How to get the lowest production of sewage sludge by using ozone

Wastewater needs treatment before discharge into rivers or lakes or to the sea, to avoid pollution of these water bodies and prevent waterborne diseases. Biological processes are usually the core of wastewater treatment plants. In these processes, microorganisms get the energy that they need to grow by degrading (removing) pollutants, so that the net effect is wastewater purification. However, they grow continuously by feeding on pollutants that are present in the wastewater. We cannot store this continuously growing bacterial mass indefinitely. This bacterial mass is mixed with water and solid/liquid separators (for example: settling tanks) divide purified water from the bacterial mass, which is concentrated in a slurry called “biological sludge”, made of more than 99% water and less than 1% solids. Before we can use it, for example as a fertilizer in agriculture or before we burn it to get energy and recovery material from the ashes, we need to treat sludge, mainly to reduce its water content. However, sludge treatment and its final disposal can be costly. Therefore, it is important to produce as little sludge as possible. Ozonation is one way to reduce sludge production at its very source, as it reduces bacterial growth inside the biological processes without adverse effects on treatment efficiency. Ozonation of sludge is applied in several full-scale plants around the world. Nevertheless, the literature does not report much information on the optimisation of the process. In another paper, we have explained that ozone reduces biomass growth. If exposed to ozone, they must use only part of the energy to grow, and use another part to adapt and counteract the strong oxidative stress caused by ozone.

However, dosing ozone is also expensive and it is crucial to get the highest efficiency in reducing bacterial growth with the lowest possible dosage. In this paper, we have shown that the action of ozone in lowering bacterial growth without affecting treatment efficiency gets its best by using low ozone doses and by injecting ozone gas through multiple points in a pipe-shaped reactor (also called “plug-flow” reactor).

Actually, if you inject ozone into a large mixed vessel, its concentration gets low because of its dilution in the vessel. On the contrary, if you inject it in a pipe, its concentration is higher at equal dosage rate. On the other hand, if you exceed in ozone concentration, its efficiency decreases. Consequently, a sequence of small injection points in a pipe-shaped reactor should be preferred to a big, single dosing point.

Secondly, ozone efficiency seems to decrease when the concentration of the sludge increases. Therefore, ozonation of diluted sludge, taken from the biological reactors may be more efficient than ozonation of more concentrated sludge, taken from concentrated sludge after settling.

Finally, from the biological point of view, we observed that an initial ‘shock’ of ozone has negligible effects on the purification performances of the bacterial mass.

You can get the best economic result of sludge ozonation in wastewater treatment plants that already adopt ozone-based treatments for the removal of unbiodegradable compounds, such as surfactants, colour removal, achieving also a very good disinfection of the final effluent.

Roberto Canziani, Davide Gardoni, Pompilio Vergine, Elena Ficara
Politecnico di Milano, Department of Civil and Environmental Engineering, Environmnetal Section Milano, Italy

Publication

A full-scale plug-flow reactor for biological sludge ozonation.
Gardoni D, Ficara E1, Vergine P, Canziani R.
Water Sci Technol. 2015