IMPACT OF HOUSEHOLD CHEMICAL USE FOR ON-SITE WASTEWATER TREATMENT AND DISPOSAL

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Abstract

While much research and numerous references estimate the water quality outcomes from on-site treatment of domestic wastewater, too little attention is paid to the potential impact on the processes and soil behaviour from poor choice of chemicals in everyday use within the home. The implication of high chemical use and low water volumes exacerbates the problems of sodicity and salinity. These issues become more pronounced on poor soils. For many households discharging through an on-site treatment system, simple initiatives such as choice of laundry detergent, fate of kitchen scraps, use of personal care products and disposal of home cleaning products can be shown to have a significant impact upon the behaviour of the soil in the land application area. Wise choices lead to prolonged life and soil health. This research examined over 200 household and laundry products to determine the potential impact on soil from sodium, phosphorus and sulphur in the wastewater and identifies poor labelling, vague statements of ingredients and typical excessive dosing recommendations.

Introduction

Our modern age requires a chemical for every special cleaning task around the home, and since the advent of synthetic detergents manufacturers continue to add to this overwhelming arrange of packets and containers of specialised household chemicals. No longer is ordinary soap the universal cleaning agent for domestic and personal cleaning as advertising invites an audience to consume the plethora of chemical powders, solutions, aerosols and spray packs available today. A visit to any supermarket will quickly convince one of the need for that 'special' chemical, irrespective of the impact it may have on the wastewater, the on-site treatment processes or the final discharge to a land application area. This research has for more than two decades examined the impact of chemicals in laundry detergents in domestic situations. Over that time, more than 400 products have been mixed at recommended doses and analysed for a range of chemical determinations, such as pH, electrical conductivity (EC), total alkalinity, major elemental constituents (sodium, phosphorus, sulphur and boron) and calculated salinity and sodicity (as sodium adsorption ratio (SAR)). Thus, using typical values for these analytes in an agricultural setting, a set of criteria for acceptable discharge to on-site land application areas has been developed.

Reduction of household chemicals

Two issues cause concern over the increasing reliance on chemicals. One is toxicity. With apparently little concern over safety with young children and easy access to hazardous powders and liquid, manufacturers, with the approval of regulators, permit the sale of toxic and hazardous household products. Recent litigation in New Zealand resulted in compensation for damage to a five year old from ingesting a small quantity of automatic dishwashing detergent (NZ Herald 2007). That case was one of 615 cases in 2 ½ years. As a result, no dishwashing detergent can be sold in New Zealand if a 1:1 mix of detergent in water has a pH greater than 10. At least this is some acknowledgement of the potential problem. The second is the impact upon microbial populations when high strength acids and bases are discharged into the on-site wastewater treatment system. Today, with the promotion of water conservation, chemical concentration increases with reduced water and not reduced chemical use. Quantification of typical kitchen detergents indicates that machine dishwashing detergents are highly alkaline, as shown in Table 1.

Table 1. Kitchen dishwashing detergents at recommended dose (averages)

	pH	Electrical conductivity (dS/m)	Total Alkalinity (mg/L as $CaCO_3$)
Hand dishwashing	5.0 – 5.6	0.023 – 0.052	6
Machine dishwashing	10.4 – 10.9	2.25 – 2.90	800

Note: pH of deionised wáter was 5.2; doses as recommended by manufacturers.

Chemicals in the bathroom

Bathroom soap is now replaced with liquid bodywash formulations in home and hotel bathrooms. That the different surfactant may lead to less natural skin oils and consequences for skin irritations does not appear in any of the promotional literature. Certainly these body care products have little impact on water quality as pH is neutral and salinity is very low. Other personal care products contain zinc or selenium (anti-dandruff products), and a range of unspecified chemicals. How these cocktails of chemical react with treatment and soil disposal areas should be challenged, whether for on-site discharge or municipal re-use.

Laundry detergents

Typical supermarket displays of 80 or more common brands of laundry powder and liquid detergents are not uncommon in Australia or New Zealand. Products are displayed in separated sections for front loader and top loader products. Supermarkets require manufacturers to label products with the clear indication as to whether the product is for 'front loader' or 'top loader'. The differences in formulations may be minor but the advertising offers an alternative suggestion. Product labelling is, in many cases a distortion of the truth. For example, products that are biodegradable can only be so for the organic components (surfactants, enzymes, perfumes) yet the labelling attempts to convince the ordinary consumer that the whole product is biodegradable, and therefore 'environmentally responsible. That only 25% of a typical laundry powder is organic suggests 100% biodegradability cannot be. Buyer beware!

The other confusing labelling is based upon dose rate for 'normal wash', whatever that purports to be. Powder detergents are sold by mass, yet recommended doses are scaled by volume. The latest concentrated powder detergents marketed in Australia and New Zealand are identified as '2X-ultra'', that is the dose is about half that of previous formulations of those same brands – a smaller scoop is supplied. Unfortunately, the consumer has no way of knowing what volume scoop is provided until the pack is open. Such deception prevents the consumer from accurately assessing the cost per wash prior purchase.

Product formulation is, understandably, a commercial in-confidence recipe for any detergent, liquid or powder. However, consumers have a right to choose a product for many reasons – avoidance of allergies, potential impact of the wash water on the receiving environment by the avoidance of phosphorus, limiting the 'manufacturing agents' added to bulk the product, or avoiding personally undesirable chemicals. Yet, the ingredient labelling is, at times, an insult to the consumer's intelligence. To 'be aware' is our greatest challenge for environmental sustainability, and our avoidance of particular chemicals should be respected. Whether we need to avoid phosphorus because our wastewater may pollute surface waters, or avoid high sodium levels that may cause detrimental structural problems to the soil in the land application area, the choice should be open to all consumers, not just those who understand chemistry. Clear explanatory labelling is required and should be a priority for all manufacturers, in the same way that food labelling intends to give us better choice. Common nomenclature for chemical compounds is essential while avoidance of nonsense statements is essential. As an example, to state that 'no petroleum products are used in this detergent' may not convey any worthwhile information about choice to the consumer.

Sodium and phosphorus in laundry discharges

Environmental pressures on laundry product formulation have been directed at replacing phosphorus with zeolite or another alternative. Phosphates are excellent builders, most important where clean water resources are 'hard' (high Ca^{2+} and/or Mg^{2+}). The replacements are less effective at the same concentration, resulting in a higher total suspended solids (TSS) than the phosphate formulations. The risk of zeolite sedimentation in the washing machines or the discharge pipes is real. In this research, all mixes with elevated TSS levels had zeolite, and sedimentation of the zeolite was obvious in the laboratory preparations.

Sodium salts are universal solubility in cold or warm water. High concentrations of Na^{+} in the wastewater may be detrimental to plants and soil structural stability. Plant osmotic potential is disrupted by elevated Na^+ with the obvious signs of 'drought stress'. In soils, dispersion may be enhanced by high levels of Na^+, particularly with elevated sodium adsorption ratio (SAR) without an elevated EC to minimise structural problems. Sodium issues are ignored in municipal works discharging to ocean outfalls where sodium levels in the wastewater are irrelevant. The same is not true for land application of on-site systems or municipal re-use schemes. The replacement of sodium salts with potassium salts may increase the cost of the formulation for a more environmentally sustainable outcome for all land applications of wastewater.

Typical sodium levels in laundry liquids and powders are given in Table 2, showing the differences for front loader and top loader washing machines. The full wash volume for front loaders was 75 L while the top loader volume was 150 L. The latest models use slightly less water to meet compliance ratings.

Table 1. Average values sodium and phosphorus loads per wash, pH and EC values for full wash cycles

	Sodium g/wash	Phosphorus g/wash	pH	EC dS/m
Liquids-front loader (n=24)	1.82	0.58	7.9	0.095
Liquids-Top loader (=39)	3.1	1.1	7.9	0.1
Powders – front loader (n=30)	21.3	1.1	10.6	1.2
Powders – top loader (n=50)	30.1	1.1	10.5	0.91

Conclusions

The outcome for on-site treatment and discharge of domestic wastewater is dependent upon the management of chemicals within the home and not on the engineering of the on-site treatment system. Many chemicals pass through the treatment system unabated to create serious problems in the land application area. Under existing practices by the chemical product manufacturers, consumers are denied the information on product ingredients that may lead to better environmental choices, The reduction in phosphorus is not desirable in all cases, but sodium concentrations need to be limited. Better consumer education is likely to lead to better environmental outcomes.

References

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