CLEANING LABORATORY EVALUATION SUMMARY

SCL #:	1994
DateRun:	11/14/1994
Experimenters:	Donald Garlotta, John Bulko
ClientType:	Forging Operation
ProjectNumber:	Project #1
Substrates:	
PartType:	Part
Contaminants:	Carbon Deposits, Inks, Dirt
Cleaning Methods:	Ultrasonics
Analytical Methods:	
Purpose:	Cleaner Performance Report

Experimental Procedure:

ABSTRACT

Eight aqueous cleaning chemistries were evaluated for removing forging lube, carbon black and other exhausted soils from aluminum ionizing scrubber plates collected at Wyman-Gordon Company. Using a 25KHz ultrasonic cleaning system, both ***Daraclean 232*** (10%) and ***Brulin 815 GD*** (10%) removed the deposited soils from scraped specimens with manual agitation in 20 and 27 seconds, respectively.

SCOPE and APPLICATION

Wyman-Gordon Company currently manufactures both **ferrous and non-ferrous forgings for aircraft, engines, turbines and machinery** products classified under SIC codes **3324, 3462, 3463** and **3728**. As part of their control technology to minimize airborne wastes from forging operations, forge exhaust streams are scrubbed using electrostatic precipitators to capture forging lubes, carbon black and other oil-based coolant fluids. Soiled aluminum collector plates from the scrubbers had previously been immersion soaked in a solution of glycol ethers and potassium hydroxide until visibly clean. The cleaning solution slowly etched the aluminum surface resulting in plate thinning and eventual plate loss.

A new cleaning process using ultrasonic agitation and aqueous-based cleaners has been evaluated and is currently being implemented. Pilot plant cleaning trials have shown one alkaline aqueous product to effectively remove all soils from the Al plates in approximately a one minute time frame at 160°F. Wyman-Gordon has requested assistance with:

- verifying performance of Blackstone® ultrasonic equipment,
- validating alkaline aqueous cleaner performance recommended by equipment vendor (***OAKITE OKEMCLEAN***),
- investigate performance of other cleaning products selected by Wyman-Gordon and TURI,
- investigate the effect of manual scraping to remove bulk of soil from plates prior to ultrasonic cleaning,
- investigate the effect of mechanical agitation on cleaning performance.

LABORATORY SUMMARY

Eight aqueous cleaning products were evaluated for their ability to remove forging lube, carbon black and other forge exhaust contaminants from the surface of aluminum (type 3003) collector plates taken from an electrostatic scrubber unit located in an exhaust hood. The collector plates were heavily soiled with an even deposit ~1/8" thick, with a paste-like consistency.

Cleaning experiments were performed using a 25KHz ***Blackstone Ultrasonics*** (Jamestown, NY) cleaning tank with 6 gal. capacity and 600 W ultrasonic generator output. The ultrasonic tank was thermostatically controlled. Contaminated samples were actual ionizing plates which were cut into either 3"x6" coupons or 2"x12" panels with accumulated exhaust soils coating both sides of the specimens. The 3x6 soiled coupons had holes along an edge to facilitate hanging in the ultrasonic tank. The larger 2x12 panels were placed in the tank vertically with the cleaning solution contacting approximately two thirds of the surface area.

Cleaning products evaluated in the ***Blackstone Ultrasonics*** tank are listed in TABLE I along with concentration and temperature used. Of the products listed, those that were specifically requested by Wyman-Gordon for evaluation have been denoted by a **(WG)** following the product name while candidates cleaners proposed by **TURI** are denoted **(TURI)**. Two aqueous cleaning products originally chosen for evaluation by Wyman-Gordon, ***OAKITE INPROCLEAN 3800*** and ***OAKITE ALUMINUM CLEANER NST,*** were withdrawn from the list of candidate chemistries as cleaning trials progressed. Typically, 5 gal. of cleaner solution at the desired concentration was prepared in the tank before the evaluation.

Cleaning trials were performed at temperatures between 154°F and 190°F. All performance trials were timed using a ***Gralab*** timer and ranged from 20 seconds to 20 minutes in duration. Specimens were removed from the tank after 20 minutes regardless of remaining soil loading. Estimates of soil removed after given time intervals were recorded for each cleaning product based upon visual examination made by both TURI and Wyman-Gordon. Several additional factors affecting the cleaning performance such as

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manual scraping of the plates and added agitation (vertical dipping motion) were also included as part of these studies. Results for each cleaning product and associated conditions have been charted in Figures 1-9 showing the estimated soil removed (%) vs cleaning time (minutes). Cleaning performance on the 3x6 coupons and 2x12 panels has been purposely separated since the soil on the smaller substrates was considered to be older in age, visibly drier in appearance and as such more stubborn to remove, thus representing the "worst case" cleaning scenario. The estimated percentage of soil removed from each coupon is relative to the amount present immediately before immersion in the ultrasonic tank. Manual scraping of the specimens did remove about 95% of the original soil load on the aluminum prior to cleaning but % removal data for trials using scraped samples was based on the amount removed relative to this lighter soil loading.

CLEANING PRODUCT	CLEANER CONCENTRATION	TEMPERATURE
	%	F
SPRAY CLEAN 400-T (WG)	10	158
SEAWASH NEUTRAL pH=7 (WG)	10	160
SEAWASH NEUTRAL pH=7 (WG)	20	160
OKEMCLEAN (WG)	10	154, 180-190
OKEMCLEAN/LADD ADDITIVE (WG)*	10% + 2.5% LADD	160
DARACLEAN 232 (TURI)	10	160-164
DARACLEAN 282 (TURI)	10	160
DARACLEAN 282 GF (TURI)	10	160-166
BRULIN 815 GD (TURI)	10	160

(WG)* The **LADD** additive was supplied by Arthur J. Berner (A.J.Associates, Westford, MA), the ***BLACKSTONE ULTRASONICS*** representative who was also the New England sales representative for ***OAKITE*** cleaning products.

Results:

Upon review of all cleaning trials performed, the three products performing the best in removing forge exhaust soils from aluminum collector plates were as follows:

TABLE II

RANK	PRODUCT	SAMPLE	SCRAPED	Agitation	Temp	Time
#			Y/N	Y/N	F	Sec
1	Daraclean 232	2x12	Y	Y	164	20
2	Brulin 815 GD	3x6	Y	Y	160	27
3	Daraclean 232	3X6	Y	Y	164	60
4	Okemclean	2x12	Y	Y	180-190	60

The specific conditions under which the experiments were performed have been listed. Changing any of the four parameters, 3x6 coupon vs 2x12 panel, "as received" vs manually scraped, with vs without agitation and bath temperature, all had an impact on performance results. Deposited soils on the 3x6 aluminum coupons were considered to be tougher to remove due to their visibly drier appearance and extended age, thereby representing a "worst case cleaning scenario". The product performing the best in cleaning the "as received" (unscraped) 3x6 soiled coupons was Daraclean 232 at 9.5 minutes. The second fastest cleaning trial, one using Okemclean w/ LADD additive, was effective in removing all soils in 12 minutes under ultrasonic conditions.

To reach the desired cleaning time of one minute (or less), manual scraping of the specimens to remove the bulk of the accumulated forging lube/carbon black was investigated. All cleaning trials using unscraped substrates exceeded acceptable time frames by a significant margin. In all trials manual agitation of the samples using a vertical dipping motion accelerated the removal of the forge exhaust soils as seen in Figure 2-A for Brulin 815 GD. Finally, temperatures of the cleaning solutions ranged from 154°F to 190°F. The objective was to achieve acceptable cleaning performance at the lowest feasible temperature. Both the Brulin 815 GD and Daraclean 232 products performed within the acceptable temperature range as determined by Forging Operation Co.

Specific results for the Spray Clean 400-T product have not been plotted as was done for the other products evaluated. Soil removed vs time data indicated slow and gradual dissipation of the accumulated soil layer with a considerable amount remaining on the surface after 20 minutes of ultrasonic agitation. Performance was comparable to the Okemclean product trial for an "as received (unscraped)" 3x6 coupon with no manual agitation at 154°F, as illustrated in Figure 3-A. Of the products listed in TABLE II, none contain any glycol ether constituents as did the previous cleaning solutions utilized at Forging Operation Company. Two products did contain a glycol ether component, Daraclean 282 and Oakite's LADD additive, yet their performance lagged behind the glycol-free chemistries. DARACLEAN 232, manufactured by W.R.Grace, is a liquid amine blend of ferrous and non-ferrous corrosion inhibitors, silicate, nonionic surfactants, anionic surfactant, EDTA and a citrus fragrance at less than 0.5% in a water base. This product contains no phosphate, chloride or nitrite. BRULIN 815 GD from Brulin Corp. is a blend of detergents, alkaline builders, phosphates and inhibitors. OKEMCLEAN, made by Oakite Products, is a proprietary blend of ingredients containing phosphates (tetrapotassium pyrophosphate), silicates (sodium and dipotassium salts) and other non-hazardous substances.

Summary:

Substrates:	

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Contaminants:	Carbon Deposits, Inks, Dirt				
Company Name:	**Product Name:**	**Conc.:**	**Efficiency:**	**Effective:**	**Observations:**
Warren Chemical Company	Sea Wash Neutral	10		☐	
Warren Chemical Company	Sea Wash Neutral	20		☐	
Magnaflux	Daraclean 232	10		☑	
Magnaflux	Daraclean 282	10		☐	
Magnaflux	Daraclean 282 GF	10		☐	
Brulin Corporation	Formula 815 GD	10		☑	

Conclusion: Eight aqueous cleaning chemistries were evaluated for removing forging lube, carbon black and other exhausted soils from aluminum ionizing scrubber plates collected at Forging Operation Company. Using a 25KHz ultrasonic cleaning system, both Daraclean 232 (10%) and Brulin 815 GD (10%) removed the deposited soils from scraped specimens with manual agitation in 20 and 27 seconds, respectively.