AQUATECH

Allied-Signal Inc.
AQUATECH Systems
7 Powder Horn Drive
P.O. Box 4904
Warren, NJ 07059-5191 U.S.A.

DOE/PC/91347--T5

Allied Signal

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August 3, 1993

Quarterly Report Period April - June, 1993

CONTRACT TITLE AND NUMBER:

SOXAL Combined SOx/NOx Flue Gas Control Demonstration

DE AC 22-91 PC 91347

Contractor Name: AQUATECH Systems
7 Powder Horn Drive
Warren, NJ 07059-5191

Contract Period: 9-10-91 - 7-1-93

1. Contract Objective: No Change

Summary of Work -

AQUATECH Systems, a business unit of Allied-Signal Inc., proposes to demonstrate the technical viability and cost effectiveness of the SOXAL process a combined SO_x/NO_x control process on a 3 MW equivalent flue gas slip stream from Niagara Mohawk Power Corporation, Dunkirk Steam Station Boiler #4, a coal fired boiler. The SOXAL process combines 90+% sulfur dioxide removal from the flue gas using a sodium based scrubbing solution and regeneration of the spent scrubbing liquor using AQUATECH Systems' proprietary bipolar membrane technology. This regeneration step recovers a stream of sulfur dioxide suitable for subsequent processing to salable sulfur or sulfuric acid.

Additionally 90+% control of NO_x gases can be achieved in combination with conventional urea/methanol injection of NO_2 gas into the duct. The SOXAL process is applicable to both utility and industrial scale boilers using either high or low sulfur coal.

The SOXAL demonstration Program began September 10, 1991 and is approximately 22 months in duration.

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During the 6 months of scheduled operations period, begun in January 1993, data will be collected from the SOXAL system to define:

1) SO_2 and NO_x control efficiencies

2) Current efficiency for the regeneration unit.

3) Sulfate oxidation in the absorber.

4) Make-up reagent rates.

5) Product quality including concentrations and compositions.

6) System integration and control philosophy

7) Membrane stability and performance with respect to foulants.

The program is expected to be concluded by November 1993.

Technical Approach Changes: No Change

Contract (by reporting element):

Task 1: Program Definition - Complete

Task 2: Engineering, Design and Construction - Complete

Task 3: Shakedown, Parametric Testing, and Disassembly

Subtask 3.1: Shakedown

Process shakedown was completed in December 1992. However, several key items have not yet been satisfactorily commissioned. The Lear-Siegler gas analyzer has not yet operated. The NO_2 injection system was checked out and commissioned in June.

Subtask 3.2: Parametric Tests

Parametric testing commenced on January 6, 1993. Between January 8 and March 5, the pilot plant was operated continuously (7 days per week, 24 hours per day). The plant was easy to operate and control. However, several problems made data collection during this period difficult. These included the lack of any gas analyses, unreliable flow sensors, and inappropriate materials of construction.

Niagara Mohawk shut down Unit No. 4 boiler on March 5 and attempted to resume operations on April 7. During the shutdown, we addressed a number of major and minor problems affecting plant operation. Most notably, we arranged for an outside CEM service (Acres International) to provide analyses of our inlet and outlet gas streams. Additionally, we had engineering companies (United Engineers and Constructors, Radian Corporation) review plant equipment and operations. They have recommended a number of minor instrumentation changes to improve control and reliability of the plant.

We also learned that Niagara Mohawk's summer schedule would not provide base-loaded boiler operation for the remainder of our testing. They planned to shut the boiler down during the weekends and operate it at reduced load during the night. We adapted to this change by rescheduling our testing for 24- hour, 5 day operation. operation of either the absorption or regeneration processes was planned to provide a testing window with consistent flue gas conditions.

Parametric testing resumed on April 26. The first two weeks of testing were used to reestablish baseline operating conditions with continuous operation. Following that we used our new procedures to verify that test results from decoupled operation would be comparable to results from continuous operation. The remaining weeks in May and June were devoted to an assortment of absorption and regeneration tests. These tests included an artificial increase in SO_2 concentration and preliminary tests of NO_2 injection. The attached table summarizes the data taken during this quarter. A thorough evaluation of these results has not been completed.

Lear Siegler attempted to fix their gas analysis equipment during April and May, without success. We are attempting to negotiate a return of their equipment and a refund of our money.

C. M. Denker

Clifford M. Denker
Program Manager

CMD:cml

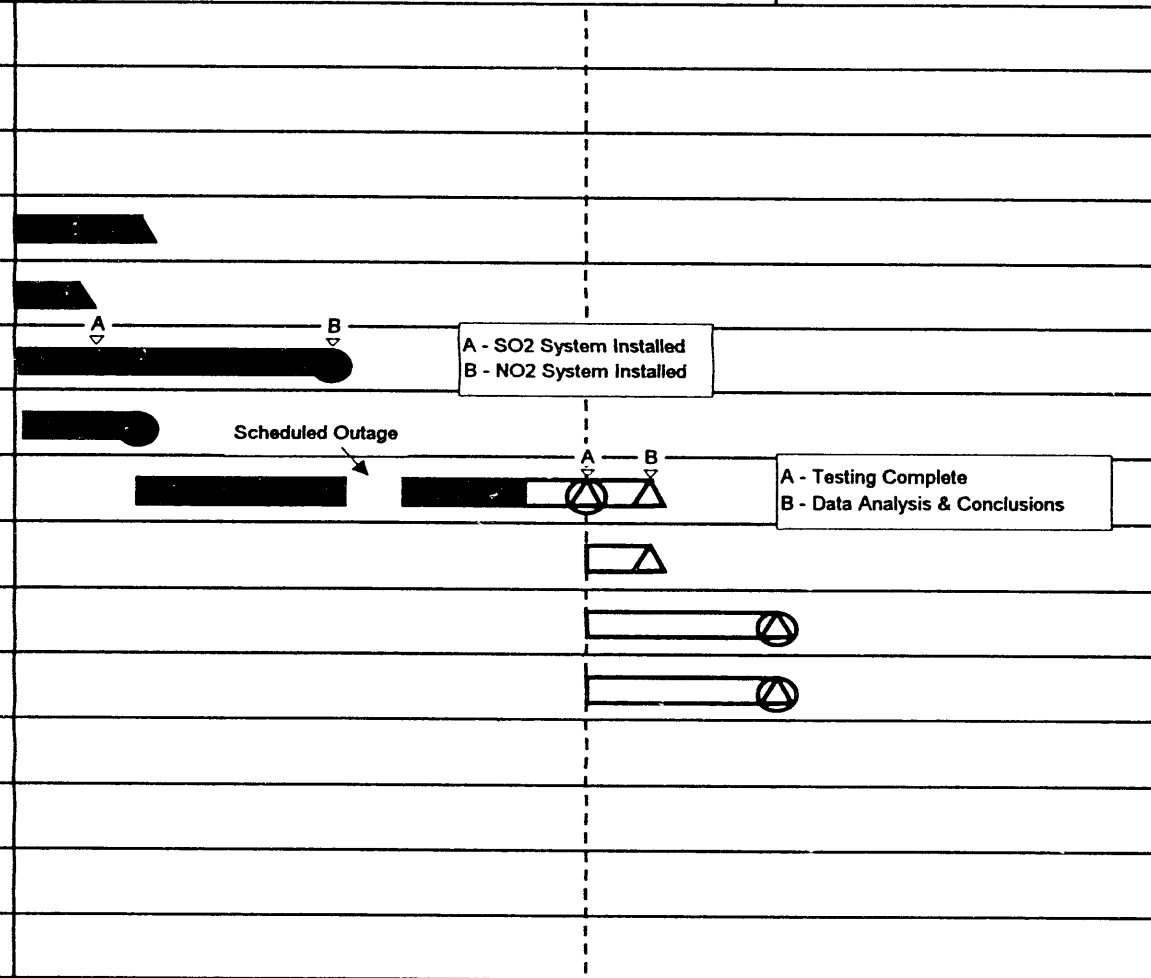
Attachments:
Milestone Schedule - June 1993
Parametric Testing Summary - April thru June 1993

DOE F1332.3 (substitute)

U.S. DEPARTMENT OF ENERGY

MILESTONE SCHEDULE ☐ PLAN ■ STATUS REPORT

1. TITLE *Combined SOx/NOx Control via SOXAL™ Process: Electrodialytic Regenerative Wet Scrubbing Process*	2. REPORTING PERIOD *June 1993*	3. IDENTIFICATION NUMBER *DE AC 2291 PC 91347*
4. PARTICIPANT NAME AND ADDRESS *Allied-Signal Inc., AQUATECH Systems* *7 Powder Horn Drive* *Warren, NJ 07059-5191*		5. START DATE *September 10, 1991* 6. COMPLETION DATE *September 1993*



7. ELEMEN CODE	8. REPORTING ELEMENT	FY 95	FY 96	10. PERCENT COMPLETE a. Plan	10. PERCENT COMPLETE b. Actual
1.1	*Cost Management Plan*			100	100
1.2	*Test Plan/Design Basis*			100	100
2.1	*Engineering Contract*			100	100
2.2	*Procurement*			100	100
2.3	*Site Work*			100	100
2.4	*Installation*			100	100
3.1	*Shakedown*			100	100
3.2	*Parametric Test*			85	70
3.3	*Disassembly*			0	0
4.1	*Conceptual Design*			0	0
4.2	*Economic Analysis*			0	0

11. SIGNATURE OF PARTICIPANT'S PROJECT MANAGER AND DATE

Parametric Testing Summary
April - June 1993

Test Description and Results - Daily Averages[1]

Test Code	Test Date	Test Description	SO2 Concentration (ppm)	Flue Gas Flow Rate (DSCFM)	SO2 Absorption (%)	Power Consumed (kWh/t SO2)	Current Efficiency (%)
A	4/26	Simultaneous[2] Baseline					101.4
A	4/27	Simultaneous[2] Baseline					81.6
A	4/28	Simultaneous[2] Baseline					83.9
A	4/29	Simultaneous[2] Baseline	916	7992[3]	98.8		98.2
A	4/30	Simultaneous[2] Baseline	1,202		99.3		86.6
A/H1	5/6	Simultaneous[2] Baseline with 1.25x Feed to Base	1,062	5,205	96.3		63.1
A/H1	5/7	Simultaneous[2] Baseline with 1.25x Feed to Base	1,115	4,798	97.5		60.8
A/H2	5/3	Simultaneous[2] Baseline with 1.5x Feed to Base	1,149	7562[3]	98.9		90.7
A/H2	5/4	Simultaneous[2] Baseline with 1.5x Feed to Base	1,189	7366[3]	97.2		71.7
A/H2	5/5	Simultaneous[2] Baseline with 1.5x Feed to Base	988	4,758	96.6		66.0
B	5/10	Absorber Baseline	861	5,201	96.8		
B	5/11	Absorber Baseline	1,385	5,609	98.7		
B	5/12	Absorber Baseline	1,365	5,201	98.8		
B	5/28	Absorber Baseline	1,316	5,709	98.4		
C	5/13	Cellstack Baseline				1,122	93.3
C	5/14	Cellstack Baseline				1,251	90.3
C	5/26	Cellstack Baseline				1,082	96.4
D1	5/17	Absorber Bottoms at 5:1 Ratio Bisulfite:Sulfite	1,361	5,309	99.6		
D1	5/18	Absorber Bottoms at 5:1 Ratio Bisulfite:Sulfite	1,278	5,175	98.9		
D1	5/19	Absorber Bottoms at 5:1 Ratio Bisulfite:Sulfite	1,085	5,711	91.9		
D1	6/10	Absorber Bottoms at 5:1 Ratio Bottoms	1,182	5,402	97.7		
D2	5/20	Absorber Bottoms at 1:1 Ratio Bisulfite:Sulfite	1,086	5,744	100.0		
E2	5/21	Absorber Recycle at 60 gpm	1,146	5,880	97.9		
E3	5/24	Absorber Recycle at 45 gpm	1,123	5,771	95.9		
F1	5/25	Absorber with One Stage	1,211	5,865	82.7		
G	6/7	Absorber with Recycled SO2	2,141	5,407	99.6		
G	6/8	Absorber with Recycled SO2	2,167	5,394	100.0		
G2	6/9	Absorber with Recycled SO2, 5:1 Ratio Bottoms	2,228	5,377	99.4		
H	6/30	Simultaneous with Recycled SO2	1,977	5,046	99.9		
H2	5/27	Cellstack with 1.25x Feed to Base				1,131	79.0
I1	6/1	Cellstack at 80 ASF				1,049	101.2
I2	6/2	Cellstack at 125 ASF				1,331	77.8
J1	6/3	Cellstack at 80% Acid Conversion				1,334	82.0
J2	6/4	Cellstack at 120% Acid Conversion				1,292	81.4
K	6/24	NO2 Injection at 150 ppm	817	5,118	99.9		
K2	6/28	NO2 Injection at 60 ppm	1,208	5,117	99.2		
K2	6/29	NO2 Injection at 70 ppm	1,118	4,869	99.9		
U1	6/14	Absorber Recycle at 45 gpm, 5:1 Ratio Bottoms	1,069	5,398	93.6		
U2	6/15	Absorber Recycle at 75 gpm, 5:1 Ratio Bottoms	1,097	5,376	94.3		
V	6/16	Cellstack with 5:1 Ratio Feed				1,152	66.6

Notes:

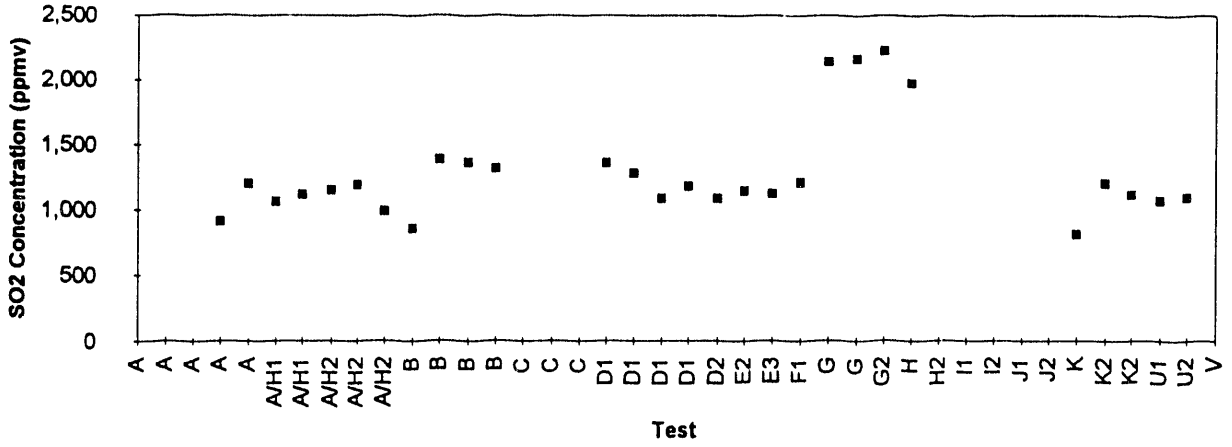
1 Data taken between 4/26/93 - 6/30/93. Each data point typically represents the average of four measurements taken during an eight-hour test.

2 Simultaneous indicates continuous operation of both absorption and regeneration processes. All other tests conducted are decoupled.

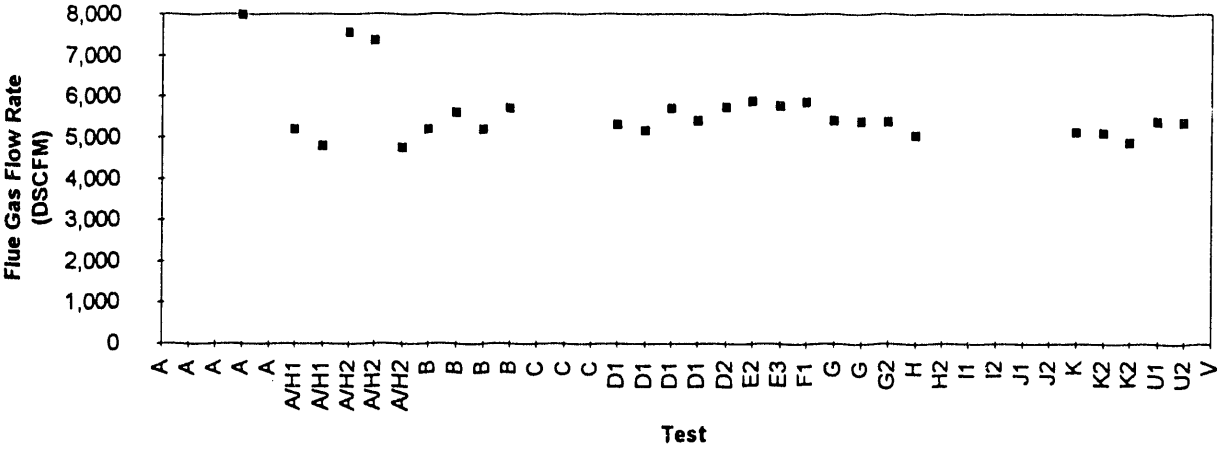
3 These flow rates in ACFM. All others in Dry SCFM.

Parametric Testing Summary
April - June 1993

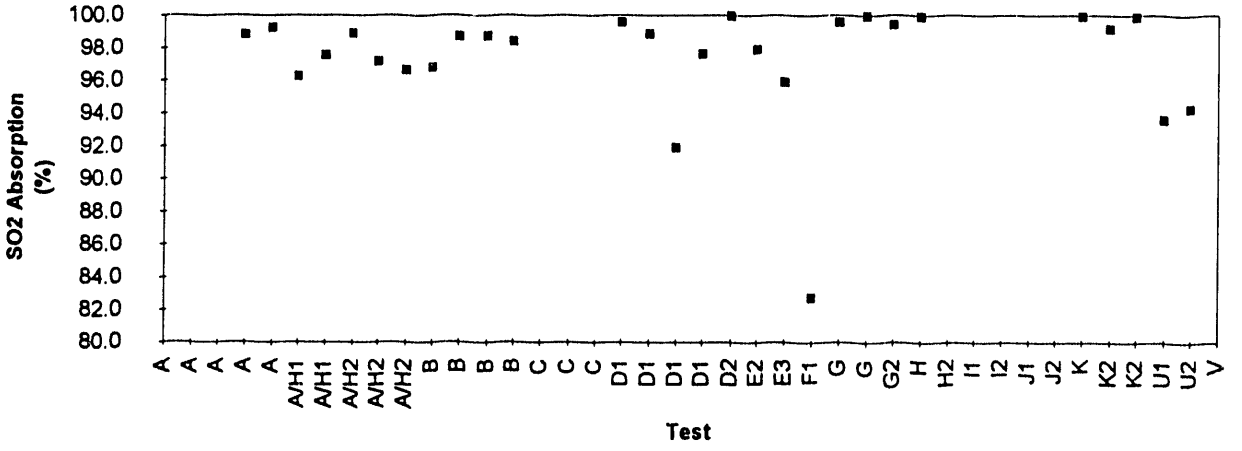
SO2 Inlet Concentration



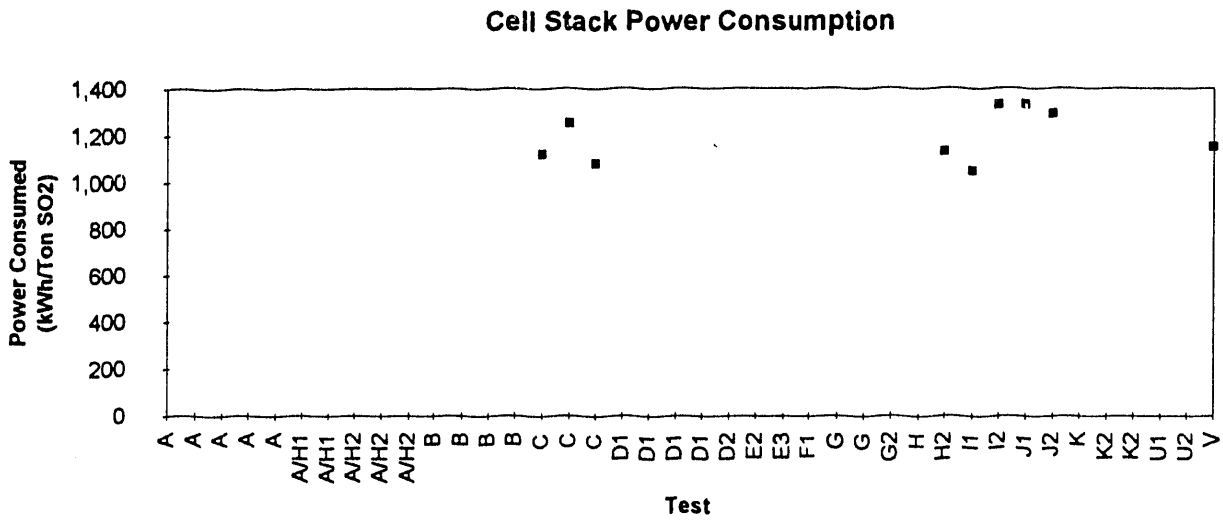
Flue Gas Flow Rate

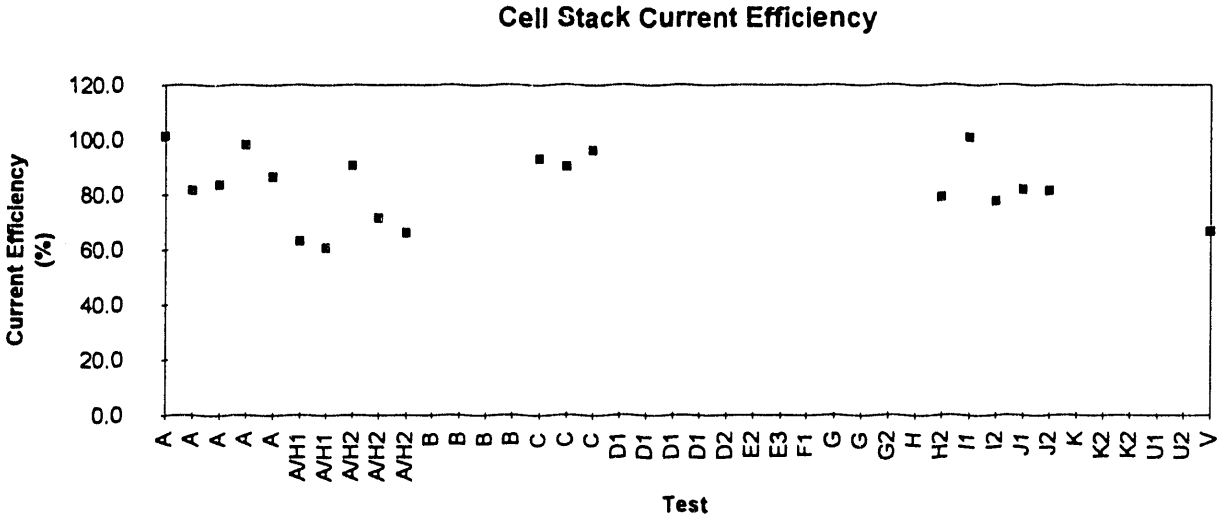


SO2 Absorption Efficiency



Parametric Testing Summary
April - June 1993





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