Good Bugs: Bad Bugs 10 Years of Microbial Balancing in Waste Water with EM

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ABSTRACT

Managing Waste Waters with EM Technology

Biological solutions to biological issues are fast becoming the modern trend in the development of best practice management systems. The burying of sewers caused an "out of sight" is "out of mind" syndrome, until the problems of smell and pollution of rivers arose. While civil and water engineers battled with the problems for decades environmentally acceptable solutions were not available due to overpowering effects of odor causing microbes. Our organization thus came up with a solution to dose wastewater and sewage with beneficial microbes and microbial products, shifting the balance to populations o"f favorable microbes. Effective Microbes were used in combination with other products to treat wastewater and the pipes carrying the waters as doses could not easily be found for large bodies of these waters. The success has been phenomenal and the programs and achievements are highlighted in the presentation.

Introduction

Biological Solutions to biological issues are now world's best practice. Microbial Balancing techniques are where the world is headed and many forums like this one are focusing on the need to work with natural systems to achieve a balanced, sustainable solution. But this was not always so. Since sewers went underground, waste water has been an "out-of sight; out of mind" issue. Problems only re-surfaced when smells became over-powering and later when rivers became overloaded. For many years fixing the problems has been the domain of Civil and Hydraulic Engineers based around plug flows and "get it out of town before sundown". But you can only seal up, mega-dose and disinfect microbial reactions in waste water so far. At some point given the ready supply of nutrient and optimal conditions for microbial growth, some populations begin to build up a momentum which cannot be stopped mechanically.

In the early 1990's a growing realisation began to spread among the community of engineers that microbial reactions, such as H2S production and Sulphuric Acid degradation work faster and react quicker than Local Authority repair efforts. The bad bugs were winning and a different solution was needed.

[slide showing early toilet systems] [slide showing treatment plant pollution plume]

In 1995 VRM first proposed that the only lasting answer to issues of microbial imbalance, was an arrny of microbial mercenaries sent in to redefine and self-manage the delicate balancing act required to process organic wastes. At that time, there were no Local Authorities in our State with a Bio-Chemist or Microbiologist on staff despite all operating biological waste treatment plants. This meant that the step from working with visual mechanics to believing in things which they could not even see was difficult for some managers. Significant hurdles still exist in this process and much of our work consists of helping engineers and operators climb gingerly over the hurdles as they explore a new way of thinking about their facilities.

Hurdles

The following concepts are among the most important'omind-shifts" we have had to explore:

Treat the pipes not the water.

The most common misconception we have found to be present when visiting waste water treatment sites for the first time is that the issues faced at the end of line treatment plant (be they odouro a lack of digestion, sedimentation issues, etc) arise from problems in the water. In reality, almost all issues of odour, degradation of structures, floating solids, and even sedimentation can be traced to impacts on the water which originate in slimes attached to the walls of pipes and other structures through which the water passes.

Microbial populations living un-checked in the many thousands of metres of pipes in a sewerage network produce substances and other effects which are carried by the water flow downstream. By the time the water reaches a treatment plant, these effects can often be too far advanced to be reversed in the time available at the treatment facility. I refer here to impacts such as development of populations of microfix parvicella and sulphate reducing bacteria, whose presence in enormous numbers is often impossible to deal with by starting at the treatment plant itself.

Time is of the essence in dealing with waste water. There is generally only a limited amount of time to deal with what is present in any tranch of water. Microbial populations take time to process different types of food and typically, digestion of organic material requires that it be passed through a series of different populations performing different tasks. And here, the microbial populations living up-stream in the pipes have an advantage. They have virtually unlimited time to manufacture negative substances (such as long-chain fats and fatty acids and hydrogen sulphide) and are not typically impacted by atmospheric changes.

[Slide drawing of pipe slimes] Throughout a sewerage collection network, there are literally millions of micro-sites at which plug flow slows down. These sites become incubators for microbial populations living and feeding on the ready supply of nutrient carried in the water. An important concept which VRM presented (now contained in various Paterrts) was the inoculation of as many of these micro-sites as was feasible with a range of organisms which could out-compete those organisms currently responsible for producing substances negative to the treatment process downstream. However, this inoculation had to be done in a fashion which allowed organisms such as lactobacillus and various yeasts to be partially self-sufficient in remote, never-visited locations in a pipe network underground.

For that, it was critical that any inoculation make use of mixed cultures of organisms which could partially support each other rather than having to operate alone or be supported by external activitylmechanisms. Enter EM. A crucial factor in the success of inoculation with EM and derivatives of EM was the ability of the key organisms in EM to perpetuate a cycle of digestion which was partially self-supporting. Those of you who have seen professor Higa's descriptions of this will recognize that the feedback loop involving re-processing and manufacture of saccharides by phototrophic organisms is critical in this ability to sustain a balanced digestion of organic solids.

With this basic tool - a partially self-perpetuating group of organisms - in hand, VRM set about describing a method for the dispersal of this ability throughout a sewerage network with optimal efficiency. A big part of this discussion was the ability to overcome existing populations and deal with widely variant conditions from place to place within a single system. In order to achieve this, a model was produced which described inoculation of the SYSTEM (not the water in the system) and which included a technique of controlled re-inoculation. A simple formula was developed which allowed operators to recognize and make use of inoculation points within their system and to use simple equipment to manage the inoculation process automatically. It was found that a random distribution of inoculation points in a system with secondary and tertiary inoculation sites chosen based on a "time in system" allowed the best uptake of inoculum.

[Slide refer to European Patent - VRM Enterprises]

Real health is a process not a band-aid - but sometimes we all need a band-aid.

A key element in the management of systems which are dependant on biological responses is that results are a function of reactions which accumulate - often with trends which are not immediately visible. Unfortunately, this takes time and in many instances, operators feel they do not have time. This has resulted in a proclivity to depend upon various chemical additives which give rapid, short term fixes to various issues. Changes in load on the system are frequent in most systems. In many systems load can vary by as much as 100% dependant on seasonal factors, rainfall and weekend activity. This causes numerous problems for operators as results are often patchy and impossible to predict or control.

In presenting an approach which relies upon the gradual development of microbial populations and not on an instantaneous response, it is often important to emphasize that "results" are not rneasured in time, but in consistency. At the end of the day, this is very easy to explain. In the beginning, it is often difficult for a treatment plant operator to accept that there is likely to be some time before he sees a change, and that his primary result will be that the outcomes are predictable.

[slide showing reduced volatility of results CSR Sarina]

While there is no doubt that predictability is a much sought-after commodity for treatment systems, it is also true that pressure over problems such as odour or a lack of sedimentation can drive the operator to make short term rather than long-term decisions.

This has led VRM to make an adjustment in how we present the inoculation process and also required an advance in how inoculating formulations were presented. It is necessary to present inoculum in more than one state of activity. For long-term stability of a system, inoculum needs to be introduced in a balanced, stabilized state - one which has reached and passed through the exponential growth of yeasts which occurs in early fermentation hnd returned to a relatively stable equilibrium. This mixture can be distributed in line with the pattern of early, accumulative inoculation throughout a system.

However, in order to deal with short term issues such as odour and a lack of sedimentation, it is necessary to present inoculum in a more active state. To achieve this, VRM worked on a mechanism of maintaining activity levels and promoting rapid short-term growth of organisms at the point of inoculation.

Called "EM Spray-Batch" this mixture gives a rapid but short-term odour control reaction -quickly addressing Hydrogen Sulphide release in most situations - and results in a rapid, short-term settlement of some floating sludges.

All VRM inoculation programs now include elements of both types of inoculation.

Donot stop when the smell goes away - or you will pay, and pay

When loads to a treatment plant change, so do the populations which feed on the organic material. However, there is a lag-time in the recovery/growth of populations which can prove fatal in terms of operational stability at the plant. Odour is a key indicator of imbalance in a system and acts as a very strong motivating factor. As a result there is a tendancy for operators to over-react when a problem appears and under-react once the problem oogoes dwaf'-rurely in response to the odour itself.

Inoculation programs are generally aimed at buffering variable levels of microbial activity. Buffering (by inoculation) against microbial die-back is a sensible option - in fact providing a similar, function to the recycling of sludges. However, it is tempting to take the approach that once odour has died down, there is no need to inoculate any more.

Unfortunately, this approach is likely to contribute to rather than assist with the "boom:bust" cycle of microbial activity which led to the odour in the first place. As populations rise and fall, certain groups reach relative dominance. By introducing a mixed culture of o'good bugs" and then ceasing this inoculation once odour is controlled,
acycle of population dominance can occurwhich makes it more and more difficult to
control the odour when it next arises.

To counter this situation it has been necessary to offer services to potential customers which include two elements: an expensive, once-off emergency odour control service, and a cheaper regular inoculation program which prevents odour reappearance. It is generally much more successful to conduct a visit once or twice per week on the same day of the week year round, than to visit three or four times each time an odour event arises. Most customers can be easily convinced of the efficacy of such a process purely based on the relative costs.

Of course it is also relatively easy to describe why such a process works especially by relating to cycles of micro-flora/micro-fauna development in a body of water. It is interesting to note that most such programs operate best on a3 % day cycle or a seven day cycle _similar to the period involved in the natural rise and fall of microbial populations in water.

[slide showing mill costs]

You can't buy microbial balancing like you buy crash repairs; you have to buy it like you buy insurance.

An interesting development in the use of microbial inoculants in waste water systems is the realization by many larger clients that it is cheaper overall to plan for issues well in advance than to deal with them iflwhen they arise. Over the course of the past l0 years, many of our clients in the Sugar Industry in Australia have come to rely on our inoculation programs as a form of insurance. Programs are ordered for a season or for a year rather than in relation to a specific event. This allows us to perform a very important aspect of any successful inoculation program _incubate on site.

There is no doubt that inoculation with formulations like EM represents a clear step forward in dealing with organic wastes in water. However, an important limitation to the success of such programs is the virtual certainty of changes in environmental conditions which exists when formulations are grown in one geographic location and used in another. At VRM we have developed a series of systems to help alleviate this 'oenvironmental shock load" _including patented inoculation techniques, stabilizing and cosseting factors built in to the inoculum itself and using equipment designed by us to suit the formulations. However, given all of these advances, without doubt the single most important factor in the long-term success of any inoculation process is the incubation of formulations on site at or near the location to be treated and using food sources similar or identical to that expected.

[slides here show inoculation technique, inoculation equipment, incubation zone]

In essence, the most successful programs we have conducted have been where we have been able to incubate formulations in large quantities on the site. There are many ways this can be done, but the most successful seems to be simply to isolate a small section of the treatment process itself and encourage some circulation of effluent through this point at a slower rate than normal while inoculating at a higher rate than otherwise is possible.

[photo from Hungary]

There is no fixed dosing amount that will fix any volume of water.

Perhaps the most difficult concept we have had to contend with in presenting microbial balancing solutions with EM is that there is no single formula which can be applied to any body of water to determine a dosing rate.

In fact, it is sometimes true that the smaller the volume is, the larger the relative dose required will be. Conversely, after a certain point, there is a relationship between dosing rate and water volume which works inversely to most chemical reactions: that is, the more dilute is the solution to be reacted, the smaller the dose required and the faster the reaction which results.

In dealing with this mysterious relationship, it is always important to relate dosage to time. Where water is in constant motion, less time available will generally mean more inoculation is needed. However, when water is not constantly in motion (for example in a pump station or filled pipe) more time means more inoculum is needed.

This can be very confusing --in particular to those responsible for placing the purchase order.

In overcoming this issueo we have found that it is generally better to keep dosing rates constant in terms of time and vary the number of dosing sites rather than ask operators to vary the dosage at different points. This means that some sites may receive a higher dose than others relative to the water which passes through that site. With experience, a generalized formula for inoculating across an entire system can be developed which accounts for differences in volume and dilution of effluent efficiently.

In this dynamic, the water should be seen more as the vehicle carrying food to organisms and organisms to feeding sites than as the focus of the treatment.

Special bugs for special jobs. How does EM fit with specialized needs?

A common criticism leveled at EM in the waste water arena is that the organisms in EM are slow to digest certain key ingredients found in waste water. Important in these are oils and fats and toilet paper fibres. In making recommendations it has been important for us to recognizethat, when used in commercial inoculation rates, EM alone is slow to digest these products in a water environment. Significantly, there is evidence to suggest that in a less moist compost environment digestion using EM as the primary inoculant is faster than most others. However it cannot be ignored that there are "one-time" formulations on the market which are faster at digesting both grease and fat and toilet paper than does EM in a Grease Trap or Sewerage collection tank or a sewerage system.

In response to this, we have been careful to use EM for the functions for which it is best fit. Importantly, the primary function of EM is to outcompete organisms responsible for variable outcomes. EM is best used as a stabilizing factor. There is little doubt that the spread of results which occurs when an inoculation program based on EM is used is significantly less volatile.

[slide showing scatter graph before and after in Mackay]

While at first glance this does not appear to address the issue of specific digestion rates for difficult products, it does allow a much clearer view of what has to be done. It has been our experience that output indicators recorded by treatment plant operators and others can be, and often are, read and interpreted in a variety of ways, generally in response to unusual inputs or variable external pressures. While this situation exists, it is extremely difficult to obtain an accurate picture of the impact on individual components of the effluent (such as fat or cellulose). Once the volatility of output indicators is reduced, it is much easier to properly address what is happening with these difficult materials.

Additionally, EM provides an important base formulation into which or alongside which can be built other specialized formulations. VRM has successfully used EM to build secondary formulations which contain populations which more rapidly digest fat and grease than does EM alone. Similarly, we have been able to add formulations containing organisms targeting cellulose/paper. What is important in this is that the addition of either of these specialized formulations does not appear to have the same effect when they are used exclusive of EM.

A quick look at the commercial benefits.

Formulations containing EM have several properties which are useful in waste treatment operations around the world. VRM has made specific use of these properties on various sites.

Odour Control There is a well-established history of odour control based on the neutralizing effects of organic acids.found in the formulations. Additionally highly motile phototrophic organisms in EM compete for Sulphate without producing Sulphide and can re-process Hydrogen Sulphide in some conditions to produce elemental sulphur. These properties are very useful in both short-term and long-term odour control. VRM uses formulations of EM to conduct odour control programs at numerous sites

[slide showing trucks]

Rapid Sedimentation Waste Water treatment is _in most treatment systems _defined by the rate at which solids can be removed from the water, leaving clarified effluent to be discharged. The inclusion of organic acids in EM together with the presence of both anti-oxidants and hydroxyl radicals formed in the presence of UV (sunlight) from hydrogen peroxide produced by lactobacillus have a rapid effect on the sedimentation rate of solids in a body of water. This effect is very useful in short term odour control (sludge settlement) together with long term sludge digestion, which primarily occurs at the bottom of the water column.

[slide showing beakers of sludge]

Enhanced Sludge Digestion A strong limiting factor on the success of waste treatment is the accumulation of organic slaudges. The feedback loop involving re-processing of saccarides which is a feature of EM allows both anaerobic and aerobic digestion of sludges to continue without continuous agitation. This is a tremendous benefit for systems which rely on a constant volume of sludge for optimal operation (septic tanks, activated sludge plants, etc). VRM operates several on-site treatment systems where Septic Tanks are included and which have operated for many years without a change in the sludge volume despite frequent changes in BOD load.

[slide of Palm Bay system]

Control of Algal blooms Motile organisms in EM compete well for nutrients with green and blue-green algae. With management of lamination of a water column (generally by low intensity aeration) and inoculation with EM algal blooms can generally be averted even in areas where spills are unavoidable. VRM has conducted several programs aimed at management of algal blooms.

[slide showing ponds at Mt St John and beakers]

Summary

Stability is everything in waste water treatment. While liule attention is focused on this property, it is VRM's experience that the enhanced stability of overall microbial processes which EM offers is its most important benefit in waste water treatment. In addition, EM can be used to successfully control odour, promote sedimentation and allow the development of targeted microbial populations to treat specific issues.

All of these properties have made consistent background inoculation with EM a useful tool in VRM's successful work in the volatile arena of waste water treatment.

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