UNCLASSIFIED

THIS DOCUMENT CONSISTS OF 8 PAGES
THIS IS COPY 14 OF 14A

DATE 3/9/49 INITIALS R.D.S.

MD-277
RECEIVED
OCT 11 1995
OSTI

Contract Number AT-33-1-GEN-53

MOUND LABORATORY

Operated By

MONSANTO CHEMICAL COMPANY

MIAMISBURG, OHIO

M. M. Haring
Laboratory Director

UNCLASSIFIED
Classification changed to
authority of P.B. Dyer Jr. 8/20/70
by Carletta L. Lewis 9/3/70
Reviewed by C.W. Huntington 8/21/79

SONIC DECONTAMINATION

(Information Report)

~~Caution~~

~~This document contains information affecting
the National Defense of the United States within the
meaning of the Espionage Laws, Title 18, U.S.C.,
Section 793 and 794, and the transmission or
revelation of its contents in any manner to an unauthorized
person is prohibited by law.~~

~~Restricted Data~~

~~This document contains restricted data as defined
in the Atomic Energy Act of 1946.~~

Date: January 25, 1949

Prepared by: R. M. Brodbeck
G. R. Schammer

Distributed: APR 15 1949

MASTER

UNCLASSIFIED

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

UNCLASSIFIED

MLM-277

DISTRIBUTION

1. - M. M. Haring
2. - J. J. Burbage
3. - R. A. Staniforth
4. - J. E. Bradley
5. - Area Manager
6. - Area Manager
7. - Area Manager
8. - F. C. Mead, Jr.
9. - R. M. Brodbeck
10. - G. R. Schommer
11. - Central Files
12. - Central Files
13. - Central Files
14. - Central Files

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

UNCLASSIFIED

UNCLASSIFIED

MLM-277

The supersonic method of cleaning glassware is an outgrowth of the fact that it has been heretofore impossible to manually clean ground glass and quartz joints because the activity became lodged in the small pores of the ground surfaces.

It has been theorized that the nature of the forces binding polonium to the glass is similar to that of the chemical bond but are less intense. The problem then becomes one of finding a force greater than this binding energy, capable of freeing the activity from the glass.

This has been accomplished by using frequencies of 100 cycles to 20 kc. at a power output from 2 to 20 watts, passing through a citric acid solution (pH-2) into which the contaminated article is placed. The optimum results, using a tank with the dimensions 7" x 7" x 7" and 3 liters of solution, has been found at 200 cycles or harmonics of 200 cycles. Citric acid was used because of the fact that it forms a soluble complex with polonium.

The frequencies used have been kept within the sonic range until enough data has been obtained and correlated to warrant the design and construction of more costly types of projectors (i.e., quartz crystals) and their allied components.

The initial tests were made with magnetic headsets which were modified for immersion into the citric acid solution and an audio oscillator and amplifier has been built to furnish the driving power (see Figure 1). A proposed set-up for maximum transfer of supersonic energy is given in Figure 2.

A number of solutions have been tried but only those containing citric acid have shown any value. Some of the solutions tried were tap water, tap water plus a wetting agent, saturated citric acid solution, saturated citric acid solution plus HCl (concentrated), and HCl (concentrated) plus tap water. Different concentrations were tried but a (0.01 per cent approximately pH-2) citric acid solution proved to be the most effective. Figure 3 gives some typical removal rates from ground glass equipment.

Results thus far indicate that this system may have possibilities for decontamination work but at present tests are delayed pending assignment of personnel to continue the investigation.

A standard QJA sonar equipment has been obtained from the Navy for purposes of further investigation. This equipment has a frequency range of 20 to 25 kc. and a power output of 130 watts. (This output is pulsed rather than continuous in order to obtain maximum power output.)

UNCLASSIFIED

UNCLASSIFIED

UNCLASSIFIED

UNCLASSIFIED
Figure 2

MLM-277

PROPOSED SETUP FOR MAXIMUM TRANSFER OF ULTRA-SONIC ENERGY.

CRYSTAL { 60 70 100 MM. DIA.
4 TO 20 MM. THICK
HV 15 KV.

UNCLASSIFIED

UNCLASSIFIED

MLW-277

Figure 3

TYPICAL RESULTS TO DATE

<u>Piece</u>	<u>d./min. Before</u>	<u>d./min. After</u>	<u>Time Min.</u>	<u>Frequency Cycles</u>	<u>(Approximate) Power in Watts</u>
Quartz Joint #1	74,000	37,000	10	150	8
Stopcock	52,000	29,000	10	150	8
Quartz Joint #2	55,000	4,400	10	150	8
Quartz Joint #3	333,000	200,000	10	150	8
Stopper	235,000	74,000	10	150	8
Joint #1	248,000	37,000	10	200	10
Joint #2	13,500	10,000	10	300	10
Joint #3	37,000	9,000	10	300	10
Joint #2	10,000	6,000	10	500	10
Stopper #1	111,000	44,000	10	4000	10
Stopper #2	74,000	12,800	11	4000	10

These pieces had previously been boiled in aqua regia for five hours with no reduction in activity.

UNCLASSIFIED

UNCLASSIFIED

MLM-277

From information obtained from Bureau of Standards Reports and Radiation Laboratory Reports, it is thought that maximum removal of activity should occur within the aforementioned ranges.

Further investigation of ultrasonic propagation and measurements is contemplated in the near future.

Contacts of various crystal manufacturers have been made to determine the availability of proper projecting systems. One favorable reply was received from the Brush Development Company indicating they would like to discuss the problem in more detail.

Velocity of Ultrasonics in Liquid

The velocity of ultrasonic propagation in liquids is expressed as:

$$V = \sqrt{\frac{K}{R B_{is}}} = \sqrt{\frac{1}{R B_{ad}}}$$

$$B = \frac{1}{V} \frac{dv}{dr}$$

- V = Velocity
R = Density of Liquid
B_{is} = Compressibility at Constant Temperature
B_{ad} = Adiabatic Compressibility
B = Decrease in Volume (dv) Caused by Increase in Pressure (dr) Per Unit V
K = C_p/C_v Ratio of Specific Heats

Absorption Coefficient

The loss of ultrasonic energy due to absorption in a liquid is given as:

$$A_T = A_R + A_L = \frac{2 \pi^2 Z^2}{V^3 R} \left(\frac{4}{3} Z + \frac{k-1}{C_p} K \right) = \frac{2 \pi^2}{L^2 V_R} \left(\frac{4}{3} Z + \frac{k-1}{C_p} K \right) =$$

$$\frac{2 \pi^2 Z^2}{V^3 R} \left(\frac{4}{3} Z + \frac{K T E^2 v^2}{W C_p} \right) = \frac{2 \pi^2}{L^2 V_p} \left(\frac{4}{3} Z + \frac{K T A^2 v^2}{W C_p} \right).$$

UNCLASSIFIED

UNCLASSIFIED

MLM-277

$A_R = \text{Absorbent due to Internal Function} - A_R = 8/3 \frac{\pi^2 Z}{L^2 V_p}$

$A_L = \text{Absorbent due to Conduction} - A_L = \frac{2 \pi^2 V K T A^2}{L^2 W C_p}$

$A_T = \text{Total Absorption}$

$N = \text{Frequency}$

$L = \text{Wavelength in Meters}$

$V = \text{Velocity}$

$Z = \text{Coefficient of Viscosity}$

$R = \text{Density of Medium}$

$T = \text{Absolute Temperature}$

$W = \text{Mechanical Equivalent of Heat}$

$E = \text{Thermal Coefficient of Expansion at Constant T}$

In H_2O $A_R = 8.5$
 $A_L = .0064$

BIBLIOGRAPHY

Radiation Laboratory Reports

No. 850 - Supersonic Delay Lines
1050 - Supersonic Components

Research Laboratory of Electronics M.I.T.

- * No. 10 - Ultrasonic Measurements on Single Xtals
- * 4 - Ultrasonic Propagation in Liquids
- * 52 - Scattering of Ultrasonic Radiation in Polycrystalline Metals
- 71 - Ultrasonic Propagation Through Mercury in Tubes

Wright-Patterson Air Force Base
Electronics Sub-Division - McReer
Attention: Brig. Gen. Tom C. Rives - Building 126

Bureau of Standards

"Ultrasonic Measurements of the Compressibility of Solutions and of Solid Particles in Suspension." Research Paper 402.

RMB:GRS/eat

UNCLASSIFIED