



DP Barcode: D165214,165215,165216,165222

PC Code No.: 043901

Date Out: AUG 22 1991

To: John Lee  
 Product Manager #31  
 Registration Division (H7505C)

From: Emil Regelman, Supervisory Chemist  
 Chemistry Review Section #2  
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Thru: Henry Jacoby, Chief  
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 Environmental Fate & Effects Division (H7507C)

*Emil Regelman*  
*Henry Jacoby*

Attached, please find the EFGWB review of...

Reg./File # :000662-TU, 000662-TG, 000662-TL, 000662-TE

Chemical Name :Glutaraldehyde

Type Product :Microbiocide

Product Name :Septacide

Company Name :BASF Corporation

Purpose :Review hydrolysis study.

Action Code: 161

EFGWB #(s): 91-0657, -0658, -0659, -0660

Date Received: 6/19/91

Total Review Time: 2 days

Deferrals to:

EEB/EFED

DEB/HED

OREB/HED

TB1/HED

TB2/HED

RSB/RD

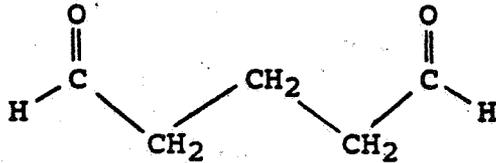
1. CHEMICAL:

chemical name: 1,5-pentanedial

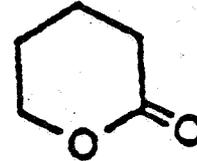
common name: Glutaraldehyde

trade name: Sepacide-25

structure:



Glutaraldehyde



Delta-Valerolactone

physical/chemical properties:

molecular formula-	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>
molecular weight-	100.12
physical state-	viscid, clear liquid
boiling point-	80-85°C at 15 mm Hg

2. TEST MATERIAL:

<sup>14</sup>C-glutaraldehyde, specific activity of 40.20 μCi/mg, 96.5% purity. The final concentration was between 107-142 ppm.

3. STUDY/ACTION TYPE:

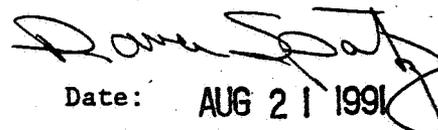
Review hydrolysis study submitted in support of registration of glutaraldehyde as a microbiocide for use in oil producing fields for treating stored connate water before it is injected into the oil-bearing formation.

4. STUDY IDENTIFICATION:

Levine, Alan. "Hydrolysis of <sup>14</sup>C-Glutaraldehyde in Aqueous Solutions Buffered at pH 5, 7, and 9." Performed by Center For Hazardous Materials Research. Submitted by BASF Corporation. Study completed on April 26, 1991. Received by EPA on June 11, 1991. MRID #: 419062-01.

5. REVIEWED BY:

Dana Spatz  
Chemist, ECRS #2  
EFGWB/EFED/OPP

  
Date: AUG 21 1991

6. APPROVED BY:

Emil Regelman  
Supervisory Chemist, ECRS #2  
EFGWB/EFED/OPP



Date: AUG 22 1991

7. CONCLUSIONS:

This study is acceptable and fulfills the Hydrolysis (161-1) Data Requirement for registering glutaraldehyde. At 25°C, <sup>14</sup>C-glutaraldehyde (109-111 ppm) was stable towards hydrolysis in sterile, buffered solutions at pH 5, 7 and 9. Calculated half-lives from the 30-day study were 628, 394, and 63.8 days, respectively. At 70°C, a high temperature that some oil formations may reach, <sup>14</sup>C-glutaraldehyde (107-142 ppm) was fairly stable at p. 5 (half-life: 53 days), but degraded rapidly at pH 7 and 9 with half-lives of 6.5 days and 5.5 hours, respectively. One degradation product was found in the 25°C experiment at pH 9. It was identified as delta-valerolactone. The formation of this degradate most likely involved a base-catalyzed aldol condensation of two glutaraldehyde molecules. At the end of the 25°C incubation period (30 days), glutaraldehyde accounted for 94% of the initially applied radioactivity at pH 5.0, 93% at pH 7.0 and 70% at pH 9.0.

Delta-valerolactone was also found in the 70°C experiment at all three pH's in addition to two glutaraldehyde condensation isomers: cycloocta [1,5]diene-1,5-dialdehyde and cycloocta [1,4]diene-2,4-dialdehyde. At the end of the 70°C incubation period (30 days), glutaraldehyde accounted for 68% of the initially applied radioactivity at pH 5.0, 10% at pH 7.0 and was not detected after 7 hours post-treatment at pH 9.0.

The material balance for samples incubated at 25°C ranged from 93%-104% of the initially applied radioactivity at pH 5.0, 94-103% at pH 7.0 and 95-102% at pH 9.0. At 70°C, the material balance ranged from 89-105% of the initially applied radioactivity at pH 5.0, 93-100% at pH 7.0 and 94-101% at pH 9.0. Volatile traps were not employed; however, the good material balances suggest that no volatiles were formed.

Quantification of glutaraldehyde and its degradates was achieved using HPLC with radioactive flow detection. GC/MS was used to confirm the identity of all residues detected at concentrations greater than 10% of applied.

8. RECOMMENDATIONS:

- A. The single intended use pattern for glutaraldehyde is to treat stored connate water before it is injected into an oil-bearing formation. Connate water is that water that is associated with oil in subsurface oil formations. Injecting the connate water into the oil formation pressurizes the formation resulting in additional oil recovery from the formation. Because the treated

connate water is stored in closed tanks before it is pumped into the oil-bearing formation and since the connate water is not exposed to light and is not applied to soil or otherwise released to the environment, the only environmental fate data requirement for registration of glutaraldehyde for this particular use is the Hydrolysis data requirement.

Should an application be made to extend the use pattern of glutaraldehyde, a careful examination of the additional uses must be made in order to ensure that the appropriate supporting environmental fate data have been generated.

- B. Although the intended use pattern should not involve direct discharge of glutaraldehyde-contaminated water into surface water, as a precaution, all product labels must prohibit the direct discharge of glutaraldehyde-contaminated water into natural aquatic environments.
- C. This study fulfills the Hydrolysis data requirement. At 25°C, <sup>14</sup>C-glutaraldehyde was stable towards hydrolysis in sterile, buffered solutions at pH 5, 7 and 9. Calculated half-lives from the 30-day study were 628, 394, and 63.8 days, respectively. At 70°C, a high temperature that some oil formations may reach, <sup>14</sup>C-glutaraldehyde was relatively stable at pH 5 (half-life: 53 days), but degraded rapidly at pH 7 and 9 with half-lives of 6.5 days and 5.5 hours, respectively. It is reported by the registrant that the pH of connate water is usually between 5.5 and 7.5, which means that glutaraldehyde will be fairly stable at lower temperatures, but will degrade as the temperature of the oil formation increases.

9. BACKGROUND:

Glutaraldehyde application rates will typically be 100 ppm in the connate water on a weekly basis to maintain control of bacterial growth. For very severe conditions of bacterial contamination, a slug of 200-400 ppm in the connate water is made until control is achieved. This is followed by the weekly maintenance treatment of 100 ppm. According to BASF, if connate water is not treated with an appropriate microbiocide, it can support the growth of large populations of sulfate-reducing bacteria leading to clogged and corroded machinery.

10. DISCUSSION OF INDIVIDUAL TESTS OR STUDIES:

See attached DER.

11. COMPLETION OF ONE-LINER:

One-liner has been amended.

12. CBI APPENDIX:

Not applicable.

## DATA EVALUATION RECORD

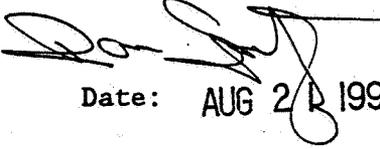
### STUDY 1

PC Code No.: 043901  
STUDY ID No.: 419062-01

Glutaraldehyde

Levine, Alan. "Hydrolysis of  $^{14}\text{C}$ -Glutaraldehyde in Aqueous Solutions Buffered at pH 5, 7, and 9." Performed by Center For Hazardous Materials Research. Submitted by BASF Corporation. Study completed on April 26, 1991. Received by EPA on June 11, 1991.

REVIEWED BY: Dana Spatz  
Chemist, ECRS #2  
EFGWB/EFED/OPP

  
Date: AUG 21 1991

### CONCLUSIONS:

#### Hydrolysis

This study is acceptable and fulfills the Hydrolysis (161-1) Data Requirement for registering glutaraldehyde. At 25°C,  $^{14}\text{C}$ -glutaraldehyde (109-111 ppm) was stable towards hydrolysis in sterile, buffered solutions at pH 5, 7 and 9. Calculated half-lives from the 30-day study were 628, 394, and 63.8 days, respectively. At 70°C, a high temperature that some oil formations may reach,  $^{14}\text{C}$ -glutaraldehyde (107-142 ppm) was fairly stable at pH 5 (half-life: 53 days), but degraded rapidly at pH 7 and 9 with half-lives of 6.5 days and 5.5 hours, respectively. One degradation product was found in the 25°C experiment at pH 9. It was identified as delta-valerolactone. The formation of this degradate most likely involved a base-catalyzed aldol condensation of two glutaraldehyde molecules. At the end of the 25°C incubation period (30 days), glutaraldehyde accounted for 94% of the initially applied radioactivity at pH 5.0, 93% at pH 7.0 and 70% at pH 9.0.

Delta-valerolactone was also found in the 70°C experiment at all three pH's in addition to two glutaraldehyde condensation isomers: cycloocta [1,5]diene-1,5-dialdehyde and cycloocta [1,4]diene-2,4-dialdehyde. At the end of the 70°C incubation period (30 days), glutaraldehyde accounted for 68% of the initially applied radioactivity at pH 5.0, 10% at pH 7.0 and was not detected after 7 hours post-treatment at pH 9.0.

The material balance for samples incubated at 25°C ranged from 93%-104% of the initially applied radioactivity at pH 5.0, 94-103% at pH 7.0 and 95-102% at pH 9.0. At 70°C, the material balance ranged from 89-105% of the initially applied radioactivity at pH 5.0, 93-100% at pH 7.0 and 94-101% at pH 9.0. Volatile traps were not employed, however, the good material balances suggest that no volatiles were formed.

Quantification of glutaraldehyde and its degradates was achieved using HPLC with radioactive flow detection. GC/MS was used to confirm the identity of all residues detected at concentrations greater than 10% of applied.

## MATERIALS AND METHODS

The  $^{14}\text{C}$ -Glutaraldehyde was determined to have a specific activity of 40.20  $\mu\text{Ci}/\text{mg}$  and a purity of 96.5%.

All glassware used for incubation of test solutions was sterilized by exposure to dry heat at 170-190°C for >1 hour. All water used in preparation of the test solutions was filter-sterilized through a 0.20 micron filter immediately before use.

Aliquots of the standard solution of  $^{14}\text{C}$ -glutaraldehyde in water were mixed in appropriate proportions to prepare the test solutions. The test solutions were buffered at pH 5.0, 7.0, and 9.0. The pH of each buffered solution was measured immediately before study initiation and at each sampling time during the study period.

Duplicate 40.0 ml aliquots of pH 5, 7, and 9 buffered solutions were placed in six individual sterilized, glass bottles. 155  $\mu\text{l}$  aliquots of the 25.9 mg/ml standard solution of  $^{14}\text{C}$ -glutaraldehyde in water were added to each of the pH 5, 7, and 9 buffered solutions, resulting in test solutions with final concentrations ranging from 108.4-142.2 ppm  $^{14}\text{C}$ -glutaraldehyde. The two sets of test solutions in separate containers were then mixed for 2 minutes to assure homogeneity. Following mixing, duplicate 20  $\mu\text{l}$  aliquots of each test solution were taken to determine the precise initial concentration and to serve as Day 0 samples. The remaining test solution in each bottle was then transferred into individual 2 ml sterile, borosilicate, screw-capped vials. The vials were immediately sealed with screw caps fitted with PTFE-faced silicone liners and the caps were wrapped with teflon tape.

One set of vials containing aliquots of pH 5, 7, and 9 buffered solutions were incubated in the dark in 2.0 ml screw capped vials in a thermostatically-controlled water bath maintained at 25°C. A second set of vials with the same contents were incubated in the dark at 70°C. At the appropriate sampling times two vials of each test solution were removed and analyzed by LSC for total radioactivity and by HPLC for characterization of  $^{14}\text{C}$ -glutaraldehyde residues.

Samples at 25°C and 70°C were taken on days 0, 1, 3, 6, 11, and 30 and analyzed immediately. In addition, because of the rapid degradation of  $^{14}\text{C}$ -glutaraldehyde at 70°C in pH 9 buffered solutions, an additional experiment was conducted for 7 hours at 106.75 ppm where samples were taken 0, 1.0, 1.5, 2.5, 4.0 and 7.0 hours after treatment.

At each sampling time, aliquots from each replicate vial were analyzed by LSC and HPLC. Separation, identification and quantification of glutaraldehyde and its degradation products was achieved using HPLC. The HPLC system was equipped with both UV and radioactive flow detectors. The detection limit was less than 0.001 ppm for LSC analysis and was 0.87 ppm for HPLC analysis with radiocarbon detection. Recovery of radioactivity by HPLC was greater than 97% of the initially-applied radioactivity for all samples.

In order to confirm the identity of glutaraldehyde and its degradates, aliquots of non-radiolabeled glutaraldehyde were added to two pH 9 buffered solutions in individual containers at 1000 ppm and 100 ppm and were incubated at 70°C for up to 72 hours. Following incubation, aliquots of the 100 ppm and 1000 ppm test solutions were shipped to BASF for GC/MS analysis.

Environmental Fate & Effects Division  
 PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY  
 GLUTARALDEHYDE

Last Update on August 21, 1991

[V] = Validated Study [S] = Supplemental Study [U] = USDA Data

LOGOUT	Reviewer: <i>[Signature]</i>	Section Head: <i>[Signature]</i>	Date: AUG 22 1991
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Common Name: GLUTARALDEHYDE

Smiles Code:

PC Code # : 43901

CAS #: 111-30-8

Caswell #:

Chem. Name : 1,5-pentanedial

Action Type: microbiocide

Trade Names: UCARCIDE

(Formul'tn):

Physical State: VISCID, CLEAR LIQUID

Use : oil field processing systems, preservatives, pulp and paper  
 Patterns : mill systems, industrial cooling water systems, instrument  
 (% Usage) : sterilent, poultry/animal housing facilities (non-food  
 : contact).

Empirical Form: C<sub>5</sub>H<sub>8</sub>O<sub>2</sub>

Molecular Wgt.: 100.12

Vapor Pressure: E Torr

Melting Point : °C

Boiling Point: 80-85 °C

Log Kow :

pKa: @ °C

Henry's :

E Atm. M<sup>3</sup>/Mol (Measured)

Solubility in ...

Comments

Water	E	ppm	@	°C
Acetone	E	ppm	@	°C
Acetonitrile	E	ppm	@	°C
Benzene	E	ppm	@	°C
Chloroform	E	ppm	@	°C
Ethanol	E	ppm	@	°C
Methanol	E	ppm	@	°C
Toluene	E	ppm	@	°C
Xylene	E	ppm	@	°C
	E	ppm	@	°C
	E	ppm	@	°C

Hydrolysis (161-1)

- [V] pH 5.0: stable (t<sub>1/2</sub>: 628 days)
- [V] pH 7.0: stable (t<sub>1/2</sub>: 394 days)
- [V] pH 9.0: stable (t<sub>1/2</sub>: 64 days)
- [V] pH 5.0:70°C> stable (t<sub>1/2</sub>: 53 days)
- [V] pH 7.0:70°C> t<sub>1/2</sub>: 6.5 days
- [V] pH 9.0:70°C> t<sub>1/2</sub>: 5.5 hours

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Environmental Fate & Effects Division  
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY  
GLUTARALDEHYDE

Last Update on August 21, 1991

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Photolysis (161-2, -3, -4)

[ ] Air :  
[ ] Soil :  
[ ] Water:  
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Aerobic Soil Metabolism (162-1)

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Anaerobic Soil Metabolism (162-2)

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Anaerobic Aquatic Metabolism (162-3)

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Aerobic Aquatic Metabolism (162-4)

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Environmental Fate & Effects Division  
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY  
GLUTARALDEHYDE

Last Update on August 21, 1991

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Soil Partition Coefficient (Kd) (163-1)

[S] Aged (30 days) glutaraldehyde residues were mobile to very mobile  
[ ] in loam, silt loam, clay loam and loamy sand soils, with  
[ ] Freundlich Kads values of 0.183-6.3. Kdes values were 0.278-1.55  
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Soil Rf Factors (163-1)

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Laboratory Volatility (163-2)

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Field Volatility (163-3)

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Terrestrial Field Dissipation (164-1)

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Aquatic Dissipation (164-2)

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Forestry Dissipation (164-3)

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PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY  
GLUTARALDEHYDE

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Long-Term Soil Dissipation (164-5)

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Accumulation in Rotational Crops, Confined (165-1)

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Accumulation in Rotational Crops, Field (165-2)

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Accumulation in Irrigated Crops (165-3)

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Bioaccumulation in Fish (165-4)

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Bioaccumulation in Non-Target Organisms (165-5)

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Ground Water Monitoring, Prospective (166-1)

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Ground Water Monitoring, Small Scale Retrospective (166-2)

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Ground Water Monitoring, Large Scale Retrospective (166-3)

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Ground Water Monitoring, Miscellaneous Data (158.75)

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Environmental Fate & Effects Division  
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY  
GLUTARALDEHYDE

Last Update on August 21, 1991

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Field Runoff (167-1)

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Surface Water Monitoring (167-2)

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Spray Drift, Droplet Spectrum (201-1)

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Spray Drift, Field Evaluation (202-1)

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Degradation Products

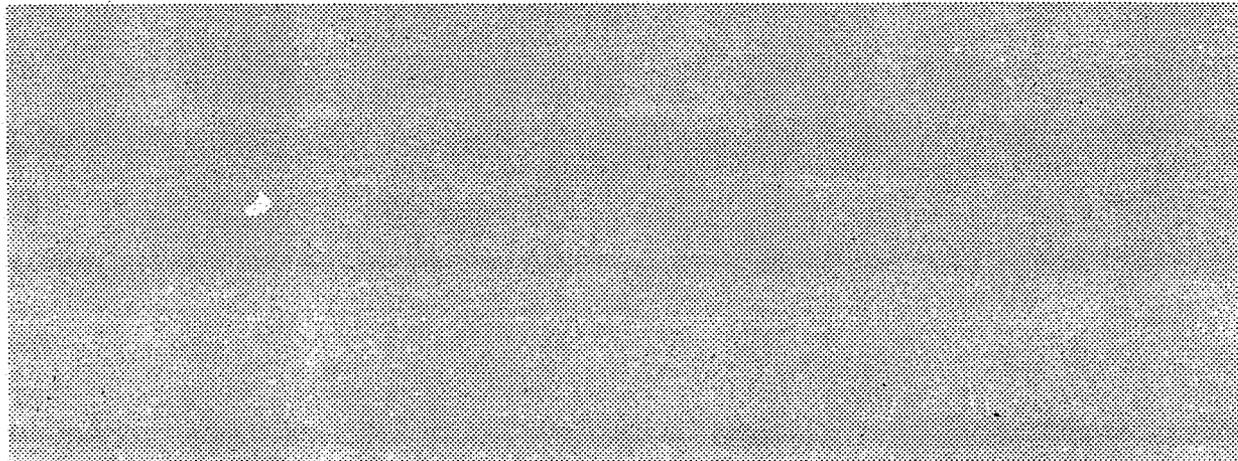
delta valerolactone  
cycloocta 1,5 diene-1,5-dialdehyde  
cycloocta 1,4 diene-2,4-dialdehyde

Environmental Fate & Effects Division  
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY  
GLUTARALDEHYDE

Last Update on August 21, 1991

[V] = Validated Study [S] = Supplemental Study [U] = USDA Data

Comments



References:

Writer : DSS

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Page 15 is not included in this copy.

Pages \_\_\_\_\_ through \_\_\_\_\_ are not included.

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The material not included contains the following type of information:

- Identity of product inert ingredients.
- Identity of product impurities.
- Description of the product manufacturing process.
- Description of quality control procedures.
- Identity of the source of product ingredients.
- Sales or other commercial/financial information.
- A draft product label.
- The product confidential statement of formula.
- Information about a pending registration action.
- FIFRA registration data.
- The document is a duplicate of page(s) \_\_\_\_\_.
- The document is not responsive to the request.

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The information not included is generally considered confidential by product registrants. If you have any questions, please contact the individual who prepared the response to your request.

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TABLE I. MATERIAL BALANCE OF THE TEST SYSTEM AS DETERMINED BY LSC ANALYSIS IN pH 5.0 AQUEOUS BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 111.47 PPM AND INCUBATED IN THE DARK AT 25°C.

Sampling Interval (Hours)	Total Radioactivity <sup>1</sup>	
	% of Initially-Applied	PPM
0	100.00	111.47
23	99.31	110.70
72	104.44	116.42
147	93.36	104.07
264	94.22	105.03
720	95.99	107.00

1. Average of two measurements at each sampling time.

TABLE II. MATERIAL BALANCE OF THE TEST SYSTEM AS DETERMINED BY LSC ANALYSIS IN pH 7.0 AQUEOUS BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 109.39 PPM AND INCUBATED IN THE DARK AT 25°C.

Sampling Interval (Hours)	Total Radioactivity <sup>1</sup>	
	% of Initially-Applied	PPM
0	100.00	109.39
23	102.91	112.57
72	102.73	112.37
147	94.23	103.08
264	95.35	104.31
720	95.17	104.11

1. Average of two measurements at each sampling time.

TABLE III. MATERIAL BALANCE OF THE TEST SYSTEM AS DETERMINED BY LSC ANALYSIS IN pH 9.0 AQUEOUS BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 109.09 PPM AND INCUBATED IN THE DARK AT 25°C.

Sampling Interval (Hours)	Total Radioactivity <sup>1</sup>	
	% of Initially-Applied	PPM
0	100.00	109.09
23	102.25	111.54
72	100.78	109.94
147	95.44	104.11
264	95.95	104.67
720	96.35	105.11

1. Average of two measurements at each sampling time.

TABLE IV. MATERIAL BALANCE OF THE TEST SYSTEM AS DETERMINED BY LSC ANALYSIS IN pH 5.0 AQUEOUS BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 109.77 PPM AND INCUBATED IN THE DARK AT 70°C.

Sampling Interval (Hours)	Total Radioactivity <sup>1</sup>	
	% of Initially-Applied	PPM
0	100.00	109.77
23	105.40	115.70
72	98.56	108.19
147	98.65	108.29
264	91.96	100.95
720 <sup>2</sup>	89.27	97.99

1. Average of two measurements at each sampling time.
2. One measurement at 720 hour post-treatment, due to analytical error.

TABLE V. MATERIAL BALANCE OF THE TEST SYSTEM AS DETERMINED BY LSC ANALYSIS IN pH 7.0 AQUEOUS BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 108.40 PPM AND INCUBATED IN THE DARK AT 70°C.

Sampling Interval (Hours)	Total Radioactivity <sup>1</sup>	
	% of Initially-Applied	PPM
0	100.00	108.4
23	98.39	106.6
72	98.66	106.9
147	96.68	104.8
266	93.97	101.9
720	92.77	100.6

1. Average of two measurements at each sampling time.

TABLE VI. MATERIAL BALANCE OF THE TEST SYSTEM AS DETERMINED BY LSC ANALYSIS IN pH 9.0 AQUEOUS BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE<sup>1</sup> AT 142.20 PPM (EXPERIMENT 1)<sup>1</sup> AND 106.75 PPM (EXPERIMENT 2) AND INCUBATED IN THE DARK AT 70°C.

Sampling Interval (Hours)	Total Radioactivity <sup>2</sup>		
	% of Initially-Applied	PPM	
Experiment 1	0 <sup>1</sup>	100.00	142.20
	1	99.11	140.93
	1.5	101.42	144.21
	2.5	98.43	139.96
	4	98.56	140.15
	7	100.20	142.48
Experiment 2	0	100.00	106.75
	23	98.85	105.52
	72	100.19	106.95
	147	94.47	100.85
	264	96.54	103.06
	720	98.46	105.11

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TABLE VII. HYDROLYSIS OF GLUTARALDEHYDE AS DETERMINED BY HPLC AND LSC ANALYSES<sup>1</sup> OF pH 5.0 BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 111.47 PPM AND INCUBATED IN THE DARK AT 25°C.

Incubation Time Hours	Glutaraldehyde	Total
<u>% OF INITIALLY-APPLIED RADIOACTIVITY</u>		
0	96.60	96.60
23	96.27	96.27
72	101.05	101.05
147	90.05	90.05
264	92.62	92.62
720	94.23	94.23
<u>PPM</u>		
0	107.68	107.68
23	106.57	106.57
72	117.64	117.64
147	93.71	93.71
264	97.28	97.28
720	105.04	105.04

1. No degradate greater than or equal to 10% of the initially-applied radioactivity was detected. Detection limit using radioactive flow detector was 0.87 ppm (0.80% of initially-applied).

TABLE VIII. HYDROLYSIS OF GLUTARALDEHYDE AS DETERMINED BY HPLC AND LSC ANALYSES<sup>1</sup> OF pH 7.0 BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 109.4 PPM AND INCUBATED IN THE DARK AT 25°C.

Incubation Time Hours	Glutaraldehyde	Total
<u>% OF INITIALLY-APPLIED RADIOACTIVITY</u>		
0	96.61	96.61
23	99.25	99.25
72	99.71	99.71
147	91.55	91.55
264	94.00	94.00
720	93.06	93.06
<u>PPM</u>		
0	105.68	105.68
23	111.73	111.73
72	112.05	112.05
147	94.37	94.37
264	98.05	98.05
720	96.88	96.88

1. No degradate greater than or equal to 10% of the initially-applied radioactivity was detected. Detection limit using radioactive flow detector was 0.87 ppm (0.80% of initially-applied).

TABLE IX. HYDROLYSIS OF GLUTARALDEHYDE AS DETERMINED BY HPLC AND LSC ANALYSES<sup>1</sup> OF pH 9.0 BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 109.09 PPM AND INCUBATED IN THE DARK AT 25°C.

Incubation Time Hours	Glutaraldehyde	Delta-Valerolactone	Total
<u>% OF INITIALLY-APPLIED RADIOACTIVITY</u>			
0	96.29	0.89	97.18
23	97.89	1.91	99.80
72	94.63	3.45	98.08
147	86.60	6.23	92.83
264	85.38	10.56	95.94
720	70.08	25.05	95.13
<u>PPM</u>			
0	105.04	0.97	106.01
23	106.78	2.08	108.86
72	103.23	3.76	106.99
147	94.47	6.79	101.26
264	93.14	11.52	104.67
720	76.45	20.25	96.70

1. Detection limit using radioactive flow detector was 0.87 ppm (0.80% of initially-applied).

TABLE X. HYDROLYSIS OF GLUTARALDEHYDE AS DETERMINED BY HPLC AND LSC ANALYSES OF pH 5.0 BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 109.8 PPM AND INCUBATED IN THE DARK AT 70°C.

Incubation Time Hours	Glutaraldehyde	Delta-Valerolactone	Glutaraldehyde Condensation Isomers	Total
<u>% OF INITIALLY-APPLIED RADIOACTIVITY</u>				
0	96.45	0.87	ND <sup>1</sup>	97.32
23	101.88	1.33	ND	103.21
72	94.61	1.19	ND	95.80
147	94.02	1.79	ND	95.81
264	88.56	1.73	ND	90.29
720	68.46	4.26	14.62	87.34
<u>PPM</u>				
0	96.80	0.96	ND	97.76
23	102.25	1.54	ND	103.79
72	94.95	1.28	ND	96.23
147	94.36	1.93	ND	96.29
264	88.88	1.75	ND	90.63
720	68.70	4.00	14.33	87.03

1. Detection limit using radioactive flow detector was 0.87 ppm (0.80% of initially-applied).

TABLE XI. HYDROLYSIS OF GLUTARALDEHYDE AS DETERMINED BY HPLC AND LSC ANALYSES OF pH 7.0 BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 108.4 PPM AND INCUBATED IN THE DARK AT 70°C.

Incubation Time Hours	Glutaraldehyde	Delta-Valerolactone	Glutaraldehyde Condensation Isomers	Total
<u>% OF INITIALLY-APPLIED RADIOACTIVITY</u>				
0	96.53	0.92	ND <sup>1</sup>	97.45
23	91.25	4.90	ND	96.15
72	82.51	13.55	ND	95.70
147	67.45	26.10	ND	93.55
264	40.12	35.48	15.91	91.51
720	10.15	20.00	57.17	87.32
<u>PPM</u>				
0	104.63	0.99	ND	105.62
23	97.31	5.23	ND	102.54
72	88.23	14.49	ND	102.72
147	70.68	27.35	ND	98.03
264	40.86	36.13	16.20	93.20
720	10.21	20.11	57.48	87.80

1. Not detected; detection limit using radioactive flow detector was 0.87 ppm (0.80% of initially-applied).

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TABLE XII. HYDROLYSIS OF GLUTARALDEHYDE AS DETERMINED BY HPLC AND LSC ANALYSES OF pH 9.0 BUFFERED SOLUTIONS TREATED WITH <sup>14</sup>C-GLUTARALDEHYDE AT 142.2 PPM (EXPERIMENT 1) AND 106.75 PPM (EXPERIMENT 2) AND INCUBATED IN THE DARK AT 70°C.

Incubation Time Hours	Glutaraldehyde	Delta-Valerolactone	Glutaraldehyde Condensation Isomers	Total	
<b>% OF INITIALLY-APPLIED RADIOACTIVITY</b>					
Expt. 1	0	80.94	ND <sup>1</sup>	19.07	100.01
	1.0	71.62	8.22	19.26	99.10
	1.5	69.97	13.29	19.35	102.61
	2.5	59.34	18.85	20.24	98.43
	4	49.42	29.56	20.37	99.25
	7	33.66	45.11	20.71	99.47
Expt. 2 <sup>2</sup>	23	ND	67.64	25.22	92.86
	72	ND	71.69	19.53	91.22
	147	ND	67.94	17.57	85.85
	264	ND	72.31	18.08	90.40
	720	ND	71.69	15.73	87.42
<b>PPM</b>					
Expt. 1	0	115.09	ND	27.11	142.20
	1	100.93	11.59	27.14	140.42
	1.5	100.90	19.17	27.90	147.97
	2.5	83.06	26.38	28.32	137.76
	4	69.26	41.44	28.52	139.22
	7	47.96	64.27	29.50	141.73
Expt. 2 <sup>2</sup>	23	ND	71.38	26.61	97.99
	72	ND	76.67	20.88	97.55
	147	ND	68.51	17.71	86.22
	264	ND	74.52	18.63	93.15
	720	ND	74.50	16.34	90.84

1. Not detected; detection limit using radioactive flow detector was 0.87 ppm (0.80% of initially-applied).
2. At Time 0 (Experiment 2), glutaraldehyde accounted for 96.27% (102.77 PPM) of the initially-applied radioactivity and valerolactone accounted for 0.78% (0.83 PPM).

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