

Renovation of waste water for direct reuse in an abattoir

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Abstract

Tertiary treatment methods were tested on secondary effluent from an abattoir biological waste water treatment plant with the purpose of renovating it for reuse in the abattoir. The colour and dissolved organic matter could be removed to such an extent that the water would comply with water of "insignificant health risk" (Department of Health). The treatment process sequence proven to be effective in upgrading this water to "insignificant health risk" standard was coagulation with a polymer blend, separation, ozonation, filtration and activated carbon filtration. The development of biologically activated carbon in practice was accepted as inevitable and desirable for optimum water quality, but not tested. A deciding factor in the selection of an appropriate treatment was that the final water would also have acceptable corrosion properties.

Introduction

Because of present and projected water shortages in South Africa (Die Departement van Waterwese, 1984), the Johannesburg Abattoir has been looking at minimising their freshwater usage. The water demand was reduced significantly by optimising water usage in the abattoir. The next phase would be to renovate and reuse the effluent.

The Johannesburg Abattoir employs biological purification to treat its waste water. This reduces the municipal effluent disposal charges. An added advantage is that single-cell organisms for which an economic application exists are harvested. This secondary treatment process removes 90% to 95% of all the organic matter from the primary effluent (Pretorius et al., 1995). The secondary effluent contains colour, suspended matter and micro-organisms that makes it unsuitable for direct reuse. Further treatment by tertiary processes could renovate it to an acceptable quality for selected applications in the abattoir.

Water quality required

Less than half of the average water demand (Van Heerden, 1995) in an abattoir is applied to processes that bring it into direct contact with products for human consumption. The balance of the water demand could be satisfied with effluent that has been renovated to comply with certain minimum health, aesthetic and economic criteria (Cowan and Steenveld, 1990).

The Department of Health proposed a three-tiered drinking water quality guideline (Pieterse, 1989) which included these limits. This guideline grades water quality into "no health risk", "insignificant" and "low health risk" categories depending on frequency of use. The renovated water could be of "insignificant health risk" quality while water complying with "no health risk" quality criteria should be supplied to the rest of the abattoir.

The Department of Health guideline stipulates permissible levels of indicator organisms which can be reached with disinfection (White, 1992). Dissolved organic matter (DOM) present in water to be disinfected can seriously hamper disinfection

efficiency, increase disinfectant demand (Rogers et al., 1987) and can lead to the formation of carcinogenic chlorinated organics (Vik et al., 1985). DOM can also be the cause of colour, odour and regrowth of organisms in a distribution system (Funke, 1969). DOM should therefore be removed to levels specified by the Departmental guideline for health and aesthetic reasons (Krenkel and Novotny, 1980).

Economic criteria require that maintenance costs should be minimised (Cowan and Steenveld, 1990). The effects of corrosion and aggressive water on equipment and pipes can be controlled by maintaining a calcium carbonate precipitation potential and limiting chloride and sulphate ions (Benefield et al., 1982).

Present water quality

Most suspended solids and biodegradable organic matter are removed during the single-cell production process (Pretorius et al., 1995). The DOM in this secondary effluent would be similar (Rebhun et al., 1969) to that found in secondary treated domestic effluents. This DOM is detectable by colour, taste and odour and the composition and characteristics are similar (Narkis and Rebhun, 1983) to DOM found in coloured surface water streams. On average 45% of DOM in secondary treated domestic sewage would be humic matter (Manka et al., 1974) whereas about 50% would be humic matter in surface water (Sierka et al., 1989). Humic matter is characterised (Christman and Ghassemi, 1966) by an unsaturated structure which is the cause of colour.

Possible treatment alternatives

Because of the possible effect of DOM on the health and aesthetic quality of the reused water, the removal of DOM was identified as a priority. Humic matter makes up the bulk of the DOM. The various methods of removal of humic matter are: chemical coagulation and separation (Edzwald et al., 1977; Grazes et al., 1995); oxidation (Edwards et al., 1994); adsorption onto activated carbon (Weber and Jodellah, 1985; Sierka et al., 1989); membrane processes like reverse osmosis, ultra- and nanofiltration (Juby and Botha, 1994; Tan and Amy, 1991); and combinations of these (Weber and Jodellah, 1985).

Coagulation is a popular treatment method and its effectiveness has been proved in coloured surface water (Christman and

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