AD20+: A More Ecofriendly Glue for Aluminum Pot Sides with Improved Properties

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Abstract

Glues and mortars are commonly used between sidewall blocks and silicon carbide slabs and against the steel shell. Most glues contain hazardous components that are carcinogenic. Mortars, even if less hazardous, usually have poor mechanical and thermal performances. There was a need to develop a new formulation, more ecofriendly and answering more severe constraints on curing time, mechanical and thermal properties. The different requirements for the new glue will be presented. Carbone Savoie has worked in the past on a clean glue formulation, but this glue cannot meet some of the new requirements. The experimental tests out will be described. Main results will focus on hardening time, easiness of spreading on both horizontal and vertical surfaces, mechanical and thermal properties after curing. The characteristics of the new AD20+ glue are compared to the characteristics of other products on the market.

Keywords: Glue, ecofriendly, curing time, mechanical properties, thermal conductivity.

1. Introduction

Glues and mortars are commonly used in the aluminum electrolysis pots at various locations. We will focus in this paper on the use of such products at the sides of the pots, either between sidewall blocks and silicon carbide slabs, or directly against the shell.

These products should answer to more and more severe technical requirements and in addition should be as ecofriendly as possible for the users.

A review of the characteristics needed for the use on the pot sides will be presented, showing the different steps of use and the new specifications that are now required. The existing products of the market, mortars and glues will be described with a focus on their pros and cons. They do not fully comply with the new requirements, and there is a need to improve some specific properties. The experimental tests used to develop a new grade will be described, and the results of the different studies carried out will be given.

2. Different Steps of Use and Characteristics Required for Jointing Materials

2.1. Conditioning and Storage of the Jointing Material

The product should be delivered in small conditioning (25 kg maximum), to facilitate the handling. The amount required per pot is variable depending upon the pot design and if the jointing material is used only between silicon carbide slabs and sidewalls, or also against the shells. But it generally never exceeds 2 tonnes per pot.

In case of glues, the curing can be quicker than for mortars, and the potlife (duration during which the glue can be spread) is limited. Therefore, it is better not to prepare a too high amount of glue.

Storage life should be 6 months minimum, as transportation itself may last one or two months.

2.2. Preparation of the Jointing Material

Whatever the type of product, mortars or glues, they require a mixing operation of generally two components: either a solid in which water will be added (as for mortars) or a powder in which a binder will be added (as for glues). This mixing operation should be easy and short (1 to 3 minutes), and must be done at room temperature (if possible in a wide range of ambient temperature). A typical tool for mixing is shown below. It is the same as for paint, and the diameter can be increased for larger amounts of product. After mixing, the material should be used with no or limited constraint on time, which means that the potlife should be long enough in order not to waste prepared product.

Figure 1. Tool for mixing.

2.3. Spreading of the Jointing Material

There are two types of cases to distinguish: either the jointing material is prepared just before use in pot, or the assemblies are made externally and delivered to the smelters to be installed inside the pots.

For internal use by the smelters on the sides of the pot, the jointing material is used on vertical surfaces only. The support material could be steel, silicon carbide, carbon or graphite, which means different roughness, surface finishing, open porosity, etc. In the case of assemblies manufactured outside of the smelters, the jointing material could be put on horizontal surfaces.

The jointing material should be spread easily with a trowel or a spatula, and should wet the support material. When the thickness of the jointing material must be monitored, the best is to use a notched spatula.

The thickness of the jointing material is typically around 5 mm, and after pressure can reach 2 to 3 mm. In the case of the product placed between the steel shell and the sidewalls, the thickness could be much more important due to the shell deformation and may reach 20 mm in the worst case. For this typical application the final thickness is not uniform all around the pot.

For the spreading on the vertical surfaces, the viscosity of the jointing material is a key parameter: the material should not be too liquid, in order not to flow down, as well as not too viscous to allow covering the whole surface with an easy spreading.

5.4. Thermal Conductivity and Thermal Diffusivity

These measurements have been performed only on AD20 and AD20+ glues. For the mortars, it was again not possible to obtain the samples. The results are given in Table 3.

Table 3. Thermal conductivity and diffusivity given by the hot disk at room temperature.

	Thermal conductivity (W/mK)		Thermal diffusivity (mm²/s)	
	green	after baking at 1 000 °C	green	after baking at 1 000 °C
AD20	1.4	1.7	0.8	1.7
AD20+	1.0	1.1	0.8	2.9

The thermal conductivity of AD20+ is slightly lower than the one of AD20, which was not expected, as AD20+ contains graphite particles whereas AD20 contains anthracitic particles. The gain after baking at 1 000 °C is of 20 % for AD20 and 13 % for AD20+. Thermal diffusivity is equivalent between both glues and even higher after baking at 1 000 °C for AD20+, but this could be partially due to its slightly lower density (1.23 versus 1.38 for AD20).

These measurements have been done at room temperature and were quite reproducible. We have not seen any influence of the sample diameter (30 – 40 or 50 mm). In the future these measurements will be done in temperature up to 600 °C.

5.5. Oxidation

Oxidation tests have been performed on both AD20 and AD20+ after baking. They both present the same weight loss of 28 %, certainly not as good as the one of SiC mortars. Anyway it has not been possible to obtain a good core sample of mortar for measurement. The experience of AD20 in pots during years shows that even if it would be an improvement to increase its oxidation resistance, it has not led to any critical problem in pots.

6. Conclusion

The new technical requirements on the jointing material between SiC slabs and carbon or graphite sidewalls ask for a much shorter curing time, together with very good mechanical properties and with ecofriendly or clean products. Usual mortars do not harden or cure at room temperature and cannot stand mechanical shocks or vibrations during paste ramming operation. A new glue AD20+ has been developed, with no carcinogenic components and less hazardous components compared to other glues on the market, which presents very good curing behavior and mechanical properties. Spreading on vertical surfaces in a corner pot model has confirmed that this glue withstands high mechanical shocks.

7. References

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