The Latest Generation of RTO Plants

Andreas Breeger

Abstract

The deadline for implementing the 30th BImSchV (German Federal Immission Control Ordinance) for mechanical biological waste treatment has expired. In the meantime, the exhaust air cleaning plants (thermal post-combustion and biological systems) have been in operation for up to four years. Operating experience regarding compliance with the limit values, corrosion issues and difficulties due to siloxanes exists and will be presented in this essay. In particular, practical examples of operational RTO systems optimized for applications in the MBT field will be introduced.

Keywords

Regenerative thermal oxidation plants, 30th BImSchV, German Federal Immission Control Ordinance, siloxanes, corrosion, mechanical-biological waste treatment

1 Reduction of Emissions for MBT Plants

The deadline for implementing the 30th BImSchV (German Federal Immission Control Ordinance) for mechanical biological waste treatment expired on 1 June 2005. In order to comply with the demanding limit values and values allowed for total organic carbon loads, RTO plants (Regenerative Thermal Oxidation plants) came into operation, either individually or in combination with biofilters. In some cases, exhaust air cleaning plants have been in operation longer than four years. Hence, it is now possible to draw conclusions on the operating experience collected.

Figure 1: RTO plant with scrubber

2 Compliance with Limit Values

Among RTO plants, there is general compliance with the threshold values set forth by the 30th BImSchV. However, a prerequisite is the normal operation of both MBT plants (Mechanical Biological Treatment) and the exhaust air cleaning plants. The demanded availability, a standstill of eight consecutive hours or 96 hours per annum, is partially difficult to achieve due to prevailing exhaust air conditions or other general conditions (biogas qualities) and current exhaust air concepts.

Odour: The limit value of 500 OU/m³ is generally complied with. To achieve this, sufficiently large and suitably designed biofilters have to be used in combination plants and effective separation of ammonia through preceding scrubbing has to be carried out at RTO plants.

Dust: The limit value of 10 mg/m³ DAV (Daily Average Value) is complied with.

Dioxins/Furans: The limit value of 0.1 ng/m³ is undercut in some instances by a factor of 10 and more.

Nitrous oxide (N_2O): The allowed laughing gas loads of 100 g/Mg are complied with. In order to prevent the formation of laughing gas, ammonia has to be separated from the exhaust air using scrubbers that are operated in acidic environments. However, it has to be mentioned that laughing gas, which can be produced in the preceding biological rotting processes, is not separated by the installed exhaust air cleaning technologies.

Total organic carbon (TOC): It is the load limitation of 55 gC/Mg of waste input that is the leading value for the design of exhaust air cleaning plants and not the allowed emission concentration of 20 mg/m³ (DAV). This partially results in concentration values of 5 mg/m³. These highly demanding limit values can generally be complied with at normal operation of the exhaust air cleaning plants. However, previous operating experience indicates that the normal operation is massively limited by basic conditions of the exhaust air. This issue is dealt with in the following sections.

3 Deposits in RTO Plants

Organic silicon compounds may be released during rotting processes. The concentrations usually range between 0.1 and 10 mg/m³. Possible causes may be among other things (Carlowitz, 0. et al., 2005 / Otterpohl, R. et al., 2005):

- Anaerobic conditions in the rot
- Moisture content in the rot
- Temperatures in the rot
- Composition of the waste

The silicon oxidizes in the RTO and clogs the heat exchanger with layers so that absorbing the exhaust air is hindered or no longer possible. As a result, the built-in components have to be cleaned of these deposits at certain intervals. Depending on the preceding process, the built-in components may even require cleaning every 20 days. The cleaning effort is generally very time consuming, as shutting down and restarting the RTO may take up to 24 hours. Such frequent cleaning intervals wear out the heat exchangers, thus necessitating their complete replacement approximately every two years. The time required for replacing the heat exchangers is up to seven days for each RTO line depending on the size of the facility.

Figure 2: Siloxane problems in RTO plants, destroyed heat exchangers

The RTO plants in use generally have multiple lines to comply with the availabilities demanded. Compliance with TOC loads at single line operation has partially proved to be difficult.

The approach taken by Wessel Environmental Technologies to solve this issue is to reduce the entrainment of organic silicon compounds in the RTO. Traditional procedures for the separation of silicon such as adsorbing units cannot be used due to the qualities of the exhaust air (damp and dust-laden). The formation of organic silicon compounds can usually be limited to specific phases of the rotting process (e.g. aerobisation during the first 24 to 36 hours of the intensive decomposition). To reduce the entrainment of siloxanes in the RTO plants, these exhaust air flows should be unloaded. About 10% of the total exhaust air flows have to be treated. Analyses have shown that approximately 90% of the formed siloxanes belong to the so-called D_5 compound. During a diploma thesis in 2007, research was conducted with specific absorbents in scrubbers at a half-technical scale. One reason for the choice of the absorbents is that they may be recycled. During the research, separation degrees of up to 80% for the D_5 compound were achieved.

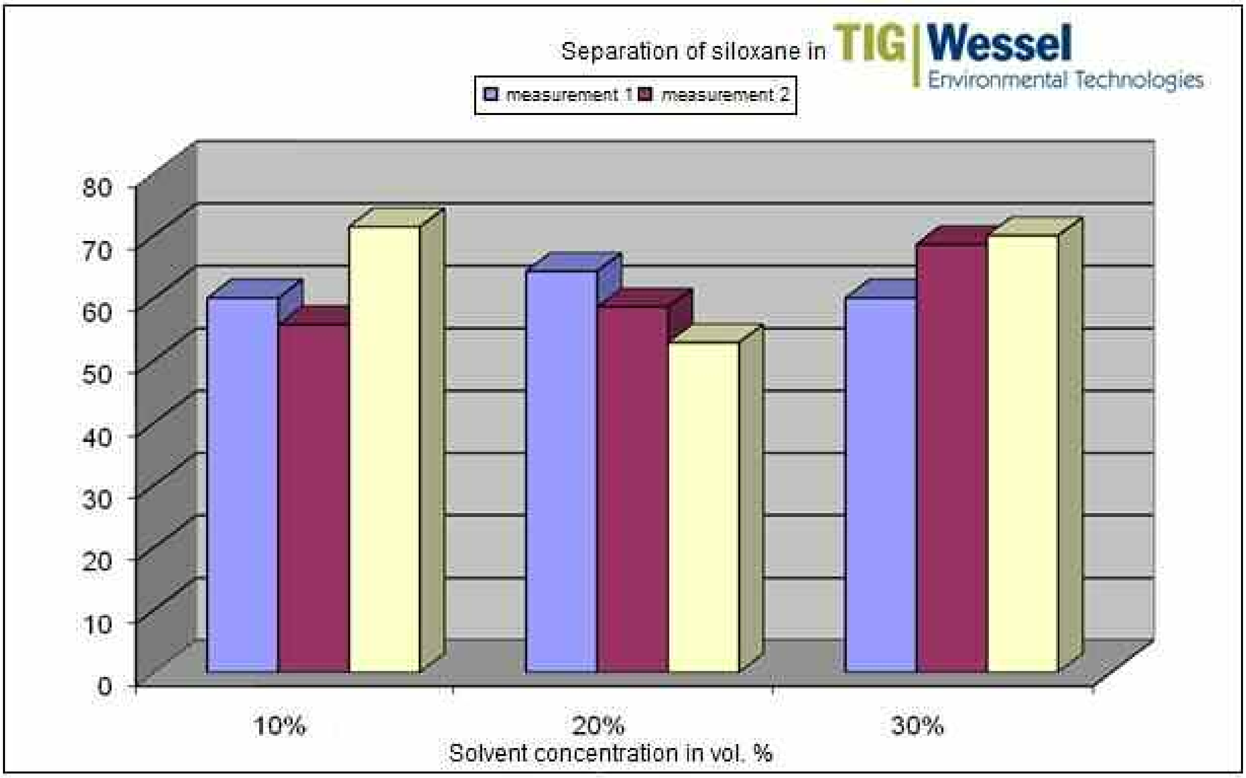

Figure 3: Separation chart for D5 compounds

In the next step, on-site field tests at MBT plants are to be carried out. This might lead to a significant prolongation of the cleaning cycles of RTO plants and to sustainable mitigation of the issue of complying with TOC loads and plant availabilities.

4 Corrosion Issues

Biological waste treatment facilities generally run the risk of being affected by corrosion. Buildings such as rotting halls are especially at risk (Fricke, K. et al.). This is caused by the damp and aggressive atmosphere. The following corrosive active components can be found among others in the process air: halogens (chlorine, fluorine), ammonia, and acids. The installed RTO plants have not been exempt from corrosion. In some cases, massive damage has occurred after only three months. The dirty gas canals are particularly affected; the clean gas canals and the combustion chamber are affected to a lesser extent. Pitting is a frequently encountered damage caused by halogen corrosion. Another cause is salt deposits of ammonium sulphate which is produced in the preceding scrubbers.

Figure 4: Corrosion in the dirty gas canal

Since the effort of avoiding corrosive substances in the exhaust air is not economically feasible, the RTO plants have to receive the best possible protection against corrosive attacks. According to what we know today (it has to be emphasized that there is not yet a “state of the art” to talk about due to the relatively short operating time of the plants) the following measures will help to avoid corrosion:

Moisture entrainment: Reduction of moisture entrainment in RTO plants by using high performance drop separators in the scrubbers. Pre-heating of exhaust air prior to the RTO and after the scrubbers to reduce relative moisture and suppress condensation effects during RTO.

Combustion chamber: With regard to high exhaust air temperatures (> 50°C / 122°F are possible) and an accordingly high moisture entrainment in the RTO facilities, external wall insulation should be added to the required internal wall insulation. This increases the temperature level of the steel wall to such an extent that condensation is impossible to occur and consequently, corrosion is avoided. Another protective measure is the use of diffusion-tight insulating material.

Dirty gas canal: Special steels such as Alloy 59 should be used in order to prevent corrosion in the dirty gas area; conventional stainless steels such as 1.4571 or 1.4539 are not permanently resistant to halogen compounds. However, the use of alloy materials is not financially possible. This is the reason why high-quality coatings such as those in the chemical industry are frequently used. When selecting the coatings, particular attention has not only to be paid to chemical resistance but also to maximum operating temperatures. In the dirty gas area of an RTO facility, temperatures of up to 200°C (392°F) may occur under certain operating conditions. Multi component polymer coatings have proven to be effective.

Figure 5: Re-engineered dirty gas canal

The RTO plants for more recent MBT plants are generally designed to permit easy dismantling and exchange of worn areas.

5 Prospective Outlook

The problems in the operation of exhaust air cleaning plants addressed by the 30th BImSchV (German Federal Immission Control Ordinance) have been recognized. The first approaches to solve the encountered issues in the field of corrosion have been found and are soon to be implemented. Meanwhile, after six months of permanent usage, the state-of-the-art RTO plants have proven their value. The previously encountered corrosion issues have not been detected so far.

Figure 6: The latest generation of RTO plants

More intensive work will be required to find solutions for the siloxane problems in RTO plants. It is up to the operators of MBT plants, designers, research institutes and plant engineers to work together on this issue.

Address of the author

Dipl.-Ing. Andreas Breeger

Wessel-Umwelttechnik GmbH

Bötelkamp 38

22529 Hamburg

Germany

Phone: +49 40 790000-120

E-mail: andreas.breeger@tig-group.com

Website: www.tig-group.com