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EVALUATION OF THE EFFECTIVENESS OF THE TURCO LOW PROFILE TURBULATOR (U)

by

J. R. Long[1], S. Grittmann[2], J. F. McGlynn[3], and W. N. Rankin[3]

[1] Westinghouse Cooperative Education Student
Clemson University
Clemson, South Carolina 29631

[2] ORAU Summer Research Student
Del Mar College & Embry Riddle Aeronautical University
Corpus Christi, Texas 78404

[3] Westinghouse Savannah River Company
Savannah River Laboratory
Aiken, South Carolina 29808

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Jenny R. Long
Sibylle Grittmann
James F. McGlynn
W. Nevyn Rankin

INTRODUCTION

The Savannah River Site produces nuclear materials for both national defense and peaceful applications. To protect personnel and the environment, the Savannah River Laboratory identifies, investigates, and implements the use of state-of-the-art decontamination technology Site-wide. This technology enables decontamination operations to be performed effectively with minimum generation of waste, minimum radiation exposure, and minimum potential for release and uptake of radioactive material.

The decontamination obtained depends on the effectiveness of the chemical used, the temperature, and the amount of agitation. These operations are most effective when an appropriate solution is used at a high temperature with a high degree of agitation. Reaction rates increase with temperature. Agitation removes reaction products from the surface being cleaned and supplies unreacted solution to the surface.

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TURCO LOW PROFILE TURBULATOR

Turbulators are tanks manufactured by Turco that have built-in agitators (Figure 1). The agitators can be programmed to automatically alternate the flow of the cleaning solution within the tank in four separate and distinct high velocity flow patterns. Agitation time is usually set in cycles with equal time periods of operation for each of the two agitators. The total agitation time can be adjusted from a minimum of 5 minutes to a maximum of 60 minutes. They are available in different tank volumes. A 150 gal unit was used in our studies.

TOOL CLEANING DEMONSTRATION

The effect of agitation, detergent, and the presence of abrasives in the bath was demonstrated. Dirty tools and parts were used. The cleanness of the tools or parts was determined by visual observation.

1. Effect of Agitation - Agitation increases the cleaning rate. No cleaning was observed on items soaked in water only at room temperature for 60 minutes. After 30 minutes with agitation some cleaning was observed.

2. Effect of Detergent - Detergent increases the cleaning rate. Items were completely clean after 15 minutes with agitation in a bath containing 1 gal of HC-212 detergent*.

3. Effect of Abrasive - Abrasives in the bath increase the cleaning rate. The items were completely clean after 60 minutes with agitation in water containing 450 grams of 5 μ aluminum oxide particles.

4. Effect of Detergent + Abrasive - Abrasives in the bath increase the effectiveness of the detergent. The items were completely clean after 10 minutes with agitation in a bath containing 1 gal of HC-212 detergent plus 450 grams of 5 μ aluminum oxide particles.

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* manufactured by Calgon Corporation

COUPON TESTS

The effect of agitation, detergent, and abrasives was determined more quantitatively by coupon tests. The coupons used were Type 304L stainless steel and Inconel 625, 1 in. (2.54 cm) x 3 in. (7.62 cm) x 1/16 in. (0.150 cm) in size. Type 304L stainless steel with an ASTM Number 2B (hot-rolled, pickled, annealed, and cold-rolled) is the material presently used for the construction of process equipment at SRS. Inconel 625 was tested because it is an example of a more corrosion-resistant material than Type 304L stainless steel. Process equipment would have a longer lifetime if it could be fabricated from Inconel 625. This material is not presently used, because it is more difficult to decontaminate than Type 304L stainless steel.

1. Tests with Cello Grease* - Specimens were weighed, coated with Cello (Stop-Cock) Grease, and reweighed. Initial testing indicated that this method yields meaningful data at low temperature settings and short cycle times.

- At room temperature (25°C), detergent has little effect on the cleaning rate:
  - 15.00% average removal without detergent
  - 15.37% average removal with 0.8 oz/gal of HC-212 detergent

- Percentage of grease removed increases with temperature (Figure 2).

Although useful data were obtained, a material that could withstand higher temperature settings and longer cycle times was necessary.

*Cello Grease™ manufactured by Fisher Scientific Company

2. Tests with Apiezon W Black Stick Wax - Specimens were weighed before and after the application of the wax (sealing wax). The percentage of wax removed was determined by a third weighing after cleaning.

Effect of Temperature (Figure 3 and 4)

Coupons were cleaned in a bath containing 1 gal of HC-212 detergent at 6 temperatures between 25 and 91 degrees C for fives cycle times between 5 and 60 minutes. The cleaning rate is the same for both Inconel and stainless steel.

- At low temperatures (25°C - 65°C), temperature has little effect on the percentage of wax removed.

- At intermediate temperatures (74°C - 83°C), increasing the temperature increases the percentage of wax removed.

- At high temperature (91°C), increasing the temperature greatly increases the percentage of wax removed.

Effect of Agitation

Coupons were cleaned in a bath containing 1 gal of HC-212 detergent for 60 minutes at 91°C with and without agitation. Results indicate agitation greatly increases the effectiveness.

- 3.26 average percent removal without agitation

- 33.54 average percent removal with agitation

The data also show that the cleaning effectiveness of a 60-minute soak is approximately the same as that of a 5-minute agitation cycle.

Effect of Detergents (Figure 5)

Coupons were cleaned for up to 60 minutes with agitation in a baths at 91°C containing different amounts of HC-212 detergent (0 gal, 1 gal, and 2 gal). No significant difference occurred in the removal rate of Apiezon Wax from either of the materials. Detergent increases the cleaning ability of the turbulator.

- At short cycle lengths (< 30 minutes) there is little difference in the cleaning rate of the solution with 1 gallon HC-212 and cleaning solution with 2 gallons HC-212 detergent.

• At longer cycle lengths (> 30 minutes) the cleaning rate of the solution with 2 gallons HC-212 is much greater than cleaning rate of the solution with 1 gallons HC-212

Effect of Abrasives (Figure 6 and 7)

Coupons were cleaned for up to 60 minutes with agitation in a baths at 91°C containing 1 gal of HC-212 detergent and 300 grams of abrasive. Abrasives used were selected on particle size (0.05μ Al_2O_3, 5.0μ Al_2O_3, 30μ Al_2O_3, and 279μ sand).

• The most effective abrasive is 30μ Aluminum Oxide.

• At short cycle lengths (< 30 minutes), all abrasives increase the removal rate.

• At long cycle lengths (> 30 minutes), there was no significant change in removal rate with the baths containing sand and 0.05μ Al_2O_3. There was a slight increase in removal rate with the bath containing 5.0μ Al_2O_3. The largest increase in removal rate was with the bath containing 30μ Al_2O_3

• The particle size appears to have a significant effect on the removal rate. Graph 6 indicates that the particle size is ineffective if it is as small as 0.05μ or as large as approximately 279 μ. The most effective particle size tested was approximately 30.0μ.

CONCLUSIONS

Agitation increases the cleaning rate.

Temperature increases the cleaning rate. There is a large increase in cleaning rate at temperatures above approximately 80°C.

Cleaning time has little effect if the temperature is below approximately 80°C.

Detergent in the cleaning solution increases the effectiveness of the turbulator. There is a large increase with greater volumes of detergent for agitation cycles longer than 30 minutes.

Cleaning solution containing 2 gallons HC-212 are more effective than cleaning solution with 1 gallons HC-212 detergent.

Abrasives increase the effectiveness of the turbulator. Abrasives can replace detergents and thereby eliminate unnecessary waste products.

Abrasive effectiveness is dependent on particle size.

PROGRAM

1. Effect of Temperature

Tests will be carried out at higher temperatures. The highest temperature used was 91°C. Temperatures up to 98°C are possible with the equipment.

2. Effect of Detergent

Tests will be carried out with a cleaning solution concentration of greater than 2 gallons HC-212 detergent per 150 gallons of water. The detergent concentration can then be optimized.

3. Effect of Abrasive

Tests with alternate abrasives will be carried out to identify the most effective particle size.

ACKNOWLEDGEMENT

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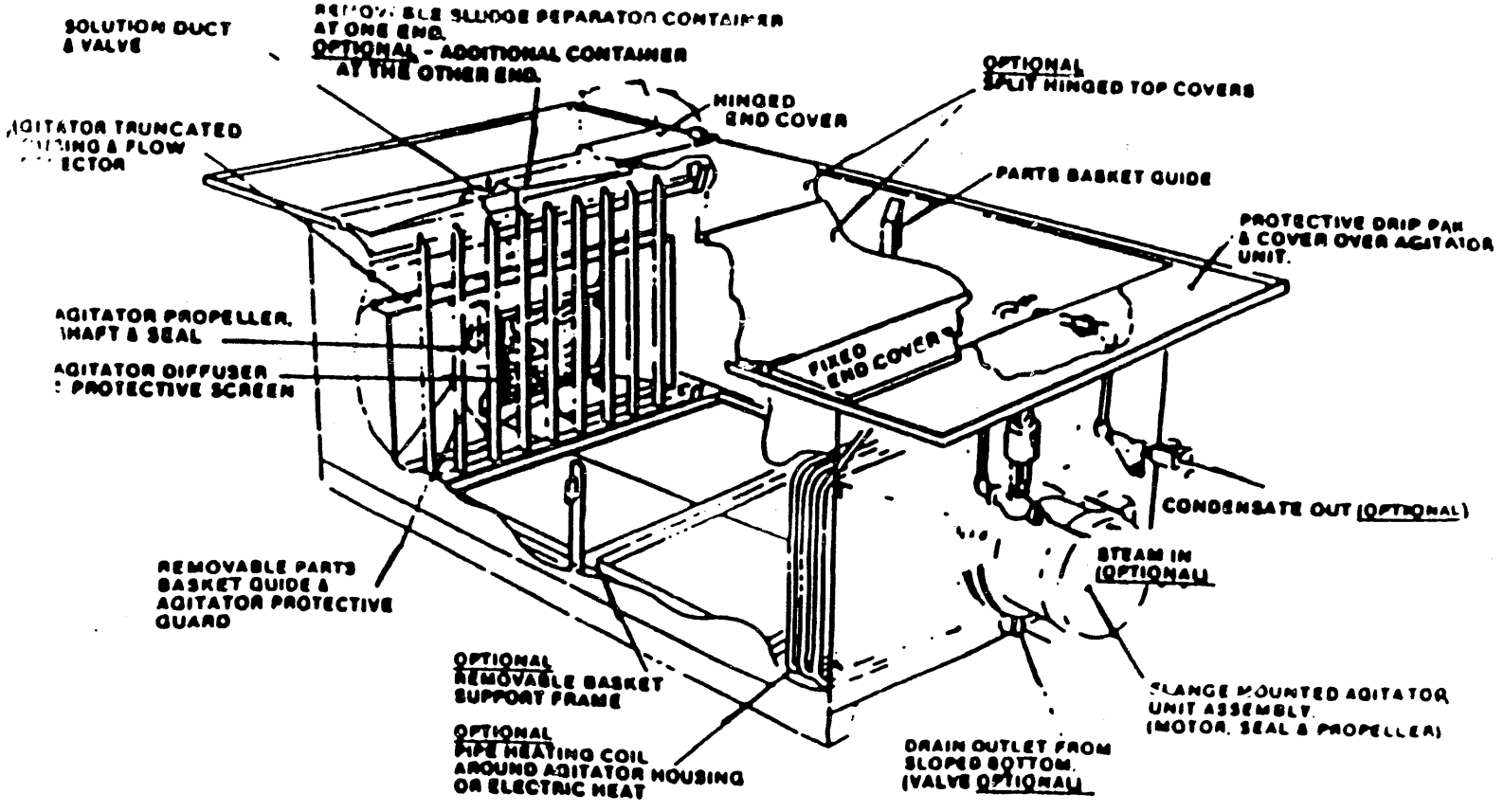
Figure 1

TURCO LOW PROFILE TURBULATOR®

U.S. Pat. 3,592,205



TYPICAL TURBULATOR ASSEMBLY

Figure 2

~~Graph 1~~

Removal ~~Rate from~~ Cello-Grease ~~Specimens of Inconel and Stainless Steel~~ of

~~Control: 2 gallons HC-212~~

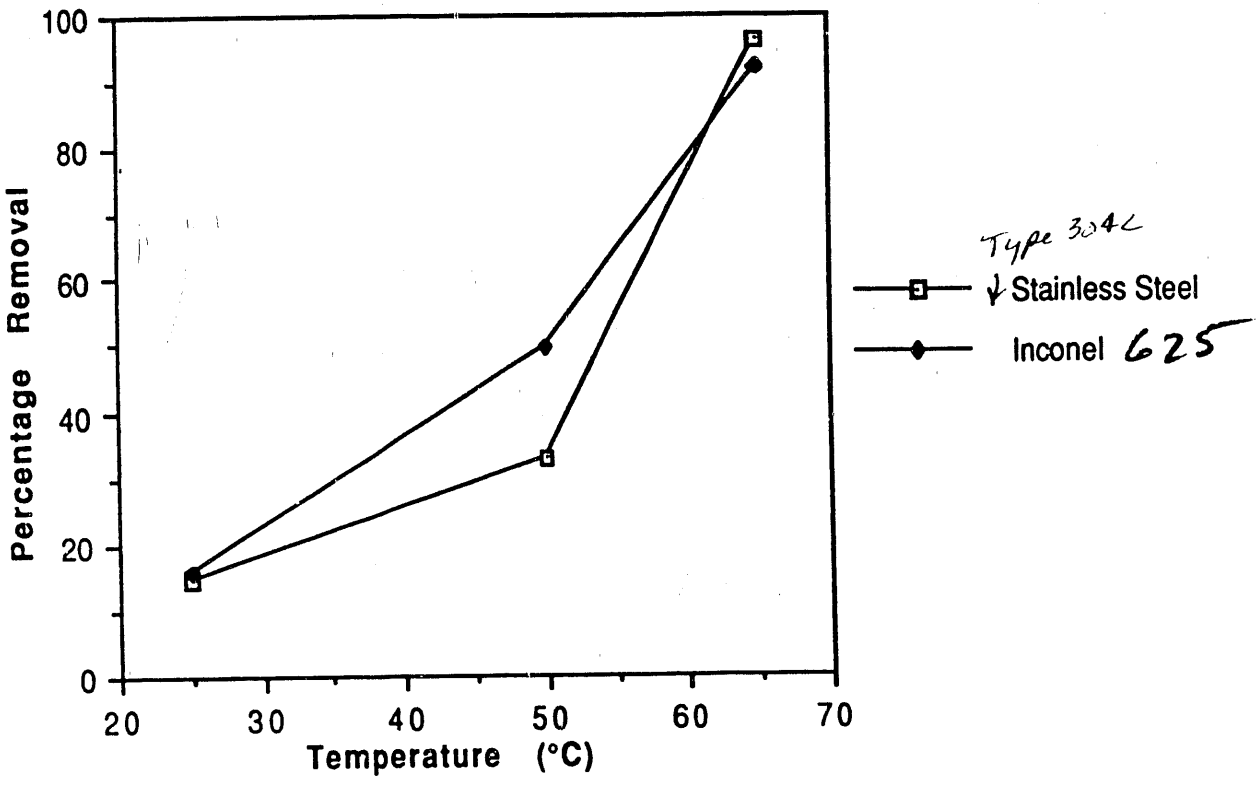


Figure 3

~~Graph 2~~

Removal of Wax from Unused 625

~~Wax Inc Testing~~

~~(Various Temp Setting of Cycle Time)~~

~~Constant: 2 gallons HO 212 Detergent~~

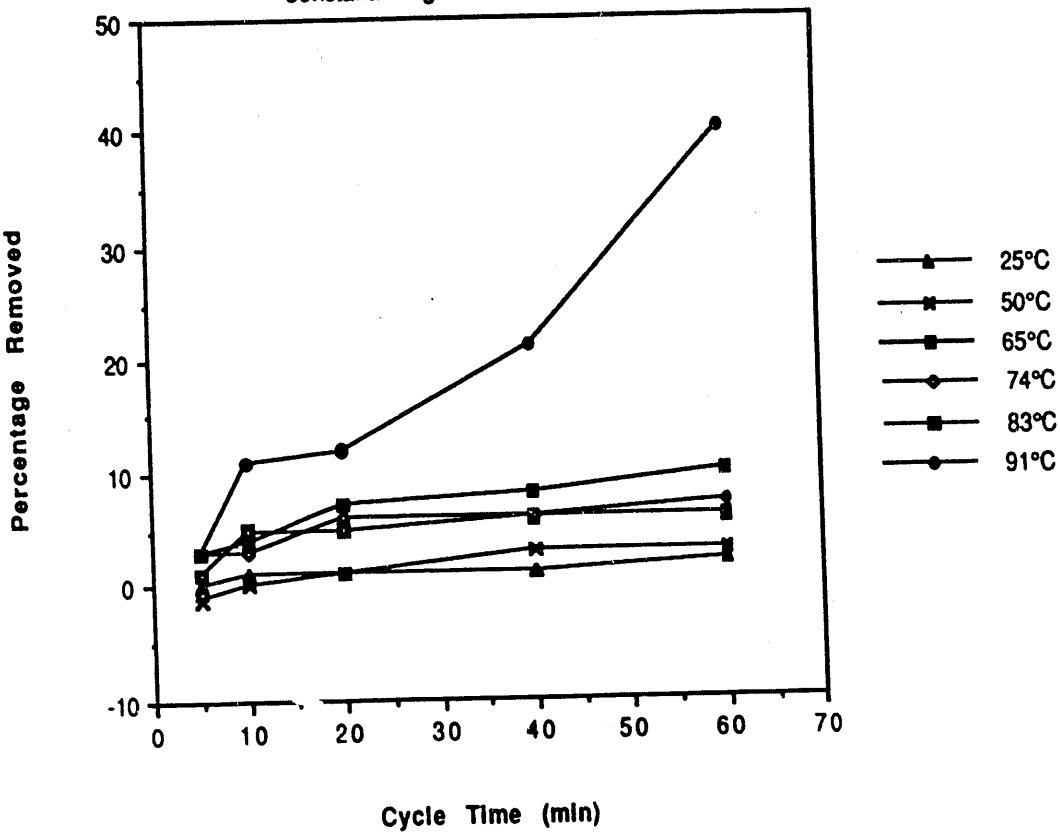
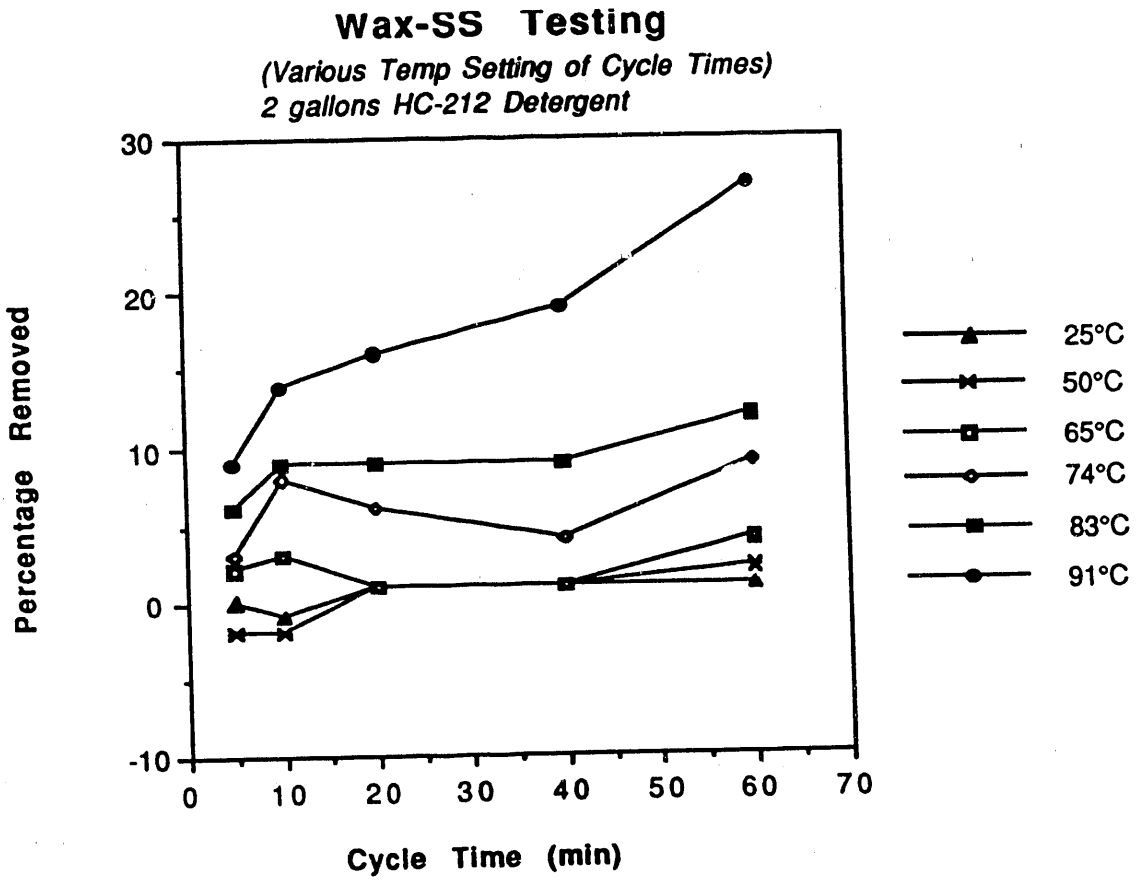


Figure 4

~~Graph 3~~

Removal of Wax from Type 304C Stainless Steel



~~Graph 4~~ Figure 5

~~Average Effectiveness~~ Effect of Detergent on Removing Wax ~~on~~ Stainless Steel & Inconel Specimens

from Type 304L ~~Control 91°C~~ 625

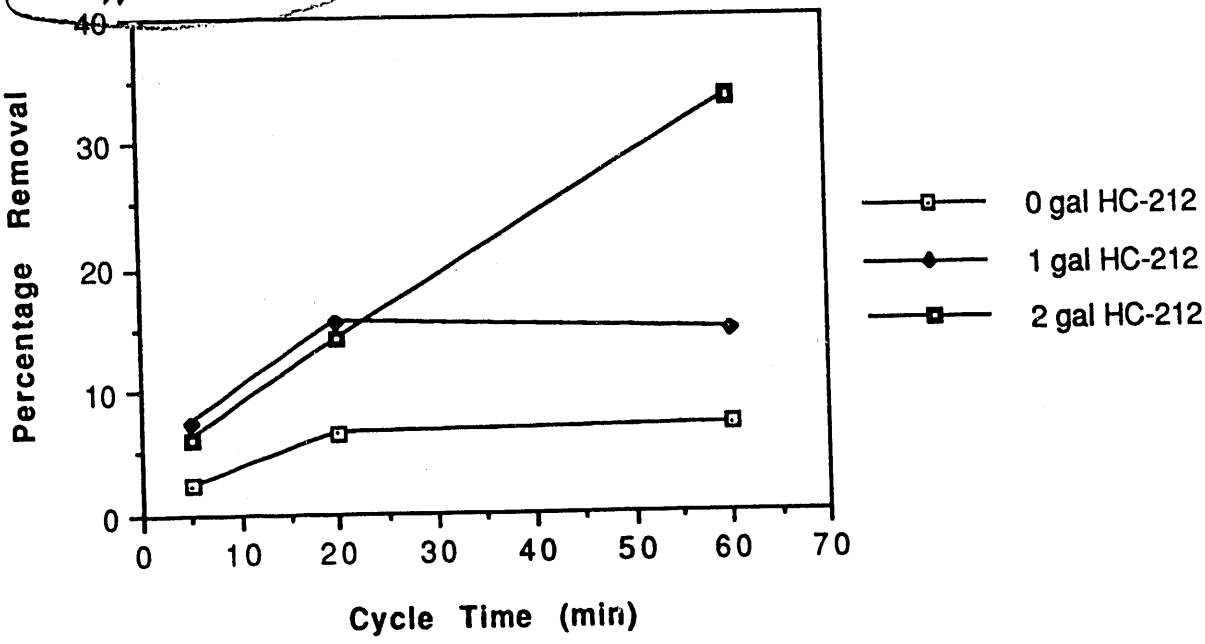


Figure 6
~~Graph 5~~

Effect of
~~Average Effectiveness of~~ Abrasives on Removing Wax
~~on~~ Stainless Steel & Inconel Specimens from
~~Control: 91°C & 2 gal HC 212 Detergent~~ 625

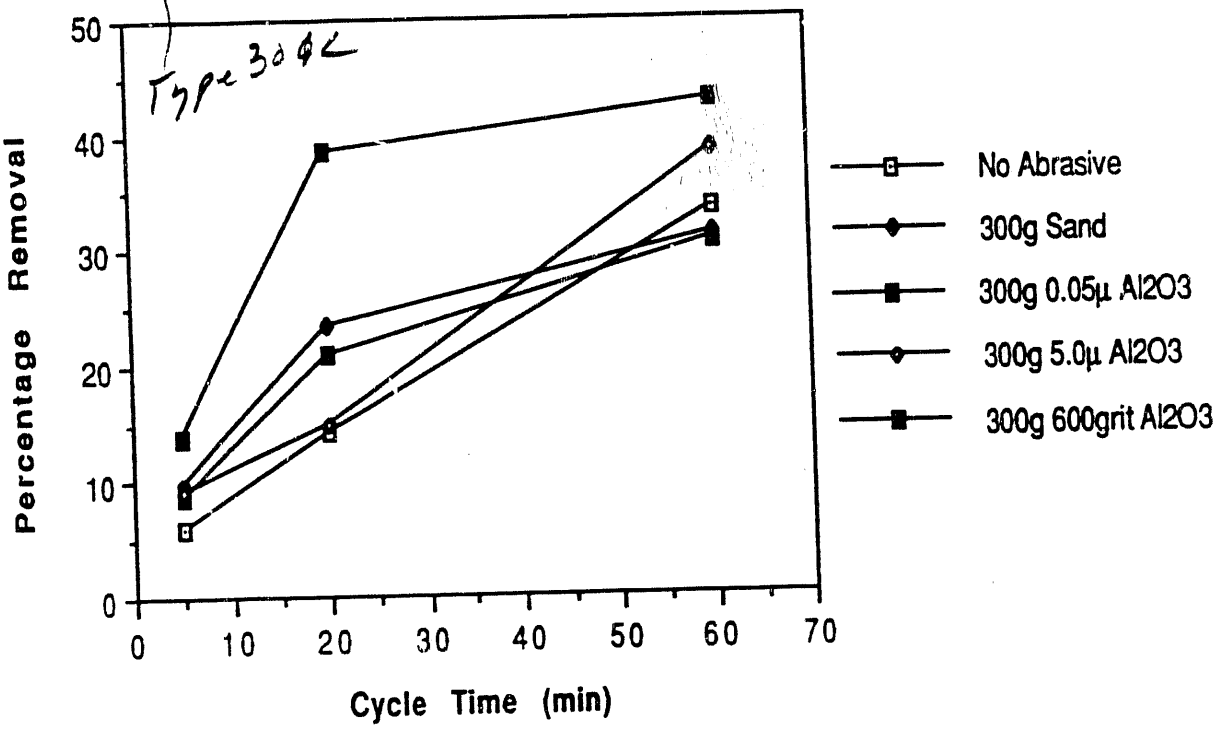


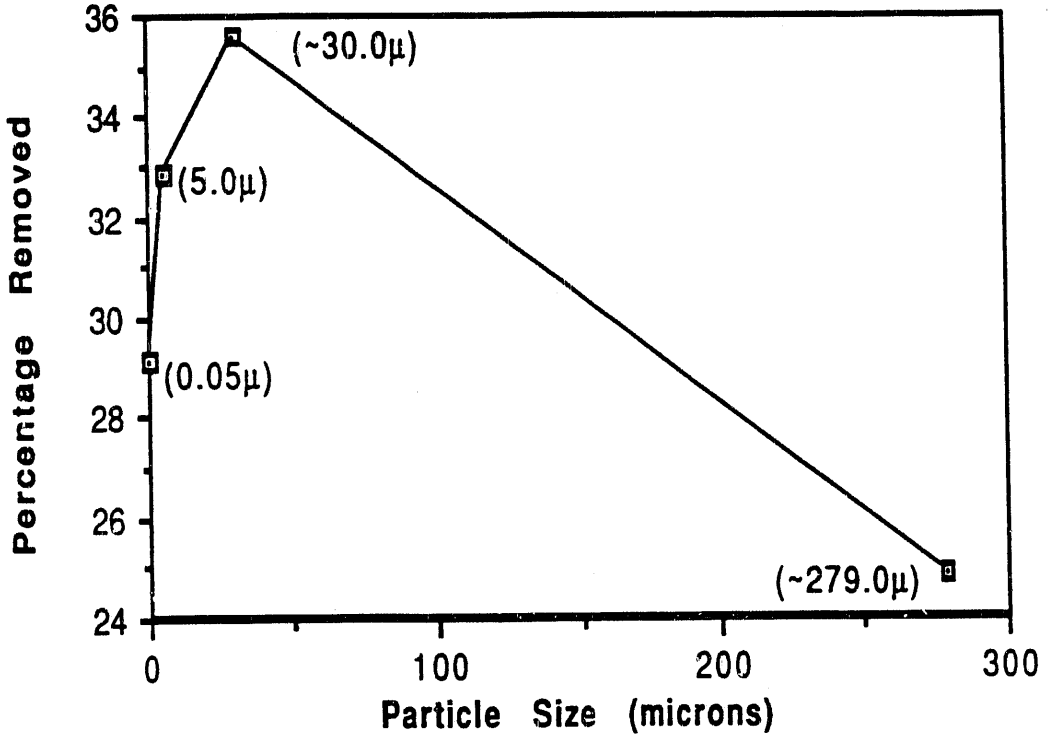
Figure 7

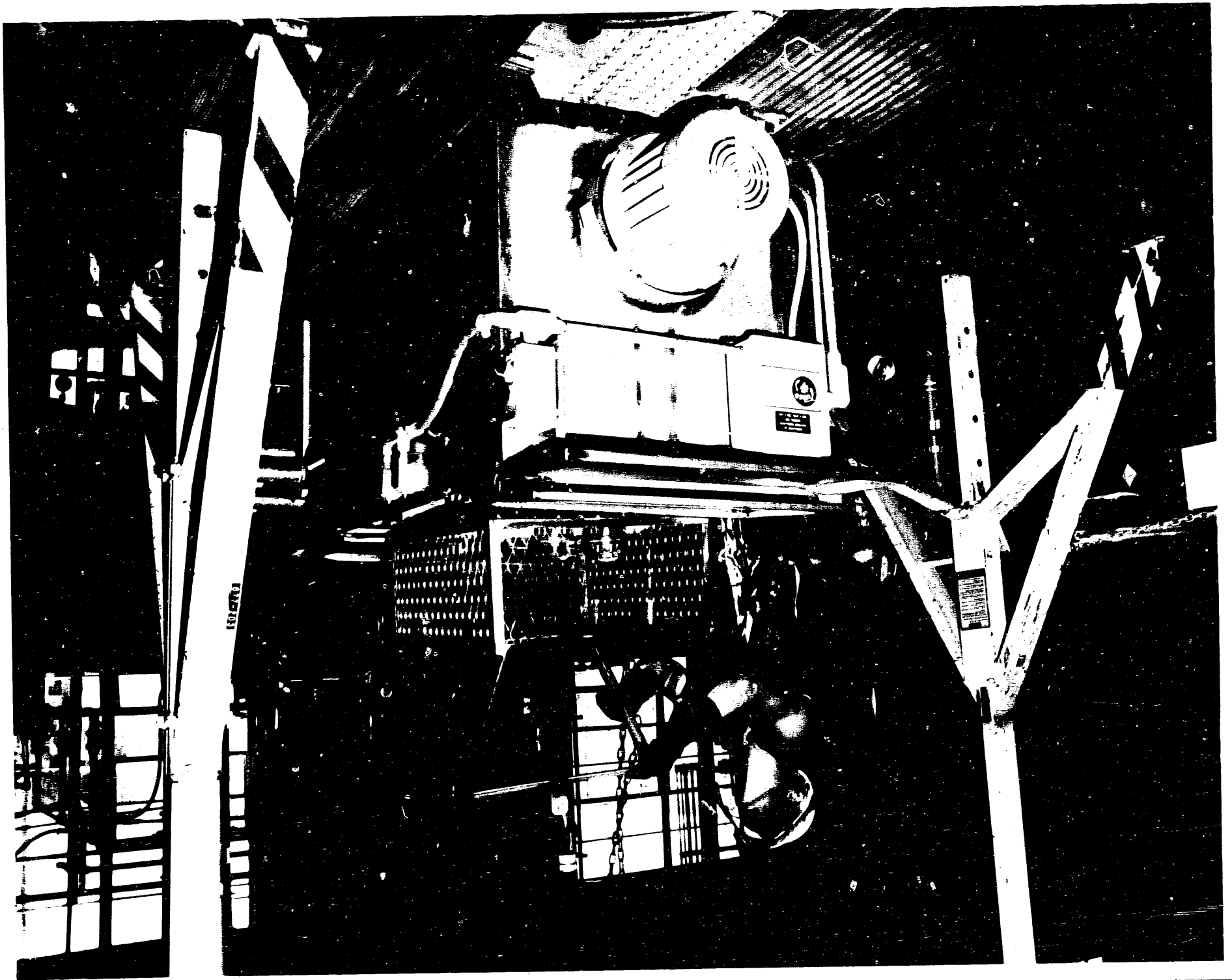
~~Graph 6~~

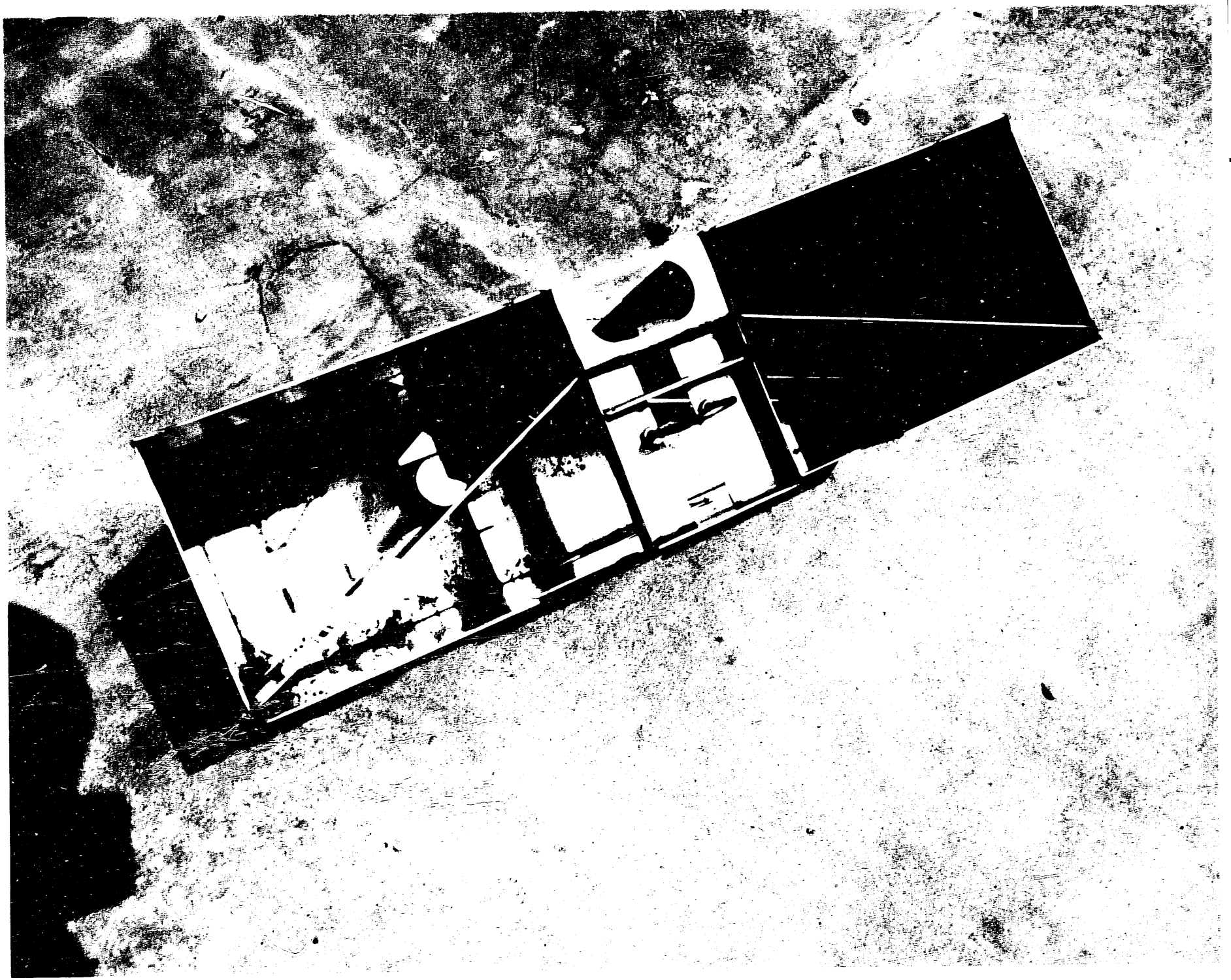
of way

Effect of Particle Size on Removal ~~Rate~~

~~*Control: 01°C, 60 min cycle, 2 gal HC 212*~~







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