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Antimicrobials respond to new threats

Plastics Additives & Compounding looks at new developments in the antimicrobial field and how the industry is helping combat some of the world’s most virulent diseases.

Suppliers of antimicrobial additives and compounds are focusing more than ever on creating products that can combat newer diseases. These include MRSA (Methicillin-Resistant Staphylococcus Aureus) and SARS (Severe Acute Respiratory Syndrome). MRSA is a bacteria which tends to affect people with weak immune systems, particularly in hospitals. Because MRSA is resistant to many antibiotics, and can develop increased resistance over time, it can lead to serious illness – according to one report, 800 people in the UK died of the disease in 2002. SARS is another serious biological threat, and killed 774 people in an outbreak in June 2003. Although cases have diminished since then, SARS remains a significant threat.

Beating MRSA

To help combat MRSA, UK-based masterbatch producer Rapid Additive Services (RAS), the technical products division of Rapid Colour Services, has developed a new range of third generation antimicrobial masterbatches. RAS claims that its new range, which is available in two grades, can effectively kill up to 99.9% of all gram positive and gram negative bacterial cells – including MRSA (See Figure 1).

The standard grade, RapidGuard S2000, is based on a silver inorganic broad-spectrum antimicrobial agent which works by allowing the active silver ions to migrate to the surface of the plastic and the positively charged silver ion to be absorbed into the membrane structures of the bacterial cells. Once inside the cells, the silver ion actively interferes with the replication biochemistry of the cell by bonding to the proteins (enzymes). With the biochemistry of the bacterial cells disrupted, the cell is unable to control its osmotic pressure and its contents leak out – resulting in its death.

As well as the silver antimicrobial agent, RapidGuard S2000 also uses a modified alumino-silicate (zeolite) structure to hold the active silver ions. This complex lattice type framework enables a controlled dose of active silver ions to continually reach the surface, giving a long lasting and very efficient effect, says RAS. Another benefit of this advanced carrier/release system is that there is none of the discoloration (photographic effect) which can occur with some previous products.

The second grade, called RapidGuard S2007, is a special glass-silver release system, which is especially good for applications in which extra clarity is required, such as fibre applications. According to RAS, both grades are available for a range of polymers including polyethylene (PE), polypropylene (PP) and polycarbonate (PC) and can be mixed with pigment in one formulation. RAS says that RapidGuard has many benefits over traditionally used organic systems and older type silver systems – for example, it is non-irritant to skin, heat stable in excess of 500°C, has good anti-wash characteristics and is Food and Drug Administration (FDA) and Environmental Protection Agency (EPA) approved. As well as combating MRSA and other bacteria, the masterbatches are also effective against fungi and algae.

The company says that the masterbatches can be used in a range of applications, such as hospital door handles and floor coverings, household chopping boards, waste bins, electrical fridge liners and mobile phones, and toilet seats and flush handles.

Antiviral compounds

Swedish specialty chemicals company Perstorp has developed a series of...
compounds called Polygiene™ which, it says, can not only combat MRSA, but also includes an antiviral additive which can kill the SARS corona (SARS-CoV) virus on contact, and prevent it from returning. The company claims that this has been confirmed by independent in-vitro testing at the institute of microbiology and epidemiology at China's Military Academy of Medical Science and at the institute of microbiology, faculty of medicine at the University of Milan, Italy in 2003. The Military Academy of Medical Science, China, has had previous experience of SARS research.

**Testing for SARS**

At the Chinese institution, scientists tested the effectiveness of five different urea mould formulations in combating the SARS coronavirus. While all of the formulations were found to be relatively active against the virus, one formulation exhibited the fastest attack on the virus. In 8 hours, the Tissue Culture Infections Dose 34% (TCID 34) of the virus on this formulation decreased from 5.83 TCID34 to 0.92 TCID34, while the virus on the control thermoplastic compound decreased from 5.75 TCID34 to 4.83 TCID34 (see Figure 2). After 24 hours of exposure, no SARS virus remained on the Polygiene formulation, according to Zhang Panhe, professor at the Chinese Academy of Military Medical Sciences.

Perstorp says that this proves that the compound will exhibit anti-SARS attributes in applications outside the science laboratory, because person-to-person contamination generally occurs at a much lower concentration of the virus than that used in the laboratory – 100 - 1.000/ml versus the laboratory concentration of ~1.000.000/ml. The compound also contains silver-based antimicrobial additives that can kill a wide range of bacteria, yeasts and moulds. Polygiene's antimicrobial qualities were tested at the University of Milan using the film contact method. The scientists moulded standard and antimicrobial grades of urea into plaques and exposed them to seven strains of pathogenic bacteria and one strain of yeast (Candida albicans, a fungus which can cause yeast infections). The bacteria included:

- Escherichia coli – one cause of diarrhoea
- Klebsiella pneumoniae – one cause of pneumonia
- Proteus vulgaris – can cause urinary tract infections
- Salmonella typhi – which causes typhoid
- Staphylococcus aureus – one cause of food poisoning
- Enterococcus faecalis – which can cause intestinal and genital tract infections
- Streptococcus pyogenes – which can cause septicemia and so-called 'flesh eating' diseases.

Perstorp says that the Polygiene compounds not only contained the growth of these microorganisms, but also killed them within 24 hours. In tests exposing the compound to Escherichia coli bacteria, the amount of bacteria on Polygiene decreased from 100,000 Colony Forming Units (CFU) to 0 CFU in 24 hours, while the amount of bacteria exposed to the standard grade control increased from 100,000 to 8,000,000 CFU in the same time period (see Figure 3).

*Figure 2: Polygiene's effects on the SARS virus.*

*Figure 3: Polygiene can reduce bacterial activity to zero within 24 hours.*
Antimicrobials

According to the test results from the University of Milan, quoted by Perstorp, “in general, the antimicrobial effect of Polygiene resins was always better than the standard urea-formaldehyde moulding compound. The Polygiene moulding compound shows a better antibacterial effect on all the bacteria species examined and the yeast.” Perstorp says that it is currently testing the compound’s effectiveness against a wider range of viruses and bacteria, including MRSA bacteria. Recent results from Milan University about the compound’s efficacy against MRSA bacteria have been “excellent”, according to Luigi Mocchia, managing director of Perstorp. He says that Polygiene has been tested as a complete material, rather than separate components and says that its anti-MRSA quality may be a result of its combination of ingredients, rather than just the silver component.

Antiviral applications

The company can reveal that the compound contains traditional silver ingredients to combat other viruses, bacteria, yeasts, and moulds on contact, but the anti-SARS ingredients are patent pending and cannot be revealed, says Mocchia. The additive is homogeneously distributed throughout the moulded part and is locked into the resin matrix, making it impossible to be worn or scratched off, says Perstorp. This means that the antibacterial and anti-SARS effectiveness of Polygiene could last for the lifetime of the part. The Polygiene range is available in a variety of injection-moulded amino compounds such as Perstorp’s Aminel® and Amitec™ resins, as well as compression-moulded amino compounds. The base amino resins already have good antimicrobial and antiviral properties and amino compounds are commonly used in applications demanding high levels of hygiene, according to Perstorp. The technology builds upon these properties and enhances this via use of a second-generation antiseptic additive.

The company adds that Polygiene products have a ceramic-like feel with a broad chemical resistance and good electrical insulating properties. They are inherently flame retardant without the use of flame retardant additives and have thermal stability and colour stability when exposed to UV light. Perstorp says that the compounds do not contain chlorinated organic compounds so there is no release of toxic or volatile carbon compounds. Polygiene compounds can be injection or compression moulded. They are commercially available worldwide and are offered in a wide range of colours. Perstorp says that the compound works best when combined with high levels of personal hygiene and a commitment to cleanliness best practices in traditional high-risk public places. The compound is designed for moulded consumer applications, such as light switches and switch plates, toilet seats, door handles, hand rails, baby changing tables, lift buttons, pens and public phones. The company says that it is liaising with laminate and textile producers to discuss manufacturing the compound in these different forms for hospital applications. Currently it is in urea moulding format.

Antibacterial aid for textiles

Elsewhere, Italian firm Viba has developed its range of what it terms ‘bacteriostatic’ masterbatches for textile applications. The company says that textiles are particularly prone to the problems microorganisms can cause to plastic materials, such as unpleasant odours, loss of colour and stains. Viba’s new Vibatan NY bacteriostatic agent 02494 is said to guarantee a very high standard of hygiene for products made of polyamide fibres and has a long lasting effect even when washed at high temperatures. It works by releasing small quantities of its active content over a very long period. Another product, Vibatan bacteriostatic agent 02495, can be used to protect polyester fibres against bacteria. The agent also has outstanding heat stability and an excellent time-release performance, says Viba. For polypropylene fibres, Viba has launched Vibatan PP/M bacteriostatic agent 02518, and Vibatan PP/M Anti Dust Mite 02637 to help prevent the proliferation of dust mites on textiles such as pillows, sofas, mattresses, blankets and carpets, making life easier for people with dust mite allergies. The agent also gives the textiles good antimicrobial performance.

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