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TEMPERATURE MAPPING - 313 BUILDING DUPLEX
INDUCTION FURNACE

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TEMPERATURE MAPPING - 313 BUILDING DUPLEX INDUCTION FURNACE

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The thermocouples used were of the chrome alumel type model number 9B2N38 manufactured by the Minneapolis Honeywell Regulator Co. The thermocouples were standardized at 600 C before and after each temperature map. Compensation for drift encountered due to thermo-cycling was made. A K-2 type potentiometer with ice bath junctions was used. The differential thermocouple principle was used whereby one thermocouple was working against the other to give a difference reading in volts. This reading gave the actual temperature difference between the fixed reference point and all other positions in the bath. The furnace working area was arbitrarily divided into six vertical and six horizontal planes. (See diagram 1) All references are relative to the transite liner which very nearly forms a 20" x 20" square. The furnaces were loaded with 16 inches of lead and 10-11 inches of Al-Si alloy.

The test on low power was representative of true equilibrium conditions. The mapping was completed without mechanical agitation and therefore the furnace tended to stay on low power. The high power mapping was arbitrarily done using a two-minute time interval from the time of placement of the measuring thermocouple until a reading was taken. The large heat input made this necessary and in most cases equilibrium appeared to have been reached.

A group of maps showing vertical sections through the furnace has been prepared for comparison purposes. (Fig. 2,3,4,5,6, and 7) The temperature gradients observed within a horizontal plane do not appear to be very great. In addition, mechanical agitation would tend to nullify those small ones that do exist. The gradients in the vertical direction between planes appear to be significant. A comparison of the average temperatures on high power and low power is given for the four planes measured in the lead zone.

Plane	Ave. Temp. Low Power	Ave. Temp. High Power	Diff. °C
1	-10.05	-7.74	2.31
2	-8.6	-6.97	1.73
3	-4.93	-3.36	1.57
4	+2.42	-9.58	12.60

It can be seen that in plane #4 (two inches below the interface) a very significant temperature difference is noted between high and low power setting operation. In addition, since furnaces under normal operational conditions remain on high power a good portion of the time, the high negative value noted in plane 4 becomes significant. This means that this portion of the fuel element is operating considerably cooler than the balance of the piece. Operation of the piece lower in the furnace helps to some degree but at some point near the bottom of the furnace the piece becomes cold on the base end. Horizontal agitation suggests a method for obtaining uniform temperature effects. Furthermore, it can be seen that the #3 plane offers the least variability with reference to the recording controlling thermocouples and also

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INTRODU

It has been found that the fuel position in the furnace and the temperature have a great influence on bilayer properties. This study is to determine the temperature gradient in the duplex furnace and the effect of power settings (high, medium) on such temperature gradient.

SUMMARY

Temperature was accomplished by measuring the temperature difference between a reference point and horizontal planes established at various levels (top, Al-Si and four lead) in the furnace temperature measurement made across each horizontal plane. In the layer at low power setting, maximum gradient of temperature was measured between reference point and average temperature readings in a plane approximately two inches from the bottom of the furnace. In high power setting, maximum temperature gradient of 9.6°C was measured between reference point temperature and the average temperature (readings) in a plane approximately fourteen inches from the bottom of the furnace (two inches above lead-Al-Si interface). Temperature gradients within six horizontal planes were not significant. Maximum variation in temperature between high and low power settings occurred at the plane two inches above lead-Al-Si interface. The maximum gradients measured in the furnace were within $\pm 7^{\circ}\text{C}$ established the process specifications.

The results of the temperature map lead to the following conclusions and recommendations:

1. Significant temperature gradient exists within the lower layer of the duplex furnace. If the core in any position other than horizontal will be non-uniform and contribute to non-uniform formation of compound. Horizontalization (currently in use on one production line) will reduce the temperature variations and is recommended for all production.
2. The location of furnace thermocouple varies among the duplex furnaces, contributing to non-uniform operation among the furnaces. Thermocouples should be located in the same position in each duplex.

DISCUSSION

The temperature map done in Bldg. production furnaces 1C and 6C. The low power setting was for the 6C furnace and the high power setting was for the 1C furnace. The variations necessitated the change from one furnace to the other.

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the least variation between power levels.

The intermediate power level was not completed at this time because of the extensive time required to complete the map. The results of the data do not suggest that more information could be gained by the additional map.

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FIGURE 1

DUPLEX FURNACE

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HIGH POWER

°C

LOW POWER

°C

Plane A

Fig. 2

D	E	F
-16.8	- 9.1	-10.6
-20.0	-19.9	-16.2
- 9.8	- 6.2	- 8.3
- 1.9	- 2.3	- 5.4
- 7.5	- 9.5	- 5.6
-11.0	- 6.0	- 7.1

6

5

4

3

2

1

Plane A

Fig. 5

D	E	F
- 6.6	- 6.5	- 6.6
- 7.5	- 7.4	- 8.4
0.0	+ 1.8	+ 2.9
- 4.1	- 4.8	- 5.3
- 7.1	- 6.1	- 7.8
- 6.4	-11.1	-11.5

Plane B

Fig. 3

D	E	F
-14.9	- 9.7	-16.8
-22.3	-18.2	-14.2
-13.3	- 6.3	- 7.0
- 3.5	- 5.3	- 4.5
- 7.4	- 8.7	- 4.5
- 7.1	- 8.6	- 9.0

6

5

4

3

2

1

Plane B

Fig. 6

D	E	F
- 8.3	- 8.0	- 7.9
- 6.1	- 6.1	- 7.5
+ 1.0	+ 2.0	+ 3.1
- 4.5	- 4.9	- 6.4
- 6.0	- 7.1	- 8.5
- 6.4	-12.9	-11.9

Plane C

Fig. 4

D	E	F
-15.4	-15.1	-17.7
-21.3	-18.1	-14.5
-14.6	-11.7	- 9.1
- 4.7	- 1.1	- 1.6
- 5.5	- 6.4	- 7.7
- 7.2	- 6.3	- 7.2

6

5

4

3

2

1

Plane C

Fig. 7

D	E	F
- 6.4	- 5.9	- 6.5
- 7.7	- 7.6	- 9.1
+ 2.9	+ 3.1	+ 4.2
- 4.9	- 6.0	- 4.0
- 7.6	- 8.6	- 9.6
- 8.8	- 9.7	-11.8