Options for Advanced On-Site Treatment

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Abstract
Identification of specific elements of a process stream and the ability to purchase elements either as a package or individually offers end-users flexibility and encourages understanding of the processes by those who have to use them. Incorporation of EM (Effective Micro-organism) based, low-energy, low-technology elements has allowed clients in sensitive areas to tailor a "modular process stream" which best suits their site and which allows meeting of the highest standards for effluent treatment and re-use. Incorporation of microbial balancing by regular inoculation enables the systems to cope with the serious problems of fluctuating loads and odour generation. A simplified process stream approach allows minimal maintenance on remote sites and multiple-failsafe mechanisms including advanced oxidation allow the process to produce high levels of effluent quality in extreme circumstances.

Key Words: *microbial balancing, advanced settlement, advanced oxidation*

Introduction

There are currently twenty-six Government approved on-site treatment packages available in Australia to developers. Distinguishing the benefits and disadvantages of these pre-packaged options is often clouded by proprietary focus or a lack of prior experience on the part of the environmental license holder or land developer. Mechanically intensive operations and concurrent maintenance issues make most of these unsuitable for sensitive and remote sites.

Australian Environmental Protection Act provisions regarding waste water have been significantly tightened in the past ten years. An example of this is found in sites within the Great Barrier Reef Marine Park area where all EPA License renewals since 1998 include a provision for nil discharge to waters. In addition, incorporation of AS,NZS 1547-2000 (On Site Sewerage Treatment) and an upgrade of Water and Sewerage Acts has seen a renewed focus on water quality outcomes and suitability of a given process for a given site. Inclusion in Australian Standards of design criteria for a range of discharge methods has also fostered a willingness to explore advanced treatment outcomes which do not focus entirely on mechanical processes.

Two prominent factors influence treatment of waste water in sensitive sites in Australia: the tyranny of distance and seasonal fluctuations in population. Distance has traditionally played a major role in system failure as maintenance presents a difficult and expensive proposition and is often overlooked as a result. Seasonal variations in occupancy have an extremely deleterious effect on operation of aerated waste water treatment plants. It is not unusual for a system to experience nil to 10% load for several weeks followed by maximum capacity for several days. Maintenance of biomass using traditional activated sludge or batch reactor processes can be nigh on impossible under these conditions.
These factors make a biologically balanced approach such as that offered by an integrated augmentation program using EM and a low maintenance system design increasingly attractive options.

Material and Methods

The Modular Process Stream offered consists four basic "Elements" which are each contained in discrete chambers (tanks) and sized and sited appropriate to the requirements of the particular operation. A brief description of these elements is included below. Typically, each system incorporates an augmentation phase where EM is added to collected effluent, a sedimentation phase where fermentation and rapid settlement of solids is promoted, an aeration phase where both intermittent and constant aeration are used to promote growth of cultures and an advanced oxidation phase where rapid disinfection and final BOD removal is completed.

Results and Discussion

The "Modular Process Stream" approach allows the perpetuation of some well- established techniques such as the use of Septic Tanks and the promotion of biological reactions rather than mechanical processes. These are supported where necessary by "higher-tech" options which help satisfy health and related concerns and offer failsafe measures for events such as system overload. Please see Diagrams 1-3, Modular Process Stream.

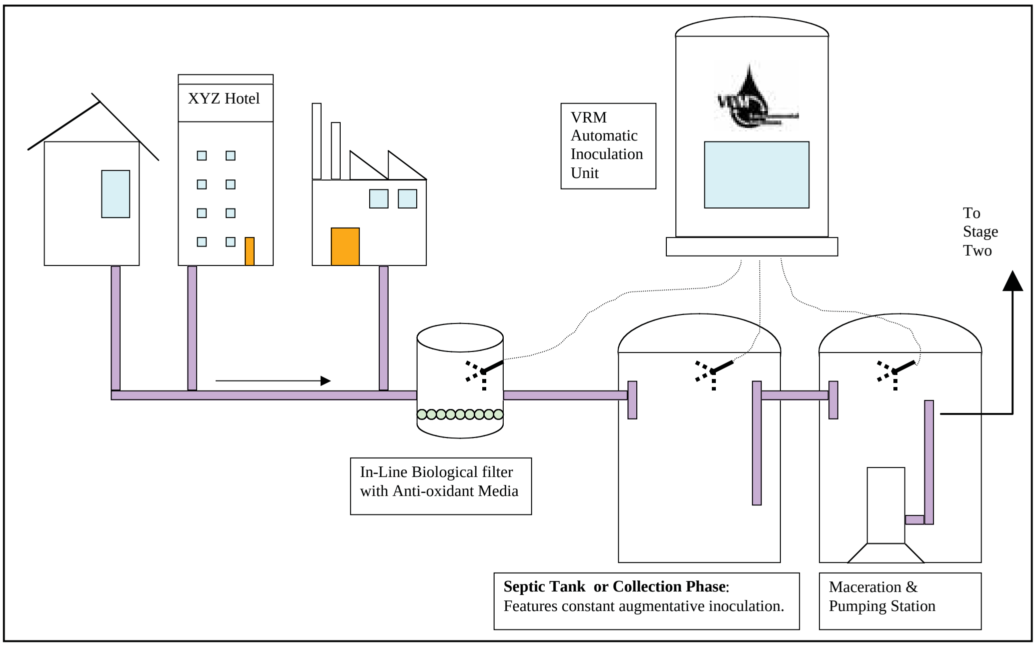

Diagram 1 Modular Process Stream – Collection and Inoculation Phase

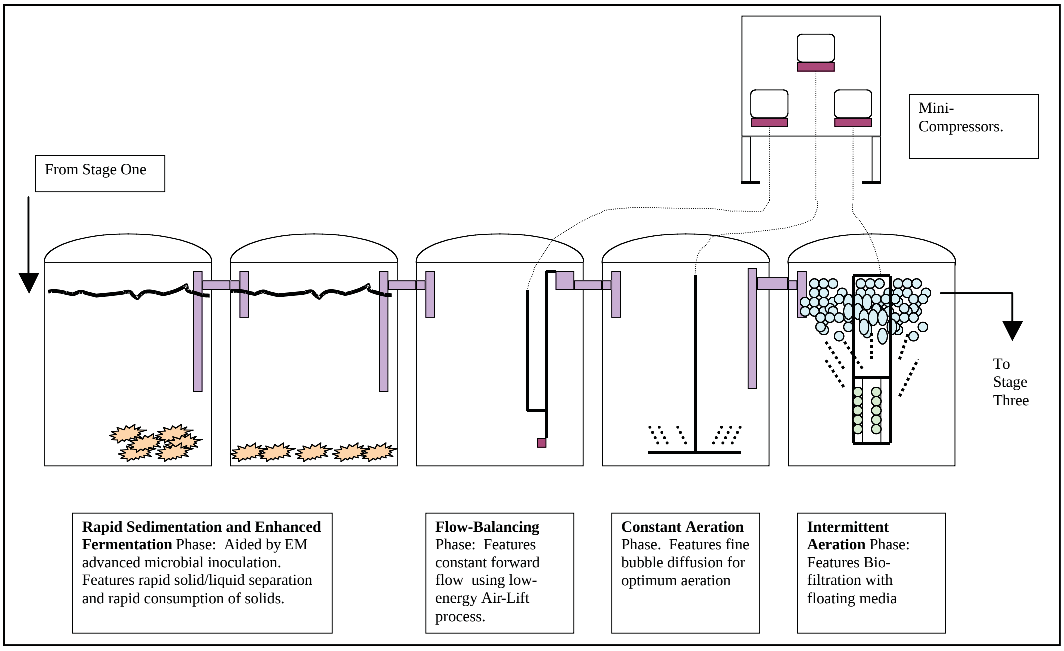

Diagram 2 Modular Process Stream-- Sedimentation and Aeration Phases

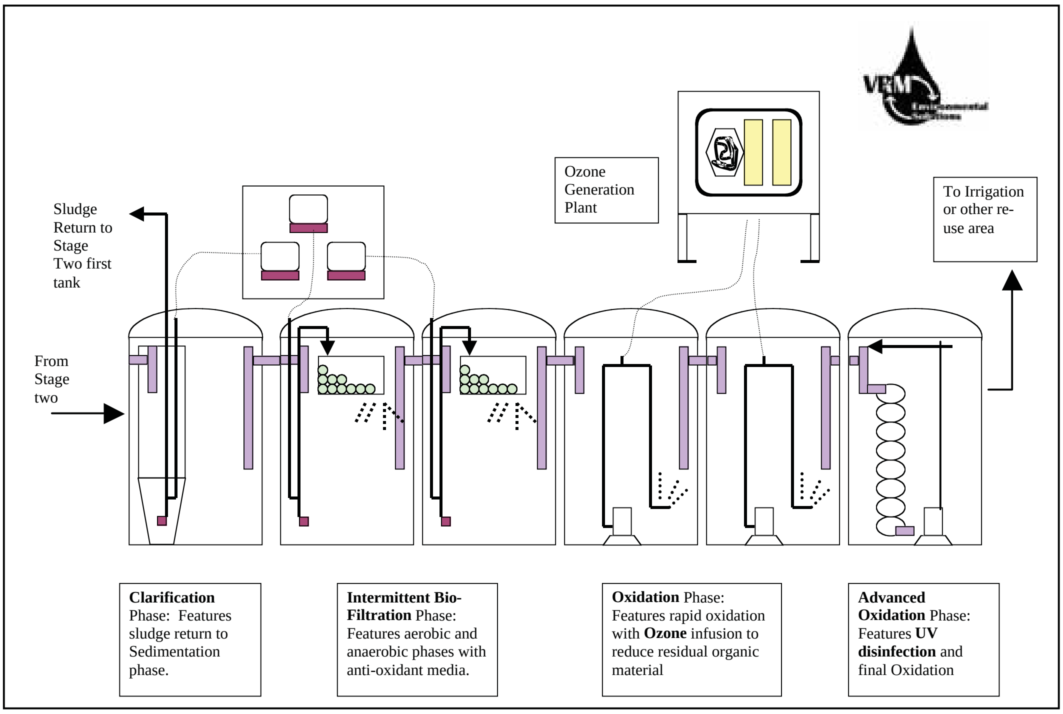

Diagram 3 Modular Process Stream – Advanced Oxidation Phase

A discussion of the four basic elements of the process stream follows:

a. Biological Augmentation

Systems make use of a proprietary technique for microbial balancing[1] employing a multi-point, low dose, constant inoculation pattern which allows a partially self-perpetuating culture of organisms to develop and which overcomes environmental shock loads normally experienced by introduced organisms. With use of EM, cultures are adaptive and persistent. Where inoculation is maintained, odour control is constant throughout a treatment system, and systems demonstrate stability of bio-logical activity despite fluctuating loads. EM demonstrates an ability to begin organic treatment of effluent in collection networks prior to a conventional treatment plant. Table A shows Reductions of Biological Load gained in a dosed collection system only (prior to Treatment Plant) over a Seven Month trial in one system.

Indicator	Units	Baseline Period (10 Weeks) Before EM	Acclimatising Period (14 Weeks) EM program Begun	Stabilised Period (10 Weeks) EM program Established	% Change in Load
BOD	Kg/day	549.81	527.81	493.8	-10.19
SCOD	Kg/day	296.05	293.23	258.08	-12.82
TKN	Kg/day	67.88	66.66	59.02	-13.06
TN	Kg/day	72.32	71.16	63.14	-12.69
TP	Kg/day	27.70	25.61	23.40	-15.53
SO4	Kg/day	86.70	84.06	72.26	-16.65

Table A – 80th percentile spread of Selected Effluent Quality Data in collection system prior to STP

b. Sedimentation

Use of EM has particular benefits in advanced sedimentation and consumption of solids. A significant concern in remote sites is the periodic removal of accumulated solids from Septic Tanks or similar chambers. Table B – Sludge readings, shows collated data from primary collection chambers at a number of sites over a two year period. To date none of the sites employing EM in an enhanced sedimentation phase has required a pump-out.

Site ID	Effluent Flow (l/day)	Primary Chamber Volume(litres)	Sludge Depth Oct '99	Sludge Depth April '00	Sludge Depth Oct '00	Sludge Depth April '01	Sludge Depth Oct '01
Fulpak Plant	6840	10000	100mm	N/D	60mm	25mm	10mm
Koorelah Packers	12800	24000	250mm	200mm	200mm	215mm	220mm
Palm Bay Resort	35200	48000			55mm	70mm	50mm
Broken River Resort	25200	20000		105mm	125mm	85mm	100mm

Table B – Sludge Depth in Primary Sedimentation Chambers with EM inoculation.

c. Aeration

Inclusion of aeration and settlement chambers including the use of low-energy flow-balancing and frictionless aeration compressors make these standard elements very user-friendly.

d. Oxidation & Advanced Oxidation.

For sites where footprint size of the treatment plant limits biological reaction time, a true rapid Oxidation process using Ozone (generated on site) offers considerable benefit in reduction of BOD and TSS to consistently outperform Advanced Wastewater treatment guidelines for these indicators. A proprietary technique[2] uses Residual Ozone and UV in synergy to provide a double barrier for pathogen control and a significant on-going benefit in terms of residual oxidation potential without the use of chlorine. In addition, the advanced oxidation process allows for almost complete removal of BOD and TSS. Final waters can be left with consistently high and persistent levels of DO and show little or no pathogen re-growth. This allows re-use with confidence in high-impact areas such as resorts and commercial establishments. See Table C—Collated Effluent Quality Data, Palm Bay Long Island Resort.

Date	BOD Mg/litre	TSS Mg/litre	Faecal Coliforms Count/100ml	DO Mg/litre
Dec '00	2	3	<2	8.1
Jan '01	5	3	<10	7.2
May '01	2	1	0	9.7
Oct '01	1	1	0	10.5

Table C – Collated Effluent Quality Date, Palm Bay Long Island Resort.

A significant result observed in these systems is the formation of high levels of dissolved oxygen in final waters. Boon and Lister[3] have shown that presence of dissolved oxygen mitigates against formation of odorous compounds (particularly hydrogen sulphide) in effluent waters. In addition, high levels of DO which persist in final effluent waters indicate a residual oxidation potential gained without the introduction of chlorine. This represents a significant cost saving for operators and an environmental benefit in reduced formation of chloride compounds.

Conclusions

A modular process stream approach to waste water treatment offers a stable and flexible treatment process especially suited to sensitive and remote sites. Use of low-tech processes backed by consistent augmentation with EM effective microorganisms and Advanced Oxidation allows extremely high treatment outcomes in a low-maintenance environment.

The production of high and persistent Dissolved Oxygen in final waters allows little or no pathogen re-growth and permits the storage and re-use of effluent in a range of circumstances without odour generation.

References

1. Australian Patent 737685, Method of Treating Waste Water, Bellamy, K.M., Newton R.K.
2. Australian Provisional Patent PR5732, Method and Apparatus for Water Treatment.
3. Boon A.G., & Lister A. R., Formation of Sulphide in Rising Main Sewers and its Prevention by Injection of Oxygen, Progress in Water Technology, Vol 7. No. 2, Pergamon Press, 1975.

Appendix A.-- Photographs

EM Inoculation Process – Island Resort

Modular Process Stream—Treatment Plant site