PHOTOGRAPH THIS SHEET

AD-A953 567

DTIC ACCESSION NUMBER

LEVEL

INVENTORY

1

WAL 710/49

DOCUMENT IDENTIFICATION

30 JAN 1936

This document has been approved for public release and sale; its distribution is unlimited.

DISTRIBUTION STATEMENT

ACCESSION FOR		
NTIS	GRA&I	[X]
DTIC	TAB	[ ]
UNANNOUNCED		[ ]
JUSTIFICATION		
BY		
DISTRIBUTION /		
AVAILABILITY CODES		
DIST	AVAIL AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

UNANNOUNCED

OTIC COPY INSPECTED

DTIC SELECTED OCT 1 9 1984 E

DATE ACCESSIONED

DATE RETURNED

84 10 17 060

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NO.

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-DDAC

DTIC FORM 70A DEC 83

DOCUMENT PROCESSING SHEET

PREVIOUS EDITION MAY BE USED UNTIL STOCK IS EXHAUSTED.

REPORT NO. 710/49

MELTING PRACTICE FOR CAST ARMOR PLATE STEEL

INDEXED

BY

E. J. ASH

Jan. 30, 1938

WATERTOWN ARSENAL
WATERTOWN, MASS.

710149

Test. Lab.

Melting Practice for Cast Armor Plate Steel

January 30, 1936

Purpose

To study the use of synthetic slags as a means of deoxidation of cast armor plate and the effect on impact and ballistic properties.

Proposed program in three parts:

Part I

Production and study of synthetic slags.

A. Using the 60# induction furnace and by means of a graphite crucible, melt the following compositions:

Mix	MnO%	SiO_2%	Al_2O_3%	FeO%	Na_2O%
1	30	50	20		
2	40	40	20		
3	35	50	10	5	
4	45	45	5	5	
5	45	50			5
6	40	50			10
7	35	50			15
8	30	55			15
9	20	70			10

B. Determine the temperature-fluidity relations of these mixtures, including their melting temperatures.

Part II

Production of metal using synthetic slags.

A. Using regular cast armor plate composition and the same (50#) charge (quantity of materials added), make the following series of melts, keeping record of all slag materials added and removed.

1. Make two heats without any attempt to protect molten bath from oxygen contamination. Add alloys of Cr-Mo-V and pig iron as charge melts, Si after charge is melted and Mn just before tap.

2. Make two heats adding the alloying constituents as above but keep the molten bath covered at all times while stirring with a synthetic slag of suitable properties as determined from Part I.

3. Make two heats as under 2, except five minutes after molten, remove old slag, add new, renew slag again after 5 minutes stirring, keeping temperature of bath below 3000°F (optical).

4. Make two heats, melting bar stock and pig iron, cover with appropriate slag, renew slag twice at five

minute intervals, bringing heat to about 2950, charge alloys with power off in the following order; FeMn, FeCr, FeMo, FeV and FeSi. Cover bath with fresh slag and stir three minutes.

5. Repeat (4) stirring bath ten minutes after alloy addition.

6. Repeat (4) using ordinary crushed glass for slag.

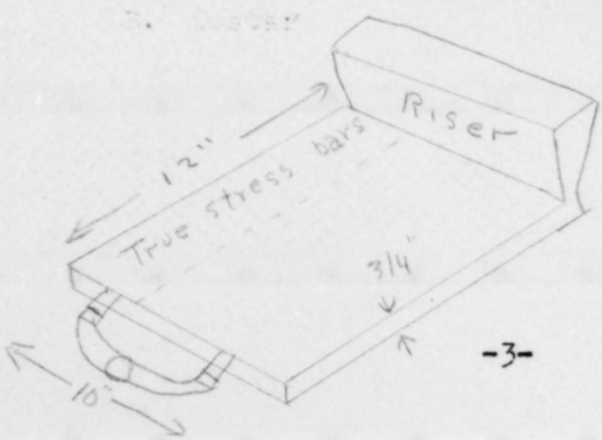
Note: In the slagging heats, sufficient slag should be added to completely cover all molten metal at all times while stirring.

7. Repeat (4), pouring metal into a heated ladle to which has been added sodium oxide (varying amounts) for elimination of sulphur and phosphorous. Other suitable cleansers may also be used, if desired.

Part III

Testing of Material

A. From each heat pour a dry sand casting plate 10" x 12" x 3/4", gated as indicated on sketch.



casting weight	25.5#
gate and riser	25
	50# total

B. Tests

(1) Macro

(2) Ballistic

(3) Six true stress bars for static and dynamic tests of heat-treated section.
One bar for static properties, the other five for dynamic tests at varying speeds.

(4) Chemical

Comments

The chief aim of this program is to develop a balanced slag for a steel composition and compare an oxidized steel with steels less oxidized. The physical tests will also indicate the tendency of a clean steel to feed out micro shrinkage or lustrous cavities.

In general, steel may be deoxidized in two ways: (1). with deoxidizers such as, Al, Si and Mn, (2) with appropriate slags. With the former, deoxidation products are formed which are removed to some extent, the residual oxides may or may not have a detrimental effect on the steel. With the latter, a slag covering is used to remove FeO from the bath. The elimination of FeO content in steel is practically the only reason for deoxidizer additions. In other words, a steel free from FeO (hence free from O_2) would not require any deoxidation.

According to the work of Körber and Olsen the MnO content of a slag in equilibrium with a melt fixes the Mn content of the bath and vice versa. For example, a bath containing .60 Mn at 1650°C will carry about 42.5% MnO and 7.5% FeO in the slag. The silica content appears to be around 50% regardless of the concentration of the other constituents. The equilibrium diagram of Körber and Olsen further indicates the relative amounts of Mn and Si in order to produce fluid deoxidation products. For example, in the above case of .60% Mn if the Si content is above .25%, the first deoxidation product to form on cooling would be SiO_2. If the Silicon is lower than .25% the first product formed on cooling would be high in MnO.

In may be further contended that the removal of FeO previous to the introduction of alloying elements proper would be of a more beneficial nature because none of these special elements would be lost as oxides. Chromium oxide is a very refractory oxide and very difficult to remove. The same for Vanadium. The amount of these special elements uniting with oxygen lessens their influence as alloying constituents.

In the above phase of the program of cleansing the bath of FeO with slag, it is important to keep the liquid metal protected from the atmosphere. At steel making temperatures formation of FeO is rapid and saturation of FeO in the liquid bath is quickly reached. Carbon in the bath tends to decrease the amount of FeO soluble, and the higher the temperature, the less FeO can exist in equilibrium. This is the reason that a hot bath of metal will bubble in our induction furnace as heating continues.

In order to remove FeO from the bath, the slag itself must be lower in this compound than equilibrium demands. In this sense ordinary glass makes a good scavenger, but owing to the low MnO content of commercial glasses there will be a loss of Mn from the bath to build up the MnO in the slag.

A few heats of metal melted and tested as outlined above will indicate the desirability of producing a clean steel and will probably suggest the trend of future study.

E. J. Ash