DO2E Digester with Hybrid Ozone Applied

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In an earlier document, I put forth a rationale for treatment of waste streams using our DO2E digesters and even mentioned the Aerators in passing. Let us concentrate our efforts with respect to ozone, especially with the Digesters, to three application areas: grease traps, selected lift stations, and down line treatment areas such as polishing ponds and effluvia of various sorts.
The DO2E digester process actually converts these collection basins into pretreatment tanks more so effectively when Hybrid Ozone is applied directly into the waste stream.

Ozone has usually (historically) been applied as an oxidizing agent and as a sterilant. The latter results from its oxidizing characteristics exclusively. The DO2E digestion process actually utilize it to do both, though a primary use is for it to break down recalcitrant molecules encountered in F.O.G. (Fats, Oils, & Grease) deposits (found in both grease traps and lift stations) as well as to attack the "diverse" compounds (found primarily in lift stations) encountered in various waste streams that are difficult to treat in other manners. Examples of these include various hydrocarbons known as heterocyclics, polyaromatic hydrocarbons (P.A.H.), other aromatic hydrocarbons that are difficult for bacteria to degrade and/or are toxic for specific microorganisms used in the degradation processes, or for some other reason are very difficult to deal with. In the cases where ozone treatment is effective, the resulting compounds formed are carbon dioxide, water, and various other oxides.

Another use we have found for ozone is to place an adsorbed charge on micro particulates engendered in our Digesters. This enables us to prevent them from settling out in the lines, to stabilize the suspensions formed so that they are pumpable, and to enable plant treatment operators to avoid "shear" problems in their clarifiers.

Yet another application for our Digesters is the delivery

of hybrid ozone to fluid streams containing metallic ions (or is some cases, non-metallic ions) so that they precipitate out or become complexed making them more easily removed.

The sizing of the delivered ozone depends on the actual problem(s) encountered; the horsepower of the Digester blower, the number of ozone tubes necessary to deliver whatever level of ozone we feel is adequate for the actual problems encountered, and taking into account any down line considerations such as impacting on microbial populations that are not targeted.

Grease traps require the highest ozone levels to effectuate grease (F.O.G., actually) management, to control odors (particularly H_2S), and to stabilize the suspension formed. The effect on the microbial community here is relatively a minor concern as any buildup in microbial numbers would adversely affect any forced main in the collection chain. Therefore, the sterilization effect of the ozone is a good thing in grease traps. Because of the relatively immediate reaction of the ozone we are using, dwell time and down line residuals can be safely ignored.

A more complex decision situation occurs where the Digesters are placed in lift stations. Here, we must take consideration of several additional factors, mainly the distance from the waste treatment plant, and, of course, the size of the lift station and where the situs of delivery is - that is, is it a forced main, a secondary station, or is it a gravity-feed to the waste treatment plant? The reason that this must all be carefully considered is that we want to treat the waste stream and not adversely impact the treatment system by wantonly killing off essential microorganisms in the process.

At this point, the ozone generation becomes of interest as different "ozone's" have different reaction characteristics, half-lives (so-to-speak), and different residual effects. We use a hybrid ozone that delivers an almost instantaneous reaction from both ozone itself and free-radical hydroxyl ions formed in this process of ozone generation. Residual moieties may be encountered, which are normally peroxide active-radicals. We have to be extremely careful to limit these other moieties as they may be transported through the collection piping to affect the microorganisms in the waste treatment plant. Naturally both

the location and velocity of the waste streams must be taken into account. The actual expert regarding sizing of ozone to determine the delivered amount is Dr. Ronald L. Barnes of Prozone in Huntsville, AL. (256)539-4570, and he is a biophysicist that can discuss atomic/molecular matters in some detail. The actual sizing application for the DO2E Digesters and Aerators can be provided at DO2E: (251)626-6550 or Randy McGuffin at (850)698-6805.

The sterilant effects of hybrid ozone come to the forefront in application to downstream effluvia, polishing ponds, and the use of our Aerators to apply in these locales.

Now, let us examine the chemical nature of ozone so that we may better understand its effects.

Ozone is an allotrope of oxygen, that is to say, it is oxygen that manifests in a different atomic form. Normally, oxygen may exist in one of three allotropic forms - in the first, there is a single oxygen atom (O), in the second, there are two oxygen atoms (O_2), and in the third, there are three oxygen atoms (O_3). The first is known as monomolecular oxygen (frequently referred to as nascent oxygen), the second is commonly encountered and called diatomic oxygen, more commonly referred to as molecular oxygen and the third is called triatomic oxygen, more commonly referred to as ozone.

Oxygen chemically is the second most active non-metal (Fluorine being the most active). Metals are atoms that lose electrons and engender regions around the atom that are positively charged (+); conversely, non-metals are atoms that gain electrons and engender regions around the atom that are negatively charged (-). All atoms in their native state consist of a neutral region caused by the balance of + and - charges, and these, in turn, are the result of the gain (or loss) of electrons (a small negatively charged subatomic particle). As an atomic nucleus has a + charge, the loss of an electron results in a net positive charge and the gain of an electron conversely results in a net negative charge.

As these elemental atoms become larger, the tendency to become more active metals increases as the positive pull of the nucleus becomes further away as a consequence of the outermost electrons being further removed from the + pull of the nucleus. In non-metals, this is just the opposite as

non-metals are more active as the pull of the + nucleus affects the outermost electrons that are nearer to it; and, nearer, in this case, relates to the decreased atomic size of the atoms.

There are other, more esoteric, considerations to be considered, but when all is said and done, only fluorine is more active than oxygen. All of these active non-metals that gain a single electron are collectively called the halogens (salt formers). As I mentioned, the most active of them is fluorine, but oxygen jumps ahead in the line ahead of the next smaller halogen (chlorine) even though oxygen has to gain two electrons. This is because oxygen is a much smaller atom than chlorine is. The problem in understanding all of this centers around the close similarity regarding the gain of two or a single electron in the case of these two elements. That is why it’s so much fun trying to sort out the various factors determining the actions of these two entities, especially related to disinfection and oxidation. This is what makes physical chemistry so interesting and challenging?

As I mentioned earlier, ozone is primarily used as an oxidant, and most of its other applications can be traced to this. To measure the activity of various oxidants, we can look at the oxidation-reduction potential of common oxidants in comparison.

The following are measured at 25°C (77.0°F) and are reported in volts:

Ozone (O_3) 2.87
[gas]

Peroxide (H_2O_2) 1.76 Ozone is 63.1% greater
[liquid/ionized form]

Hypochlorite (HClO) 1.49 Ozone is 92.6% greater
[Hypochlorous Acid]

Chlorine (Cl_2) 1.39 Ozone is 106.4% greater
[gas]

Bromine 1.07 Ozone is 168.2% greater
[liquid/gas]

Similar comparisons hold for various commonly-used sterilants measured against ozone.

This submission is a "backgrounder", and a more detailed explanation of the issues regarding the Aerators will ensue.