INSTITUT FÜR SIEDLUNGSWASSERWIRTSCHAFT und ABFALLTECHNIK
UNIVERSITÄT HANNOVER
Prof. Dr.-Ing. Dr. phil. S. Kunst

Translation of the original document

Scientific research of the aerobic and anaerobic biodegradability of the product *Glass Wax* (G.B.P. Glass Bottles Process) in a biological water purification plant

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1. Introduction

The product *Glass Wax* (G.B.P. Glass Bottles Process, Gries, F) is a suspension for the surface treatment of scuffing damaged returnable glass bottles. The main ingredient is highly purified paraffin, and contains a small amount of secondary ingredients (various fatty acids esters).

Since *Glass Wax* is applied to the surface of the bottles when they are washed, it can be assumed that the product reaches the waste water. According to the manufacturer data, a maximal concentration of 0.004% v/v of the product must be accounted for in the waste water.

The Water and Waste Water Biology Department of the *Institut für Siedlungswasserwirtschaft und Abfalltechnik* (ISAH) of the University of Hanover (ISAH) has been called upon to determine the aerobic biodegradability through the culture fluid of the water purification plant of the *Privatbrauerei Ihring-Melchior* from a delivered sample of the product.

The anaerobic biodegradability was determined through the culture fluid of a local water purification plant.

A sample of the product was delivered on 29.06.2000.

The ISAH had precise descriptions of the product and safety data sheets to their disposal during the research.

2. Material and methods

2.1 General parameters

The pH and the Chemical Oxygen Demand (COD) have been identified before the beginning of the trials. The COD measurement resulted from various steps of dilution at threefold destinations.

2.2 Research of the aerobic biodegradability

Culture fluid of the water purification plant of the *Privatbrauerei* was introduced for the trials. The culture fluid was first aerated during the night without adding any substratum, to guarantee a wide breathing of the COD absorbed at the culture fluid flakes.

The determination of the oxygen feeding rates of the culture fluid saturated in oxygen, at basis breathing without addition of substratum (OV_e) and at substratum breathing (OV_S) under addition of increasing amounts of substratum took place in a closed airtight container with a specific volume, in which the diminution of the oxygen concentration was calculated though an oxygen electrode and recorded over time.

The specific oxygen consumption of the culture fluid increases with the increasing choice of substratum and a sufficient oxygen concentration, and tends towards a saturation value (maximum breathing), above which higher concentrations of substratum do not cause other increases of the specific oxygen consumption.

A maximum breathing curve was registered for the product aid of a growing nutrition of oxygen at an increasing substratum concentration. The suspension was neutralised before the beginning of the trial (pH 7). Peptone was introduced in aqueous solution in various dilutions as reference substratum. This has been proven to be highly and constantly degradable through the culture fluids of COD eliminators.

Conclusions about the primary aerobic dissolution of the product can be drawn from the difference of the respiration rates of the culture fluid with peptone i.e. *Glass Wax* as substratum.

In a second series of trials a constant and maximum breathing speed was firstly registered through the addition of a sufficient quantity of peptone solution. An increasing quantity of *Glass Wax* was then added. From the comparison of the constant maximum breathing with the respiration rates under addition of the tested product can be determined if and from which concentration of the product a diminution of the breathing activity enters the culture fluid.

Four concentrations between 0.01% and 0.20% v/v were tested.

2.3 Research of the anaerobic biodegradability

In the beginning of the trial, a determined quantity of local culture fluid of the *Hanover-Herrenhausen* water purification plant was put in little airtight bottles with known volumes. A strong vacuum was created, after which the bottles were incubated at 37° C. On the following day beer was a dded as substratum, constantly at an equal quantity, because previous research has proved it to be particularly well degradable. An attempt has been led without substratum as a control. An increasing quantity of G.B.P. *Glass Wax* product was added. The quantity of the produced methane was determined gaschromatographically. The corresponding dissolution rates of the COD were calculated from the gas assembling expressed in percentage with known volumes of the bottles.

Some complimentary analyses of culture fluid and waste water were carried out (dry residue TR, loss of incandescence GlV, pH, COD).

G.B.P. *Glass Wax* product was delivered in a concentrated solution. In the Batch tests product concentrations were estimated between 0.004% and 0.19%.

3. Results

3.1 General parameters

Table 1 summarises the results of the determination of the pH value and COD of the sample.

Table 1: Analyses results of *Glass Wax* product

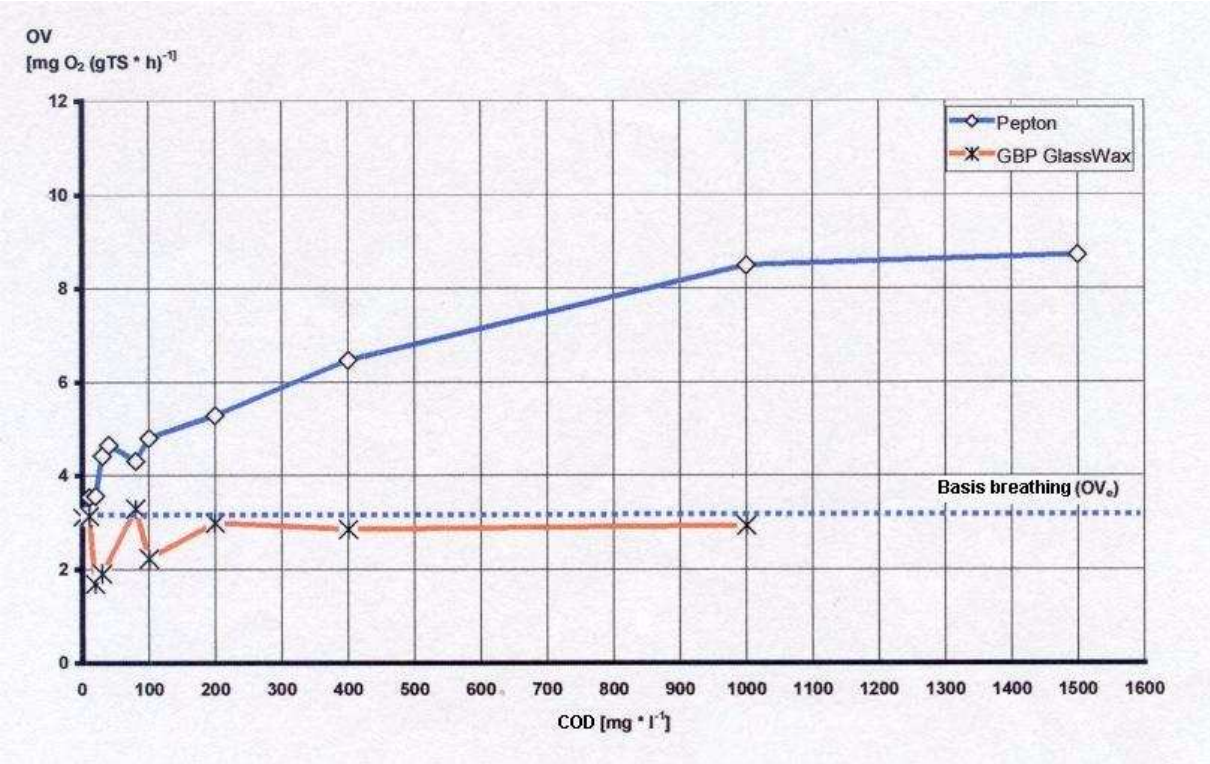
Product	**pH**	**COD**
GlassWax	5.76	147.3 gO_2/l

3.2 Aerobic biodegradability

Table 2 and graph 1 show the specific respiration activities. COD concentrations were tested up to 1.000 mg / litre.

Table 2: Breathing activity measured in the culture fluid with increasing concentrations of *Glass Wax* in comparison with a peptone reference substratum.

COD [mg/l]	**Specific respiration activity**	
	Peptone [mg O_2/gTS * h]	***Glass Wax*** [mg O_2/gTS * h]
Basis breathing	3.1	3.1
10	3.5	3.1
20	3.6	1.7
30	4.4	1.9
40	4.6	Unavailable
80	4.3	3.3
100	4.8	2.2
200	5.3	3.0
400	6.5	2.8
1 000	8.5	2.9
1 500	8.7	Unavailable



Graph 1: Respiration activity measured in the culture fluid with an increasing concentration of *Glass Wax* in comparison with a peptone reference substratum.

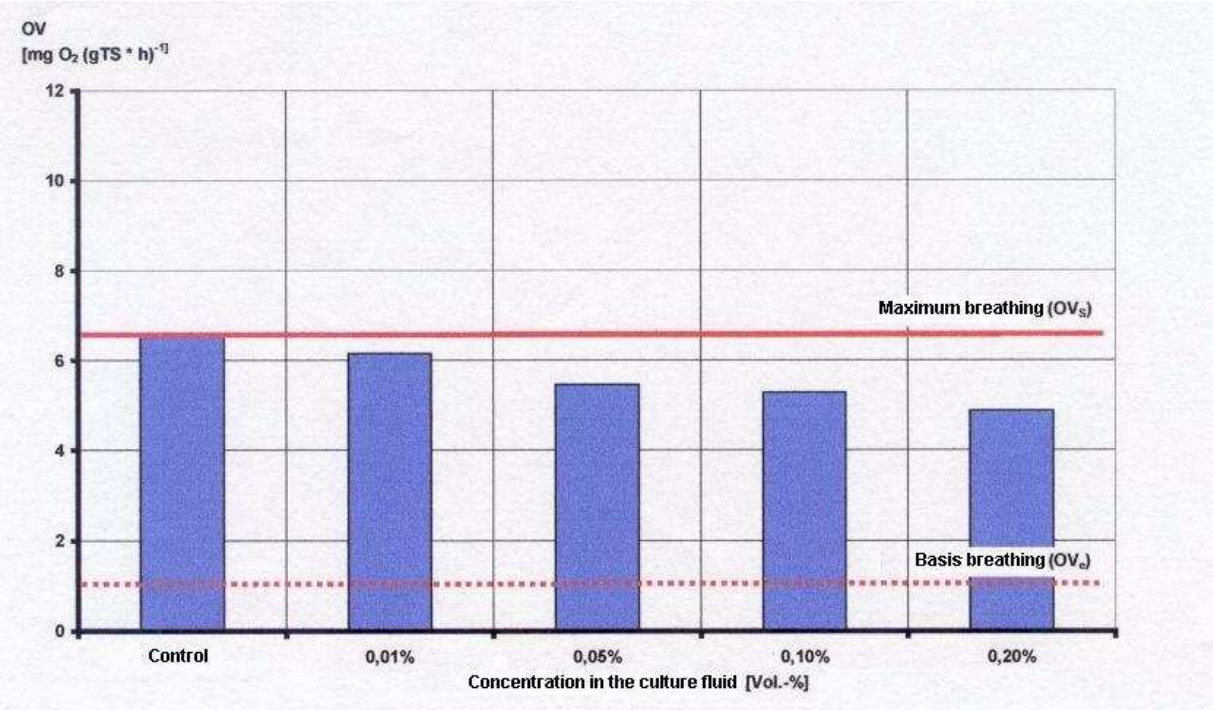
Increasing breathing activity was not noticed through the addition of *Glass Wax*. The breathing activity was constantly situated at the level of the basis breathing, i.e. slightly below. However, no decrease in basis respirations could be determined. In the tested concentrations *Glass Wax* is to be considered as non- biodegradable for a non adapted culture fluid in a short-lived trial.

It has to be noticed that not only the basis breathing but also the absence of any decrease of the maximum breathing with peptone as substratum are considered to be relatively small. A possible reason is the very small pollution of the culture fluid of the water purification plant of the *Licher Privatbrauerei*.

The consequences of the volume increase of the product on the maximum breathing of the culture fluid can be seen in graph 2.

Increasing concentrations between 0.01% v/v (= 100 ppm) and 0.2% v/v (= 2000 ppm) slightly decreased (gradually stronger effect) between 5% and 25%, due to the maximum breathing activity.

Therefore, in concentrations situated distinctly above the given concentrations and which are maximum to be expected in the culture fluid of the water purification plant (0.004 % v/v = 40 ppm), the tested *Glass Wax* sample first slightly decreased. In a higher product concentration, the maximum oxygen consumption of the test culture fluid deceased further.



Graph 2: Influence of various concentrations of *Glass Wax* on the maximum breathing activity of the culture fluid.

Considering that hydrocarbons with long chains (as main component of the product) can in theory be used under aerobic conditions of micro-organisms as substratum, it can be expected that after a certain adaptation time, *Glass Wax* is at least in part aerobically biodegradable in culture fluid. No conclusion can be drawn that high concentrations on the maximum breathing of an adapted culture fluid can increase less.

3.3 Anaerobic biodegradability

The results drawn from the trial evaluations with *Glass Wax* are shown in table 3 and 4. Graph 3 and 4 show the course of the trial.

Table 3: Results of the analytic research of the culture fluid, the substratum and the *Glass Wax* product

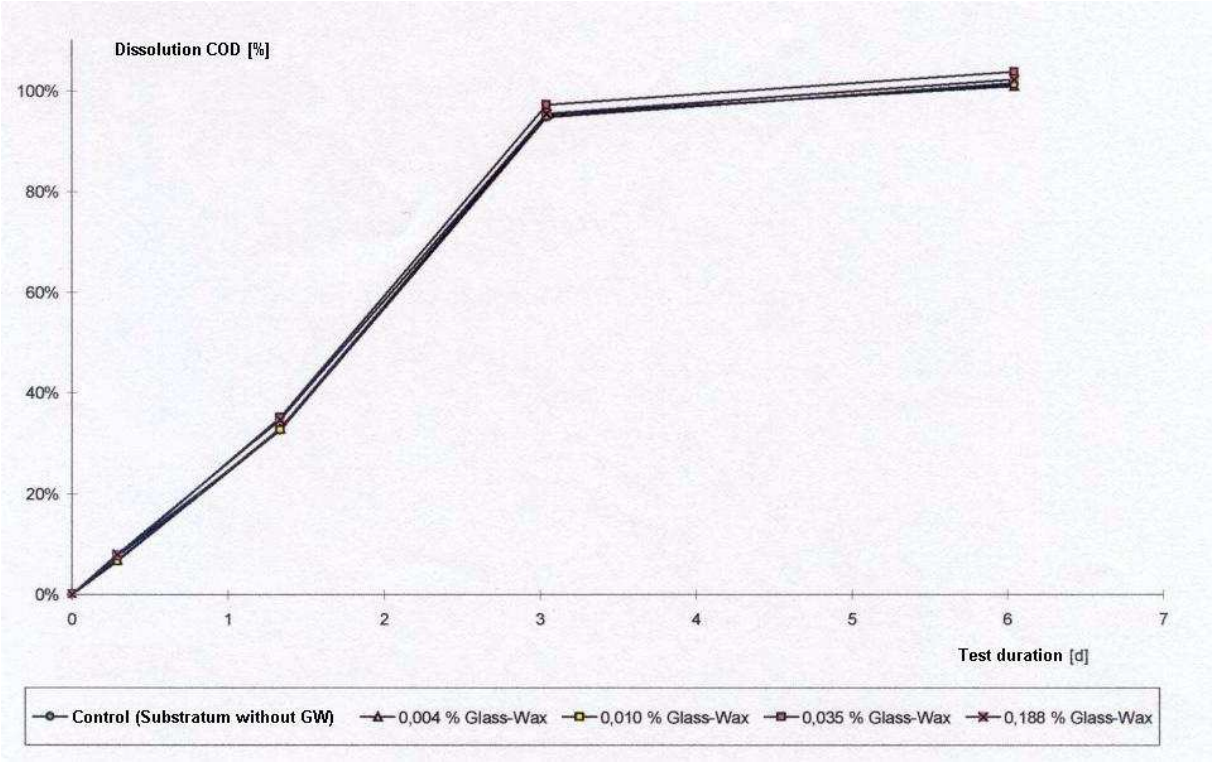
Analyse values	**Culture fluid**	**Glass Wax**	**Substratum (beer)**
pH value	7.28	5.76	4.5
Dry residue TR [g/kg]	32.63		
TR org. [g/kg]	18.17		
Loss in incandescence GV [%]	52.91%		
COD		147 300	120 000

Table 4: Influence of the increasing dosage of *Glass Wax* on the application of anaerobic substratum of a local culture fluid

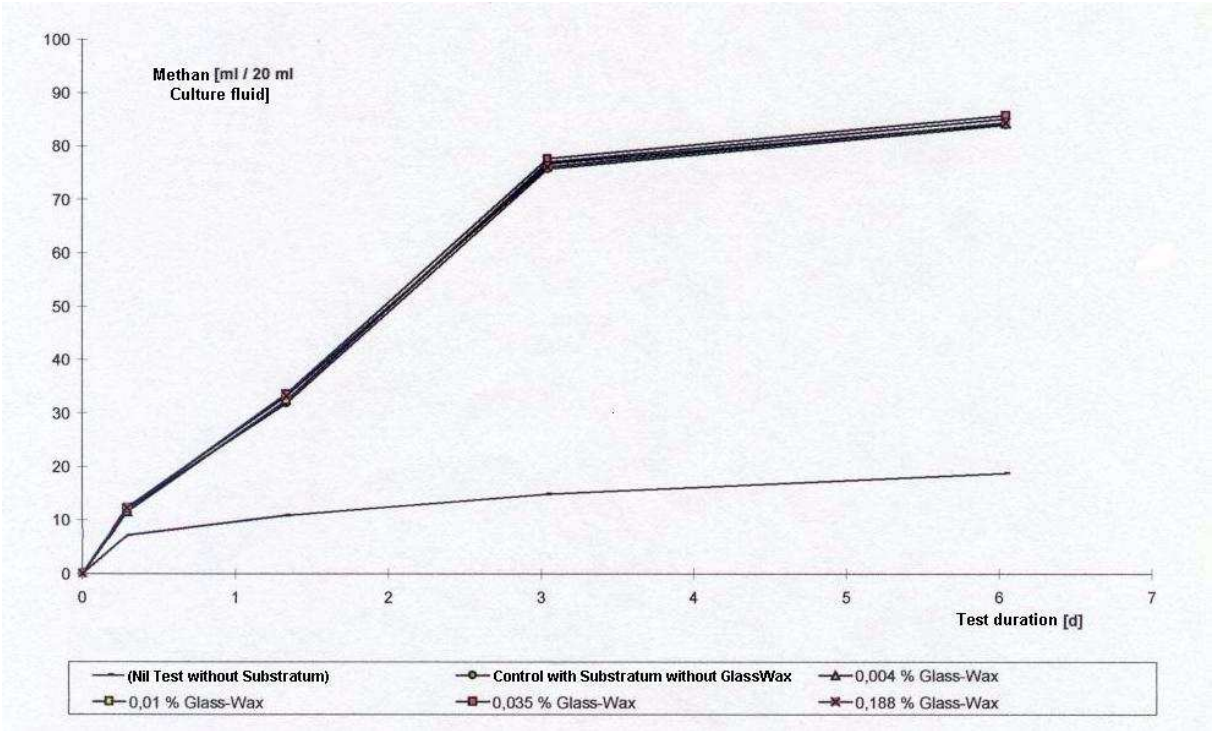
Trial basis	**1**	**2**	**3**	**4**	**5**	**6**
GlassWax addition	0.000%	0.000%	0.004%	0.010%	0.035%	0.188%
Space weight B_R [gDCO/L]	0.00	8.06	8.16	8.23	8.13	8.31
Fluid weight [gDCO/goTR]	0.00	16.33	16.54	16.69	16.49	16.87
$DCO_{Substratum}$ dissolution after 7h		7.67%	6.81%	6.60%	7.59%	7.97%
$DCO_{Substrat}$ dissolution after 6d		101.3%	100.7%	101.1%	103.5%	102.1%
DCO_{ges} dissolution after 6d		101.3%	100.6%	100.9%	102.9%	98.68%
$DCO_{GlassWax}$ dissolution after 6d			com-plete	com-plete	com-plete	60.33%
pH at the end of the trial	7.62	7.11	7.11	7.10	7.11	7.08

The beer substratum beer was totally dissolved after six days without the addition of *Glass Wax.*

A total dissolution of the entire introduced COD could be reached through the addition of *Glass Wax* in a concentration of up to 0.035 %. The smaller dissolution of COD with a concentration of *Glass Wax* of 0.188 % is to attribute to the high COD of the G.B.P. product *Glass Wax.* It could not be totally dissolved during this trial period at this high concentration, in theory *Glass Wax* is totally anaerobically degradable.



Graph 3: Biodegradability of $COD_{substratum}$ in increasing concentrations of *Glass Wax*



Graph 4: Production of methane in increasing concentrations of *Glass Wax*

4. Summary

4.1 Aerobic biodegradability

The tested product *Glass Wax* (G.B.P. Glass Bottles Process, Gries, F) was first not aerobically biodegradable through the non adapted culture fluid of the water purification plant of the *Licher Privatbrauerei*. A decrease in the average respiration of the culture fluid was nevertheless not identified up to a concentration of 1.000 mg COD / litre.

Glass Wax showed a slight decrease in on the maximum respiration (5% decrease in the maximum breathing activity of the introduced culture fluid) at a concentration of 0.01% v/v in the culture fluid. Higher concentrations lead to larger decreases (25% decrease at 0.2% v/v). Considering that according to manufacturer data the expected concentration in waste water must not exceed 0.004% v/v, no measurable decrease of the maximum breathing activity is expected from the results of the trials.

It can be assumed that *Glass Wax* is at least partly aerobically biodegradable in an adapted culture fluid, because the main components of the product are in principle accessible to the displacements of aerobic micro-particles.

4.2 Anaerobic biodegradability

A concentration of up to 0.188 %of the product *Glass Wax* (G.B.P. Glass Bottles Process, Gries, F) has not caused a decrease in methane production of the culture fluid of a local water purification plant. *Glass Wax* could be totally dissolved after six days of trials in small concentrations, at higher concentrations of up to 0.188%, *Glass Wax* could still be 60% anaerobically biodegradable during the same trial period.

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Institut für Siedlungswasserwirtschaft

und Abfalltechnik der Universität Hannover

(Prof. Dr.-Ing. Dr. phil. S. Kunst)

(Dipl.-Biol. T. Gaul)

(C. Lorey)