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ALSI SLOPOVERS

STUDIES, METHOD OF ELIMINATION, & RESULTS

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December 7, 1963

Explains steps taken to reduce the CPR rate to a
consistently low figure and the theory involved.

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ALSI SLOPOVERS
STUDIES, METHOD OF ELIMINATION, & RESULTS

INTRODUCTION

In the process of fuel element assembly, a dip-brazing process, the aluminum can which is ultimately a jacket for a uranium core is protected from the molten AlSi solution by a steel sleeve. Once the can is inserted into the sleeve and thermal expansion is complete, a mechanical block is accomplished by upset metal rings that prevent molten AlSi from flowing between the can and sleeve, a situation that warrants rejection of the assembled element. Passage of the molten solution beyond the upset metal to a point on the can wall not removed during the subsequent facing operation is called an "AlSi Slopover" or "Slop." See figure I. "A" represents an assembled fuel element rejected as a slopover; "B" is a slopover element after cap-end facing.

SUMMARY

With discovery of a solution* which would effectively mask 8001-F aluminum alloy from molten AlSi, efforts were immediately directed towards using this solution to eliminate AlSi slopovers. With proper application and control, PWR 125 proved that cans coated with PXL288 did not allow AlSi in the molten state to pass beyond the upset metal region during canning. Since this material has been used on total production, the CPR rate has been greatly reduced. Currently, the percentage of rejects attributable to the CPR category is approximately five-tenths of one percent (0.5%).

THEORY

Because the use of PXL288 has proven so successful in reducing the number of AlSi slopovers, it is felt that an explanation of the theory and action involved is in order.

PXL288, when properly used, offers two beneficial effects:

1. A physical block is created in view of the thickness of the film deposited around the upset metal of the can. This impedes the flow of AlSi.
2. The presence of PXL288 on the surface of the aluminum can reduces the solid surface tension, thus reducing the wettability of the surface.

When a film presents a sufficiently non-wettable surface, the molten AlSi will not spread; such conditions have been described as "autophobic." Consider a drop of molten AlSi on a smooth horizontal surface of 8001-F alloy. Assuming the aluminum is clean and deoxidized, without PXL288 the drop will spread itself over a relatively large area. The AlSi has wet

*PXL288 - A Diversey Corporation experimental product consisting mainly of sodium, phosphorus, and silicon (named "Seren-dip" by author).

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the aluminum. With PXL288 on the surface, the drop would remain in drop form and no spreading would occur. The latter is the case when applying PXL288 to the groove region of the can prior to the brazing process. (See figure I, C and D; figure II.)

TECHNIQUES AND OBSERVATIONS

Pilot Plant Testing

With the decision to use an experimental product to reduce AlSi slop-overs, 306 pilot scale testing was initiated. Earlier tests using Diversy PXL275 and PXL288 indicated that resultant non-wetting of aluminum components treated with these compounds could be used to advantage. PWR 122-61 (1962) demonstrated that a variety of cans could be masked against molten AlSi solutions. The subject cans were coated with PXL288 and dipped in the canning furnace without sleeves. In every case the areas of the components treated rendered a clean unbrazed surface as compared to completely brazed areas adjacent to the treated portions. (See figure II. Note the upset metal region of the can.)

Some questions were offered regarding the effect of PXL288 on the closure weld integrity. Inasmuch as the coating could cover the portion of the can normally welded (cap end), and the effects of the PXL288 on brazing were so definite, it remained to be demonstrated that weld quality would not be lessened.

As a demonstration, a large number of 05N fuel elements were faced, dipped in PXL288, and welded. In all cases the weld quality was at least as good as normally processed pieces.

It was also determined during this test period that stains caused by the PXL288 during canning were of no concern with regard to hindering formation of an effective autoclave film. Final etch removed the majority of deposits; the residual stains were not discernible after autoclaving.

Only after the aforementioned data had been collected and evaluated, were plans for a 313 feasibility test started.

313 Building Feasibility Testing

On December 7, 1962, PWR 125 was run on Line 1 and 2 in 313. These lines were canning 03E elements, a slop-prone model, and witnessing the usual high CPR rate. It was decided to treat cans and feed them to Line 1 and 2 in periods. Periods of untreated cans would be run alternately as a control.

The results were:*

Line 1

First period (untreated)	4.4% CPR
Second period (treated)	0.3% CPR
Third period (untreated)	4.1% CPR
Fourth period (treated)	0.0% CPR

Line 2

First period (untreated)	8.4% CPR
Second period (treated)	1.3% CPR

With confidence in the process innovation building, a similar test was run on December 11:

Line 1

Before coating	5.6% CPR
After coating	0.6% CPR

Line 2

Before coating	6.9% CPR
After coating	0.5% CPR

By December 13, total production was covered by PWR 125 with a very low CPR rate. It was determined that 70-80% of the reduced CPR rate was stuck sleeves indicating that slopovers were occurring at an insignificant rate.

On December 20, uncoated cans were used for four hours on swing shift (4 - 8 p.m.):

	<u>Line 1</u>	<u>Line 6</u>	<u>Line 3</u>	<u>Line 5</u>
4:00 - 8:00	0.8%	6.4%	2.3%	8.0%
8:30 - 12:00	0.0%	1.5%	1.7%	0.0%

The reduced CPR rates in the 8:30 - 12:00 p.m. period when almost all cans were coated is an indication of the effectiveness of the coating. Since that time, all cans are treated with PXL288. Recent data shows that the CPR rate, including stuck sleeves, spire leakers, slopovers, etc., has stabilized at approximately 0.5%.

During initial 313 testing, a close watch was kept on rejects downstream from canning. There was no indication that the coated cans caused problems anywhere in the process except at component preparation where

coating of the cans was slow and crude. The paint brush method of application was abandoned in preference to a device developed by Equipment Development. (See figures III and IV.)

Another use was discovered for PXL288 when canning line operators found that by dipping their canning tongs in the solution, the molten AlSi did not adhere to them. Prior to this method of coating the tools, a special coating had to be baked on in an oven.

PXL288 has proven very useful in the past year and represents a savings of approximately \$45,000. In addition, it was cause for submitting of a "Report of Invention" and a subsequent patent award.*

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*Letter W. E. Johnson to J. D. Schaffer, November 12, 1963.

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HANFORD ATOMIC PRODUCTS OPERATION
SPECTROCHEMICAL LABORATORY - BUILDING 3706
SPECTROCHEMICAL ANALYSIS REPORT

DATE REPORTED

12-3-62

SPEC. LAB. NO. SPM

13338

SUBMITTER'S NO.

PX 1275 & 1288

ANALYZED BY

J. Birge

MATERIAL

Diversey

PLATE NO.

20370

SUBMITTED BY

J. D. Schaffer

REMARKS:

ELE- MENT	1275	88	ELE- MENT	1275	88	ELE- MENT	1275	88	ELE- MENT	1275	88	ELE- MENT	1275	88
A			Cu	-	-	La	-	-	Pt			Th		
Ag	-	-	Dy			Li	-	-	Ra			Ti	-	T
Al	T-M	T-M	Er			Cu			Rb			Tl		
As	-	-	Eu			Mg	T-M	T-M	Re			Tm		
AsA	-	-	Fe	T-M	T-M	Mn	T-M	T	Rh			U	-	-
B	-	-	Ga			Mo	-	-	Rn			V	-	-
Ba	-	-	Gd			N			Ru			W		
Be	-	-	Go			Na	S	S	Sb	-	-	Xe		
Bl	-	-	H			Nd			Sc			Y		
C	%	%	Ho			Ne			Se			Yb		
Ca	T-M	-	Hf			Ni	-	-	Sl	T-M	S	Zn	-	-
Cb	-	-	Hg	-	-	O			Sm			Zr		
Cd	-	-	Ho			Os			Sn	-	-			
Ce			In			P	S	S	sr	-	-			
Co	-	-	Ir			Pb	-	-	Ta	-	-			
Cr	-	-	K	-	-	Pd			Tb					
Cs			Kr			Pr			Te					

SYMBOL	MEANING	APP'X. CONC.	SYMBOL	MEANING	SYMBOL	MEANING
S	STRONG	GREATER THAN 1 %	L	LESS THAN	NUMERICAL VALUES	PARTS PER MILLION
M	MODERATE	1% TO 0.01%	G	GREATER THAN	L100 +	EXAMPLE IN WHICH LOWER LIMIT OF 100 PPM. IS SET BY REAGENT OR SPECTRUM INTERFERENCE
T	TRACE	LESS THAN 0.01%	-	ELEMENT NOT INVESTIGATED	L100 -	EXAMPLE IN WHICH 100 PPM. IS LIMIT OF SENSITIVITY
+	DETECTED	MINOR CONSTITUENT	.	ELEMENT NOT DETECTED		
			T.	INTERFERENCE		
				DETECTION UNCERTAIN, INTERFERENCE		

REMARKS:

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REPORT APPROVED - /s/ P. R. Anderson

FIGURE I

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FIGURE II

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FIGURE IV

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END