

## **Testing an Alternative Method for Treating Molten Aluminum at Florida Extruders**

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The current method of cleaning the melt with a combination of chlorine and nitrogen gas mixtures has many local, state, and national authorities monitoring the residual and resultant process by-products. The heightened environmental concerns has many present day producers of extruded aluminum products expressing a desire to eliminate fluxing with gaseous chlorine from their processes and replace it with a more environmentally friendly treatment process that meets or exceeds the current level of metal cleanliness.

Florida Extruders Inc., an aluminum billet producer, contacted Pyrotek for assistance with replacing their current system with a more environmentally safe process that eliminates chlorine. Pyrotek recommended the newly designed injection system, **FIF-50**, which uses the fused refining agent **Zendox SF**.

Since the FIF – 50 does not rely on the use of chlorine gas the risk of creating visible gaseous and particulate emissions cause by over treating with chlorine gas is eliminated.

## **INTRODUCTION:**

Florida Extruders Inc., an aluminum billet producer for the building products market, contacted Pyrotek requesting an alternate treatment to replace bi-gas fluxing using gaseous chlorine at their Sanford, Florida plant. The challenge was to replace the existing bi-gas wand treatment process without any resultant performance decrease. Pyrotek and Florida Extruders determined the final level of hydrogen present would be the measurable performance criteria. The desired allowable hydrogen levels had to be as good as or better than the old processing technique. Hydrogen levels were to be monitored continuously through out the furnace cycle using the Bomem AlScan Hydrogen Analyzer.

## **PYROTEK'S SOLUTION:**

Pyrotek offers a complete range of molten metal treatment systems than can be adapted to provide a host of different processes<sup>1</sup>. These can include complete in line processing equipment like the SNIF Systems, in furnace treatment like the HD-2000 and PHD-50. Other equipment systems available can treat the melt with the injection of a fused refining agent. Pyrotek also manufactures a complete range of these fused refining agents to improve, molten metal cleanliness, reduce alkali content, reduce emissions and decrease dross. The goal was to select the proper fused refining agent coupled with an injection system that would be compatible with the operations of a secondary billet casting facility. The fused refining agent selected was **Zendox SF**, delivered by a newly designed Pyrotek injection system, **FIF-50**.

The FIF-50 injects a fused refining agent delivered by argon gas via a flux pipe. The portable FIF-50 can be programmed with adjustable process flows parameters controlled, simply, through the on-board PLC. Performance reports show that the FIF-50 delivers, improved alkali metal removal, reduced emissions, improved molten metal cleanliness, and less dross generated, while eliminating the use of chlorine gas<sup>2</sup>.

## DESCRIPTION: ZENDOX SF AND FIF-50

**ZENDOX SF** is a fused composite of magnesium and potassium salts in injectable form with a mean diameter of 3mm. It reacts quickly to efficiently remove sodium, calcium and lithium from molten and aluminum-magnesium alloys, as well as from refractory furnace linings. Sodium levels less than 3 ppm are attainable. The use of **ZENDOX SF** also permits the elimination of chlorine gas usage and produces cleaner furnaces.



**FIF-50** is a mobile, automated flux injection system that provides an alternate process to chlorine fluxing for billet casters. The unit consists of a pressure vessel receiver for granular or powder flux mounted on a heavy steel frame that sits on caster wheels.

Controls are PLC mounted on a NEMA IV enclosure, with warning lights and push-button start.

Flux is metered through a sophisticated patented gas delivery system that assists the flotation of the particulate into the gas



stream prior to exiting the unit horizontally. The material hopper can hold 110 pounds and is equipped with a mixing paddle to prevent clogging. A PLC allows 99 different pre-programmed options for injection times and quantities. Argon flow rates can be adjusted up to 90 litres per minute and refining agents up to 7.3 pounds per minute. The pressure vessel is certified and the unit is CE approved for all electrical appliances. Power requirements are

220 volt or 110 volt single-phase 60 hertz. Gas requirements are 100 PSIG, 100 SCFH maximum.

**PROCESS:**

Florida Extruders current practice is to melt secondary purchased scrap, mill scrap and P10/20 in a 30 Ton rectangular, gas fired reverberatory furnace. Charge materials are added to the furnace with fork trucks via a large front furnace door. A typical furnace cycle is: fill furnace, fire to flat bath, sample for chemistry, skim, add alloy, truck mix, re-sample, de-gas, and pour.

**Florida Extruder's Treatment Cycles:**

	<b>Florida Extruder's Current Degassing Treatment</b>	<b>Pyrotek's Recommended Treatment with the FIF-50</b>
<b>Process Time</b>	<b>30-40</b> minutes	<b>25</b> minutes
<b>Method</b>	One steel flux wand (through furnace front door)	One steel flux wand (through furnace front door)
<b>Reagent</b>	Bi-gas with <b>50%</b> nitrogen and <b>50%</b> chlorine	<b>30</b> pounds of ZENDOX SF
<b>Delivery gas</b>	N/A	Argon at <b>80</b> PSIG @ <b>80</b> SCFH
<b>Hydrogen Removal Efficiency</b>	<b>20%</b>	<b>25.8 %</b>
<b>Measured Reaction Time Post Treatment</b>	<b>0</b> minutes	<b>20</b> minutes

### **Data Collection Technique:**

Continuous hydrogen readings were obtained using a special probe submerged in the melt for the complete furnace cycle. The Alscan probes were inserted via the furnace temperature thermocouple hole in the furnace sidewall. Several cycles were observed for both the gas fluxing and FIF-50 treatment processes. The author's did report some process variability as a function of varying charge materials. In general the processes were repeatable and appeared to be in control.

### **RESULTS:**

The injection of 30 pounds of ZENDOX SF using the FIF-50 injector system improved hydrogen removal from the melt when compared to bi-gas fluxing with a 50/50 mixture of nitrogen and chlorine. The bi-gas cycle using a mixture of nitrogen and chlorine was 20% efficient. The ZENDOX SF, FIF-50 cycle was 25.8% efficient. The FIF-50 cycle time was 5 minutes shorter than the bi-gas cycle. The rate of reaction for the FIF-50 with ZENDOX SF was measured to remain active after the injection cycle stopped. The ZENDOX SF continued to be active for an additional 20 minutes. This was not the case observed with bi-gas treatment.

The removal of calcium from the bath was also greatly improved over previous methods with an average reduction of 47% using Zendox SF. The average calcium levels were reduced from 23 PPM to 12 PPM during the tests. Sodium levels both before and after treatments were recorded as less than 2 PPM.

### **Theory of Measured Results:**

The improved hydrogen removal of an injected material like ZENDOX SF versus a mixture of nitrogen and chlorine gases suggests the following. The gas-to-gas absorption reaction in the melt is the higher order reaction or first order reaction. By injecting the refining agent into the bath, the fused salt melts and becomes miscible in the molten aluminum and finely dispersed. Since the liquid salt has a lower buoyancy than the carrier gas, it is retained in the bath for an extended period of time where as the gas vents off quickly. This produces the secondary extended reaction where the molten salts continue to remove hydrogen and include oxides as it slowly rises in the bath. The reaction so described, utilizes more efficiently the refining agent by intimate interaction over an extended period of time with hydrogen, oxides and rare earth alkali metals. This secondary refinement action is demonstrated by the continual reduction in hydrogen gas levels for up to 20 minutes following the end of the flux injection sequence. *See Figures 1 and 2.*

FIF - 50 unit at Florida Extruders Sanford, Florida. USA			
Plant :	Florida Extruder		
Alloy :	6063		
Date :	8/15/01		
Holder Capacity 31,800 Kg. (70,000 pounds)			
Treatment Cycle: Promag RI for 20 minutes at an Argon flow			
Hydrogen Reading in the holder before treatment 0.330 cc / per 100 g/Al			
Hydrogen Reading in the launder after treatment 0,245 cc / per 100 g/Al			
Timing	minutes	H <sup>2</sup> cc/100 g/Al	% removed
Start Treatment	Start Treatment	0.330	0.0%
Furnace Treatment	10	0.311	5.8%
Furnace Treatment	11	0.307	7.0%
Furnace Treatment	12	0.305	7.6%
Furnace Treatment	13	0.303	8.2%
Furnace Treatment	14	0.302	8.5%
Furnace Treatment	15	0.324	1.8%
Furnace Treatment	16	0.323	2.1%
Furnace Treatment	17	0.321	2.7%
Furnace Treatment	18	0.318	3.6%
End Treatment	19' End Treatment	0.315	4.5%
Furnace Settling	21' Start Settling	0.278	15.8%
Furnace Settling	22	0.276	16.4%
Furnace Settling	23	0.273	17.3%
Furnace Settling	24	0.270	18.2%
Furnace Settling	25	0.268	18.8%
Furnace Settling	26	0.265	19.7%
Furnace Settling	27	0.261	20.9%
Furnace Settling	28	0.258	21.8%
Furnace Settling	30	0.255	22.7%
Furnace Settling	31	0.253	23.3%
Furnace Settling	32	0.251	23.9%
Last Furnace Analysis	33' Last furnace analysis	0.250	24.2%
Casting	40' CASTING	0.245	25.8%

Figure 1.

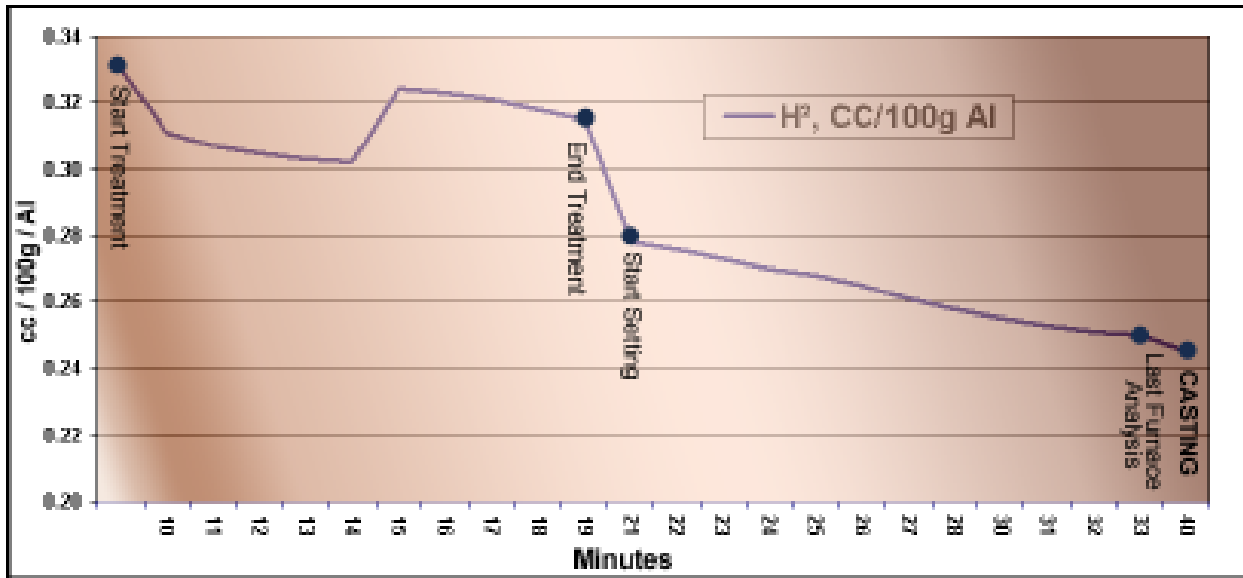


Figure 2. Hydrogen Alscan Measurements at Florida Extruders (August 2001)

### SUMMARY:

The injection of a fused refining agent with argon used as a transport gas can efficiently remove hydrogen and rare earth metals from aluminum melts. Pyrotek's fused refining agent ZENDOX SF, when injected by the FIF-50 Injector, can replace bi-gas wand furnace fluxing and eliminate the use of gaseous chlorine.

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<sup>1</sup>*Improvements in Cast Shop Processing Using Pyrotek's HD-2000 and PHD-50 Rotary Injector System*

Mickey McCollum Pyrotek Inc. SNIF System Cleveland, Ohio

Peter Flisakowski Pyrotek Inc. SNIF System Spokane Washington

<sup>2</sup>*Injection of PROMAG Fused Refining Agents—The Safe Alternative to Chlorine*

Robert Bridi; Sevimetal, Chambéry, France

V. Dopp, S. Ray Foseco Aluminium Ltd.