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Anaerobic digestion of blackwater and hydrolysis leachete using CSTR und UASB- technique; energy recovery from waste streams with process- integrated pharmaceutical degradation

The anaerobic treatment of organic mass fluxes, which are resulting from the wastewater and waste sector, is getting more and more important in the last 20 years. Specific reasons for that are on the one hand the possibility to increase the cost effectiveness of treatment by producing biogenic, methane- rich digester gas, on the other hand is the opportunity to reduce the demand of land and the needed volume of treatment reactor technology by using anaerobic digestion technology instead of aerobic, state of the art treatment steps. By using technical and scientific improved knowledge, it is possible to perform anaerobic treatment plants under stable conditions, not only in a big scale application also in decentralized, smaller sanitation and waste management systems.

Former studies document that no or an ineffective treatment of produced wastewater and biowaste, increases the environmental hazards significant. The number of problematic substances in the compartments wastewater and waste is high and it is difficult to find an overall treatment solution for all of them. One major column of environmental polluting substances is the group of pharmaceuticals and pharmaceutical residues. By using anaerobic CSTR- und UASB- technique for treatment of source-separated wastewater within a co- digestion of biowaste, different advantages can be shown. It was able to show approved positive treatment results of pharmaceutical degradation out of wastewater and an increased digester gas recovery by feeding biowaste and wastewater together by providing experiments using a constructed anaerobic pilot plant.

Additionally to that a pre- hydrolysis plant was projected and constructed to produce an organic rich fluid for a connected decentralized digestion of biowaste, greenery and other organic wastes to treat them together with the decentralized blackwater. In the first stage, an initial comprehensive study was investigated to see a principle possibility of stable anaerobic treatment of this innovative co- substrate. Furthermore some additional, positive effects within this co- fermentation were shown. The feeding of pharmaceutical rich blackwater together with defined doses of hydrolysis water (including 32000mg/l acetic acid i.a.) increases the treatment performance of the

anaerobic bioceonosis and the degradation rates of selected pharmaceuticals in the monitoring getting increased (see table 1).

Table 1: effect of selected pharmaceuticals, average daily doses, pbt- index and aerobic as well as own generated anaerobic degradation performances (in red)

pharmaceutical substance	***effect in human body***	***average of daily dose [1][2] [ddd]***	***pbt-index (pbt) [1]***	***degradation performance[%]***	
				aerobic	**anaerobic with co-substrate [11] [12] [13]**
Diclofenac	anti- rheumatic agent	10.015.675	4 (301)	<10 [3]	93
Ibuprofen	anti- rheumatic agent	13.363.692	2 (002)	90 [4]	29
Metoprolol	selective- β receptor blocker	16.377.224	4 (301)	60[4][5]	36
Metformin	oral anti-diabetic agent	8.214.307	5 (302)	50 [6]	95
Amoxicillin	antibiotic agent	1.187.403	6 (303)	30 [7]	75
Carbamazepine	anti-convulsing agent	1.166.333	4 (301)	<10 [8]	44
17-alpha-Ethynilestradiol	sexual hormone	21.477.195	9 (333)	96 [9]	94
Sulfa-methoxazol	antibiotic agent	198.734	6 (303)	28 [10]	82

[1] SLL (2009), [2] Baumgartner & Lutters (2011), [3] Kümmerer et al. (2011), [4] Jekel & Dott (2013), [5] Rosal et al. (2010), [6] Scheuerer et al. (2009 & 2012), [7] Valvo et al. (1997), [8] LANUV-NRW (2007), [9] Tennhard (2004), [10] UBA (2005), [11] Wätzel et al. (2013), [12] Wätzel & Kraft (2014), [13] Wätzel et al., 2014

Comparing the anaerobic treatment results using CSTR as well as UASB- technique most of the pharmaceutical substances can be degraded more efficient than using aerobic, state- of – the art treatment techniques (MWWTP, SBR, MBR, etc.).