DEVELOPMENT OF THERMOCOUPLE FOR ANODE BAKING FURNACE

Abstract: Temperature measurement of Flue Wall/Anode, costs heavily both on direct cost of material and cost of man hour on replacement. “HyTemp” is developed to reduce and overcome problems associated with conventionally used thermocouples.

INTRODUCTION:

Anode baking process is done in Pit type furnace. Anodes are baked through indirect heating by flue gas of burnt fuel. Proper baking of Anode is required for proper Roding and pot line process. Proper baking of Anode is assured by maintaining an established temperature profile. Hence thermocouple is a critical component in Anode baking process.

Normally for this temperature range N type thermocouple with Alloy 600/Alloy 800/Alloy 601/SS 446/SS 310/Nicrobel (Trademark of Nicrobel Pty Ltd) are used as a protection well material. Except SS446 all other alloys are Nickel/Chromium/Iron alloys.

LIMITATIONS OF NICKEL-Chromium-Iron ALLOYS.

All Nickel based alloys are good against oxidation. Mechanism of oxidation resistance can be described as below,

High Nickel in the alloy helps resist corrosion due to presence of many organic/inorganic compounds at High temperature. Chromium forms Chromium Oxide layer on the outer surface of the thermowell and prevent further oxidation by Isolating non oxidized second layer from oxygen. This mechanism works well in non cyclic high temperature process and oxidizing or reducing environment. In Bake Oven, due to cyclic nature of process this mechanism doesn’t work since Chromium Oxide layer chips off the surface. As a result, inner layer gets exposed and again gets oxidized and process goes on and on. Adding to the problem is presence of Sulfur. Nickel has a poor corrosion resistance against Sulfur. Both of reasons explained above don’t allow Nickel/Chromium/Iron based heat resistance alloy to perform to their caliber.
DEVELOPMENT OF “HyTemp”

Using our expertise and experience of 20 years in industrial thermometry, we experimented on Chromium/Aluminum/Iron alloy. It was assumed that this alloy will perform better to Ni/Cr/Fe based alloy for following reasons,

(1) Absence of Nickel

(2) Aluminum in the alloy gets oxidized before Chromium and forms a protecting outer layer of Aluminum Oxide. Aluminum Oxide has excellent adherence to the base alloy.

Due to above property, oxidation and corrosion resistance of “HyTemp” in Bake Ovens were presumed to perform excellently. To confirm above assertions we performed experiment with “HyTemp” and Ni/Cr/Fe based Alloys. Protection well of O.D 22 mm were prepared and given a temperature Cycles of 1250 deg along with, few of above mentioned alloys. After 30 cycles results were recorded. SS 310 lost its weight by 27%, Alloy 601 lost its weight by 15% and “HyTemp” lost only 0.7% of its weight.

CONCLUSION

These results are suggestive of better oxidation resistance of “HyTemp” and can be used in Anode Baking Furnace.

Comparison of “HyTemp” and Inconel-601

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<th>HyTemp</th>
<th>Inconel-601</th>
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<tbody>
<tr>
<td>Ni</td>
<td>Nil</td>
<td>56 to 63%</td>
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<tr>
<td>Cr</td>
<td>19 to 23 %</td>
<td>21 to 25%</td>
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<tr>
<td>Fe</td>
<td>Remainder</td>
<td>Remainder</td>
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<tr>
<td>Al</td>
<td>4.5 to 7.5%</td>
<td>1 to 1.7%</td>
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<tr>
<td>Melting Point:</td>
<td>1450 deg C</td>
<td>1400 deg C</td>
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<tr>
<td>Max operating Temp:</td>
<td>1350 deg C</td>
<td>1200 deg C</td>
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Performance of the product was reconfirmed by installing 30nos “HyTemp” thermocouples along with conventionally used thermocouples in Anode backing furnace in an Aluminum Smelter in India.

Results are well explained by photo graphs given below,

“HyTemp” Fluewall thermocouple after 6 months of operation
Alloy-601 Flue wall thermocouple after 4 months of operation