

Table of Content

1	Introduction.....	1
2	Production, Use and Acceptance of Sewage Sludge.....	4
3	Batch Humification of Sewage Sludge in Grass Beds	9
3.1	Outline of the Process	9
4	Investigations	14
4.1	Investigations in a Pilot Scale Humification Plant.....	14
4.1.1	Construction of the Pilot Plant and Upscaling.....	14
4.1.2	Investigation Program on the Pilot Plant.....	15
4.1.3	Analysed Parameters and Methods:.....	17
4.1.3.1	Liquid Samples	17
4.1.3.2	Solid Samples.....	17
4.2	Evaluation of Operation Data from Full Scale Humification Plants	19
5	Basics, Results and Discussion.....	19
5.1	Water Content.....	20
5.1.1	Dewatering Phase	20
5.1.1.1	Aerobic Sludge	21
5.1.1.2	Digested Sludge	25
5.1.2	Drying Phase	26
5.1.2.1	Aerobic sludge.....	26
5.1.2.2	Digested sludge.....	28
5.2	Organic Matter	29
5.2.1	Aerobic Sludge	32
5.2.2	Digested Sludge	34
5.2.3	Respiration Activity	34
5.2.3.1	Temperature Dependency of the Respiration Activity.....	37
5.2.4	TOC and COD in the Leachate.....	37

5.3 Nitrogen	40
5.3.1 Aerobic Sludge	42
5.3.1.1 Nitrogen in the Leachate.....	42
5.3.1.2 Nitrogen in the substrate (aerobic sludge)	46
5.3.2 Digested Sludge	48
5.3.3 Accumulation of Nitrite	49
5.3.4 Nitrogen Balances in the Pilot Plant.....	54
5.4 Phosphorous	57
5.4.1 Aerobic sludge	59
5.4.1.1 Phosphorous in the Leachate	59
5.4.1.2 Phosphorous in the Substrate.....	61
5.4.2 Digested Sludge	62
5.4.3 Phosphorous Balances	63
5.5 Potassium	66
5.6 Heavy metals	66
5.6.1 Mobility of heavy metals.....	67
5.6.2 Results of the investigations	69
5.7 Organic Contaminants	72
5.7.1 Monitored Parameters	74
5.7.2 Results of the investigations	78
5.8 Hygienic aspects	81
5.8.1 Pathogen Reduction during Humification.....	82
5.8.2 Investigations of Hygienic Parameters on the Pilot Plant.....	83
5.8.2.1 E. Coli	83
5.8.2.2 Salmonella	85
5.8.2.3 Fecal Streptococci	85
5.8.2.4 Helminth Ova	86

5.9 Emission of greenhouse gases	87
5.9.1 Carbon Dioxide.....	88
5.9.2 Methane.....	91
5.9.3 Nitrous Oxide.....	93
5.10 Influence of the Grass	98
5.11 Specific Load	99
6 Suggestions for the Dimensioning and Operation of Humification Plants in Germany	99
6.1 Required Sludge Quality.....	99
6.2 Required Area.....	100
6.3 Number of Humification Beds.....	100
6.4 Sowing of the grass.....	101
6.5 Duration of one Cycle and the total Process.....	101
7 Effects on the wastewater treatment process and suggestions for a suitable integration of the humification	103
8 Cost Comparison between Humification and Mechanical Dewatering	109
8.1 Capital Costs.....	109
8.2 Operational costs.....	111
8.3 Cost comparison.....	113
9 Options for the Use of Humificated Sewage Sludge	115
9.1 Relevant Legal Regulations in Germany and Abroad.....	115
10 Concluding Summary and Outlook	120
11 References	126
12 Patents	135
13 Appendix	136