

But where do the siloxanes in biogas come from?

CHP plant running on biogas from landfills or AD plant in sewage works accumulate silica on internal surfaces, which is visible as a white deposit.

The silica comes from the burning of siloxanes, which are silicon-containing chemicals in the biogas. These chemicals are of low molecular weight and hence volatile at landfill and sewage works liquid temperatures.

The consequence of the deposits is well known – damage to pistons, valves and cylinder heads, short oil life, irregular running and increased downtime.

These problems can be controlled by the use of carbon filters or regenerative filter systems, but this does not address the origin of this problem.

Little work appears to have been done on the sources of siloxanes. Known applications, including cosmetics and pharmaceuticals are frequently cited, but these applications are common to the entire population, in which case similar levels should be seen in all works, which is not the case. Industrial liquid waste, tankered to sewage works, is a potential source, especially if it comes from the pharmaceutical or chemical industries.

Siloxanes are very insoluble in water – D5, for instance, has a solubility of 0.2mg/L. It is instructive to consider what happens within the sewer and sewage works system. After discharge to sewer, the siloxane will partition between the headspace and sewage and this process will continue in Primary Clarifiers and be considerably enhanced in Activated Sludge plant. By the time the sludge arrives at the AD plant, it is difficult to imagine that any significant level of siloxane can exist. It is possible that the siloxanes are bound to particulate material in the sewage and hence are carried through the above processes to the AD plant, but no information is available to suggest this.

Silicone oils are commonplace in industry and in the home and may be the source of siloxanes.

Silicone chemicals – mainly as oils – are common agents for lubrication in food plants and many others, as release agents in everything from fruit cakes to sticky tapes and as flexible fillers for the building trade. Silicones, which are very long chain polymers, degrade to siloxanes, especially in AD processes and landfills. It appears that the siloxane fragments preferentially reassemble themselves into the cyclic siloxanes D4 and D5, perhaps explaining why we see these two molecules more than any others.

Surprisingly, the AD food waste operators see silica damage, sometimes of catastrophic scale. Siloxanes or silicones may have been used in packaging of the food or in formulation or as process additives.

In particular, the use of silicone-based foam suppressants is commonplace in the brewing industry and tankered waste may go to sewage works or food AD plants.

Detergents based on silicone-PEG chemistry are well established and have both antifoam and cleaning functions. Laundries discharge to sewer, so this source of silicone will also arrive at the works.

There are silicone based antifoam agents designed for the AD process, used to maximise the charge in the AD vessel. Given the ability of the AD process to generate siloxanes, it is interesting to speculate whether users of this material are creating difficulties for themselves.

The biogas CHP industry defends themselves from siloxanes by carbon filters when they are in a position to do so, but an exploration of the fundamental sources of the contaminant might allow a proactive approach to be taken – for instance, if it could be demonstrated that Laundry use of silicone based detergents was a major source of silicone, then some Laundry process modification might be very worthwhile.

Currently, there appears to be no research being carried out into the sources of silicones and siloxanes in sewer systems, but this would appear to be a very beneficial task.

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