LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

LLNL-TR-747321

Ultraviolet (UV) Oxidation Final Report CRADA No. TC-0350-92

F. Wang, S. Oster

March 6, 2018

Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Ultraviolet (UV) Oxidation

Final Report
CRADA No. TC-0350-92

Date: September 16, 1997 Revision: 1

A. Parties

The project is a relationship between the Lawrence Livermore National Laboratory (LLNL) and Ionization Research Co., Inc.

University of California
Lawrence Livermore National Laboratory
7000 East Avenue, L-795
Livermore, CA 94550

Ionization Research Co., Inc.
1823 Houret Court
Milpitas, CA 95035

B. Project Scope

This CRADA was a collaborative agreement between the above parties to develop a more efficient ultraviolet (UV) oxidation process than the existing commercial processes. The proposed new process would be capable of completely mineralizing the organic constituents in aqueous mixed-wastes (wastes that contain both radioactive and organic constituents) and converting them into ordinary radioactive wastes, which would mean cheaper and easier disposal.

C. Technical

Milestones and Deliverables	Completion Date Scheduled	Actual	Attached
(1) Complete preliminary parametric studies on model contaminants and demonstrate the mineralization contaminants.	02/94	02/94	Report #1
(2) Completed the preliminary comparison study between a xenon flashlamp and a mercury lamp. The xenon flashlamp is ~2 times more efficient than the mercury lamp.	06/94	06/94	Report #2
(3) Complete treatability tests on destructing oxalic acid and tributylphosphate in both HCL and HNO3 solutions..	09/94	09/94	Report #3
(4) Complete the evaluation of a least one excimer lamp. The delivery of an excimer lamp from Russia is delayed for at least 8 months. The delay is due to the difficult conditions in Russia. For example, they were unable to obtain large size of quartz tubings. We have to provide the tubings. The excimer lamp will be delivered to LLNL in July 1995	12/95	05/96	Report #2
(5) Complete the building of a bench-scale system, using the best lamp.	04/95	Cancelled due to reduction in funding	
(6) Complete testing and optimization of the bench-scale system.	02/96		
(7) Complete the design of a commercial process and the economic evaluation.	06/96	Cancelled due to reduction in funding	

D. Partner Contribution

In phase one, LLNL was primarily responsible for identifying the optimum conditions for achieving an efficient UV/H_2O_2 process using a microwave-pumped mercury lamp. Ionization Research Co./Ecosolutions (IRCES) consulted and carried out some experimental work. In phase two, IRCES was primarily responsible for building and testing the efficient bench-scale UV/H_2O_2 system. IRCES was also responsible for designing and evaluating the economics of a pilot or commercial-scale UV/H_2O_2 process for treating aqueous waste streams, with LLNL consulting.

E. Documents/Reference List

Quarterly Reports:

07/01/93 - 09/30/93
10/01/93 - 12/31/93
01/01/94 - 03/31/94
04/01/94 - 06/30/94
07/01/94 - 09/30/94
10/01/94 - 12/31/94
01/01/95 - 03/30/95
04/01/95 - 06/30/95
07/01/95 - 09/30/96

F. Acknowledgment

Participant's signature of the final report indicates the following:

1) The Participant has reviewed the final report and concurs with the statements made therein.
2) The Participant agrees that any modifications or changes from the initial proposal were discussed and agreed to during the term of the project.
3) The Participant certifies that all reports either completed or in process are listed and all subject inventions and the associated intellectual property protection measures attributable to the project have been disclosed or are included on a list attached to this report.
4) The Participant certifies that if real property was exchanged during the agreement, all has either been returned to the initial custodian or transferred permanently.
5) The Participant certifies that proprietary information has been returned or destroyed by LLNL.

Steve Oster 3/15/98
Steve Oster Date
Ionization Research Co., Inc.

Francis Wang 4-6-98
Francis Wang Date
Lawrence Livermore National Laboratory

Attachment I – Final Abstract
Attachment II – Project Accomplishments Summary
Attachment III – Final Quarterly Report

Ultraviolet (UV) Oxidation

Final Abstract
Attachment I
CRADA No. TC-0350-92

Ultraviolet/hydrogen peroxide (UV/H_2O_2) oxidation has been used in groundwater remediation, where large volumes of effluent containing traces of organic contaminants are treated. With appropriate UV wavelength (200-250 nm), hydrogen peroxide undergoes photochemical decomposition by the UV light to produce OH· radicals that are capable of oxidizing many organic compounds stepwise to complete mineralization. In general, the treatment is acceptable if toxic organic compounds are partially oxidized into nontoxic compounds. However, use of the UV/H_2O_2 process to treat aqueous mixed-waste streams has not been demonstrated. Such application requires complete mineralization of organic constituents and is quite different from "polishing" relatively clean groundwater. The radioactive components should not effect the mineralization of organic in the UV/H_2O_2 process.

Lawrence Livermore National Laboratory is operated by the University of California for the U.S. Department of Energy
Technical Transfer Initiatives Program, P.O. Box 808 L-795, Livermore, CA 94551

Ultraviolet (UV) Oxidation

Project Accomplishments Summary (Attachment II)
CRADA No. TC-0350-92

Date: September 16, 1997 Revision: 0

A. Parties

The project is a relationship between the Lawrence Livermore National Laboratory (LLNL) and Ionization Research Co., Inc.

University of California
Lawrence Livermore National Laboratory
7000 East Avenue, L-795
Livermore, CA 94550

Ionization Research Co., Inc.
1823 Houret Court
Milpitas, CA 95035

B. Background

Ultraviolet Oxidation technology uses UV light to generate oxidizing species that can mineralize many organic compounds in aqueous solutions (i.e., all carbon atoms are oxidized to CO_2, hydrogen atoms to H_20, and other nonmetallic elements to corresponding anions). The UV light can also directly excite organic compounds, making them more reactive and susceptible to oxidation. Among several demonstrated UV oxidation technologies, ultraviolet/hydrogen peroxide is the best established process. This CRADA was proposed to work on improving this technology.

C. Description

Ultraviolet/hydrogen peroxide (UV/H_2O_2) oxidation has been used in groundwater remediation, where large volumes of effluent containing traces of organic contaminants are treated. With appropriate UV wavelength (200-250 nm), hydrogen peroxide undergoes photochemical decomposition by the UV light to produce OH· radicals that are capable of oxidizing many organic compounds stepwise to complete mineralization. In general, the treatment is acceptable if toxic organic compounds are partially oxidized into nontoxic compounds. However, use of the UV/H_2O_2 process to treat aqueous mixed-waste streams has not been demonstrated. Such application requires complete mineralization of organic constituents and is quite different from "polishing" relatively clean groundwater. The radioactive components should not effect the mineralization of organic in the UV/H_2O_2 process.

D. Expected Economic Impact

Tangible benefits will include the development of a UV/H_2O_2 process that is more efficient to mineralize organic components in a waste stream than the existing processes. This may lead to patentable and licensable materials which should generate income for LLNL, IRCES and DOE and provide a technical competitive advantage for IRCES in the water treatment industry, including both groundwater remediation and treating industrial waste water for reuse.

E. Benefits to DOE

Several of the DOE/DP sites are on the superfund list. Environmental and waste management problems at the DOE weapons facilities are serious and costly to correct. To conduct a more effective cleanup, new technologies must be developed and existing technologies must be improved. UV oxidation is very promising as a technology for treatment of aqueous mixed wastes. It appears that it will be able to convert mixed waste into non-mixed waste by mineralizing the organic components. After the treatment, water could be reused in the plant or released to the environment if all the impurities have been removed. Successful demonstration of a bench-scale UV/H_2O_2 process can lead to a full-scale demonstration of the technology.

Large quantities of aqueous mixed wastes are stored at many DOE weapons facilities. The wastes cannot be disposed of because there is no suitable treatment technology. As examples, at the LLNL site alone there are about 35 cubic meters (m3) of water/Trimsol/uranium wastes and 190 m3 of other waste waters. The UV oxidation technology can also be used to treat nonmixed aqueous waste streams, such as aqueous wastes from high explosive handling processes.

F. Industry Area

Industrial waste treatment industry.

G. Project Status

LLNL's portion of the CRADA was completed.

H. LLNL Point of Contact for Project Information

Francis Wang
P.O. Box 808, L-365
Livermore, CA 94551
PH:(510) 423-7305
FX: (510) 423-2389

I. Company Size and Point(s) of Contact

Company Size: XX? employees
Point of Contact: Steve Oster, PH: (408) 451-4294, FX: (408) 935-8054

J. Project Examples

K. Release of Information

I certify that all information contained in this report is accurate and releasable to the best of my knowledge.

Karena McKinley, Director
Industrial Partnerships
and Commercialization

12/15/95
Date

RELEASE OF INFORMATION

I have reviewed the attached Project Accomplishment Summary prepared by Lawrence Livermore National Laboratory and agree that the information about our CRADA may be released for external distribution.

Steve Oster
Ionization Research Co., Inc.

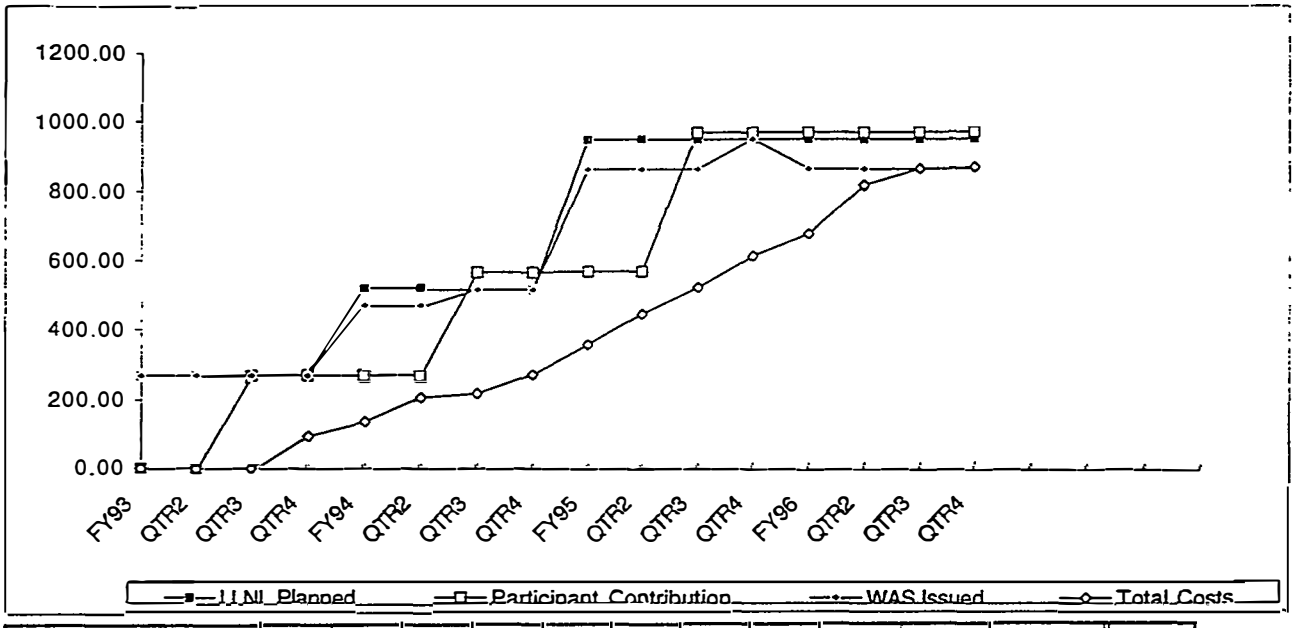
3/15/98
Date

Lawrence Livermore National Laboratory

Title:	Ultraviolet (UV)Oxidation	Reporting Period:	07/01/95 - 09/30/96
Participant:	Ionization Research Co.	Date CRADA Executed:	6/11/93
DOE TTI No.:	93-LLNL-081-C1	DOE Approval Date:	6/1/93
CRADA No.:	TC-0350-92	Scheduled Ending Date:	6/11/96
TACT:	E&E	Project Completed:	9/30/96
Account Numbers	4705-04	B & R Code (S):	DP0301
Account Closed:	9/30/96		35DP03

Approved Funding Profile (SK)

	FY93	FY94	FY95	FY96	FYOUT	Total
LLNL Planned	270	250	430	0	0	950
Participant In-Kind	270	300	400	0	0	970
Participant Funds-In	0	0	0	0	0	0
WAS DP0301	270	250	430	-87	0	863
WAS 35DP03	0	0	0	0	0	0
Total Costs	101	175	337	254	0	866



DP0301	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	FYTD	866
FY93	0	0	0	0	0	0	0	0	0	32	46	23	101	
FY94	15	14	11	8	26	35	1	9	2	13	17	25	175	
FY95	29	27	28	30	40	17	33	27	18	25	28	35	337	
FY96	26	22	17	51	48	40	35	7	5	-9	13	0	254	
FYOUT	0	0	0	0	0	0	0	0	0	0	0	0	0	

35DP03	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	FYTD	0
FY93	0	0	0	0	0	0	0	0	0	0	0	0	0	
FY94	0	0	0	0	0	0	0	0	0	0	0	0	0	
FY95	0	0	0	0	0	0	0	0	0	0	0	0	0	
FY96	0	0	0	0	0	0	0	0	0	0	0	0	0	
FYOUT	0	0	0	0	0	0	0	0	0	0	0	0	0	

STAFF w/phone:

Lab PI:	Francis Wang (510) 422-7305	Participant:	Steve Oster (408) 451-4294
Resource Manager:	Ilene Detherow (510) 422-1853		
DOE OAK:	Jerry Scheinberg (510) 637-1653	DOE HQ:	M. Michaelis (202) 586-4105

Lawrence Livermore National Laboratory

Reporting Period: 07/01/95 - 09/30/96
DOE TTI No.: 93-LLNL-081-C1
CRADA No.: TC-0350-92

Milestones and Deliverables:

List the complete set of milestones for all phases of the CRADA. Continue on a separate page if necessary.
Report any changes from the original CRADA or previous quarterly report on the CRADA Change Form.

	Completion Date: Scheduled	Actual
1. Complete preliminary parametric studies on model contaminants and demonstrate the mineralization contaminants.	02-94	02-94
2. Completed the preliminary comparison study between a xenon flashlamp. and a mercury lamp. The xenon flashlamp is ~2 time more efficient than the mercury lamp.	06-94	06-94
3. Complete treatability tests on at least one real (but cold) waste stream. Complete the treatability tests on destructing oxalic acid and tributylphosphate in both HCl and HNO3 solutions	09-94	09-94
4. Complete the evaluation of at least one excimer lamp. The delivery of an excimer lamp from Russia is delayed for at least 8 months. The delay is due to the difficult conditions in Russia. For example, they were unable to obtain large size of quartz tubings. We have to provide the tubings. The excimer lamp will be delivered to LLNL in July 1995	12-94	delayed to 05/96
5. Complete the building of a bench-scale system, using the best lamp.	04-95	Cancelled due
6. Complete testing and optimization of the bench-scale system.	02-96	to reduction
7. Complete the design of a commercial process and the economic evaluation.	06-96	in funding

Verification of participants' in-kind contribution was made in accordance with LLNL policy. Explain basis of verification: Please initial: YES X NO ____

List any subject inventions by either party (include IL# for LLNL inventions), additional background intellectual property, patents applied for, software copyrights, publications, awards, licenses granted or reportable economic impacts

Verification that all equipment and proprietary information has been returned to the initial owner or permanently transferred Please initial: YES X NO ____

Accomplishments

Describe Technical/Non-Technical lessons learned and other observations.
Summarize causes/justification of deviations from original scope of work.

See Final Report.

Reviewed by CRADA project Program Manager: Date:

Reviewed by Karena McKinley, Director, LLNL/IP&C: Karena McKinley Date: 12/15/98

Direct questions regarding this Report to IP&C Resource Manager, Carol Asher, at (510) 422-7618