidis</td>
<td>0.64</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>0.32</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>0.32</td>
</tr>
<tr>
<td>Pseudomonas fluorescens</td>
<td>0.08</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>0.32</td>
</tr>
<tr>
<td>Aspergillus niger</td>
<td>0.25</td>
</tr>
<tr>
<td>Penicillium funiculorum</td>
<td>0.06</td>
</tr>
</tbody>
</table>

RECOMMENDED DOSE RATES
Protectol PE can be used at a level of 10 to 15% by weight in water miscible and water emulsifiable metal working fluid concentrates. This is designed to achieve a concentration of approximately 0.5% in the final use dilution, thereby conferring good antimicrobial protection to the fluid in use.

For other industrial products, the recommended use levels are 0.5 to 1% depending on system conditions and the presence of other biocides.

SAFETY CHARACTERISTICS
Protectol PE has been used for many years in a number of application areas. During this time, it has been shown to be extremely safe and effective. It has a low acute toxicity with rat oral and dermal LD₅₀’s being greater than 2000mg/kg.

Protectol PE is not irritating to the skin and is not mutagenic in in-vitro studies. In the E.U., under the Dangerous Substance Directive, Protectol PE is classified as harmful if swallowed (R22) and irritating to the eyes. (R36)

Protectol PE is readily biodegradable, showing more than a 70% decrease in dissolved organic carbon in a Zahn-Wellens test.

REGISTRATIONS

NORTH AMERICA
USA
FDA , 21 CFR – Code of Federal Regulations
175.105 – indirect food contact use in adhesives.
TSCA Listed
Protectol HT biocide is a 76% solution of Hexahydrotriazine, a formaldehyde-release biocide, and is particularly suitable for use as a preservative in metalworking fluids, adhesives, industrial additives, polymer dispersions and chain lubricants. It can be used as a stand-alone preservative or in combination with other biocides.

**QUALITY**
Protectol HT (1,3,5-Tris-(2-hydroxyethyl)-1,3,5-hexahydrotriazine) is a clear, colourless to slightly yellowish solution and can be regarded as a premium quality “triazine”, due to its purity, odour, stability and colour.

As a concentrate Protectol HT is stable for up to 12 months when stored in sealed containers at temperatures below 30°C.

**ANTIMICROBIAL ACTIVITY.**
Protectol HT, as a formaldehyde-release biocide, has a similar range of activity to that of formaldehyde. It shows excellent activity against a wide range of bacteria, yeasts and moulds, including those responsible for product spoilage. The Minimum Inhibitory Concentrations (M.I.C.) against a range of test organisms are displayed in the following table.

M.I.C. data is generated according to in-house methodology.

<table>
<thead>
<tr>
<th>Test Organism</th>
<th>M.I.C. (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>500</td>
</tr>
<tr>
<td>Bacillus cereus</td>
<td>500</td>
</tr>
<tr>
<td>Klebsiella aerogenes</td>
<td>500</td>
</tr>
<tr>
<td>Enterobacter aerogenes</td>
<td>500</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>500</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>500</td>
</tr>
<tr>
<td>Aspergillus niger</td>
<td>1000</td>
</tr>
</tbody>
</table>

**Recommended Dose Rates**
To inhibit the growth of spoilage microorganisms during manufacture, storage and distribution, Protectol HT may be dosed at between 150–1500ppm based on final formulation volume. Lower concentrations are required if Protectol HT is used together with other active substances.

**SAFETY CHARACTERISTICS**
Protectol HT is of low to moderate acute toxicity. Acute studies in rats gave an oral LD₅₀ of approximately 1000mg/kg and a dermal LD₅₀ of >2000mg/kg. It is not mutagenic in both in-vitro and in-vivo studies. It is non-irritating to rabbit skin and non-sensitising to the skin of guinea pigs up to a concentration of 0.4%. In the E.U., however, the active ingredient is classified as a skin sensitiser (R43) at concentrations at or above 0.1%. It is also harmful if swallowed (R22) and irritating to the eyes (R36).

Protectol HT is readily biodegradable in the environment, however, the product should not be discharged into the waterways without prior treatment. Protectol HT is harmful to fish with an acute LC₅₀ of 21.7mg/l.
BASF’s Specialty Chemicals biocide business supply a range of formulations based on Glutaraldehyde including Protectol GA 50 / GA 24 biocide for preservation of technical products e.g. polymer dispersions, adhesives and industrial additives.

QUALITY
These products are clear, colourless aqueous solutions based on Glutaraldehyde as the active ingredient. Protectol GA 50 has an active content of 50% Glutaraldehyde and GA 24 contains 24% Glutaraldehyde. Under recommended storage conditions the solutions have a shelf life of at least six months.

ANTIMICROBIAL ACTIVITY
The Glutaraldehyde products are extremely effective antimicrobial agents, being active against a broad range of microorganisms including Gram positive and Gram negative bacteria and fungi commonly found as spoilage organisms in industrial products. The ability of Glutaraldehyde to control contamination at low dose levels makes it extremely cost effective.

The table below illustrates the Minimum Inhibitory Concentration (M.I.C.) of Glutaraldehyde required to inhibit the growth of a range of test organisms. The M.I.C. figures are expressed as ppm of the 50% active product. It should be noted that Glutaraldehyde can react with the media components used in the M.I.C. tests. As a result, the figures obtained are generally higher than the effective doses required in-use.

<table>
<thead>
<tr>
<th>Test Organism</th>
<th>M.I.C. (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus spp.</td>
<td>50</td>
</tr>
<tr>
<td>Bacillus spp.</td>
<td>1250</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>150</td>
</tr>
<tr>
<td>Pseudomonas spp.</td>
<td>150</td>
</tr>
<tr>
<td>Candida spp.</td>
<td>1250</td>
</tr>
<tr>
<td>Aspergillus spp.</td>
<td>500</td>
</tr>
</tbody>
</table>

SAFETY CHARACTERISTICS
In order to support the safe use of Glutaraldehyde, a wide range of toxicology studies have been carried out. The extensive nature of this database is particularly helpful in supporting product registrations and answering any concerns on product safety. Glutaraldehyde is toxic if swallowed or inhaled and is corrosive to the skin and eyes. It may cause skin sensitisation and has been classed as a respiratory sensitizer in the E.U. Glutaraldehyde is not teratogenic or carcinogenic and is not mutagenic in animal studies.

Glutaraldehyde is readily biodegradable in the environment and has a low potential to bioaccumulate. Under normal use conditions, it will not cause problems either to effluent treatment plants or to the environment following discharge into wastewater. Glutaraldehyde is harmful to fish and Daphnia (LC50 10-100mg/l) and is very toxic to algae (LC50 0.1-1mg/l).
REGISTRATIONS

NORTH AMERICA

USA
EPA - BASF’s Glutaraldehyde is registered for industrial uses such as water-based coatings for paper and paperboard
FDR 21 CFR – Code of Federal Regulations
175.105 – indirect food contact in adhesives
176.170 - components of paper and paperboard in contact with aqueous and fatty foods
176.180 - components of paper and paperboard in contact with dry food
TSCA listed

CANADA
BASF’s Glutaraldehyde is registered as a technical product for use in manufacturing registered microbiocides

EUROPE (EU)

GERMANY
BGVV - Recommendations for food contact applications:
XXXVI, B VII - paper and board
XXXVI/2 IIG - paper and board for bakeries

JAPAN
MITI listed
Other Chemistries/Actives for Industrial Product Preservation

**Protectol™ DA**

*Industrial Biocide*

2,4-Dichlorobenzyl alcohol (DCBA) is a biocide supplied by BASF Specialty Chemicals Division under the tradename of Protectol DA. It provides a broad spectrum antimicrobial activity as a preservative for a range of industrial and technical products e.g. plastics, polymers and concrete admixes.

Protectol DA is a white to yellow crystalline solid of minimum 98% purity with a shelf-life of at least three years. It is extremely stable at high temperatures and over a wide pH range. There was no evidence of instability when DCBA was tested in a number of formulations with pH’s ranging from 2.7 to 9.0. Solutions in alcohols and glycols are stable and aqueous solutions are reasonably stable although gradual oxidation to the corresponding aldehyde and acid may take place.

At concentrations ranging from 100ppm to 500ppm, it inhibits the growth of yeasts, moulds and fungi. Bacteria are inhibited by higher concentrations ranging from 500ppm to 2000ppm. The incorporation of 0.05% to 0.1% Protectol DA in industrial products and emulsions such as natural and artificial latexes, cellulose gels etc. can inhibit fungal spoilage and odour. Broad spectrum control of bacteria may require combination with other preservatives (e.g. Myacide™ AS).

At normal in-use concentrations, it is non-irritating and non-sensitising to the skin and eyes. Protectol DA has a low toxicity with acute oral and dermal studies in the rat giving LD₅₀’s of >2000mg/kg. Safety studies have given no indication of mutagenicity, carcinogenicity or reproductive toxicity. In the E.U., under the Dangerous Substances Directive, DCBA is classified as irritant (R41).

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**Protectol™ TD**

*Industrial Biocide*

Tetramethylacetylene diurea is a biocide supplied under the tradename of Protectol TD. It is a formaldehyde-release biocide with the chemical name of Imidazo[4,5-d]imidazol-2,5-(1H,3H)-dione,tetrahydro-1,3,4,6-tetrakis-(hydroxymethyl). It is a clear colourless or yellowish liquid with a minimum 47% active ingredient. It is used to preserve technical products such as metalworking fluids, adhesives, industrial additives, polymer dispersions, cutting fluids and chain lubricants.

Protectol TD has a similar range of activity to that of Formaldehyde. At in-use levels, aqueous solutions of Protectol TD will hydrolyse to form free Formaldehyde. The pH and temperature of the solution will determine the amount of free Formaldehyde released. Protectol TD is active against bacteria and fungi i.e. *Staphylococcus* spp., *Escherichia* spp., *Proteus* spp., *Pseudomonas* spp., and *Candida* spp.

The product is soluble in water, Ethanol and Propylene glycol in all proportions and is very stable over a wide temperature range, which makes it a worthwhile preservative candidate for many industrial formulations. Protectol TD is compatible with nonionic, anionic and cationic surfactants and chelating agents.

The recommended use concentration depends on the product to which the preservative is added and is usually determined in practical trials. Protectol TD is normally added to products at levels between 0.5% and 4% if used as the sole preservative. This concentration is reduced if it is combined with other active ingredients such as Isothiazolinones (CIT/MIT).

Protectol TD has a low acute toxicity. It is non-irritating to skin and eyes, however there is a danger of skin sensitisation on repeated contact.

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**REGISTRATIONS**

**EUROPE (EU)**

**GERMANY**

BvV Polymer dispersion positive list (No. 7) for biocides.
Protectol™ DZ / Protectol™ DZ P
Industrial Biocide

Dazomet is a biocide supplied under the tradename of Protectol DZ and Protectol DZ P. Protectol DZ P is the powder grade product and Protectol DZ is the fine granular form. Both products are off-white in colour and contain a minimum of 99% Tetrahydro-3, 5-dimethyl-2H-1,3,5-thiadiazine-2-thione.

Protectol DZ is a proven industrial preservative for the preservation of technical products such as polymer dispersions and adhesives.

It is active against a broad range of bacteria and fungi such as Staphylococcus spp., Escherichia spp., Proteus spp., Pseudomonas spp., Candida albicans, Aspergillus spp. and the anaerobic Desulphovibrio spp.

Protectol DZ has a relatively low water solubility (max 3% w/w) but it is sufficiently soluble to act effectively in industrial water-based formulations. It is also compatible with a range of additives used in industrial formulations.

For use in polymer dispersions and wax emulsions, the recommended use rate for Protectol DZ is between 100 - 500ppm based on the final product.

Protectol DZ has an extensive toxicity data package due to its use in the agrochemical industry. As supplied, Protectol DZ has a moderate acute oral toxicity and is an eye irritant but is neither irritant nor sensitising to the skin. Protectol DZ is also not carcinogenic, mutagenic or teratogenic.

REGISTRATIONS
NORTH AMERICA
USA
BASF’s Dazomet has EPA registration for the manufacture of antimicrobial products.
178.3120 Animal glues for indirect food contact additives
TSCA Listed
CANADA
BASF’s Dazomet is approved by Health Canada for the manufacture of formulated products.
EUROPE (EU)
GERMANY
B&VV recommendations for food-contact applications
XIV, 21 Substances added to dispersions to prevent microbial attack

The information submitted in this publication is based on our current knowledge and experience. In view of the many factors that may affect processing and application, this data does not relieve processors of the responsibility of carrying out their own tests and experiments; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose. It is the responsibility of those to whom we supply our products to ensure that any proprietary rights and existing laws and legislation are observed.