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DISSOLVER ANTI-FOAM JETS 0 9

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DISSOLVER ANTI-FOAM JETS

Prepared By

J. Robert LaRiviere and L. R. Michels

October 17, 1956

Extraction Design & Development
Facilities Engineering Operation
CHEMICAL PROCESSING DEPARTMENT**DISCLAIMER**

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DISSOLVER ANTI-FOAM JETSINTRODUCTION

Current Purex dissolver operations are now limited both by inadequate iodine removal facilities and poor dissolver tower flexibility. Following completion of the new backup iodine removal facility (Project CG-647), the new electrical off-gas heaters (Project CA-513-A) and the new Prototype Silver Reactor, iodine liberation should no longer be a factor in limiting Purex dissolver operations. At that time, dissolver tower performance would be the remaining bottleneck in the dissolver systems.

In early Purex dissolving operations it was noted that dissolver tower differential pressure readings were excessively high during cuts at the higher dissolution rates. The high differential pressure condition caused the dissolvers to become pressurized during cuts, thereby permitting escape of radioactivity into the canyon ventilation system. It was noted however, that a continuous air sparge of about 25 SCFM could usually maintain tower dp within reasonable limits at low dissolving rates. The air sparge was introduced into the bottom of the dissolvers and thus sparged the entire column of dissolver solution. Continuous sparging of dissolver solution is undesirable because of (1) increased duty on iodine removal equipment, and (2) inability to control tower differential pressure at high dissolution rates, resulting in inadequate acid recovery and unnecessary contamination of the canyon ventilation filter.

PURPOSE

The purpose of this report is (1) to present observations, developed jointly with Purex Technology Operation, which support the "foam" theory for high dissolver tower differential pressure, and (2) to recommend the installation of test jets in a dissolver jumper which should destroy dissolver foam and thereby improve overall dissolver performance.

SUMMARY & CONCLUSIONS

Various theories are presented in this report as to the cause of dissolver tower high differential pressure. It is concluded that high dp is caused by the formation of tenacious dissolver foam or froth. Various means of eliminating foam are presented in this report, and a recommendation is made that foam destruction be best accomplished by means of air jets directed at the foam blanket. A scope design is presented for the installation of three air jets in an existing spare dissolver nozzle using a single jumper. The cost of this entire installation is estimated at \$2,000. A test program is proposed to study the performance of the air jets so that a permanent installation might be incorporated into each dissolver.

DISCUSSIONObservations of Tower Performance

During dissolving operations a high differential pressure develops across the dissolver towers. This occurs about an hour to an hour and a half after start of a cut. The differential pressure indicator, DPI A-3 (B-3), which records the dp across the vapor inlet pipe and the tower, goes steadily and completely off scale. The range of this instrument is 0-15 inches of water. Simultaneously, the vacuum in the dissolver drops steadily. Both the dissolver WFR and the SGR readings drop. As this phenomena first occurs no change is noted in the reading of DPI A-2 (B-2), indicating the differential pressure across the knockout pot. After several minutes have elapsed this instrument also steadily and completely goes off scale. The range of the latter instrument is 0-2 inches of water.

In order to prevent loss of dissolver vacuum the air sparger is turned on and air is bubbled into the dissolver from the bottom of the vessel. Immediately the differential pressure across the tower is reduced. The dissolver vacuum starts to rise again to 13 to 14 inches of water. Concurrently, weight factor and specific gravity readings return to normal. By maintaining the air sparge at 20-25 SCFM the dissolver vacuum can be maintained at 13 to 14 inches of water and the differential pressure across the tower can be held below three inches of water at low dissolving rates.

Cause of Dissolver Tower High Differential Pressure

Theories to account for high tower dp are as follows: (1) excessive vapor pressure drop in the vapor feed line to the tower due to friction, (2) tower-flooding, and (3) excessive foaming.

1. Calculations based on peak vapor load rates indicate extremely low pressure drop in the vapor inlet pipe, which cannot explain the phenomena.
2. Both differential pressure indicators, DPI A-3 (B-3) and DPI A-2 (B-2), have one common pressure tap. If the tower were flooded this common pressure tap would be affected. This would necessitate simultaneous movement of both of the instruments, with DPI A-2 tending to move in an opposite direction to DPI A-3. However, a large time lag occurs before DPI A-2 (B-2) shows any movement whatever, during which time DPI A-3 (B-3) has gone off scale. The dp instrument for the knockout pot is seven times as sensitive as the instrument across the tower, yet it fails to move until the other has been off scale for some time, and then moves in the same direction as DPI A-3. This excludes the theory of tower-flooding.
3. Using the reasons listed above in (2) the cause of excessive pressure indication across the tower must affect the pressure tap which is located in the top of the dissolver.

Since, as stated in (1) above, the vapor pipe is adequate to remove all the gases and vapors at peak load, build up of back pressure in the vapor space should not occur in the vicinity of the pressure tap. But, if a foaming condition were present it is conceivable that the foam could cover over the entrance to the vapor pipe and the dissolver pressure tap and hence give high differential pressure readings. This would cause the dissolver vacuum to drop, and the differential pressure across the tower to rise. It is possible that the foam could continue up the vapor pipe and drop into the tower. After a few minutes the foam could build up in the bottom of the tower and in the bottom of the knockout pot. This would then cause a change in the differential pressure indicator across the knockout pot and could cause it to move off scale also. This would imply that the cold surfaces of the dissolver tower are not capable independently of completely breaking dissolver foam.

Foams have been broken by sparging air into the liquid phase as is now done in Purex dissolving operations. In a similar uranium dissolving operation it has been reported that foaming was greatly decreased by use of the air sparger (Reference 1).

The above evidence points to foaming as the cause of high differential pressure across the tower. However, a combination of foaming and bumping could also be responsible for the observed phenomena.

Disadvantage of Continuous Air Sparging

Continuous air sparging of dissolver solution is undesirable because it increases the emission of iodine into the dissolver off-gas. This imposes an additional duty on the iodine removal equipment necessitating more frequent regeneration of the silver reactor and shortening its useful life.

Dissolver tests, which have been conducted recently by Purex Technology Operation, using large cuts and heels, demonstrate the inadequacy of the present sparging technique in controlling dissolver tower differential pressure. Pressurization of dissolvers has occurred despite an increase in air sparge to about 40 SCFM.

Owing to difficulties in controlling dissolver tower operation, it is difficult to admit sufficient air in-bleed into the system for good acid recovery. Present acid consumption in dissolving averages about 3.5 mols per mole of uranium, but has been as high as 3.8 mols per mole on occasion. The corresponding acid consumption in Hot Semi-Works tests was about 2.8 mols per mole.

General Methods For Elimination of Foam

Listed below are the standard methods for eliminating troublesome foam (Reference 2):

1. Direct Mechanical Methods
2. Thermal Methods
3. Chemical Methods

(1) CF-55-3-190 - Unit Operations Status Reports For Jan-Feb-March 1955 - Oak Ridge National Laboratories.

(2) Chemical Engineering - Vol. 63 No. 10 - October 1956 - Page 173.

1. Direct Mechanical Methods

- a. Foam Breakers - Blades or bars are used on rotating shafts, or grids and mesh in stationary apparatus.

Installation of a rotating shaft or stationary apparatus in the present dissolvers is impractical.

- b. Sprays and Particles - Foams may sometimes be destroyed by simply dropping solid particles or liquid droplets on them.

To be most effective equipment to accomplish this objective would necessarily have to be installed in the vapor pipe. Since nozzles in the vapor pipe are not available, this method is not considered practical.

- c. Fluid Jets - Jets of gas or liquid may be directed against the foam blanket.

Fluid jets are considered feasible and practical, affording the simplest and cheapest method of foam elimination, and are recommended in this report.

- d. Pressure Changes - Subjecting the bubbles of a foam to sudden changes in pressure will cause them to coalesce, become unstable, and burst.

Air Jets partially fulfill the requirement of subjecting bubbles to pressure changes.

- e. Sonic Fields - Sound waves of the proper frequency can collapse foam.

This is not considered practical in dissolver service.

2. Thermal Methods

Thermal foam control involves heating (or cooling) the foam in some way - usually over a small area of the total foam blanket to promote local breakdown.

Installation of cooling pipes is not practical in the foam section of the present dissolvers and only partial assistance could be expected in breaking foam. An air jet directed into the foam blanket will render some thermal shock to help break the foam.

3. Chemical Methods

Anti-foam agents constitute one of the most effective and widely used means of foam control.

Use of chemical anti-foam agents in this operation would necessitate a test program to determine suitable agents and the chemical effect of these agents on the process solutions. This would be costly and time consuming and should be attempted only as a last resort.

The installation of fluid jets in a spare nozzle at the top of the dissolver is recommended to eliminate dissolver foam. These jets would direct air streams towards the areas where the foam is believed to be blanketed. The installation would provide (1) a jet stream, (2) a local pressure change and (3) some thermal shock.

Scope Design

Design of Anti-foam Jets

The design of the air jet installation which is proposed for the destruction of dissolver foam is presented in SK-2-2909 and SK-2-2910, the engineering flow diagram and jumper drawing respectively. Briefly, the design calls for the installation of three air jets in a single dissolver jumper, extending from gallery nozzle "G-12" to dissolver nozzle "G". Only one such jumper is presently contemplated, to serve as a test unit. It is proposed that this jumper be installed in A Cell, although the installation could be made in B or C Cell at the discretion of Purex Operations. As shown on the engineering flow diagram, the jets are oriented to destroy foam in various sections of the dissolver above the liquid-foam interface. Jet C is directed at the vapor outlet, while jets A and B cover other areas above the dissolver slug crib. Foam originating in the dissolver would pass through either two or three jet streams prior to discharge through the gas outlet. In the event these jets should not be able to overcome completely high tower differential pressure independently, they could be used to supplement the present air sparge.

The three jets are valved for independent air supply with manual control at the Pipe and Operating Gallery. The 5/32-inch diameter jets are sized to discharge about 25 SCFM of plant air at 100 PSIG supply pressure. A pressure gage is proposed in the supply manifold downstream of the one-inch control valve to assist in regulating flow when operating at reduced air pressure.

Dissolver tower differential pressure is now controlled with about 25 SCFM of air through the present sparger in the liquid phase, although dissolver tower performance with sparge in the liquid phase is considered inadequate. The three new air jets would provide a total of 75 SCFM maximum at 100 PSIG air pressure for direct foam destruction.

If tests with the proposed jets prove successful, the new jumper could be retained as a permanent installation. However, for ease of operation in a permanent installation, it would be desirable to replace the one inch manual control valve in the P & O Gallery with a diaphragm operated valve which would be manually loaded from the Head End Control Room.

The cost of the test jumper and air piping in the P & O Gallery is estimated at about \$2,000.

Potential Advantages of Air Jet Destruction of Foam

If the dissolver tower high differential pressure can be overcome by the jet destruction of dissolver foam, the following advantages can be expected:

1. Dissolver acid recovery should improve.

7079-G-M7-

P.F.O. GALLERY

CANYON

LEGEND
— NEW
— EXISTING

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ASSEMBLY-PLAN

Diagram illustrating the Plan view of the pipe assembly. The diagram shows the layout of the pipes and valves. Key components labeled include:

- PIPE "A" (top left)
- PIPE "B" (top right)
- PIPE "C" (bottom left)
- Valves (indicated by symbols on the pipes)
- Dimensions: 3' 6" (vertical distance between pipes A and C), 1' 6" (horizontal distance between pipes A and B)

The word PLAN is written below the diagram.

[illegible]

Architectural drawing of a wall section. The drawing includes the following elements:

- Reference Elevation:** REF. EL. - 698'-0"
- Dimensions:**
 - Vertical dimensions: 9'-0", 9'-0", 9'-0", 9'-6"
 - Horizontal dimension: 10'-1 1/2"
 - Base slope: 45°
- Callouts:**
 - 1: Top corner detail
 - 2: Small rectangular detail on the wall
 - 3: Vertical rod or pin
 - 4: Wall section
 - 5: Horizontal rod or pin
 - 6: Sloped base
 - 7: Corner detail
 - 8: Corner detail
 - 9: Corner detail
 - 10: Corner detail
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 - 12: Corner detail
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 - 100: Corner detail
- Text:** CORNER TO FIT

Diagram illustrating a three-pipe joint configuration. The pipes are labeled 5 (PIPE 'C'), 6 (PIPE 'A'), and 7 (PIPE 'B'). The joint is shown with a cross-section view on the right, indicating a radius R . Other labels include 8 and 9, which point to specific components or dimensions of the joint.

1 of 512 MOLES. SEC
DETAIL III

SEE DETAIL II

ASSEMBLY-ELEVATION

BILL OF MATERIAL

HWS-1603
PAGE - 1

ITEM NO	NO	DESCRIPTION	SIZE	MAT'L	REMARKS
1	1	CONN. ASSEM. HORIZ. MTC	8" DIA. 1/2"	-	N-1-51000
2	1	CONN. ASSEM. VERT. MTC	8" DIA. 1/2"	-	N-1-51911
3	1	LIFTING BAIL	STD	-	N-2-33543
4	13'	STRUCTURAL TEE	3T & 1 1/2"	ASTM A7-51T	
5	55'	PIPE	7" SCH 40	EST.	
6	2	PIPE	7" SCH 40	ASTM A7-51T	
7	2	PIPE	7" SCH 40	ASTM A7-51T	
8	1/2"	PLATE	1/2" THK	ASTM A7-51T	
9	1-2"	FLAT BAR	1/2" x 1"	ASTM A7-51T	
10	1-1"	FLAT BAR	1/2" x 1"	ASTM A7-51T	
11	1	PLATE	1/2" THK	ASTM A7-51T	
12	1/2"	FLAT BAR	1/2" x 1"	ASTM A7-51T	
13	3	FLAT BAR	1/2" x 1"	EST.	DETAIL - III
14	3	PLATE	1/2" THK	EST.	DETAIL - III
15	1	FLAT BAR	1/2" x 1"	EST.	DETAIL - II

KEY PLAN

JUMPER DATA									
JUMPER IDENTIFICATION NO.	INSTALL DRAWING NO.	CELL	LINE NO.	WALL CHAIN	FOUR NO.	WIRE NO.	AS BUILT DIMENSIONS		
							A	B	C
A-G12-A3	N-233500	A	A 079	G-12	TK-A3	0			

APPROVED
FOR DESIGN
NOT FOR CONSTRUCTION

~SCOPE~

NOTE

MATERIALS, FABRICATION & TESTING SHALL BE AS PER SPEC HWS-5700.

SECTION C-C

DETAIL III
(TYPICAL 3 PLACES)

DETAIL II

DETAIL IV

DESCRIPTION		REV. BY	DATE	REV. BY	DATE
REVISIONS					
DWG. NO.	APPROVALS				
SCALE:	BY	CHECKED	DATE	BY	DATE
PROJECT NO.	U. S. ATOMIC ENERGY COMMISSION HANFORD ATOMIC PRODUCTS OPERATION GENERAL ELECTRIC				
PIPE JUMPER - CELL 'A'					
G-12 TO TK-A3					
TEST JUMPER					
BLDG. NO. 202A	DWG. NO. SK-2-2910				

2. Silver reactors should not require regeneration as frequently as at present, and therefore a savings in silver nitrate solution could be realized. Conversely, for the same frequency of silver reactor regeneration, greener slugs could be processed through dissolving. Air jetting of dissolver foam should liberate less iodine than the present sparging of dissolver solution.

Likewise the overall service life of silver reactors should be increased as the iodine load is decreased.

3. Dissolver capacity could be increased significantly.
4. Operators would no longer be required to "ride-herd" on dissolvers during cuts.

Test Program For Air Jets

The test program on the jets should be directed towards optimum utilization of compressed air in destroying dissolver foam. The following test program is suggested:

1. To determine which jet or jets are most beneficial, each jet should be tested independently by varying air pressure to vary air flow. Air flow should be reduced until a build up of tower differential pressure is noted.
2. With the three 1/2-inch valves to each jet open, manifold pressure should be varied, to determine whether the three jets together give better control than a single jet.
3. Finally, the new jets should be tested concurrently with the present air sparger to determine the performance of the dual system.

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JRL/LRM:jes

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HW-46019

cc: CR Bergdahl LR Michels
A Bradway PEL Nussbaum
JR Cartmell EL Reed
JB Fecht WC Schmidt
MK Harmon HP Shaw
ER Irish RE Tomlinson
CE Kent LL Zahn
JR LaRiviere 300 File
File Co

November 13, 1956

O. C. Schroeder, Manager
Purex Operation
202-A Bldg., 200-E Area

USE OF AIR JETS TO IMPROVE PUREX DISSOLVER OPERATION

Reference: HW-46019, "Dissolver Anti-Foam Jets", by JR
LaRiviere and LR Michels, October 17, 1956.

The reference document, attached, summarizes an investigation made of the current Purex dissolver limitation observed as high dissolver tower differential pressure during high dissolving rates. Air sparging serves at the present time to control this limitation. Various theories were explored to explain the observed phenomenon, and it was concluded that the high dp is caused by the formation of foam within the dissolver. Following the theoretical explanation of the cause of the problem, corrective measures were considered, and a preliminary design developed, for a feasible and inexpensive solution. The proposed installation consists of a single jumper for each dissolver installation which will convey high pressure air to the dissolver and direct it through jets upon the foam blanket.

We wish to point out that neither the theory behind nor the efficacy of the proposed design has been proven by experience. However, in view of the advantages that could be obtained if this dissolver limitation were eliminated, and in view of the relatively modest cost of the proposed installation, \$2,000 per dissolver, it is felt that installation and testing would be appropriate. We propose that one such jumper be fabricated and installed on a Purex dissolver. We would be willing to assume the cost of design and fabrication of this jumper and would wish to follow its testing. We would also propose that the jumper be fabricated and mocked up by the Shops Operation and that the Purex Operation install and test the assembly.

We are prepared to proceed with the proposal as outlined above pending your approval of installation in Purex.

Manager, Process Design & Development
Facilities Engineering
CHEMICAL PROCESSING DEPARTMENT

JB Fecht/LLZ:jes
Att: Ref. Document

END

**DATE
FILMED
11/10/1993**