THE ODOUR REDUCING PROPERTIES UNIQUE TO VIROFLOW™ TECHNOLOGY & VIROSEWAGE™ TECHNOLOGY REAGENTS

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INTRODUCTION

Wastewater treatment, solid waste management, and various industrial practices involving complex organic compounds have traditionally produced unpleasant odours. However, the ability to control and manage odour-related problems is complicated by difficulties in isolating, quantifying, correcting and monitoring such odours and in planning for their long-term treatment.

Moreover, the number of complaints regarding unpleasant odours from industrial and municipal facilities has increased considerably in Australia over the last ten years primarily as a result of the encroachment of residential developments onto land surrounding industrial facilities and the greater awareness the public has of its rights over environmental issues.

The growing importance placed on odour control from sewage treatment plants, solids waste composting facilities, and industrial sites such as tanneries and paper pulp mills, has led to governments enforcing stricter regulatory controls on odour emissions. This also results in planning applications for new plants or modifications to existing plants being challenged where odours may have negative impacts on the local community, and a greater willingness on the part of regulatory authorities to warn, fine and even close offending facilities.

Sewage treatment plants, industrial plants, tanneries and facilities like piggeries are increasingly being subjected to odour production limits.

For these reasons, odour control and prevention are key issues, both in the management and operation of existing facilities, and in the design of new facilities that must meet stricter environmental regulations.

Virotec has known for several years that reagents derived from its Platform Technology have odour reducing effects, and the company has conducted odour abatement projects in tanneries, solid waste composting facilities, and sewage treatment plants in Australia to demonstrate the effectiveness of its technology in the reduction or elimination of odours.

Virotec's scientists have found that several mechanisms contribute to the odour reduction properties of our ViroFlow™ Technology and ViroSewage™ Technology reagents. The mechanism that makes the greatest contribution to odour reduction in any given application

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depends on the cause of the odour. In most instances, several odour reduction mechanisms have an influence.

The primary odour reduction mechanisms in ViroFlow™ Technology and ViroSewage™ Technology reagents (derived from Platform Technology) are summarised below.

MECHANISM #1: THE BINDING OF POLAR MOLECULES AND CHARGED PARTICLES

The principal reason Virotec's reagents remove odour is their composition. All ViroFlow™ Technology and ViroSewage™ Technology reagents consist of a cocktail of very fine grained minerals and most of these will have a positive or a negative surface charge depending on the pH conditions they are exposed to. The very fine grain size of the mineral particles gives them a high surface area to volume ratio, and most of the particles also have a high surface charge to mass ratio.

These properties make the reagents extremely surface active and give them an excellent ability to attract and hold charged particles or polar molecules. Many other fine grained materials also have this ability, but the Virotec advantage is due to the mixture of so many different surface active minerals.

The complex mixture means that some particles will be negatively charged while others are positively charged over a wide range of pH conditions (commonly, from a pH of less than 3.0 to a pH of over 9.0). Unlike materials that consist of few mineral constituents, Virotec's reagents attract and hold both positively and negatively charged particles or polar molecules over a wide range of pH conditions. Charged particles are usually held more strongly than polar molecules, and larger molecules are usually held more strongly than smaller ones.

Most odour causing molecules are polar, or can form charged particles in water and, consequently, they are attracted to the constituents in the reagents over a wide range of pH conditions. Different minerals within the reagents bind particular odour molecules under different pH conditions, and under many pH conditions it is possible that two different minerals in the reagents are simultaneously attached to the oppositely charged ends of a polar molecule. When odour causing molecules are attached to the solid mineral particles in the reagent, they are unable to disperse in the atmosphere to produce objectionable odours.

MECHANISM #2: HYDROLYSIS OF FATS, OILS AND GREASES

In some situations our engineers encounter high concentrations of fats, oils and greases (FOGs) in effluent and these FOGs create highly objectionable odours. Such applications are often at the extreme end of odour production, and include sites such as tanneries and

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biosolids and solid waste composting facilities.

However, ViroFlow™ Technology and ViroSewage™ Technology reagents contain reactive hydroxides that hydrolyse FOGs allowing them to form charged or polar reaction compounds that become attached to oppositely charged mineral particle surfaces in the reagents. The binding of fatty acids in particular helps ensure there are fewer molecules available that can react to form esters and other odourous compounds.

MECHANISM #3: THE BINDING OF ESTERS

Esters are organic molecules formed when an acid (usually an organic acid) reacts with an alcohol; the reaction also produces water. The most common esters found in nature are fats, which are esters formed from fatty acids. Many esters have distinctive odours; some pleasant and some not. Most esters that have a particularly strong odour are polar molecules that can be electrochemically bound by the charged mineral particles in Virotec's reagents as described in Mechanism #1. Other esters can be saponified (as described in Mechanism #2) and thereby develop a greater attraction for charged mineral particles.

MECHANISM #4: THE BINDING OF SULPHIDES AND SULPHUR DIOXIDE

Volatile sulphides and sulphur dioxide have particularly noticeable, unpleasant odours. More importantly, gasses such as hydrogen sulphide are extremely toxic and can cause human fatality. These gasses are also slightly soluble in water, where they form acidic solutions and are one of the main causes of "acid rain".

The minerals in Virotec's reagents react with the charged ions that are formed when sulphides or other sulphur compounds dissolve in water, neutralising acid and forming new low solubility mineral compounds that, in turn, enhance the ability of the reagents to trap and bind other potential contaminants, such as heavy metals. The minerals in the reagents are very effective at permanently removing volatile sulphides and sulphur dioxide. Virotec's reagents also bind organic sulphides (e.g. dimethyl sulphide or dimethyl sulphoxide and mercaptans very effectively by Mechanism #1. These organic sulphides and mercaptans include many known foul smelling substances and odour management requires reducing their concentrations to very low levels.

MECHANISM #5: MECHANICAL FILTRATION

The aggregation of the very fine mineral particles in the reagents leaves the solid material with a well developed micro-porosity that enables it to trap organic particles, and some large molecules, that can contribute to odour generation.

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MECHANISM #6: BIOGEOCHEMICAL EFFECTS

The minerals in ViroFlow™ Technology and ViroSewage™ Technology reagents also provide an attractive substrate for several types of bacteria and fungi that accelerate the breakdown of many organic compounds. This effect not only helps with odour reduction but also helps reduce composting times when these reagents are added to the organic materials being composted.

MEASURING ODOUR REDUCTION

Biosolids produced from the ***Pine Rivers Shire Council STP,*** a large-scale BNR sewage treatment plant in Strathpine, Queensland, Australia were treated to determine the amount of odour reduction that could be achieved by ViroSewage™ Technology. Initial analyses were performed using a GCMS (Gas Chromotography Mass Spectrometer) to determine which compounds in the untreated biosolids were contributing to odour generation. The results showed that both hydrogen sulphide (H_2S) and methyl mercaptan (CH_3SH) were the primary contributors to odour.

Following the initial analyses, both hydrogen sulphide and methyl mercaptan concentrations were analysed using a gas chromatograph with a flame photometric detector. The results showed that in biosolids treated with the ViroSewage™ Technology reagent, the hydrogen sulphide had been completely eliminated and the methyl mercaptan concentration had been significantly reduced. The total peak area for hydrogen sulphide was reduced from 18.1 million to zero, and methyl mercaptan was reduced from 1.54 million to 53,000. All analyses were performed by a NATA-certified laboratory in Melbourne.

ODOUR REDUCTION APPLICATIONS

Virotec has engineered and implemented three advanced odour abatement applications in Australia.

The first application was at ***Tasman Sheepskin Tannery Pty Ltd*** ("Tasman"), a well-established medium-sized tannery in Southeast Queensland. Tasman was producing a waste with high Cr III loadings. More importantly, Tasman's process was producing an obnoxious smell, that resulted in multiple complaints to the Queensland Environmental Protection Agency.

Virotec introduced its ViroFlow™ Technology reagent as part of a treatment system that reduced the chromium concentration from 50-100 ppm to 0.3ppm, and lowered BOD and COD from 1,000-2,000 ppm to 222 ppm, and 2,000-3,000 ppm to 350 ppm respectively.

Odour levels were reduced from "very high" to "very low". Significantly, there have been no complaints to the EPA at all since treatment commenced.

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The Manager of Tasman, Peter Moffat, stated that "a substantial benefit of the ViroFlow™ Technology treatment is the reduction in odours. I have found that there was substantial odour reduction during application of ViroFlow™ Technology, particularly when we compare the results to our usual system".

The second application was at ***Queensland Organic Recycling Systems*** ("QORS"), a trade waste processing and composting facility in Southeast Queensland. Virotec was called into a critical situation where QORS was facing warnings and possible fines from the Queensland EPA for excessive odour emissions. The key objective was to treat two leachate ponds to immediately reduce odour generation and improve water clarity. The affected Ponds No. 2 and No. 3 had turned anaerobic, resulting in generation of offensive odours in the affected contained liquor.

Over a three-day period, Virotec introduced a staged treatment that saponified FOGs, stabilised pH, removed odour generating molecules, bound heavy metals, killed bacteria (including anaerobic bacteria), increased coagulation of solids to help clarify the treated water, and polished the water to improve clarity and visibility.

After treatment the ponds were fitted with automatic aerators designed to keep the ponds aerobic in the long-term.

In Pond No. 2, the water clarity was improved from 0.0 mm to 300 mm, and in Pond No. 3 from 0.0 mm to 120 mm.

More importantly, site personnel reported that odour was reduced in both ponds from "high" to "not detectable".

After unannounced site visits to QORS by the EPA and as a result of using hydrogen sulphide meters to measure odour levels, ***the EPA declared that on a scale of 0-10 with "10" representing the most objectionable level of odour generation, QORS had a measure of "0".*** As a result of these findings, QORS avoided a warning or penalty from the EPA.

The third application was at the ***Kilcoy Shire Council*** ("Kilcoy") sewage treatment plant (STP) located in Southeast Queensland.

At Kilcoy, Virotec implemented a ViroSewage™ treatment that reduced P concentrations in effluent from 70 mg/L to 0.05 mg/L, BOD from 500 mg/L to 9 mg/L, E-coli from 26 million cfu to 7,000 cfu, and improved clarity from 20 mm to 2,200 mm. Analyses were conducted by Australian Laboratory Services, an independent, NATA-certified laboratory. As measured qualitatively, odour levels were reduced from "extremely high" to "extremely low" in and around the plant. Cec Forbes, the Kilcoy plant engineer, stated: ***"We have found that there has been substantial odour reduction from the typical odour generation points, such as the primary clarifier and digester".***

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It is clear that Virotec's reagents derived from Virotec's Platform Technology significantly reduce, and sometimes eliminate odours, generated from organic sources in municipal and industrial waste treatment facilities.