USE OF ASBESTOS-FREE MATERIALS IN ALUMINUM PRODUCTION

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Results are presented for industrial tests of contemporary asbestos-free insulation and sealing materials and articles in electrolyzer production. It is shown that asbestos-free insulation materials and articles makes it possible to exclude entirely use of asbestos-containing materials in electrolyzer production. The main restraining factor for large-scale introduction of asbestos-free materials is their relatively high cost.

At the end of the twentieth century it was demonstrated that asbestos exhibits carcinogenic properties and therefore today there is the acute question of a requirement of excluding it from all forms of production. This is particularly important for exporting enterprises, since health standards of the majority of the Western states forbid delivery into their territory of product with traces of asbestos and stringent sanctions are applied to offenders of these requirements. The company RUSAL sends the majority of its aluminum production abroad and therefore the problem of excluding asbestos from use in the production cycle is very important.

In August 2002 in RUSAL a program was developed and adopted for excluding asbestos-containing materials in aluminum plants of the company. Work for replacement of asbestos-containing materials by ecologically safe materials was accompanied by considerable difficulties. The following situations relate to objective difficulties:

- asbestos is a special material exhibiting unique properties and therefore recreation of a whole set of physiochemical properties, that are exhibited by asbestos, by an ecologically safe analog is almost impossible;
- with use of asbestos in different fields of industry it demonstrates a variety of properties. In the aluminum industry in replacing asbestos it will be necessary to develop eight to ten new materials;
- the production technology for ecologically safe asbestos replacement materials is almost absent in Russia;
- the cost of asbestos replacements produced in Russia exceeds the cost of asbestos-containing materials by several factors.

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INDUSTRIAL TESTS OF ASBESTOS-FREE MATERIALS

In accordance with a working program for performing tests of asbestos-free materials in electrolyzer producers OAO KrAZ, OAO SAZ, OAO BrAZ different asbestos-free materials and objects of domestic production have been selected, both produced industrially and newly developed. In aluminum plants test batches of materials and objects manufactured by OAO Sukholozhsk Refractory Plant, OOO Uralresursy, OOO Regional Trade-Commercial Company, OOO NPK Vladimir, OOO NPK Term, ZAO RLB Silica have been supplied. The following materials were tested in 2004 – 2005: mullite-silica coiled material MKR-130 according to GOST 2369□79; flexible refractory glass fiber board MKRG-400 according to TU 14-8-537□93 with changes Nos. 1, 2; sheet refractory glass fiber refractory board MKRKL-450 according to TU 1593-003- 05802307–98 with change No. 1; flexible refractory heat insulation ceramic fiber board KVK according to TU 1593-001-13706960–2004; refratory heat insulation ceramic fiber board KVKL according to TU 1593-001-13706960–2004; braid silica filler ShKN(Kh)-1-20 according to TU 5952-166-057896904–02; coiled needle-punched silica heat protection insulating material Supersil S-10/130 according to TU 5952-156-05786904–00 with continuous sewing. Industrial testing of asbestos-free materials was carried out in electrolyzers types S8BM and S8B with sealing of bloom windows, in insulation assemblies for beams beneath the cathode, in assembly and erection of the gas-collecting bell of an anode unit, in electrolyzer gas lines beneath the body and in folding side openings of channels of electrolyzers type S255.

SEALING OF BLOOM WINDOWS

One of the reasons preventing an increase in the service life of electrolyzers is premature breakdown of the side lining from the direction of the casing due to oxidation by air. Oxidation (breakdown) of the side lining mainly depends on the capacity of the materials used for sealing the bloom windows to prevent penetration of air through them. Until recently as a sealing material there has been use of asbestos mortar prepared on the basis of ground asbestos and waterglass for filling the gap between the bloom and sealing ring of the window with subsequent filling by refractory concrete of the expansion joint in the region of brow (Fig. 1*a*) and asbestos cement of the same composition with filling of the expansion joint with chamotte filler (Fig. 1*b*).

In order to evaluate the efficiency of these materials dry runs were carried out for two electrolyzers S8BM and two electrolyzers S8B in OAO KrAZ. The extent of oxidation of the side linings was evaluated from the direction of the longitudinal walls. With external examination the state of the sealing material in the bloom windows of the cathode housing revealed cracking of it and gaps with a thickness up to 5 mm between the seal and the sealing ring caused by shrinkage phenomena of the asbestos mortar during drying. After dismantling of the longitudinal wall it was established that in both versions of sealing there is breakdown of the side blocks due to oxidation over the whole length of the longitudinal wall above the level of the brow; in a version of sealing with asbestos mortar with a filling of chamotte breakdown of the side blocks as a result of oxidation is more extensive in nature (up to half the height of the side block and up to half of its thickness. Thus, results of dry runs showed insufficient efficiency of the sealing material used currently.

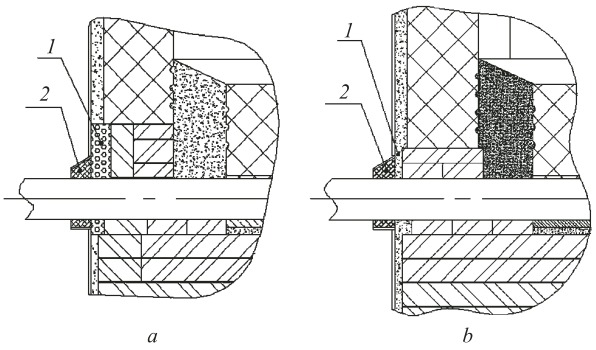

Fig. 1. Cathodes of electrolyzers S8BM (*a*, *1* is refractory concrete; *2* is asbestos mortar) and S8B (*b*, *1* is chamotte filler, *2* is asbestos mortar).

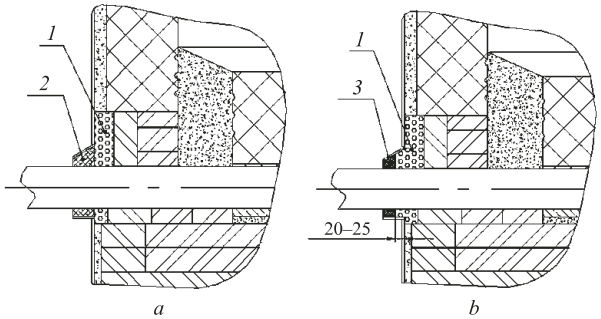

Fig. 2. Versions (*a*, *b*) of sealing bloom windows: *1*) concrete; *2*) mullite-silica material MKRR-130; *3*) refractory mix.

In order to increase the efficiency of sealing for bloom windows and also to exclude use of asbestos mortar the following sealing versions were proposed: filling of the bloom window seal from the outside and inside of the cathode housing with mullite-silica coiled material MKRR-130 (Fig. 2*a*) or refractory mix (Fig. 2*b*) with sealing of the expansion joint in the region of the brow with refractory cement. Within the framework of the program one of the S8BM electrolyzers was monitored in which one side of the bloom window was sealed by the first version (see Fig. 2*a*), and the second side by the second version (see Fig. 2*b*). As a result of examination of the cathode unit in the second and ninth days after start-up the most suitable material as a replacement for asbestos mortar was material MKRR-130.

From the results of this work the volume of tests was expanded to ten electrolyzers of different types, and production rules were developed for sealing bloom windows with material MKRR-130. work was carried out in ten cathode units of different types. With filling of the expansion joint in the region of the brow over the longitudinal side of the cathode housing the material provided reliable protection from occurrence of cement dissolution in the bloom window. Visual examination of the cathode units in the subsequent period showed absence of both damage to the sealing material and also separation of evaporation products. This technical solution was introduced into production, i.e. filling in the standard design of the cathode lining of the socle with unified construction of electrolyzers S8B and S8BM.

ASBESTOS-FREE SEALING MATERIALS FOR THE GAS COLLECTOR OF THE ELECTROLYZER ANODE UNIT

In carrying out assembly work for installing gas collectors of anode units of electrolyzers as a sealing material asbestos board KAON-2 was selected according to GOST 2850–95 and asbestos braid ShAON-20 according to GOST 1779–83. In order to exclude sealing asbestos-containing materials during assembly of a gas collector within an electrolyzer of building No. 12 asbestos-free sealing materials were tested: board MKRG-400 and braid ShKN(Kh)-1-20. Before carrying out assembly work for the anode gas collector bell board was cut into strips 250 mm wide and 1500 mm long, and braid was cut into prepared lengths of 200 mm. during gas collector assembly it was established that these materials provide joint tightness between sections and the anode housing (Fig. 3), and the strength characteristics of the materials makes it possible to retain the integrity of sealing during assembly. The materials were introduced into production in

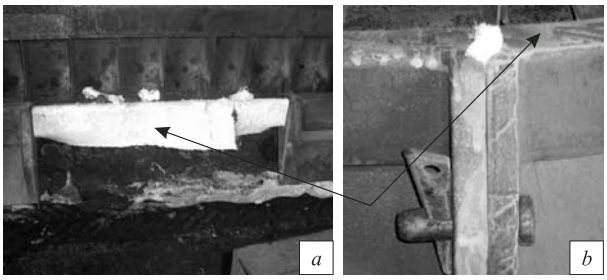

Fig. 3. Strip of board MKRG-400 installed in one of the sections of the gas collector bell (*a*) and the mounted cast iron section of gas collector bell with sealing of the gap by braid ShKN(Kh)-1-20 (*b*).

OAO KrAZ (laid down in the standard plan for sealing gas collectors of anode units with electrolyzers S8BM and S8B, ÉYu-16) and to day they operate successfully.

ASBESTOS-FREE MATERIALS IN INSULATION UNITS FOR ELECTROLYZER BEAMS BENEATH THE CATHODE

In assembling cathode units of electrolyzers S8BM and S8B in insulation units of beams beneath the cathode as expansion fillers asbestos board KAON-2 has been used previously. In order to replace it by asbestos-free materials tests were carried out for board grades MKRG-400, MKRKL-450, KVK and KVKL. Asbestos-free expansion fillers in insulation units for beams beneath cathodes were tested on a bench in the overhaul workshop for electrolyzers. Before installing the board for expansion fillers on supports for a unit it was cut into lengths with a size of 450x450 mm. Before installing the fillers the cathode unit was raised by a bridge crane, test fillers were placed on the supports of the unit and the cathode unit with a lining (overall weight 200 tons) was lowered on to the unit supports. After holding the cathode unit on the stand for 20 – 30 min it was raised (Fig. 4), the test fillers were extracted and examined. Tests showed that the fillers made of board MKRG-400 and KVK had through damage and local breakdown of material to a loose state, and fillers made of KTM, MKRKL-450 and KVKL showed absence of damage at the surface of fillers or their local breakdown even with 2 – 3-fold lowering and raising of the cathode unit. Today during assembly of cathode units for electrolyzers S8BM and S8B the insulation assemblies beams beneath the cathode the expansion fillers used are board MKRKL-450. Use of board KVKL as an expansion filler in insulation units for beams beneath the cathodes was considered undesirable due to its high cost.

ASBESTOS-FREE MATERIALS FOR INSULATING GAPS BENEATH THE BODY OF ELECTROLYZER GAS CONDUITS

In assembly of inserts in the insulation gap of gas conduits beneath the body in electrolyzer production OAO KrAZ has used asbestos cloth AT-3 according to GOST 6102–94. For assembly of inserts in the insulating gap of a gas conduit beneath the body (Fig. 5) needle-sewn material Supersil S-10/140 was selected. This material is multifunctional, ecologically clean, heat, electricity and sound insulating, elastic, it readily facilitates a surface of complex shape, and it retains its structure at high temperature. Heat and electrical insulation Supersil is used effectively in electrolyzers and flame furnaces for heat insulation of the working space and other structural elements.

Assembly of an insulating gap made of material Supersil S-10/140 material 10 mm thick in the insulation gap of the gas conduit beneath the body was carried out identically to assembly of the insert of asbestos cloth AT-3. Before carrying out assembly of the insert in the insulation gap of a gas conduit the material was cut into strips of the required length and width. Prepared strips of the material were wound successively into one layer on the gas conduit after which the insert made of galvanized sheet 0.55 mm thick was installed

Fig. 4. Raised cathode unit with expansion fillers placed on the support of the unit.

Fig. 5. Installation of Supersil S-10/140 in the insulation gap of the gas conduit beneath the body.

followed by fastening it with two twists of aluminum wire 10 mm in diameter. The process for assembling inserts using Supersil S-10/140 material is distinguished by convenience and simplicity.

Industrial testing showed that use of asbestos-free material Supersil S-10/140 for assembling inserts in the insulating gaps of gas conduits made it possible to exclude asbestos cloth AT-3 used currently. The service life of an insert made of Supersil S-10/140 material was three to four months.

ASBESTOS-FREE INSULATION MATERIAL FOR FOLDING SIDE OPENINGS OF ELECTROLYZERS

Currently in electrolyzers types S175 and S255 with firing anodes in folding side openings there is use of textolite insulating material according to GOST 2910□74. After two to three months of operation breakdown of the insulating material commences for the textolite cover that occurs due to burn-up of the organic binder of the material as a result of high temperature (300 – 400°C). Board KVKL with an operating temperature of 1500°C was used instead of textolite. In order to carry out industrial tests on electrolyzer S157 in June 2005 the folding side opening was installed with insulation of the flap made of board KVKL (Fig. 6). During operation of the folding side opening with insulation made of board KVKL visual monitoring of the state of the insulation was carried out constantly. It was established that over nine months breakdown of the insulation did not occur. Operation of the opening made of the new material used is continuing.

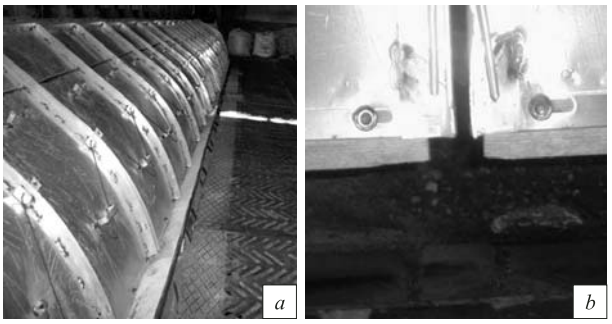

Fig. 6. Folding side opening of an electrolyzer (*a*) and sections of the folding side opening of an electrolyzer assembled using board KVKL (*b*).

CONCLUSION

Within the framework of this program for excluding asbestos-containing materials in aluminum plants of the RUSAL company industrial tests have been carried out for asbestos-free insulating and sealing materials and objects for sealing bloom windows of electrolyzers, insulation of assemblies of beams beneath the cathode, assembly and installation of gas collecting bells of the anode unit, insulation of gas conduits of electrolyzers beneath the body, insulation of folding side openings of electrolyzers. It was shown that asbestos-free insulating materials make it possible today to exclude entirely use of asbestos-containing materials in electrolyzer production. The main restraining factor for widespread introduction of asbestos-free materials is their high cost.