1974034

A Study of Residual Iron Left on a Metal Surface After Peening to Various Arc Heights with Glass Beads

Objective:

A study was made to determine the amount of free iron which is left on surfaces of various metals when peened with glass beads.

The following is a listing of the various metals used:

1. Lead - Soft
2. Aluminum - Soft
3. Copper - Half Hard
4. Stainless Steel (316) 72 Rockwell B
5. Brass - 73 Rockwell B

Bead sizes used were C, AF, and AH. Arc heights for the various bead sizes were .007A_2, .008N_2, and .005N_2 in the same order of bead size listing.

Method:

Item I - General

The metals used for this study were non-magnetic. They start with very soft metals such as lead and aluminum, then progressively are harder up to the 316 stainless and the 80 - 20 brass.

Several methods for the residual iron determination could have been used. One method is to remove any residual iron from the sample after peening by using a magnet. It could then be removed from the magnet by brushing it into a beaker. Any suitable acid could be used to dissolve the iron and finally after correct procedures titrate it using a standard volumetric method.

Another method is to remove any residual iron after blasting by using an acid which would dissolve the iron but would not or to a small degree, react with the metal panels which had been used. A blank is run for iron on each metal prior to peening of the panel for a correction for the determination after peening. Final analysis for the iron is a colormetric method using a Hach Kit_1. This method was used for this study.

Item II - Standardization of Conditions

Accurate weight charges for the various bead sizes are not required for a study such as this, however, good operating practice calls that they should be approximately the same.

Sieve analyses for the individual charges are required. Samples should be taken mechanically in duplicate using a 2 to 1 Tyler splitter$_2$. Sieve analyses are made in duplicate using Tyler matched screens$_3$. The same operator should perform all sieve analyses in order to eliminate any differential in techniques.

The blast unit was cleaned thoroughly before placing any charge in it. This consisted of the hopper, blast cabinet, pressure pot and dust house$_4$. After peening with any one charge, the hopper, blast cabinet and pressure pot were cleaned before placing any new charge in the unit. The dust bags were shaken periodically during operations$_5$. The dust house was cleaned after the peening with every other charge.

The perpendicular distance between blasting nozzle and the specimen was six inches. The nozzle was supported and clamped to a stand to maintain the set distance. Arc heights were found by using Almen N and A strips on an Almen N-2 gage$_6$.

A Rockwell hardness tester$_7$ was used to determine the hardness of two of the metals. The other three were rated as soft or half hard. The hardness of each of the three metals would be lower than B O when using a 1/16" ball and a 100 kg. load. The surface finish, RMS, before and after peening for each metal was taken using a surfindicator$_8$.

All panels used were 4 x 3" in order that comparative tests of peening areas would be constant for all arc heights and bead sizes.

Operations:

A model 200P direct pressure unit manufactured by Vacu Blast was used for these tests. Any comparable unit could be used. The target or panel distance was set at 6" from the 3/16 I.D. nozzle at a 90° angle. Feed rate was maintained by using a 1/8" I.D. grit stem at a pressure of 30 P.S.I. All conditions were the same for each bead size and the corresponding arc heights.

One panel of each metal, lead, luminum, copper, 316 stainless and 80 - 20 brass was used as the target for each of the three bead sizes. These sizes and the arc heights for the stated conditions were as follows: C - .007A$_2$, AF - .008N$_2$, and AH - .005N$_2$. Hydrochloric acid was used to dissolve the iron from the lead, copper and 80 - 20 brass. Nitric acid was used on the aluminum and stainless.

General procedure was to complete one series of the five metals using one bead size then follow with a series of metals with the second bead size and finally the third size.

The specific procedure for any one metal panel per given bead size was as follows:

The panel was weighed to within .1 mg. on an analytical balance$_9$. The RMS was then determined using a surfindicator. The panel was placed in a shallow petri dish, covering the panel with a measured amount of the proper 1 to 10 acid depending upon the type of metal used. The solution was warmed to 150°F and gently agitated for ten minutes. The panel was removed and cleaned by washing with distilled water using a wash bottle. At this point, the panel was dried and reweighed on the analytical balance. The solution from the washing was added to the acid in the petri dish. The total solution was allowed to cool then transferred to a 100 ml. volumetric flask. Distilled water was added until the 100 ml. mark on the flask was reached. Ten ml. of this solution was transferred to and made up with distilled water until the second volumetric flask contained 100 ml. of solution. In each instance the solutions in the flasks had been thoroughly mixed by holding the stopper at the neck and turning the flasks upside down at least five times. A clean "Hach tube" was filled to the proper mark with distilled water. A second tube was filled to the proper mark with solution from the second volumetric flask. One "pillow" of reagent was added to this Hach tube. A rubber stopper was placed in the mouth of the tube and the solution was shaken for thirty seconds. The two tubes were placed in their respective places in the comparator and compared with the standard disk. Reading from the disk was in PPM, (Parts per Million). This reading was used as a blank for the correction factor for the final iron determination, after peening, for this particular panel.

The panel was peened to saturation on both sides with glass spheres of a definite size and arc height. It was reweighed and the RMS recorded. The panel was placed in the petri dish and covered with the same quantity of acid as when the blank determination was run. The remaining part of the procedure was the same as for the blank. All chemicals, distilled water and time were also the same.

Calculation:

In the peening field, one usually refers to metal finishing in terms of time per square area. Time was omitted and in its place, PPM of iron was substitued. The final expression was PPM of iron per square area

All panels were 4" x 3" and were peened on both sides resulting in an area of twenty-four square inches. The PPM of iron for that square area was the blank iron determination substracted from the final iron determination.

The following is a listing of the recorded data:

Sieve Analyses of Beads Used

C Beads Drum 122		AF Beads Drum 111		AH Beads Drum 106	
U.S. Sieve	% On*	U.S. Sieve	% On*	U.S.Sieve	% On*
30	0.0	80	0.0	140	0.0
40	22.5	100	9.41	170	4.93
50	74.0	120	25.90	200	35.31
60	2.3	140	41.79	230	24 44
70	.4	170	13.48	270	19.10
Pan	.8	200	7.08	325	13.55
Total	100.0	Pan	2.34	Pan	2.67
		Total	100.00	Total	100.00

* Average of Two Sieve Analyses

Timing of Arc Heights

C Beads, Drum 122 90^{o} angle, 6" distance, 3/16" nozzle, 1/8" grit stem

P.S.I.	Time/Seconds	A_2 Arc Height
30	2.5	.006
30	5	.0065
30	10	.0070
30	20	.00725
30	40	.00750

AF Beads, Drum 111 90^{o} angle, 6" distance, 3/16" nozzle, 1/8" grit stem

P.S.I.	Time/Seconds	N_2 Arc Height
30	2.5	.0065
30	5	.0075
30	10	.0080
30	20	.0085
30	40	.0090

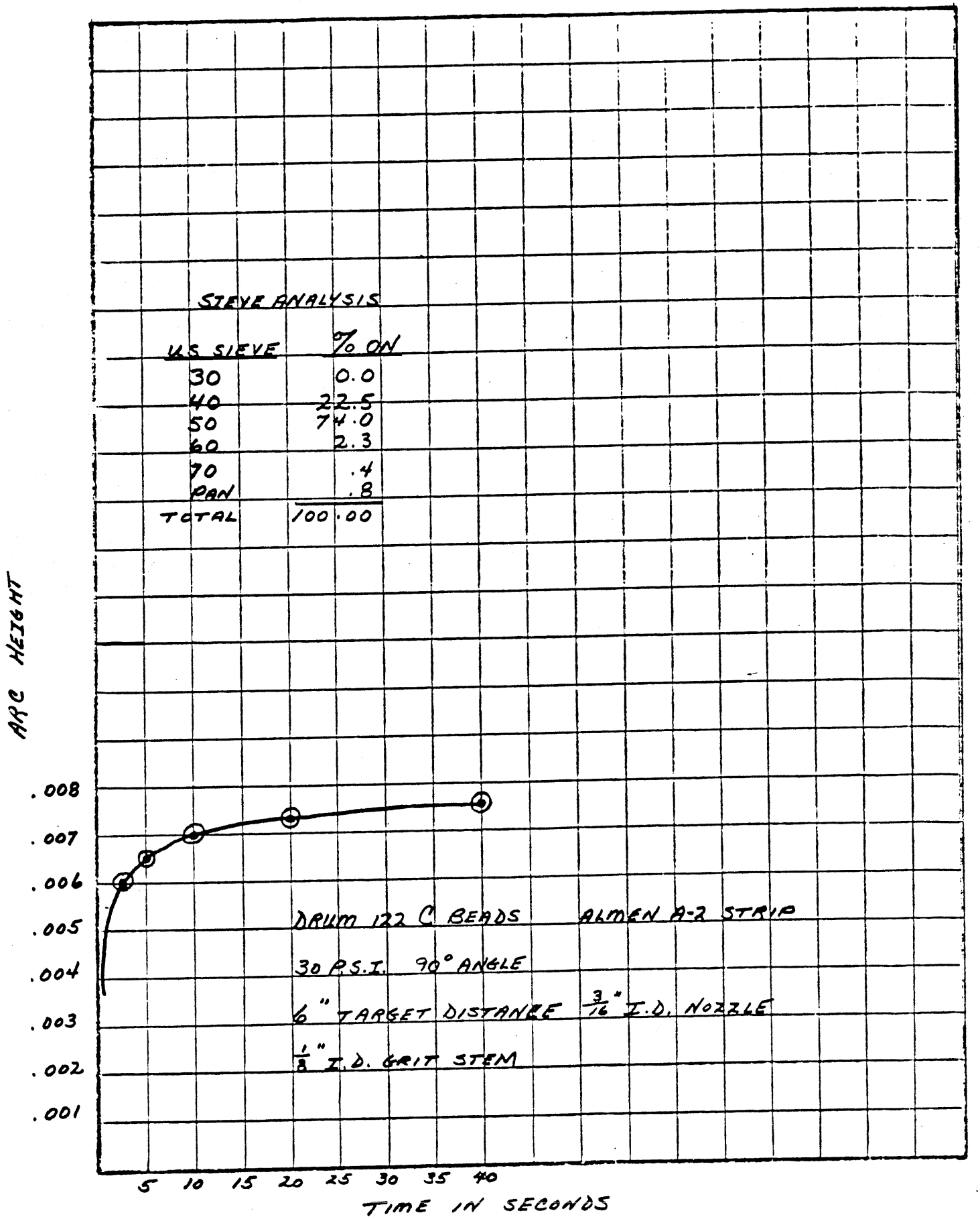
AH Beads, Drum 106 90^{o} angle, 6" distance, 3/16" nozzle, 1/8 grit stem

P.S.I.	Time/Seconds	N_2 Arc Height
30	2.5	.004
30	5	.00425
30	10	.00475
30	20	.00525
30	40	.006

RUN ON 200P DRY HONER

SIEVE ANALYSIS

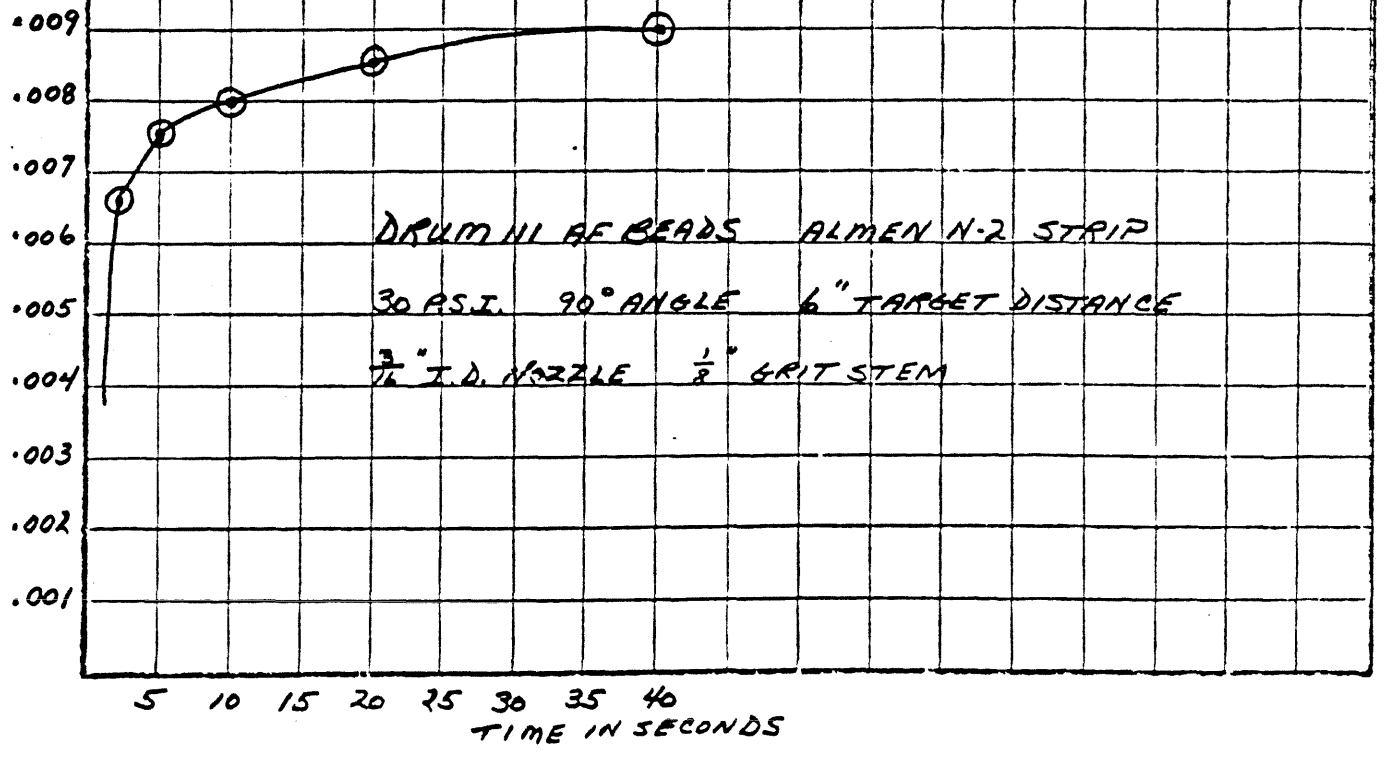
US SIEVE	% ON
30	0.0
40	22.5
50	74.0
60	2.3
70	.4
PAN	.8
TOTAL	100.00



RUN ON 200P DRY HONER

SIEVE ANALYSIS

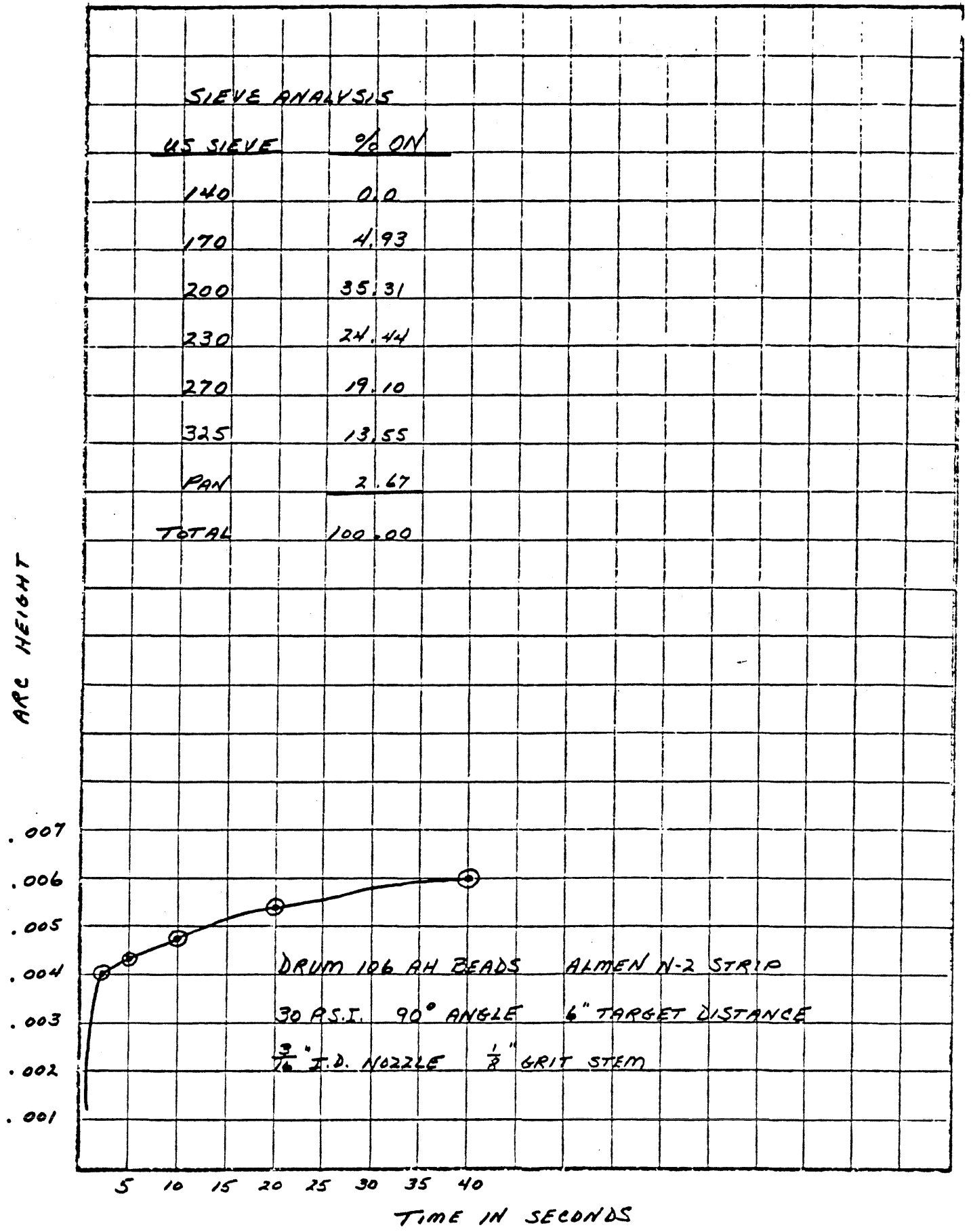
US SIEVE	% ON
80	0.0
100	9.41
120	25.90
140	41.79
170	13.48
200	7.08
PAN	2.34
TOTAL	100.00



RUN ON 200P DRY HONER

SIEVE ANALYSIS

US SIEVE	% ON
140	0.0
170	4.93
200	35.31
230	24.44
270	19.10
325	13.55
PAN	2.67
TOTAL	100.00



Run on 200 P 90° Angle, 6" Distance

Material	Lead	Aluminum	Copper	316 Stainess	80-20 Brass
Size Pcs.	4 x 3	4 x 3	4 x 3	4 x 3	4 x 3
Wt. Before Fe	81.0522	17.3932	52.7737	47.7760	53.9563
R.M.S. Before Fe	70-80	10-15	5-10	8-15	5-10
P.P.M. Fe	0.7	0.7	0.8	0.9	0.6
Wt. After Fe	81.0254	17.3910	52.7642	47.7735	53.9541
Bead Size	C	C	C	C	C
Arc Height	$.007A_2$	$.007A_2$	$.007A_2$	$.007A_2$	$.007A_2$
Pressure P.S.I.	30	30	30	30	30
Wt. After Blast	81.0073	17.4089	52.7496	47.7425	53.9159
R.M.S. After Blast	+ 300	200-225	150-175	80-85	145-155
P.P.M. Fe After Blast	0.7	0.7	0.7	0.9	0.6
Final Wt.	80.9821	17.3932	52.7436	47.7400	53.9118
Acid Used	HCl	HNO_3	HC1	$HN0_3$	HC1
Rockwell Hardness	Soft	Soft	Half Hard	72B	73B

All weights are in grams

Run on 200 P 90° Angle, 6" Distance

Material	Lead	Aluminum	Copper	316 Stainless	80-20 Brass
Size Pcs.	4 x 3	4 x 3	4 x 3	4 x 3	4 x 3
Wt. Before Fe	81.9725	17.3900	54.0709	47.4564	53.1090
R.M.S. Before Fe	70-80	10-15	5-10	8-12	5-10
P.P.M. Fe	1.2	0.8	1.1	0.9	0.8
Wt. After Fe	81.9541	17.3889	54.0610	47.4459	53.1073
Bead Size	AF	AF	AF	AF	AF
Arc Height	.008N_2	.008N_2	.008N_2	.008N_2	.008N_2
Pressure P.S.I.	30	30	30	30	30
Wt. After Blast	81.9165	17.4123	54.0476	47.3864	53.0809
R.M.S. After Blast	200-250	140-150	70-80	45-55	70-80
P.P.M. Fe After Blast	0.5	0.8	0.7	0.9	0.8
Final Wt.	81.8797	17.4040	54.0432	47.3842	53.0772
Acid Used	HC1	HN03	HC1	HN03	HC1
Rockwell Hardness	Soft	Soft	Half Hard	72B	73B

All weights are in grams

Run on 200 P 90° Angle, 6" Distance

Material	Lead	Aluminum	Copper	316 Stainess	80-20 Brass
Size Pcs.	4 x 3	4 x 3	4 x 3	4 x 3	4 x 3
Wt. Before Fe	75.2000	17.2208	52.4092	47.2113	52.0810
R.M.S. Before Fe	70-80	10-15	5-10	8-15	5-10
P.P.M. Fe	0.7	0.7	0.7	0.5	0.6
Wt. After Fe	75.1770	17.2173	52.4032	47.2093	52.0784
Bead Size	AH	AH	AH	AH	AH
Arc Height	$.005N_2$	$.005N_2$	$.005N_2$	$.005N_2$	$.005N_2$
Pressure P.S.I.	30	30	30	30	30
Wt. After Blast	75.1719	17.2219	52.4010	47.2054	52.0753
R.M.S. After Blast	145-155	75-85	55-60	25-30	40-45
P.P.M. Fe After Blast	0.7	0.7	0.7	0.5	0.6
Final Wt.	75.1462	17.2174	52.3784	47.2031	52.0703
Acid Used	HC1	HN03	HN03	HN03	HC1
Rockwell Hardness	Soft	Soft	Half Hard	72B	73B

All weights are in grams

Discussion:

The 200 P dry honer is equipped with a magnetic separator. This is located in the hopper above the pressure pot. Its function is to remove free magnetic material. If the peening media is magnetic, the separator may be removed. When using glass beads, the unit is run with the separator.

Inside the blast cabinet there is a blow off hose with a valve on the end of it. After peening any specimen, normal dry operating technique is to "blow off" the part with compressed air using this valve. All panels after peening were "blown off" as per normal peening operations.

No analysis was made to determine the percent iron in any panel as an alloy or an impurity. The 316 stainless steel is known to contain iron. The other metals studied may contain iron as an impurity. The acids used were chemically pure, however, each contains a very low percentage of iron as listed on their respective bottles. When using the same quantities of acids, maintaining time, temperature and distilled water, the total correction of iron for any one panel as a blank may be found.

Two 100 ml volumetric flasks were used for each iron determination. The solution was transferred to the first volumetric flask from the petri dish. It was made up to the calibrated mark with distilled water, thoroughly mixed and allowed to stand. Any solids which may have been in the solution would settle to the bottom. Without further agitation, ten ml from this flask was transferred to the second 100 ml flask. Distilled water was added until the calibration mark on the flask was reached. The solution was then mixed throughly. The proper amount of this solution was used in the comparator. The solution was clean having no turbity. This procedure was followed as a safety factor that all solutions would be as clear as the distilled water which was used.

All panels after peening lost weight with the exception of the aluminum. Each of these peened gained weight. No attempt was made to determine with by excessive blow off time that they would follow the pattern of the other panels of losing weight. All panels were peened to saturation. At a future date, a study will be made on aluminum of this type.

Conclusion:

When peening the metals studied to saturation, and using the normal blow off technique, there is no surface iron remaining as a contamination media. This statement is based on the method used for the iron determinations, the arc heights, the type of unit and the use of Ballotini glass beads.

For any given panel of the same material and starting R.M.S, an increase in arc height for a given bead size will also increase the R.M.S. of the panel after peening.

Footnotes:

1. Hack Kit Model R-18 from Hack Chemical Co. of Ames, Iowa.

2. For sampling and sieve techniques refer to testing sieves and their uses. Handbook 53, W.S. Tyler Company, Mentor, Ohio.

3. For matched sieves, refer to testing sieves and their uses, page 39. Handbook 53, W.S. Tyler Company, Mentor, Ohio

4. Cleaning of blast unit may be found on pages 39 through 32 of Dry Honer Model 200P Instruction Manual Vac-Blast Company, Inc. Belmont, California.

5. Cleaning of dust bags may be found on page 30 of Dry Honer Model 200P Instruction Manual Vacu-Blast Company, Inc. Belmont, California.

6. Almen N and A strips also Almen N-2 Gage from Metal Improvement Co., Carlstadt, New Jersey.

7. Operating instructions may be found on page 8 in Instruction Book Rockwell Twin Testor. Wilson Mechanical Instrument Division, American Chain and Cable Co., Bridgeport, Connecticut.

8. Surfindicator from Brush Instruments, Division of Clevite Corporation, Cleveland, Ohio.

9. Analytical Balance type LCB #50179 from Ainsworth & Sons, Inc. Denver, Colorado.

The writer wishes to thank Miss Isabelle Murray of our Research & Development Laboratory for her help in the determinations of the sieve analysis.

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