



## LAS BIODEGRADATION AND SAFETY IN SLUDGE AND SOILS

Biosolids, commonly called sewage “sludge,” are produced during wastewater treatment, especially in activated sludge treatment plants, the most commonly used type of wastewater treatment plants (WTP) in North America and Europe. Linear alkylbenzene sulfonate (LAS) can become attached (adsorbed) to sewage sludge before it enters wastewater treatment and, while continuing to biodegrade, can be present in sewage sludge following treatment. Similarly, LAS from sludges can sometimes be found in soil mixtures shortly after treated sludges are applied to agricultural lands as fertilizer. Concentrations of LAS in these "sludge-amended soils" rapidly decrease with time. Studies show that LAS levels typically found in treated sludge are safe. Thirty years of hazard assessments show that any trace amounts of LAS present and breaking down in soil do not harm plants, earthworms and soil bacteria.

- About 30 percent of the LAS entering a sewage system adsorbs onto sewage sludge before treatment.<sup>(1-5)</sup> A final step in sewage treatment is to reduce excess sludge using either an anaerobic or an aerobic (less common) digester.
- In sewage sludge that has been treated in an anaerobic digester, the calculated median LAS concentration is 5.6 grams per kilograms dry weight sludge (5.6 g/kg<sub>dw</sub> sludge) (15.1 g/kg<sub>dw</sub> sludge at the 95th highest percentile). During sludge transportation to farmland, sludge storage, or application on agricultural soil, aerobic conditions are restored and rapid degradation of LAS resumes.<sup>(6)</sup>
- Typical LAS concentrations in aerobic sludge are <0.5 g/kg<sub>dw</sub> sludge.<sup>(2,6)</sup>
- In sludge-amended soils, LAS has a maximum half-life of one week (primary biodegradation), where half-life is the time it takes for half the substance to breakdown. Monitored concentrations were around 1 milligram (mg = 0.001 g)/kg<sub>dw</sub> soil (maximum 1.4 mg/kg<sub>dw</sub> soil) at harvesting time 30 days later. No accumulation in soil and no bioaccumulation in plants could be detected experimentally.<sup>(6)</sup>
- Accurate data for degradation of LAS in sludge-amended soil under realistic field conditions indicate its degradation in soil is increased by the presence of crop plants with soil concentrations decreasing from 27 mg/kg<sub>dw</sub> to 0.7-1.4 mg/kg<sub>dw</sub> soil at harvesting time after 30 days (half-life <4 days).<sup>(7)</sup>
- Results from several monitoring studies of LAS concentrations in soil are available for various soil types, sludge application rates, and averaging times.<sup>(6)</sup> LAS concentrations in sludge-amended soils were reviewed concluding that they were generally below 20 mg/kg soil, depending on the application rate or sampling time after sludge application.<sup>(8)</sup>

At sludge application rates less than 5 tons per hectare per year (5 t/ha/y), 30 days after its application, LAS concentrations in soil are expected to be in the low mg/kg range. With sludge application rates higher than those used in the normal agricultural practice (6-10 t/ha/y), LAS concentrations in an experimental field of soil-pots with rapes dropped from an initial measured value of 27 mg/kg<sub>dw</sub> soil to 0.7-1.4 mg/kg<sub>dw</sub> soil at harvest time after 30 days.<sup>(7)</sup>

- LAS effect levels for test crops (including sorghum, wheat, corn and sunflower) range from 167 mg/kg to more than 407 mg/kg (for most plant species tested). These levels are three to several hundred times higher than even initial concentrations of LAS present before degradation in sludge-amended soils.<sup>(9)</sup>
- LAS has no observable effect on earthworm test species (*Eisenia foetida* and *Lumbricus terrestris*) at concentrations up to 250 mg/kg and 613 mg/kg, respectively. Again, these levels are much higher than even the initial levels in sludge-amended soils.<sup>(9)</sup>
- No significant effects to the microbial community were observed after prolonged exposure to heterogeneous LAS distributions in agricultural soil following sludge amendment.<sup>(6)</sup>
- A sludge PNEC of 49 g/kg<sub>dw</sub> sludge, also called the sludge quality standard (SQS), of LAS can be back-calculated from the soil PNEC, taking into account the exposure of sewage sludge on agricultural soil and the soil PNEC of 35 mg/kg<sub>dw</sub> soil.<sup>(10)</sup>
- Real world concentrations of LAS in sludge and in sludge-amended soil do not exceed the PNEC values discussed above, indicating that current uses of LAS are safe and do not pose a risk to organisms present in sludge or soil.

## KEY REFERENCES

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Updated October 2018