ALTIUS ENVIRONMENTALS

Industry - Agriculture - Water

The Mayor
Modimole Municipality

Dear Sirs,

Proposal to treat Sewerage for Modimolle Municipality with Effective Micro-organisms (EM)

Thank you for the time afforded us on our visit to your beautiful town. May I also complement you on the commitment you have demonstrated to make Modimolle a leader in responsible environmental management.

Introduction

We briefly examine the ways and means in which EM and MBT (Microbial Balancing Technology) can reduce sludge accumulations (even old sludge deposits accumulated over many years) in waste streams (including tanks, digester tanks, pipes, canals, lagoons, ponds, etc.) and also yield numerous other benefits as well, often **reducing costs** of treatment and disposal.

A glossary of terms used in this proposal may be found at the end of the document.

Background

In any waste treatment system, sludge is produced both intentionally (as an end-product for eventual use in a variety of applications, primarily to soil) and unintentionally (such as solid residue in sluiceways, on equipment surfaces, in streams, ponds and lagoons.) Excessive sludge from waste water treatment, as well as from industrial and agricultural waste streams, causes problems in many ways, including noxious odours, toxic off-gassing, over-limit levels of pathogenic microbes, toxic moulds, high BOD and COD, and lastly, creating a storage problem simply due to potentially massive volumes. Since much of the sludge is produced from waste facilities this may have a number of undesirable consequences. It is hard to find methods to easily dispose of this sludge, and even harder to find means to dispose of it in ways that are environmentally friendly and sustainable as a consequence of its odour, potential toxicity and probable presence of pathogens.

Primary and Secondary Effects in Waste Treatment of EM Utilisation

Primary and secondary effects of EM-based interventions are often remarkable, where the primary target effect is gross reduction in build-up of sludge via microbial-mediated disintegration and even removal of large accumulations of old sludge. Secondary effects will usually include:

- Drastic reduction or complete elimination of odours and toxic gases from waste, including H2S, ammonia, mercaptans, sulphide gases such as methyl sulphide and dimethyl sulphide, and putrefactive off-gassing products (putrescine, cadaverine, etc.);

- Drastic reduction in pathogenic bacteria, yeasts, and protozoa, as well as drastic reduction in "toxic" moulds implicated in toxic mould syndromes;
- Reduction (often drastic) in BOD and COD of recovered water and recovered solids;
- Utility and effectiveness under both aerobic, partially-aerobic and anaerobic conditions;
- Reduction in breeding and proliferation of flies and mosquitoes in and near channels, sluiceways, ponds, lagoons and treatment facilities carrying or holding waste liquids and solids;
- Reduction in colour (aka decolorisation) and turbidity, and improvement in clarity, of waste water;
- Reduction in suspended solids (SS) and dissolved solids (DS) in end-product recovered wastewater;
- Reduction or elimination of heavy scum layers (often caused by undesirable species of actinomycetes) on surface of wastewater;
- Oftentimes the reduction in undesirable species of algae (phyto-plankton);
- In aerobic and semi-aerobic settings, an improvement (increase) in levels of DO (dissolved oxygen);
- Due to reduction in BOD and COD, a reduction in the need for aeration thus allowing frequency and duration of aeration of ponds or tanks to be reduced significantly;
- Reduction in levels of (undesirable) nitric acid, nitrous acid and sulphuric acid in wastewater. These substances result in toxicity to wildlife and livestock, and also in corrosion of plant equipment, including accelerated corrosion of metal surfaces;
- Further to the above we notice a reduction in corrosion (including rusting) of metal and other surfaces of plant and facility equipment in or near the waste stream. This is due in part to drastic reduction of the nitrogen and sulphur acids mentioned earlier, and also due to drastic reduction of oxidative free radicals, aka reactive oxygen species. Both classes of substances are responsible for most corrosion and rusting. This reduced corrosion results in lower maintenance and equipment costs;
- Reduced nitrate and nitrite levels in final recovered wastewater and solids;
- Reduced phosphate levels in final recovered wastewater and solids;
- Increase in the efficacy and speed of waste digestion, thus often allowing greater throughput or faster flow rates for a given system/plant size;
- Reduction in levels of heavy and toxic metals in waste, including cadmium (Cd), chromium (Cr), mercury (Hg, aka quicksilver), arsenic (As), copper (Cu) lead (Pb) and nickel (Ni). This is accomplished by the destruction of ionised oxidised forms of metal and reductive conversion of such oxidised forms to non-ionised forms via antioxidative (aka reductive) redox processes. Non-ionised, non-oxidised forms of metals are largely inert and are relatively harmless to plants and animals, and are also undetectable in many types of tests for harmful metals;
- Reduction in levels of particularly harmful or toxic oxidised forms of metals (e.g., hexavalent chromium, aka Cr6, Cr(VI), Cr+6 and CrVI, also the polyvalent forms of arsenic (As), such as arsenic (III) and (V) oxyanions), selenium oxyanions, and halogens (e.g., polyvalent fluoride oxyanions), along reduction of toxic metal cations in waste stream and solids. Again, as noted above, this is largely accomplished by the destruction of ionised oxidised forms of metal and reduction conversion of such oxidised form to non-ionised forms via antioxidative (aka reductive) redox processes;

- Reduction of toxic compounds such as chlorinated hydrocarbons, aldehydes, formaldehydes and nitrosamines;
- Normalisation of pH from extremes;
- Decrease in costs associated with managing waste;
- Drastic reduction in need for toxic substances in the management waste or odour management of the waste stream;
- Improvement in quality and usability of recovered water and recovered solids, rendering them far more suitable for eventual use in a variety of applications;
- Improve nutrient value, safety and (value of) microflora of recycled waste solids which will be applied to soil.

The net effect is to significantly and sometimes drastically increase the effectiveness of recycling of resources, while reducing harmful side-effects and residues.

As a cautionary note, it is important to realise that many of the above-listed results do not appear immediately upon initiation of EM usage, but rather appear progressively over a period ranging from two weeks to three months. This is due to the establishment of the beneficial microbes in mud, gravel, concrete, and on hard surfaces (rock, concrete, etc.) and in interstices, and also to the encouragement of other "wild" beneficial microbes with anti-oxidative (reducing) rather than oxidative properties, with the attendant ("competitive") discouragement of undesirable microbes and undesirable processes.

Basics of EM Technology

The basic EM technology is a mixed synergistic and metabiotic microbial consortium consisting of at least 20 naturally-occurring and beneficial microbes from across at least three genera.

This beneficial microbial consortium can function effectively in either aerobic or anaerobic conditions, and many of the microbes in the consortium exhibit pronounced antioxidative (reducing) and syntropic (negentropic) effects, performing microbial reduction and also producing numerous reducing compounds which have marked effects upon many substances found in waste streams.

It is important to note that several products in the EM family, particularly some which are frequently used in waste and sludge treatment, such as SAEM (Super Activated EM) contain not merely the beneficial microbial consortium in a propagatable culture, but also contain a number of substances which are highly important in helping the microbial consortium to propagate and to become established in waste media; some of these special substances are:

1. Minerals and trace elements -- these help to nourish the beneficial EM microbes and other beneficial naturally-occurring wild microbes which will eventually form an even larger synergistic and metabiotic consortium in the waste stream.
2. Nutrients and trace nutrients, including selected carbon sources which selectively nourish the beneficial EM microbes and other beneficial naturally-occurring wild microbes which will eventually form an even larger synergistic and metabiotic consortium in the waste stream.

3. Organic antioxidative (aka reducing) substances such as quinones, anthocyanins, polyphenols, flavonoids and carotenoids – these were produced largely via EM microbial noxious substances (including gases) found in waste, but also help to create in the waste stream a beneficial environment where the EM microbial consortium may become quickly established and assure competitive advantage over undesirable (e.g., putrefactive or pathogenic) microbes.
4. "Energy substances" and energy carriers such as quinones, ubiquinone, ATP, NADH, bacteriochlorophylls, microbial cytochromes, etc.; these assist in drastically shifting the chemistry and microbial balance of the waste stream and solids.
5. Unique soluble organic electron-shuttling compounds which enable catalytic conversion of oxidative toxins, commonly found in sludge, via facilitated reduction (redox) reactions. This allows breakdown by redox of many toxic and hard-to-remediate substances which can ordinarily become problematic in waste streams. Some common electron shuttles or electron relays are quiniones, ubiquinone (COQ10), soluble microbial humic substances and certain organic acids such as malic acid and malates1.
6. Reducing agents, including low molecular weight and very low molecular weight antioxidants, including simple dielectric anionic hydrides and atomic hydrogen, both of which offer strong reducing (redox) power for neutralisation of hard-to-remediate substances often found in waste streams. The presence of these simple dielectric anionic hydrides and atomic hydrogen (the latter produced by some of the phototrophic microbes in EM products) may often be evidenced by downward shifts toward the reducing range of measures such as ORP (oxidation reduction potential) and the relative hydrogen score (aka rH2 or rH score, computed from pH and ORP) of waste liquids. These substances act as powerful reducing agents to reduce oxidative toxic substances and break up clumped bulked sediment consisting largely of acidic oxidative end-products.

It is also worth noting that the beneficial microbes in EM also produce considerable quantities of of the above-named substances listed in numbered list items 3 through 6 as the microbes propagate in the waste stream and sludge. These nutrients, factors and co-factors are a very important vehicle for many of the changes rendered by these EM products.

Experience shows that the judicious use of metabiotic antioxidative syntropic microbial cultures such as EM can yield decreases in sludge biomass (aka biomass solids) of from 15% to 90%, even drastically reducing sludge accumulations which may be many years old. In general, the methods via which EM and EM products achieve breakdown of sludge solids are as follows:

1. Much sludge bulking and "hardening" is created by filamentous organisms (usually certain actinomycetes and fungi).
2. EM acts to not only inhibit the growth and proliferation of such long-filament filamentous organisms, but also act to cause die-off and disintegration of existing "old" sludge biomass which had been colonised and "affixed" by such bulking microbial proliferation. Thus, not only are new sludge deposits due to such bulking actions largely prevented, but also old deposits, even those which may be many years old, are gradually disintegrated and dissolved. This is accomplished not only by the beneficial

microbial consortium in EM and by wild helper microbes, but also facilitated by the special nutrient compounds in products such as SAEM which help to remediate long-standing microbial nutrient deficits in such bulk deposits and sediments, thus allowing them to be disintegrated.

3. Some sludge bulking is caused by undigested fats (oils, lard, etc.). The organisms and nutrients in EM products act to promote digestion of these fats by EM microbes and by related wild helper microbes whose growth and proliferation is encouraged by the EM products. This results in break up and ultimate disintegration of oil-bound bulk sludge deposits and clusters.
4. Some sludge bulk in certain settings is caused largely by lignocellulosic matter -- often fibrous -- which is often resistant to digestion, thus causing bulk deposits held together in part by insoluble and hardy fibres. The organisms and nutrients in EM products act to promote digestion of lignocellulosic matter by EM microbes and by related wild helper microbes whose growth and proliferation is encouraged by the microbes and nutrients (including trace nutrients) in EM products. This results in the break up and ultimate disintegration of lignocellulosic fibre, bulk sludge deposits and clumps.
5. A significant portion of the biomass in most sludge are materials which were not able to be sufficiently digested by beneficial microbes in nature. In most waste streams, this failure is due not so much to any intrinsic indigestibility of the biomass in question, but rather to the following factors:
    - Insufficient presence or total absence of the appropriate microbes which can digest the biomass;
    - Absence or deficiency of key nutrients and trace nutrients needed to allow beneficial and appropriate microbes to multiply and propagate in the waste material to allow digestion;
    - Presence of substances which are rather toxic to beneficial microbes and thus inhibit or entirely halt their growth. These toxic substances can include powerful oxidants, toxic oxyanions of heavy metals, and toxic organic products of putrefaction;
    - Extremely low DO and high BOD and COD, which further limit those beneficial microbes which are obligate aerobes or facultative aerobes. Over-proliferation of undesirable aerobic and anaerobic microbes, which not only out-compete beneficial microbes, but which create an environment inhospitable to most beneficial microbes.
5. EM and the EM-containing products (the most effective of these is SAEM) act to not only supply sufficient quantities of desirable microbes, but also act to create conditions which will allow these microbes and other beneficial microbes to multiply.
6. At this point, it may be time to pause and offer a bit more detail – on the level or chemistry and biochemistry -- on how the microbes found in EM and the substances produced by them are able to break down sludge accumulations. Briefly, the beneficial microbes (those found in EM and those beneficial wild microbes whose growth is encouraged and nurtured by EM) and the substances produced by them perform their activities via any one or more of the following modalities, beyond microbial digestion of solid mass:

- Redox reactions such as microbial reduction (aka bacterial reduction), neutralising many oxidants and oxidised substances, including bacterial reduction of toxic metal oxyanions;
- Redox reactions such as oxidation, usually microbial oxidation, to neutralise some toxic compounds and metal cations;
- Disproportionate reactions, often breaking down or neutralising substances (e.g, halogen compounds) which have often been considered to be resistant to bioremediation;
- Redox-coupled proton translocation;
- Electron shuttling (aka electron-transfer or electron-relay) reduction of organic oxidation products, oxidising toxins and metals;
- Bimodal and polymodal proton transfer in acid-base pairs and in catalysed redox reactions to transform molecules and ions;
- Shuttling of protons via consecutive hydrogen-bond (H-bond) formation, breaking, and proton transfer steps;
- Breakdown or degradation of lignocellulosic materials via microbial digestion;
- Common acid-base reactions. Although acid-base reactions are the mainstay of chemistry and are likely the most common chemical reaction in the biosphere (e.g., where life exists on the face of the earth), such reactions are actually in a minority in the EM-mediated treatment of waste products. Rather, redox reactions such as reduction and microbial reduction tend to predominate in such an environment, followed by electron and proton shuttling (aka translocation). Indeed, one common reason for failure of traditional waste treatment methods is an excessive reliance upon acid-base reactions and failure to recognise the importance of allowing reduction and other redox reactions mediated by beneficial microbes.

Please Note:

It is important to realise that when EM is first introduced to a new system (that is, one which previously had not been treated with these beneficial microbes), there is often an initial settling or adjustment period in which the beneficial microbes multiply and gradually, via, competition, entrainment and domination, shift the microbial flora of the entire biomass. During this early transition phase, which may last from as little as two weeks to as long as 3 months in complex or heavily-loaded (primarily with old sludge) systems, many of the beneficial effects may not be witnessed spontaneously, and begin to appear slowly and gradually.

Thus, beneficial results may not be visible immediately upon initiation of EM treatment – as measured quantitatively, qualitatively and in terms of scope and breadth of results – but rather will build slowly, due to establishment of the beneficial microbes in mud, gravel, concrete, and on surfaces (rock, concrete, etc.) and in interstices, and also to the encouragement of other “wild” beneficial microbes with antioxidative (reducing) rather than oxidative properties, with the attendant (“competitive”) discouragement of undesirable microbes and undesirable processes.

Further, when first transitioning an existing waste treatment system to EM, some measures and parameters may even show temporary "disturbance" or "fluctuations", and thus may seem to grow worse for a short period before settling into a trend which shows steady improvement.

These early-stage "burps" are temporary and transitional, and are often due to shifting of the dominant microbial cultures – some of which had been long-established -- in the waste material, and to digestion of old accumulations of sludge and toxic residue.

Proposal

We are confident that SAEM will demonstrate benefits almost immediately especially with the odour control (smell) in the affected areas with the initial applications. Once the EM has establishing itself throughout the process flow it will also start to positively affect the other important parameters, as discussed, leading to a reduction of current costs.

The initial dosing will be applied at the inlet to the sewerage farm so that the EM can distribute throughout the whole system. This will also positively affect the final effluent and sludge in bringing EM's into other environments. When the sludge is pelletised and/or composted, it will contain EM's, which will greatly benefit plant growth, where the fertiliser is used, in making nutrients more readily available to the plants.

Implementation

1. We have quoted on a brewing plant that is able to treat 4,000,000 litres per day according to a brewing protocol that will be supplied.
2. We have quoted for horizontal translucent 5000 litre tanks.
3. All tanks need to be placed on a solid platform, so that EM can be decanted easily and that stirring can take place in comfort.
4. It is assumed that there are electrical and water connections.
5. The brewing room setup is discussed in the 'brewing setup' document to be supplied when project is approved.
6. Depending on specific on-site conditions, we will make a decision of how to keep the brew warm. If the room is too large it might be cheaper to heat the tanks individually, rather than heating the whole space.
7. Cost of electricity and water has not been included.

The dosing has been calculated as follows:

- Week 1 to 3 – 1,800 litres/week,
- week 4 to 7 - 900 litres/week,
- thereafter 2,100 litres/week.

Please note that the above dosing indications are generic and indicative only based on experience, and that may need to be adjusted under the actual site specific circumstances.

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Certain prices are ex Johannesburg, so please note that we have included a 5% contingency for possible cost corrections & transport.

Procedure

Initially we will construct and establish up a brewing plant at the sewerage works. We will develop and adjust the brewing process, methodologies and application techniques and fine tune individual processes.

We will also design the methodology and train your staff on the appropriate techniques for effective composting of accumulated sludge with EM and the rehabilitation of sacrificial lands.

We thank you for the opportunity to submit our proposal. We look forward to implementing this earth saving environmental solution with you.

Should you require any further information please do not hesitate to contact either Thomas or myself.

Kind regards,

Mark Palmer
Director

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Costing:

Effective Micro-organism Brewing Plant for Modimolle Sewerage System				
ITEM	**QTY**	**COST**	**VAT**	**TOTAL**
5000 litre tank	3	R 9 500.00	R 10 830.00	R 32 490.00
Heating elements	3	R 950.00	R 1 083.00	R 3 249.00
Lights (fittings and globes)	6	R 320.00	R 364.80	R 2 188.80
25 litre Buckets	2	R 66.00	R 75.24	R 150.48
Large Funnel	2	R 44.00	R 50.16	R 100.32
Industrial KDF filter	1	R 1 750.00	R 1 995.00	R 1 995.00
replacement cartridge	2	R 850.00	R 969.00	R 1 938.00
Insulation of rooms	40	R 95.00	R 108.30	R 4 332.00
Platform/materials	9	R 450.00	R 513.00	R 4 617.00
electronic pH/temperature metre	1	R 1 500.00	R 1 710.00	R 1 710.00
Extension cables	1	R 1 000.00	R 1 140.00	R 1 140.00
Transfer pump	1	R 3 300.00	R 3 762.00	R 3 762.00
Sundry materials	2	R 750.00	R 855.00	R 1 710.00
Subtotal				**R 59 382.60**
Design	10	R 5 000.00	R 5 700.00	R 57 000.00
Setup facility	6	R 7 500.00	R 8 550.00	R 51 300.00
Training	2	R 7 500.00	R 8 550.00	R 17 100.00
Follow-up visits	6	R 10 000.00	R 11 400.00	R 68 400.00
Subtotal				**R 193 800.00**
EM supply for 52 weeks Estimate	5200	R 50.00	R 57.00	R 296 400.00
Molasses supply for 7 weeks	350	R 7.00	R 7.98	R 2 793.00
Mineral Mix	518	R 118.00	R 134.52	R 69 681.36
Subtotal				**R 368 874.36**
Subtotal				**R 622 056.96**
Contingency Provision				R 50 000.00
TOTAL				**R 672 056.96**

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Glossary and Endnotes

Glossary of Terms

A few terms which will be encountered in this document may be a bit foreign to anyone but a chemist or microbiologist, and thus we offer a brief glossary of terms to ensure that all readers understand the meaning of terms as they are used herein.

Antioxidant

The term "antioxidant" is a term which indicates that a substance has reducing power, where reduction is the opposite of oxidation, and where the reducing substance donates an electron or hydrogen atom to an atom, molecule or ion. An antioxidant is therefore the opposite of an oxidiser, and an antioxidant is a substance which has the ability to neutralise or destroy oxidised substances and oxidant radicals, also sometimes known as reactive oxygen species (aka ROS). Further, some antioxidants, in certain situations, have the ability to reverse the damage caused to organic molecules by oxidants (aka ROS). Antioxidants, as noted above, are actually a part of a larger family of substances called reducing agents, all of which neutralise oxidised substances or oxidant radicals. Usually, particular reducing agents, which are useful in the fields of human or animal nutrition, or in industry (e.g, prevention of corrosion, preservation of plastics, etc.) are called antioxidants.

EM

EM is a shorthand term for a microbial consortium (mixed culture) consisting of synergistic, metabiotic, antioxidative, syntropic microbes from at least three different genera, and more often six or more genera and always containing purple non-sulphur bacteria (PNSB), aka phototrophic organisms; the culture technology is usually used in fermentation, agriculture and waste management, but also in other settings as well. Many EM products also contain various nutrients and trace nutrients as well.

Consortium

see section entitled microbial consortium

Disproportionation reactions

Disproprotionation reaction are those in which a substance (usually a molecule or ion) is simultaneously oxidised and reduced, thus changing it considerably. Because of the bi-directional and simultaneous nature of this exchange, such reactions are usually considered to be in a realm beyond traditional redox reactions.

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Metabiotic

A metabiotic micro-organism creates environmental conditions that favour the survival and growth of certain other microbes, and thus it co-operates with certain other microbes. A metabiotic relationship is one in which two or more species of microbes create conditions which nurture and support growth of each other, which is a type of synergy, often forming a relatively stable and robust microbial consortium. Thus, a metabiotic consortium (or aggregate) is a community of microbes which are mutually supportive and adaptive.

Microbial Consortium

Historians of science, as well as those who study the philosophy of science have noticed that biologists for much of the past two hundred years had tended to look at microorganisms only as single species at a time, and it was therefore (mistakenly) assumed by many in science that this was how they usually functioned in nature, as independent single species. It has been only quite recently that biologists have come to understand that this earlier assumption of "individualist" species and colonies was a gross misconception, and that most species of microorganisms are found in nature not alone, but rather as part of a cluster or aggregate of from nine to about 35 (sometimes far fewer and sometimes far more) synergistic species, which biologists have started to call by the name microbial consortium (or consortia, as some authors use it, depending upon plurality.)

ORP

ORP, aka oxidation-reduction potential, shows relative degree of oxidative power or reductive (antioxidant) power of a liquid. ORP is measured with a special probe and an ORP meter on a scale of +1,200 millivolts (mv.) to –1,200 mv., where a score of 1,200 indicates maximal oxidative ability and no reductive (antioxidant) ability, and where a score of –1,200 indicates maximal reducing (antioxidant) capability. However, since true hydrogen and reducing power is influenced strongly by pH as well, ORP alone is only a rough and relative indicator of true oxidative or reducing (aka antioxidative) power of a liquid, and relative hydrogen score (aka rH or rH2 or RH), computed from pH and ORP, is a far more accurate indicator; please see section entitled relative hydrogen score.

Oxidation

This term comes from the fields of chemistry and biochemistry, and literally means the opposite of reduction. Oxidation means the removal of an electron from an atom, molecule or ion by an oxidiser or oxidant substance. Oxidation, in effect, reverses reduction, and oxidation usually results in breakdown of organic materials and of complex substances, sometimes yielding toxic or foul-smelling compounds. For a bit of perspective, oxidation and reduction reactions are quite common in chemistry and biochemistry, likely second only to acid-base reactions, and are often referenced via the shorthand term of “redox reactions”.

Oxidiser

An oxidiser, aka an oxidant, is a substance which aggressively tries to steal electrons from another substance, often damaging substances or living tissues in the process, thus resulting in a lower energy state and lower state of complexity and structure, which is also known as

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increased entropy. Please see sections on oxidative free radicals and reactive oxygen species (aka ROS) as well. Oxidisers may be neutralised, and further, the damage which they wreaked may sometimes be reversed by, substances known as reducing agents, which, if useful in the field of human or animal nutrition, are often called antioxidants.

pH

pH indicates relative degree of alkalinity or acidity of a liquid. Scale is semi-logarithmic, and runs from 0 to 14, where 7 indicates neutral, a score below 7 indicates acidity, and a score above 7 indicates alkalinity; 0 indicates maximum acidity, and 14 indicates maximum alkalinity.

Phototrophic micro-organisms

Phototrophic micro-organisms are microbes which are photosynthetic, which can use sunlight to produce energy and energy compounds. All EM cultures contain at least 2 or 3 species of phototrophic organisms, usually from the extremely powerful and versatile and near-magical Purple Non-Sulphur Bacteria (PNSB) family, a family of soil-based and pond-based microbes commonly found in nature in soils, in ponds, on green leaves, in pitcher plants, and in icicles and other ice formations in the wild. These organisms are not obligate phototrophes, and can also consume organic material and even inorganic chemicals in anaerobic and even aerobic conditions. See also section in Glossary on Purple non-sulphur bacteria.

PNSB

PNSB is an abbreviation used for the purple non-sulphur bacteria, an essential class of organisms found in EM culture, and the heart of the culture. Most EM cultures contain at least 2 or 3 species of PNSB.

Redox reactions

Oxidation and reduction reactions are a means via which substances may be modified in chemical form. These reactions are quite common in chemistry and biochemistry, likely second only to acid-base reactions, and are often referenced via the shorthand term of "redox reactions".

Reducing compound or reducing agent

A reducing agent is a substance which neutralises oxidative radicals, aka reactive oxygen species (ROS), and, if a reducing agent is useful in the field of human or animal nutrition, it is often called an antioxidant. Not all reducing agents known to science are useful antioxidants for life forms such as humans and animals, and so it may be said that not all reducing agents are effective antioxidants, but it is true that all antioxidants may function as reducing agents. Please see antioxidant section as well. EM, AEM and EM brews contain large amounts of live-food form, raw antioxidants.

Reduction

While the word "reduction" in normal everyday usage will usually mean to decrease the quantity of some factor or measure, the term "reduction" has a more specialised meaning in the fields of chemistry and biochemistry, and literally means the opposite of oxidation. Thus, where oxidation means the removal of an electron from an atom, molecule or ion by an oxidiser or oxidant substance, reduction is the donation of an electron, or more precisely, the donation to an atom, molecule or ion of an electron or a hydrogen atom or a negatively-charged hydrogen atom. Reduction, in effect, reverses oxidation, and can often neutralise highly oxidised compounds. As a matter of note, all substances which are called "antioxidants" are reducing agents. For a bit of perspective, oxidation and reduction reactions are quite common in chemistry and biochemistry, likely second only to acid-base reactions, and are often referenced via the shorthand term of "redox reactions".

Reductive agent or reductive compound

Please see reducing compound

Relative hydrogen score, aka rH2 or rH score

Relative hydrogen score, also known as rH2 or RH score, is a score proposed by Clark in 1923, derived from the Nernst equation, which expresses true hydrogen concentration/power in a liquid far more accurately than ORP alone. rH score is computed from pH and ORP, and rH scores run from 0 to 42, where 28 is midpoint, scores approaching 42 indicate maximal oxidative power, and a score approaching 0 indicates maximal reducing or antioxidative power. RH score is often employed in various sectors of the beer brewing industry, in the high-end aquarium world and in the food industry (esp. bottling of juices, etc.) to indicate relative oxidative damage to a liquid product versus relative reducing power (aka antioxidant protection) levels in such a product

Endnotes

Some additional electron shuttles or electron relays are melanin, melatonin, NAD, heme groups in microbial cytochrome,flavin groups of FAD in microbial cytochrome, microbial dehydrogenase and microbial reductase, most or all of which are found in EM products; these compounds are produced by the beneficial microbes in the EM consortium.