Successful Case Studies of Fluxes when Melting Metals

September 14th 2006 Meeting
American Foundry Society
North East Ohio Chapter

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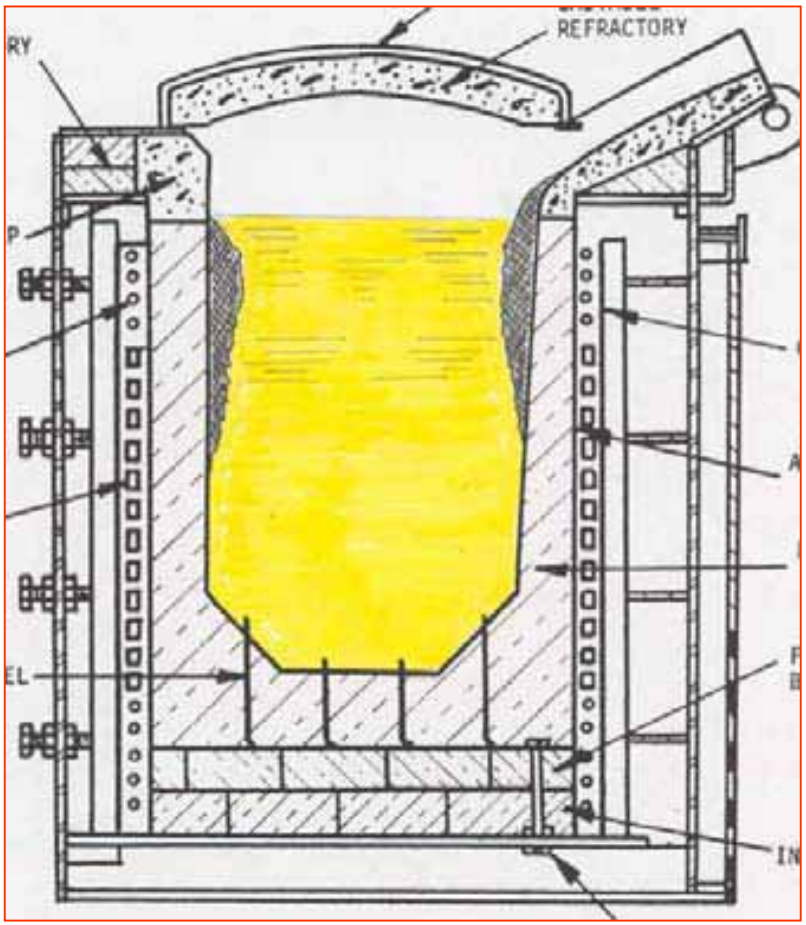
Columbus Ohio

Successful Case Studies of Fluxes when Melting Metals / D. Williams, ASI

- Continuous Flux Additions to a Coreless Furnace Charge to control Sidewall Build-Up
- Semi-Continuous Flux Additions to a Vertical Channel furnace to control Slag Ring formation /Cupola fed iron
- Low Heel Superheat / Superboost Flux Addition for Removing a Clogged throat or Inductor channel.
- Continuous Flux Addition to Ductile Iron Treatment Ladle

Continuous Flux Additions to Coreless Charge

Insoluble Build-Up in Coreless Induction Furnaces - Iron and Steel



Reduction of Furnace Capacity

Slower Melting Rate

Possible Localized Superheating, Increased Saturation

Render Ground Detection Useless

Continuous Flux Additions to Coreless Charge

Slag Coreless Fce #1 (%)		Slag Coreless Fce #2 (%)	
SiO2	82.1	SiO2	72.6
Al2O3	5.7	**CaO**	**7.5**
CaO	**3.9**	FeO	5.8
FeO	2.1	Al2O3	4.7
Na2O	**2.1**	MnO	4.4
MnO	2.0	**Na2O**	**2.4**
MgO	0.9	MgO	1.4
ZrO2	0.5	S	0.4
TiO2	0.3	TiO2	0.3
K2O	0.2	ZrO2	0.2
S	0.1	K2O	0.2
BaO	0.1	Cl	0.1

1) **During the backcharging sequence of either 60 cycle or medium frequency coreless furnace, add Flux per ton of metallic charge <u>entering</u> the furnace. DO NOT ADD ANY FLUX TO AN EMPTY FURNACE. THERE SHOULD ALWAYS BE AT LEAST 50% MOLTEN METAL BATH REMAINING INSIDE OF THE FURNACE.**
2) **Once all of the solid charge has been melted, Remove the slag from the top of the molten metal bath.**
3) **DO NOT LEAVE THE RESIDUAL SLAG INSIDE OF THE FURNACE AFTER FLUXING HAS BEEN ADDED.**
4) **Take a representative slag sample before and after the flux addition, in order to quantify any change in the slag. Save these results for future review**
5) **Repeat this process on the following production heats.**

Semi-Continuous Flux Additions to Channel Holding Furnace supplied by Cupola Melt

Flux Treatment for Vertical Channel furnace Continuous Treatment for 4 days at the End of Week

The following information represents a procedure for use by a foundry melting in an 16 ton/hour cupola feeding directly into a 25 ton vertical channel furnace at the same rate. Their operation is 5 days/24 hrs.

They begin adding 2 lbs of FLUX per ton of molten iron going into the receiver of channel furnace starting Wednesday. Per hour, this equates to 32 lbs of Flux per hour through the fill/receiver spout.

They continue to do this continuously for 8 hours each day. They repeat this for next 4 days.

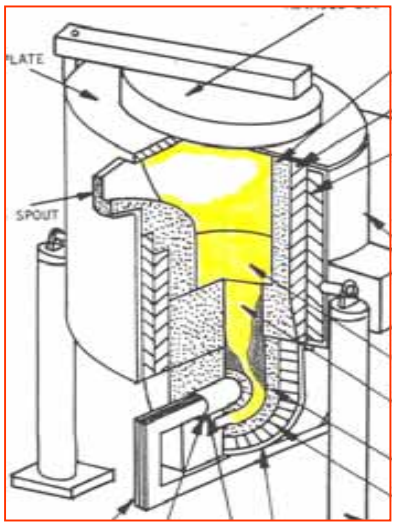
Each day at 4:00 am, they will remove all of the slag in the furnace so that they can start each day with a clean furnace.

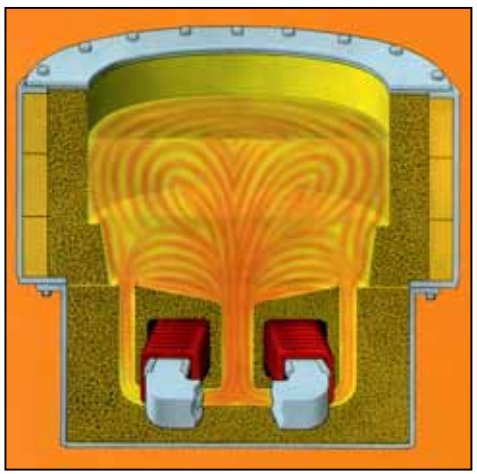
Courtesy of Asea Brown Boveri.

Semi-Continuous Flux Additions to Channel Holding Furnace supplied by Cupola Melt

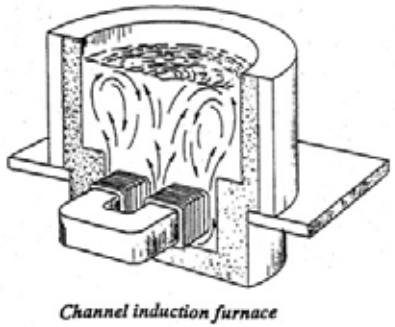
Case Study: Fluxing 30 ton Vertical Channel Melting Furnace

Low Heel Superheat / Superboost Flux Addition for Removing a Clogged throat or Inductor channel.

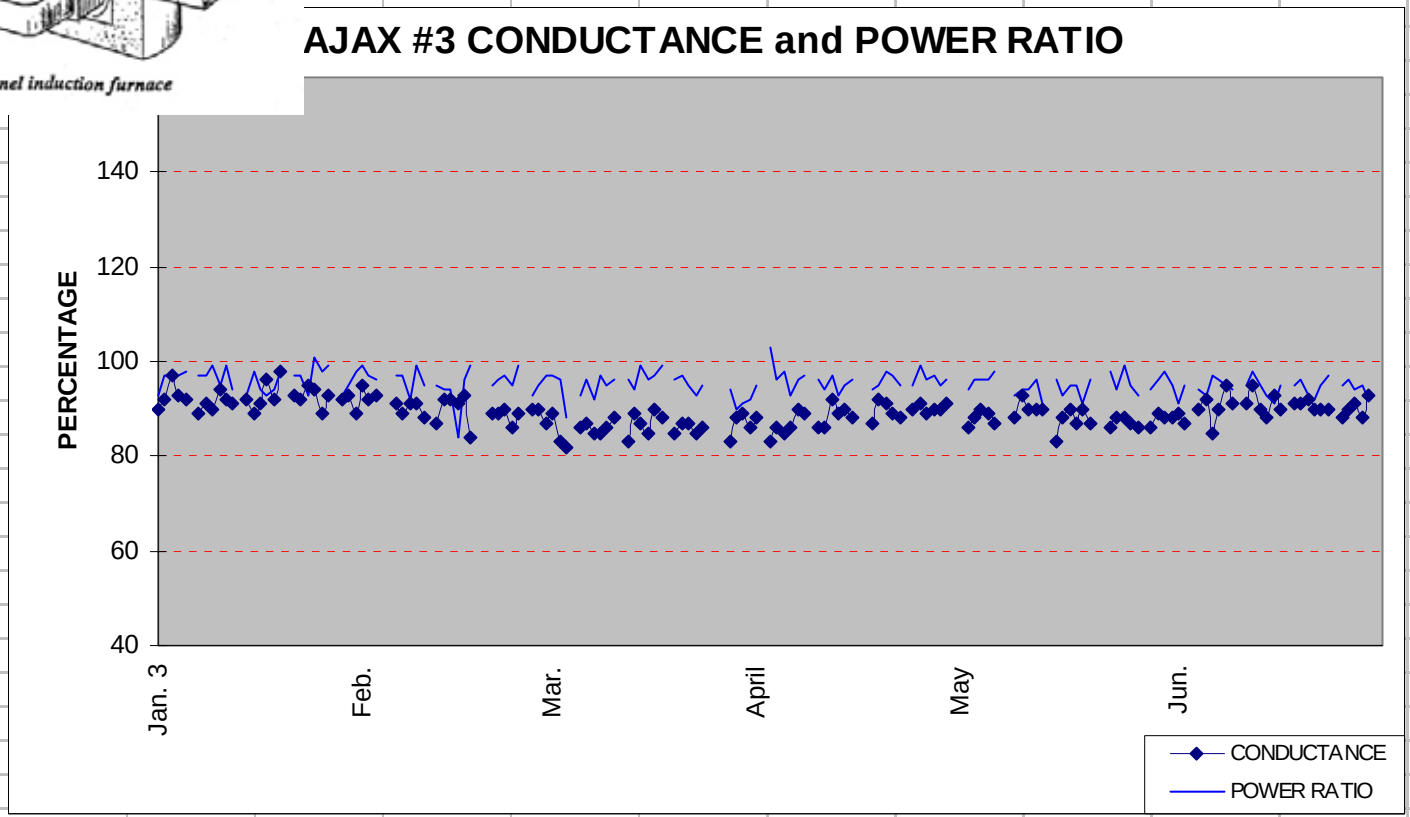




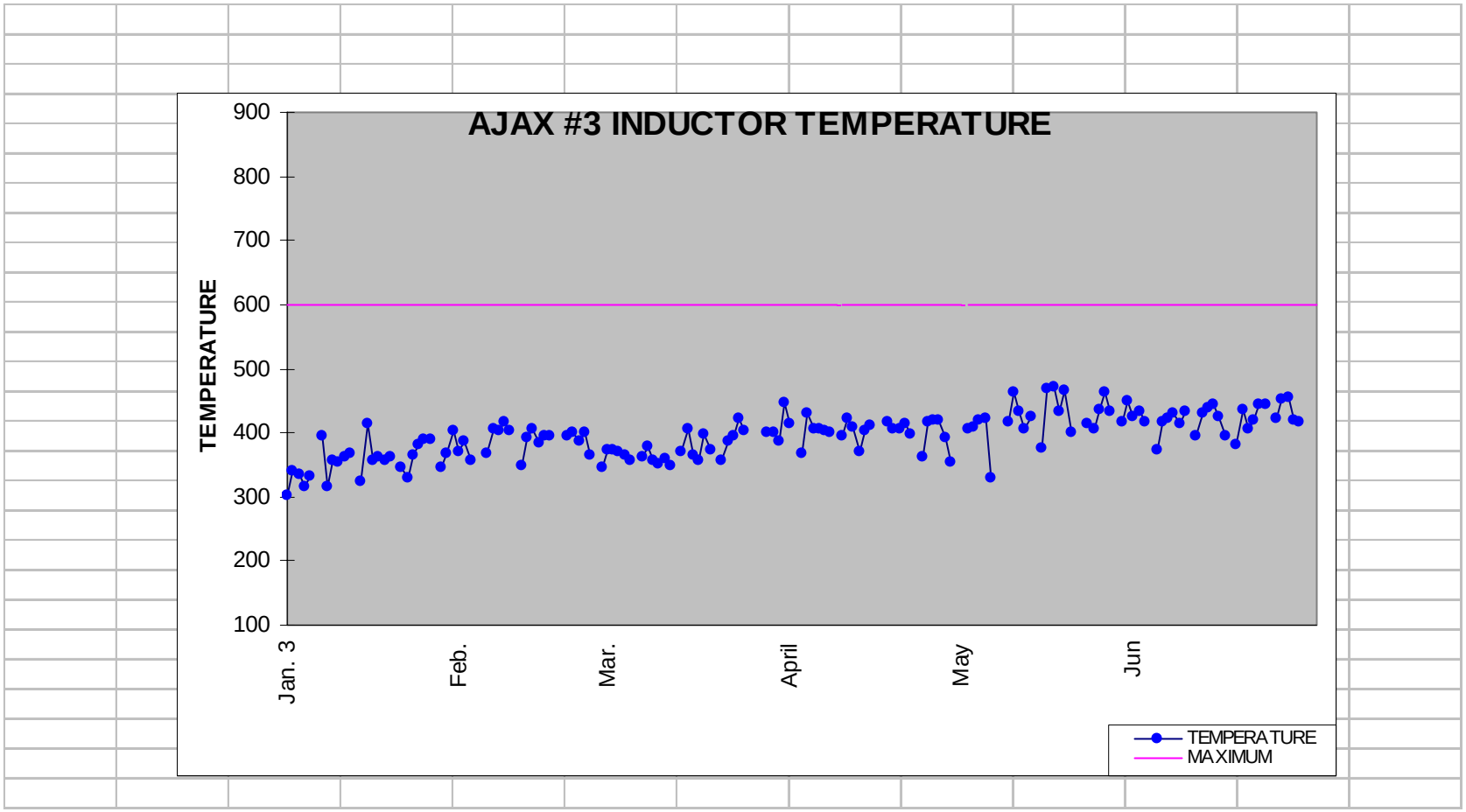
Case Study: Fluxing 30 ton Vertical Channel Melting Furnace



Channel induction furnace



Case Study: Fluxing 30 ton Vertical Channel Melting Furnace



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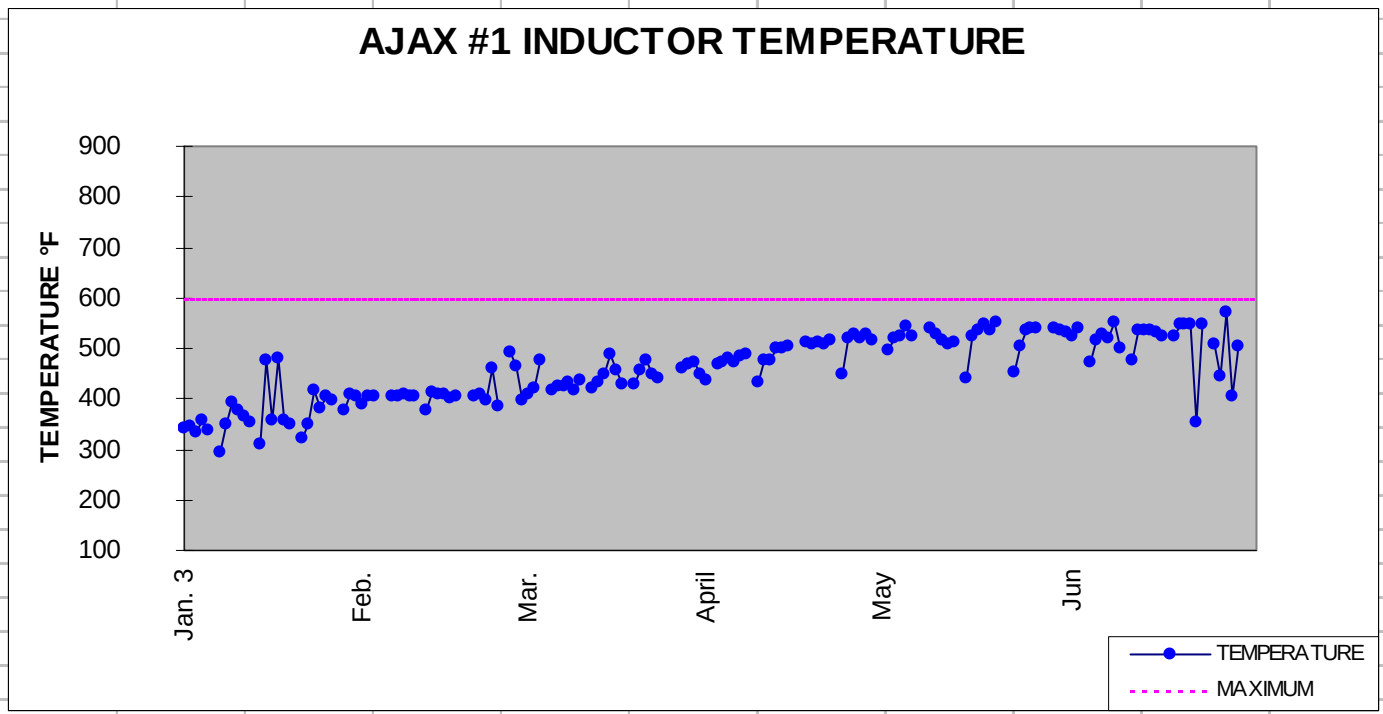

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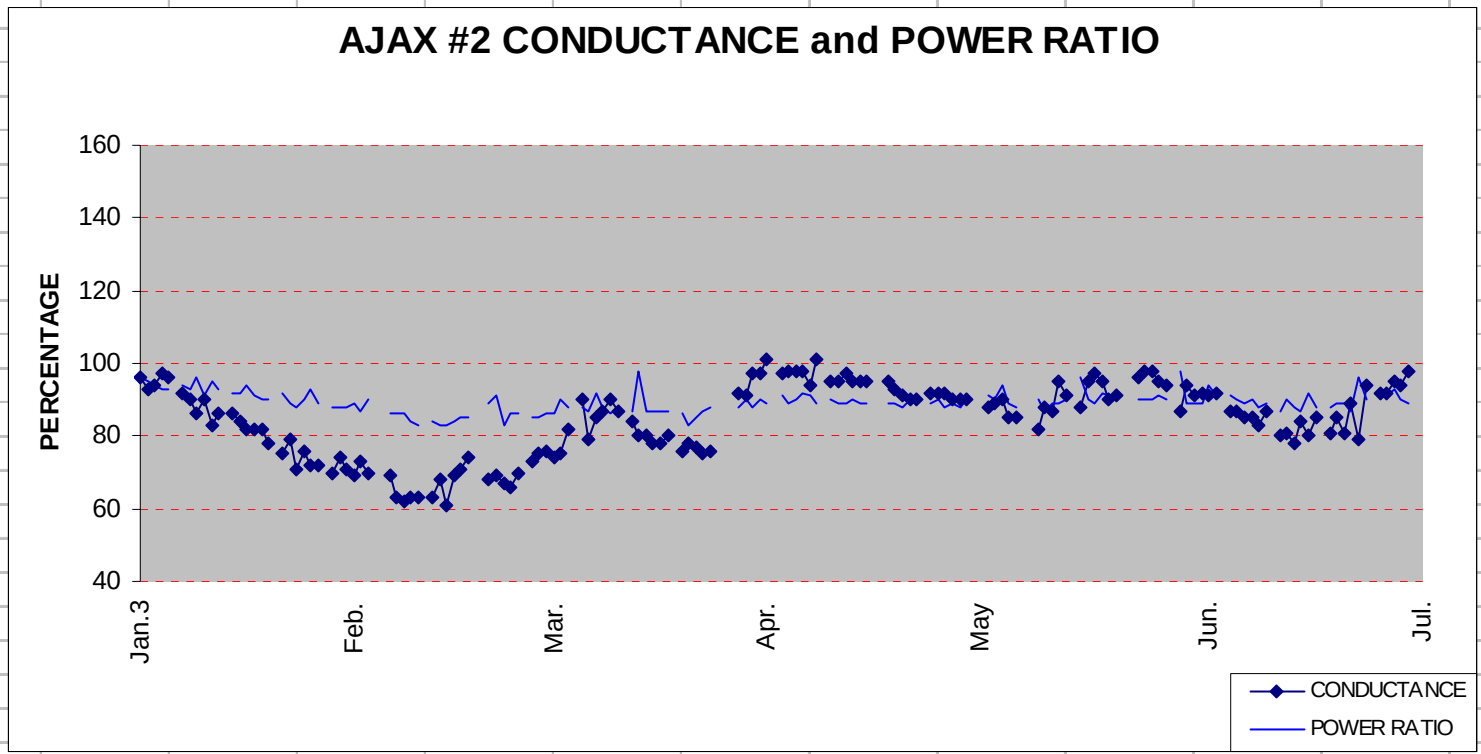
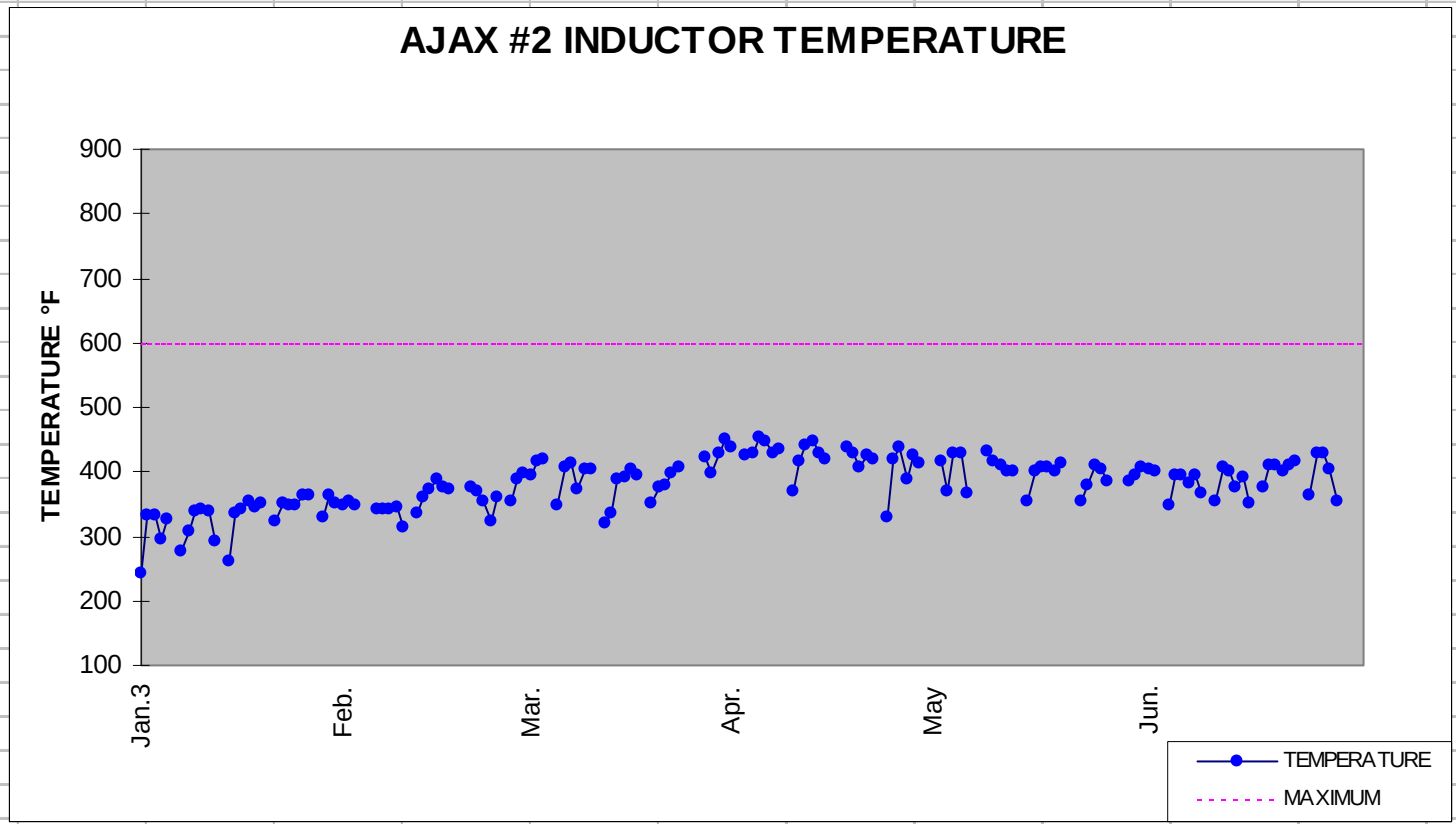
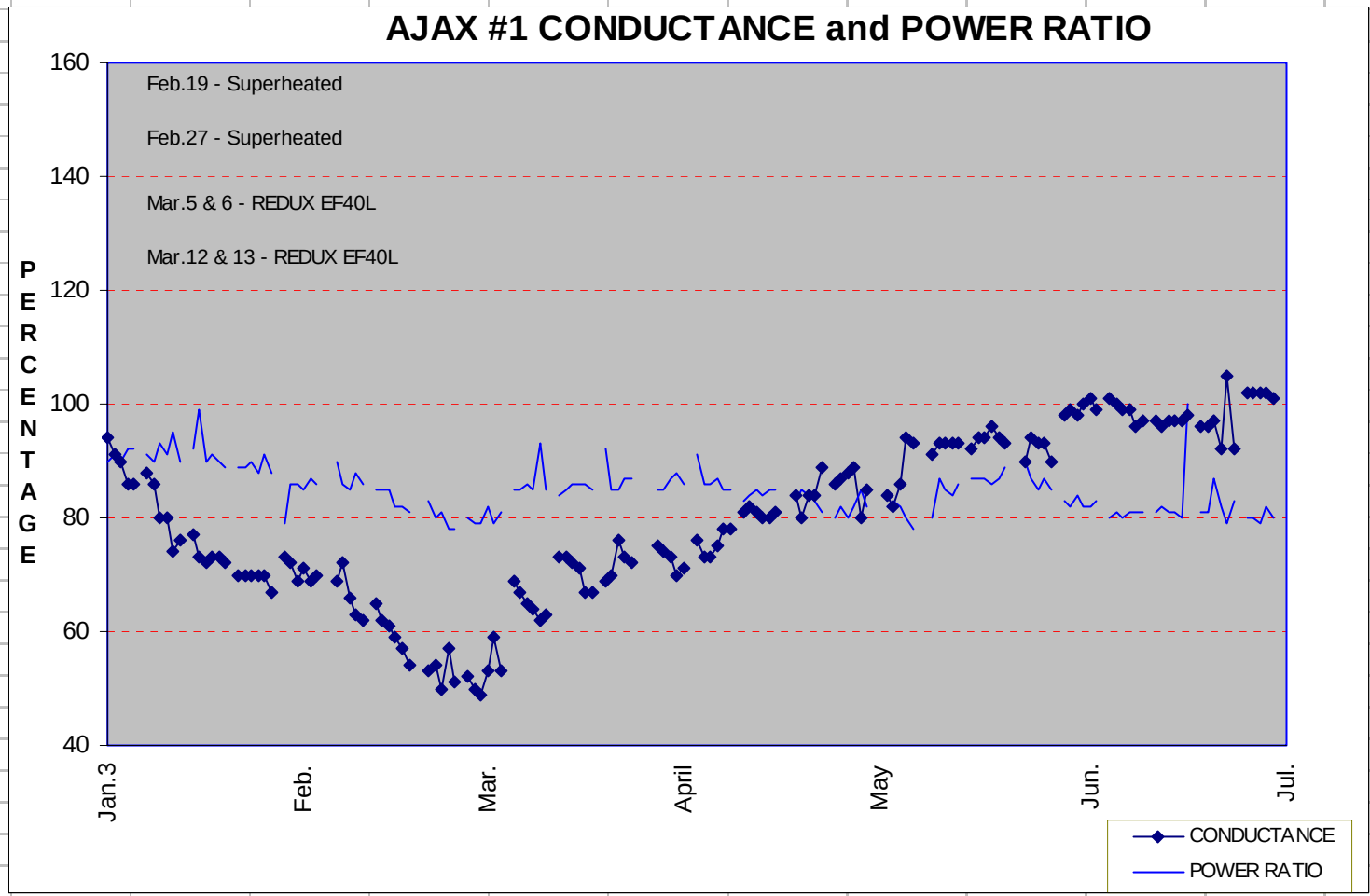


Case Study: Fluxing 30 ton Vertical Channel Melting Furnace



Case Study: Fluxing 30 ton Vertical Channel Melting Furnace

A Comparison of Clogged Condition vs Normal Condition in AJAX Channel Melter 2006



Insoluble build-up typically occurs in inductor, throat, upper case and entrances to spouts

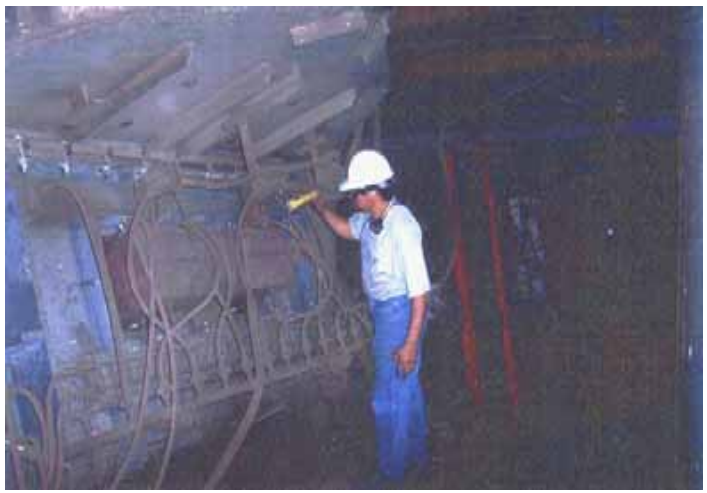
- **energy inefficiencies, poor temperature control, diminished heat transfer**
- **unmonitored superheating in clogged inductor loop can lead to dangerous run-outs**

Case Study: Fluxing 30 ton Vertical Channel Melting Furnace

Channel Slag Results Before and After

Ajax 1 prior redux			Ajax 1 after 1st redux			Ajax 1 after 2nd redux		
	(%)			(%)			(%)	
SiO2	43.7		SiO2	48.0		SiO2	45.5	
Al2O3	30.3		Al2O3	28.6		Al2O3	32.2	
FeO	13.9		MgO	6.9		MgO	7.4	
MnO	5.2		Na2O	4.9		CaO	4.6	
CaO	3.0		CaO	4.2		Na2O	4.4	
MgO	2.3		FeO	3.8		MnO	2.2	
TiO2	0.6		MnO	2.4		FeO	2.2	
K2O	0.4		TiO2	0.5		K2O	0.4	
Na2O	0.2		K2O	0.4		TiO2	0.4	
Cr2O3	0.2		BaO	0.2		BaO	0.2	
BaO	0.1		CeO2	0.1		ZrO2	0.2	
ZrO2	0.1		ZrO2	0.1		CeO2	0.2	
			La2O3	0.1		La2O3	0.1	

Case Study: Fluxing 30 ton Vertical Channel Melting Furnace



1) **Open cover of the furnace, and remove slag from the top of the molten iron.**
2) **Lower the molten iron level to minimum Heel.**
3) **Add flux per ton of CLEAN molten iron, to 2700 F (1480C) iron.**
4) **Turn inductor power on maximum power.**
5) **For 300-650 Kws, leave inductor on max power for 4 hours. For 750Kw – 1100Kw, leave inductor on max power for 3 hours. Monitor the molten iron temperature so that it NEVER exceeds 2950F(1620C). It may be necessary to cut back the power momentarily, but the maximum power should be resumed immediately. Also it may be necessary to replenish the Flux addition after the second hour of Superheating..**
6) **After the superheating period of the inductor has been completed, the molten iron should be cooled to normal holding temperatures. There will be more slag created which SHOULD BE REMOVED. However, depending on the foundry, it can be left inside for removal on the following day.**
7) **Close cover and check the spout openings.**
8) **Repeat the entire process after 24 hours.**

This foundry is now considering a daily Flux addition to their charge to help minimize build-up from forming by floating the insolubles into the slag.

Case Study: Fluxing 30 ton Vertical Channel Melting Furnace

The Cost Savings realized by this Foundry

Downtime to Reline and commission this Furnace: 5 DAYS

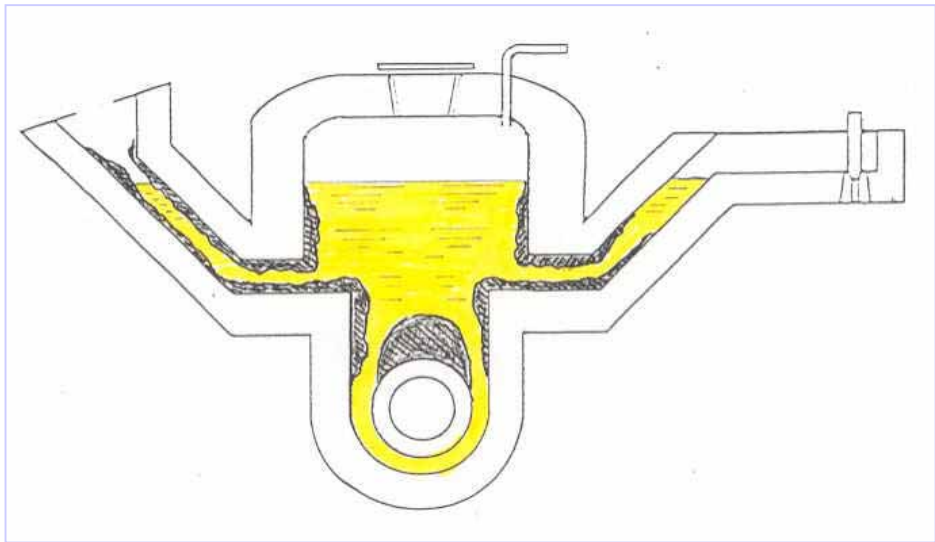
Cost of $80,000 to the foundry

Loss of Production for 5 Days for this furnace: $50,000 x 5

Total Savings $330,000

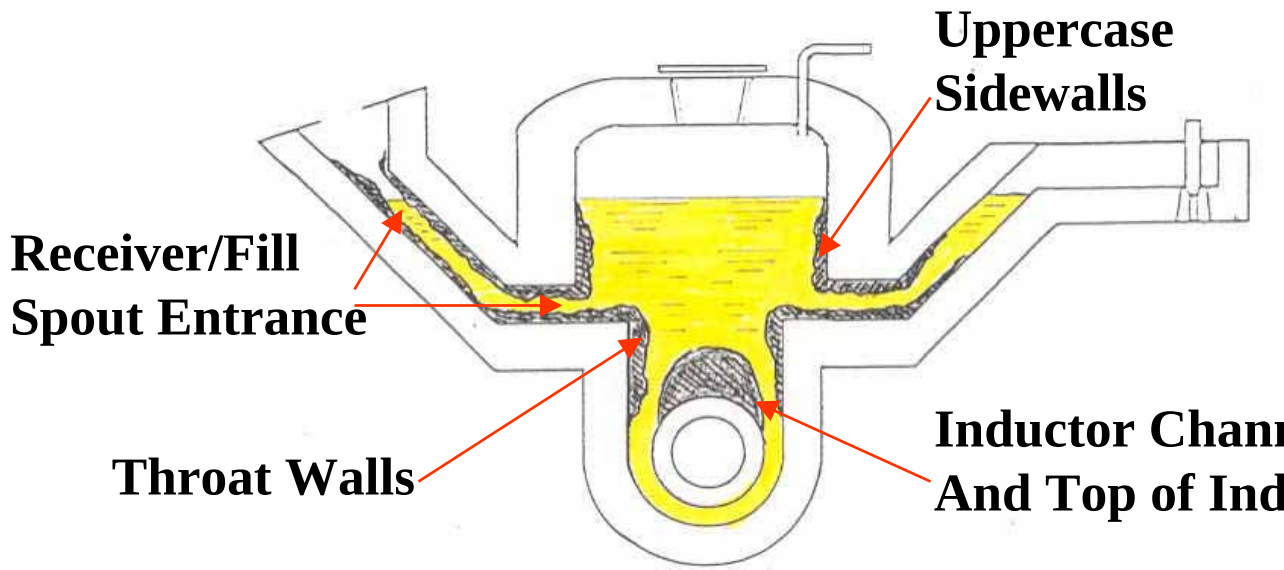
Treated Ductile Iron Build-Up in Pressure Pour Furnaces

Insoluble Build-Up in Iron Pressure Pour Channel Furnaces Holding/Pouring Treated Ductile Iron or Alloyed Iron



Treated Ductile Iron Build-Up in Pressure Pour Furnaces

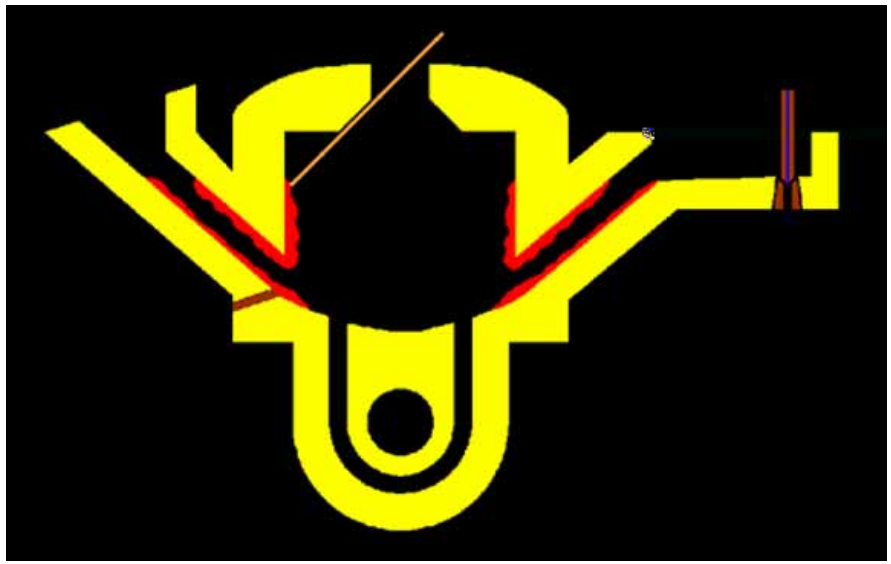
Insoluble Build-Up in Iron Pressure Pour Channel Furnaces Holding/Pouring Iron – Flux Treatment Locations



Insoluble build-up typically occurs in inductor, throat, upper case and entrances to spouts

- **energy inefficiencies, poor temperature control, diminished heat transfer**
- **unmonitored superheating in clogged inductor loop can lead to dangerous run-outs and extreme heavy saturation.**

Treated Ductile Iron Build-Up in Pressure Pour Furnaces

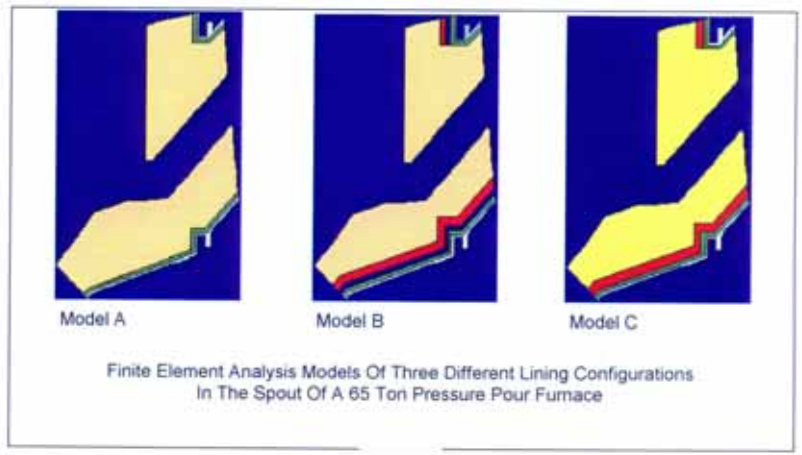


Daily/Weekly Mechanical Scraping

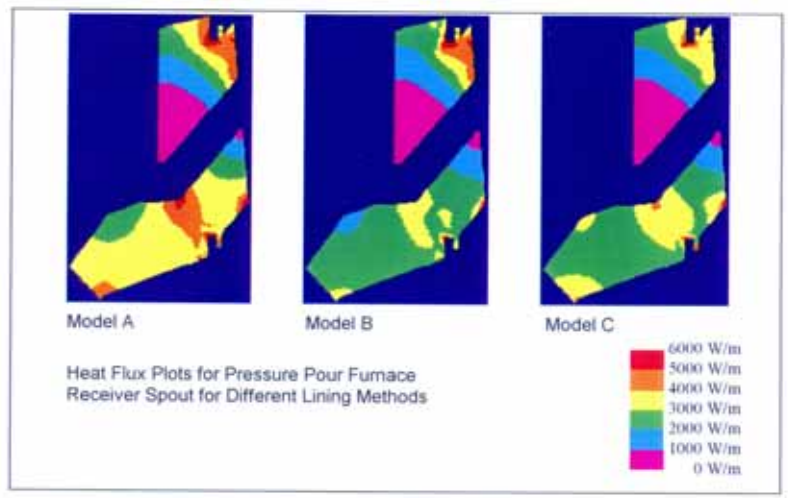
Continuous flux additions to Fill Spout

Low Heel Superheating/Flux Addition

Periodic Pulsing of Inductor during Production.



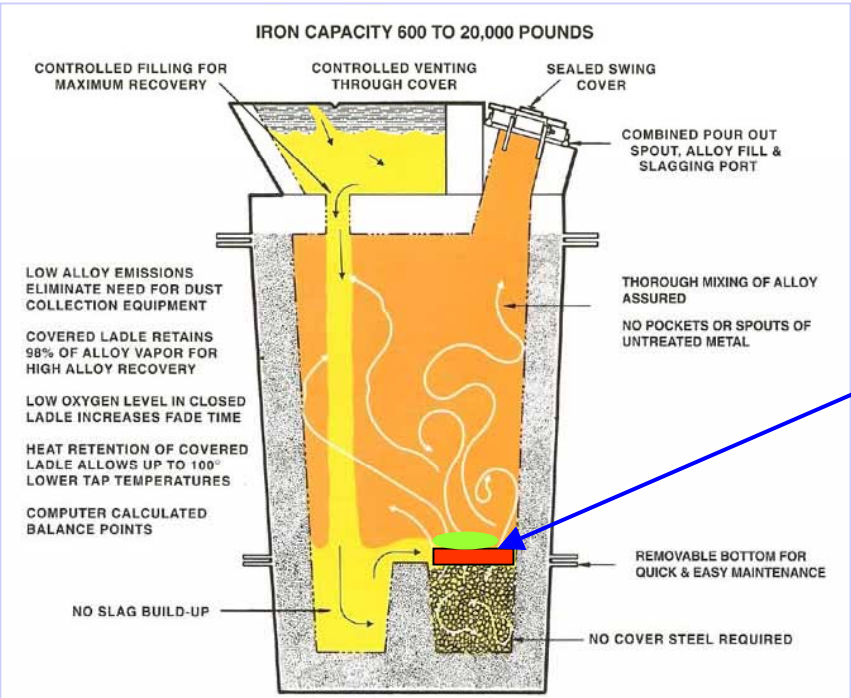
Different Refractory Designs for Fill Spout



Thermal Studies of Different Fill Spout Designs

Continuous Flux Additions to Ductile Treatment Ladles

Restoring Ladle Capacity for Treatment Ladles



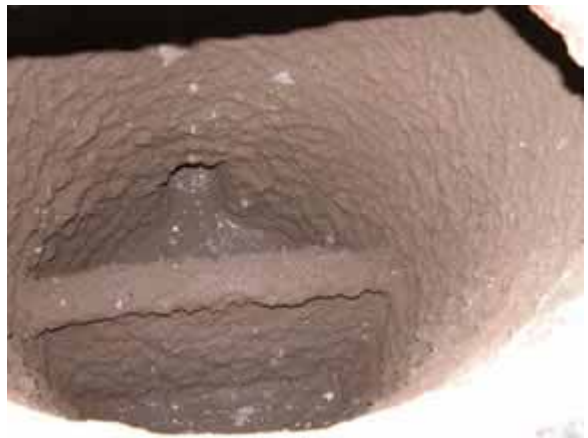
Courtesies of D&L Ladles

Daily addition of Flux should be added on top of the Cover steel, not in the pocket as shown in the adjacent drawing.

For Fischer Converters, the Flux should be used after the pure Magnesium has been added.

Continuous Flux Additions to Ductile Treatment Ladles

3000 lb Tundish Ladle



Original Pocket w/ Ref. Coating

Pocket Build-Up after
24 hrs Production

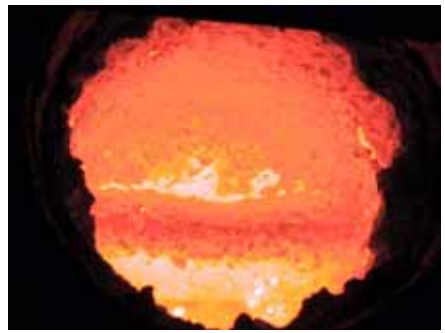
Continuous Flux Additions to Ductile Treatment Ladles

Continuous addition of 1 lb Flux per 1 ton of molten Iron fed into the Molten metal stream

Continuous Flux Additions to Ductile Treatment Ladles

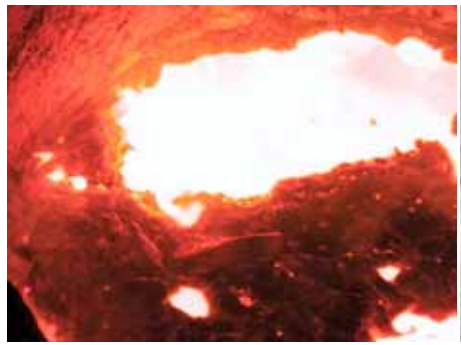
Fluxing a 1 ton Treatment Ladle with 5 “Wash Heats” one lb(0.4Kg) Pack per Ladle



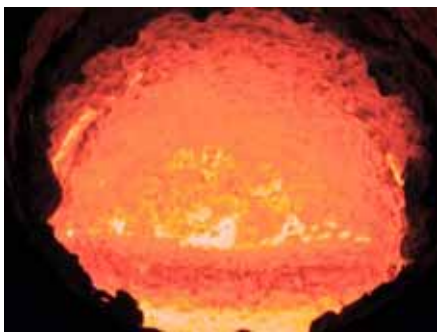



Initially, loss of pocket capacity due to Insoluble Build-Up. After 5 separate Wash heats





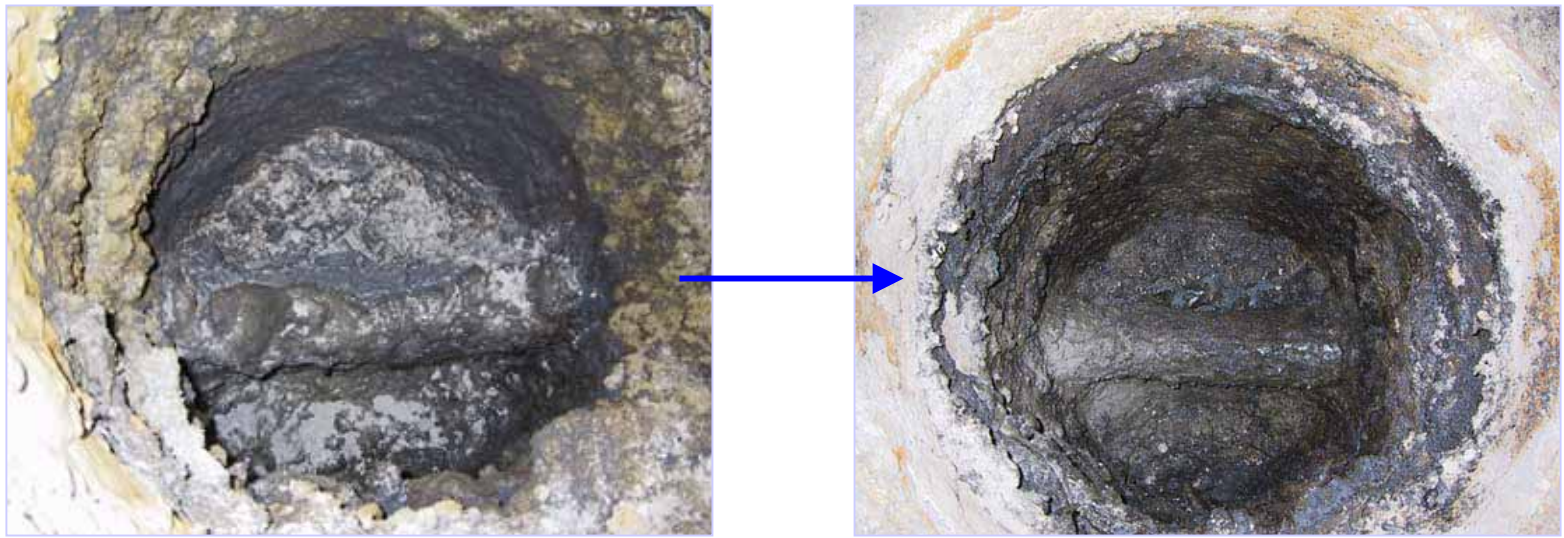

After the 5 individual treatments, pocket capacity was restored as shown




Continuous Flux Additions to Ductile Treatment Ladles

Before Treatment

After Treatment



This was achieved with minimal scraping, strictly the addition of Flux to 5 different “wash heats.” Note that there was minimal refractory erosion of sidewalls and pocket.

Continuous Flux Additions to Ductile Treatment Ladles

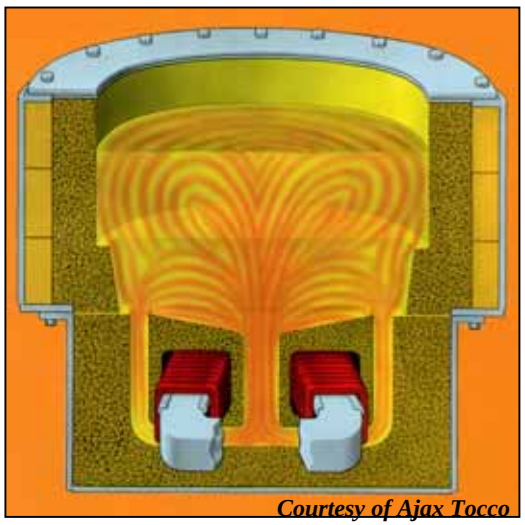
These foundries found that they were able to extend the service life of the Ladle from 24 hours to 3-5 days.

Continual refractory maintenance was still required but to a lesser degree, and less mechanical damage was done on the refractory.

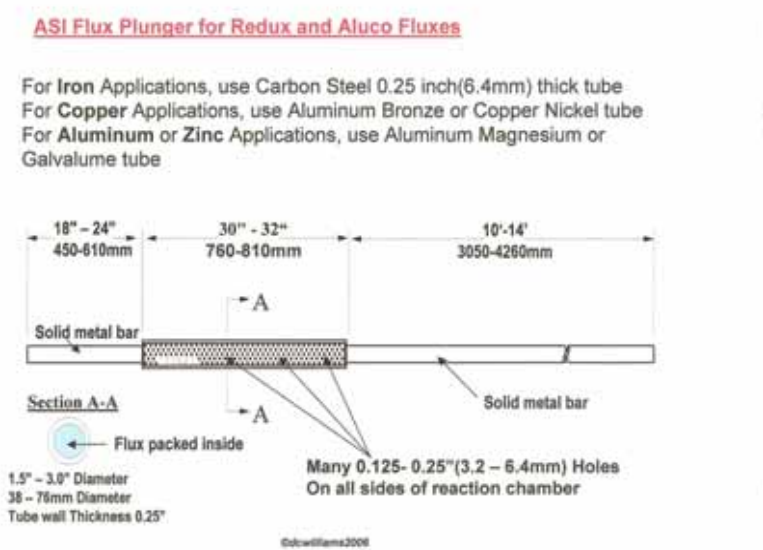
Pocket dimensions no longer varied during the day, allowing for consistent treatment properties.

Ductile Iron Build-Up in Channel Furnaces

A Method of adding Flux to Correct Severe Inductor Clogging



Plunging Method “The Wallbanger”



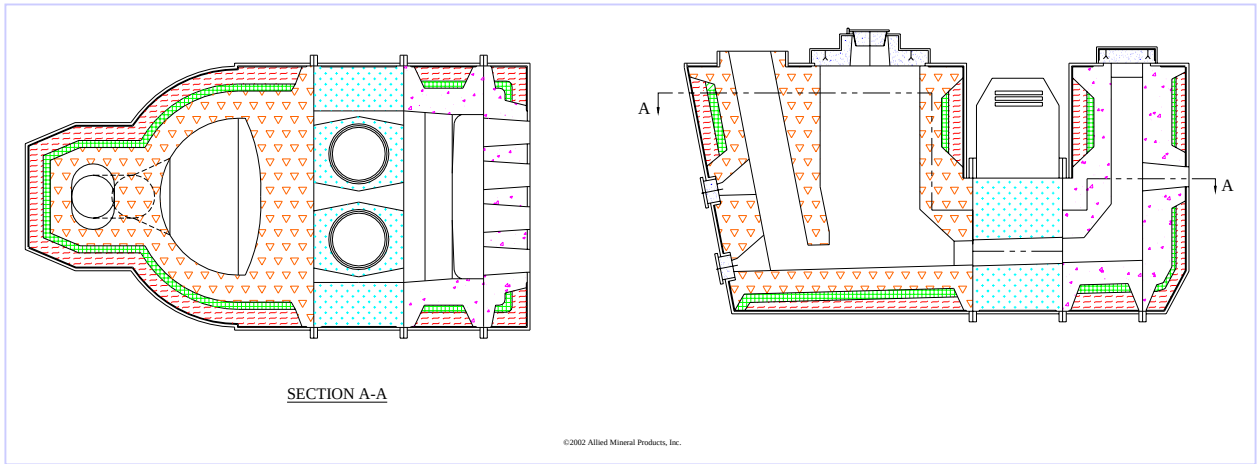
Other Flux Applications for Today's Metalcasters

Insoluble Build-Up in Coreless Induction Furnaces Melting Copper-Based Charge

Build-Up will cause inefficient melting, reduction of furnace capacity, and may lead to malfunction of the ground detection system.

Current Flux Additions for Horizontal Copper Casting furnace

Insoluble Build-Up in Channel Induction Furnaces Melting/Holding Copper-Based Alloys



Flux was continuously added to alleviate build-up in the transverse inductor channels at the rate of 1-2 lbs. per ton entering the Receiver/fill spout.

Successful Case Studies of Fluxes when Melting Metals

Although the majority of this presentation dealt with Real-life Case Histories in Ferrous foundries, these concepts/procedures have been applied successfully for the non-ferrous market as well.

I hope that this talk has reinforced the positive effect that Fluxes can have in tackling some of the toughest Build-Up Scenarios with minimal negative consequences to the molten metal and/or to the refractories. When used properly, foundries can truly Realize a benefit to their application.

I would like to Thank the AFS North East Ohio Chapter for the Opportunity to talk to all of you tonight. Thank you.