**VANTOCIL™ Antimicrobial**
Disinfectants for the Food Industry

**APPLICATION INFORMATION**

**VANTOCIL IB** is a highly effective, fast-acting biocide for use in the formulation of disinfectants for the food processing and manufacturing industries. It has excellent activity against food pathogens, such as *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. Formulations containing **VANTOCIL IB** can be used for disinfection of equipment, floors and other hard surfaces and can also be used for both open plant and clean-in-place (CIP) applications. Application can be either manual, by soaking or by recirculation and must be followed by a potable water rinse. **VANTOCIL IB** can be used as sole disinfectant active agent, or can be formulated with other commonly available disinfectants. Depending on the final formulation, **VANTOCIL IB** is typically used at a concentration of 0.1-0.3%.

**Features**

**VANTOCIL IB** is based on poly(hexamethylene biguanide) hydrochloride, also known as PHMB, which provides the following properties of direct relevance to the food industry:

- Extensive toxicity studies suggest acceptable use risk to humans
- Approved use for more than two decades in regulated food-related applications (See Regulatory section).
- Fast acting bactericide, effective at low concentrations against Gram positive and Gram negative vegetative bacteria. At higher concentrations effective against yeasts.
- Highly active towards food pathogens and contaminants.
- Active against enveloped viruses and naked viruses.
- Non-specific mode of action with no known evidence of development of organism resistance.
- Water soluble; which means it is readily water rinsed so minimising risk of residues.
- At typical use levels, has no smell, no taste and is non-staining.
- Retains activity in the presence or organic matter, such as proteins, fat and blood, so providing reliable performance in the presence of remnants of food (fish, meat, poultry, vegetables) or soils after poor cleaning.
- Active in both soft and hard water.
- Effective and stable over a pH range of 1-11.
- Very low foam, making it suitable for CIP applications.
- Readily formulated with non-ionic surfactants (e.g. alcohol ethoxylates) and sequestrants (e.g. EDTA, NTA).
- Provides stable formulations with acids (e.g. phosphoric) and alkalis (e.g. KOH).
- Low corrosion, and compatible with common materials of construction at typical use levels.
- Dilutable in both cold and warm water.
- Product is temperature and pH stable.
- Readily detected in aqueous solution by use of **VANTOCIL™** Test Kits.

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Formulation Options
• **VANTOCIL IB** can be used as the sole active agent in terminal disinfectant and sanitiser formulations. It is supplied as a 20% aqueous solution of PHMB, pH 4.0-4.5, and is typically used on pre-cleaned solid surfaces at a concentration of 0.1-0.2%.
• **VANTOCIL IB** can be co-formulated with other common disinfectant biocides, particularly quaternary ammonium compounds (QACs). Combinations of **VANTOCIL IB** with QACs provide complementary performance, offering the benefits of **VANTOCIL IB** whilst enhancing the overall activity towards fungal organisms. **VANTOCIL IB** is commonly co-formulated with QACs such as dialkyl dimethyl ammonium chloride (DDAC) and alkyl dimethyl benzyl ammonium chloride (ADBAC).
• A detergent-sanitiser formulation is available containing **VANTOCIL IB**, where the cleaning power is enhanced by use of non ionic (higher fatty alcohol type) surfactants.
• **VANTOCIL FHC** contains **VANTOCIL IB**, ADBAC and non ionic surfactants (alcohol ethoxylates). It is supplied as a 40% aqueous solution of biocide/surfactant (20% biocide; 20% surfactant), with pH 6-7 for a 1% solution. **VANTOCIL FHC** is highly effective at removing dirt, and inactivating both bacterial and fungal organisms on solid surfaces. **VANTOCIL FHC** is typically used at 0.3-0.5% product, the higher level for dirty conditions. **VANTOCIL FHC** can also be used for disinfection of soil microbes, such as *Bacillus cereus* from boots by use of a cleaning sink containing 0.3% **VANTOCIL FHC**.
• **VANTOCIL IB** can be formulated into alkali detergent systems, in combination with non-ionic surfactants and alkalis such as potassium hydroxide (KOH). This combination provides enhanced detergency e.g. saponification of fats etc. Such alkali detergents are formulated into stable products at pH 9 and above.

Microbiological Activity Data

**Intrinsic Activity Against Key Food-Borne Pathogens**

Guidelines issued by the UK Public Health Laboratory Service (PHLS) identify those organisms against which food microbiological quality and associated food hygiene practices should be measured. The intrinsic activity of **VANTOCIL IB** (MIC - minimum inhibitory concentration) against these organisms is shown in Table 1. (# denotes further data generation in progress.)

<table>
<thead>
<tr>
<th>Organism</th>
<th>VANTOCIL IB MIC (ppm a.i.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicator Organisms</strong></td>
<td></td>
</tr>
<tr>
<td><em>Enterobacteriaceae</em>, e.g. <em>E. cloacae</em></td>
<td>NCIB 8271</td>
</tr>
<tr>
<td><em>Salmonella sp.</em>, e.g. <em>choleraesius</em></td>
<td>ATCC 11311</td>
</tr>
<tr>
<td><em>St.typhimurium</em></td>
<td>ATCC 14028</td>
</tr>
<tr>
<td><strong>Pathogens</strong></td>
<td></td>
</tr>
<tr>
<td><em>Escherichia coli 0157:H7</em></td>
<td>NCTC 12900</td>
</tr>
<tr>
<td><em>Vibrio cholerae Non 0:1</em></td>
<td>NCTC 11348</td>
</tr>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>ATCC 15313</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>ATCC 6538</td>
</tr>
<tr>
<td><em>Clostridium perfringens</em></td>
<td>NCTC 8081</td>
</tr>
<tr>
<td><em>Bacillus cereus</em></td>
<td>ATCC 9193</td>
</tr>
<tr>
<td><em>Campylobacter jejuni</em></td>
<td>ATCC 29428</td>
</tr>
</tbody>
</table>

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Summary of Antibacterial Activity in Standard European Tests
Table 2 illustrates the antibacterial activity of VANTOCIL IB under a range of conditions, as determined by recognised European test protocols.

Bactericidal Activity of VANTOCIL IB and VANTOCIL FHC in Hard Water
Disinfectant products employed in food processing and manufacturing factories are commonly provided as concentrates, which are diluted on site to the required working strength. The hardness of the dilution water will vary from location to location. Although sequestrants can be used in hard water areas it is advantageous that the disinfectant's activity is not impaired by hard water salts.

The effect of hard water (300ppm CaCO₃) on the bactericidal activity of VANTOCIL IB, VANTOCIL FHC and quaternary ammonium compounds was determined by employing test EN1040:1997. Two organisms were used; Pseudomonas aeruginosa ATCC 15442 and Staphylococcus aureus ATCC 6538 with a contact time of 5 minutes.

Table 3.
The Effect of Hard Water on the Activity of Cationic Disinfectants

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Pass Conc. (ppm active ingredient)</th>
<th>Ps.aeruginosa</th>
<th>S.aureus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soft Water</td>
<td>Hard Water</td>
<td>Soft Water</td>
</tr>
<tr>
<td>VANTOCIL IB</td>
<td>5</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>VANTOCIL FHC</td>
<td>25</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>N,N-bis(3-aminopropyl) dodecylamine</td>
<td>25</td>
<td>175</td>
<td>25</td>
</tr>
<tr>
<td>didecyl dimethyl ammonium chloride</td>
<td>25</td>
<td>75</td>
<td>5</td>
</tr>
<tr>
<td>alkyl dimethyl benzyl ammonium chloride</td>
<td>75</td>
<td>175</td>
<td>25</td>
</tr>
</tbody>
</table>

1 See Table 3  2 See Table 4
Activity of VANTOCIL IB and VANTOCIL FHC in EN 1276:1997

It is recognised that food debris and microorganisms are found in combination, no matter how insignificant the level of each. If cleaning processes are inadequate then inactivation of the disinfectant will occur. It is therefore important that a disinfectant retains its activity in the presence of organic matter.

The effect of hard water and dirty conditions on the bactericidal activity of VANTOCIL IB and VANTOCIL FHC and QACs was assessed by EN 1276:1997. Results are shown as concentration of active ingredient needed for a 5 log reduction in viable count after 5 minutes contact time.

Table 4.
The Effect of Hard Water and Dirty Conditions on the Activity of Cationic Disinfectants

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Ps.aeruginosa ATCC 15442</th>
<th>S.aureus ATCC 6538</th>
<th>E.coli ATCC 10536</th>
<th>E.hirae ATCC 10541</th>
</tr>
</thead>
<tbody>
<tr>
<td>VANTOCIL IB</td>
<td>200</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>VANTOCIL FHC</td>
<td>350</td>
<td>150</td>
<td>125</td>
<td>100</td>
</tr>
<tr>
<td>N,N-bis(3-aminopropyl)dodecylamine</td>
<td>900</td>
<td>150</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>didecyl dimethyl ammonium chloride</td>
<td>450</td>
<td>200</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>alkyl dimethyl benzyl ammonium chloride</td>
<td>900</td>
<td>250</td>
<td>250</td>
<td>200</td>
</tr>
</tbody>
</table>

The data presented in Tables 3 & 4 clearly demonstrates that VANTOCIL IB is able to retain its broad spectrum of activity in both hard water and dirty conditions.

Microbial Activity of Detergent Sanitizers

As indicated previously, the antifungal activity of VANTOCIL IB may be enhanced by co-formulation with a quaternary ammonium compound.

The broad spectrum of activity of such a blend, VANTOCIL FHC is shown in Table 3.

Table 5.
Intrinsic Bactericidal and Fungicidal Activity of VANTOCIL FHC

<table>
<thead>
<tr>
<th>Source</th>
<th>Organism</th>
<th>MIC (ppm product)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated bacteria from decomposed food</td>
<td>Staphylococcus aureus</td>
<td>~5</td>
</tr>
<tr>
<td></td>
<td>Escherichia coli</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Proteus vulgaris</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Pseudomonas aeruginosa</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Streptococcus faecalis</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Salmonella typhimurium</td>
<td>25</td>
</tr>
<tr>
<td>Isolated fungi from decomposed food</td>
<td>Alternaria tenuis</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Aspergillus niger</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Aureobasidium pullulans</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Chaetomium globosum</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Trichoderma viride</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>Penicillium rubrum</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Trichophyton mentagrophytes</td>
<td>100</td>
</tr>
</tbody>
</table>

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Physical Properties

Foaming Characteristics and Surface Tension
Low foaming in use is a desirable and indeed a necessary requirement in some disinfection applications. Compared to many products, VANTOCIL IB offers very low foaming in-use as illustrated in Figure 1. In addition, the surface tension of these solutions is shown in Figure 2.

Figure 1.
Foaming Characteristics of 200ppm Aqueous Solutions of PHMB and QACs as a Function of Time

Figure 2.
Surface Tension of 200ppm Aqueous Solutions of PHMB and QACs (Du Nouy Ring Tensiometer)

Compatibility with Common Materials of Construction
It is an obvious requirement that any disinfectant product must not adversely effect the appearance or physical integrity of materials commonly found in food processing and manufacturing factories. The suitability of the active agent of VANTOCIL IB (PHMB) has been evaluated and a summary is provided in Table 6.

Table 6.
Compatibility of Disinfectants to Typical Plant Construction Materials

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Stainless Steel</th>
<th>Mild Steel</th>
<th>Galvanized Steel</th>
<th>Aluminium</th>
<th>Copper</th>
<th>Brass</th>
<th>PVC/PTFE</th>
<th>Painted Surfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHMB</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>

- Not recommended - corrosion a problem
+ Corrosion limited or only at certain pHs
++ Completely suitable - no corrosion

More detailed and extensive data is available from Arch on the effect of VANTOCIL IB on the corrosion, physical characteristics and appearance of common metallic and non-metallic materials of construction.

VANTOCIL IB Toxicological Information
Arch holds an extensive mammalian toxicity data package for the PHMB active ingredient found in VANTOCIL disinfectants. This package includes:
• Acute toxicity studies
• Human studies
• Subchronic toxicity studies
• Chronic toxicity and carcinogenicity studies
• Genotoxicity
• Reproductive toxicity studies
• Metabolism studies

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For VANTOCIL IB, the results show:
- low acute toxicity via oral or dermal routes
- low skin and eye irritancy potential at typical use levels
- low long term toxicity
- non-genotoxic
- not teratogenic
- no effect on reproduction in a two-generation study
- not represent a carcinogenic hazard to humans

Material Safety Data Sheets containing appropriate health and safety advice on VANTOCIL disinfectants are available from your nearest regional office.

Further, highly qualified Arch Safety, Health and Environment professionals are available to help define and manage any joint potential risks to human health or to the environment when using VANTOCIL disinfectants.

Regulatory
VANTOCIL IB holds a number of global registrations/clearances in relation to its use in food handling areas, outside of the USA. Some specific approvals include the following:
- Australia; Sanitizer for registered export meat establishments
- Brazil; Sanitizer for food handling equipment
- Canada; Sanitizer for food handling equipment
- Denmark; Sanitizer for food handling equipment
- France; Cleaning agent for food contact materials
- New Zealand; Sanitizer for dairy, meat and game factories

VANTOCIL IB is also widely used on a worldwide basis where no specific food approvals exist, such as Japan.

For any further information on worldwide regulatory approvals, please contact your local Arch Office.

Further Information
Additional Application Information Sheets are available from Arch, including:
- "VANTOCIL IB - a disinfectant for the brewing industry"
- "VANTOCIL IB - a disinfectant for the dairy industry"

Enquiries for further information and samples should be addressed to your local sales office.

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