EXTRACTION OF RARE-EARTH METALS FROM WASTES OF MAGNETIC ALLOYS AND WARES FROM THEM

Report 2. Wastes of alloys of the system «neodymium-iron-boron»

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The review of different technologies of neodymium extraction and other rare-earth elements from a bar and wastes of alloy on the basis of the system Nd-Fe-B and permanent magnets, made from this alloy is executed.

Keywords: NdFeB alloy, permanent magnets, scrap, grinding waste, slag, sludge, separation of iron, extraction of REM

Permanent magnets, containing rare-earth metals (samarium, neodymium, dysprosium, празеодим, terbium and other), especially alloys on the basis of the system Nd-Fe-B, excel other magnetic materials on the size of magnetic energy on unit of volume and on the size of coercitivity.

At processing of wastes of NdFeB alloy and wares from its the problem of effective extraction of neodymium is set -, for what, first of all, the problem of separation the ferrous constituent of alloy must be decided. With this purpose that ends in work [1] it is suggested to carry out melting of REM-containing sludge in carbon crucible at a temperature 1550 °C. Here metallic iron forms an alloy, and REM remain in form oxide slag, easily dissociated from a metal. The losses of REM with an alloy are insignificant. In work [2] wastes of NdFeB alloy alloyed with $B_2O_3$ in crucible from the boron, and then cooled in the flowing of argon to the room temperature. Researches showed that from fusion two phases are crystallized only: $\alpha$-Fe and $Fe_2B$, and neodymium practically all remains in glass.

In most cases the task of neodymium separation and iron decides on the stage of hydrometallurgy. For dissolution of scrap of NdFeB-magnets in work [3] four reagents was tested: NaOH, HCl, HNO$_3$, H$_2$SO$_4$. It is shown that at the optimal mode of lixiviating sulphuric acid allows to extract 75.41 % neodymium.

In the method of extraction of neodymium from wastes of production of NdFeB-magnets [4] slag, containing a neodymium, process amidosulfate acid ($NH_2SO_3H$) at pH = 2-3 under anodic potential. Thus iron is deposited on a cathode, and HF add to amidosulfate solution, getting sedimemt of NdF$_3$, which is dried out in a furnace. Coarse Nd$_2O_3$ process an acrtic acid at pH = 4.7, transferring a neodymium in solution as Nd(CH$_3$COO)$_3$. Solution is evaporated, getting the crystals of acetate of neodymium which at treatment by hydrofluonic acid transforms in NdF$_3$. Trifluoride neodymium dry, getting the finished good with 3 % moistures.

Hydrochloride lixiviating, used in work [5], allowed to get the oxide of neodymium of high degree of cleanness on an output at technology of processing of
wastes of production and scrap of magnets of \textit{NdFeB}. The separation of neodymium and dysprosium was executed by the method of liquid extraction.

On the Siberian chemical combine (Seversk, Russian Federation) there are produce \textit{NdFeB} alloys and \textit{DyFe} ligature on out-of-furnace fluoride technology, and magnets - by the method of powder-like technology \cite{6}. Dignity of «wet» charts of processing of metallic wastes consists in the concentration of REM by the separation of boron, iron (complete or partial) and limiting admixtures, such as a nickel, chrome, aluminium, silicon, copper and other.

Method of melting of bar of \textit{RFeB} magnets (where \textit{R} - \textit{Nd}, \textit{Pr}, \textit{ Tb}, \textit{Dy}, \textit{Y}), on a patent \cite{26}, consists of melting in the furnace of metallic charge, not containing REM (electrolyte iron, \textit{FeB}, cobalt, aluminium alloys or their mixture) and introductions to fusion of charge, REM-containing (\textit{Nd-Fe} and \textit{Dy-Fe}), and \(0.1-50\%\) charge from the bar of rare-earth magnets and/or sludge. Melting is conducted in an inert atmosphere at a temperature \(1500-1800\) °C.

Electro-slag remelt for processing of wastes of production of \textit{NdFeB}-magnets is offered in work \cite{7}. The body of heating is a slag, containing \textit{CaF}_2, \textit{CaCl}_2, and also chlorides or REM fluorieds.

Ordinary technology of recovery of neodymium from scrap of rare-earth alloys and magnets consists in acid dissolution of wastes, liquid extraction and renewal of the got connection to the metal. For the production of \textit{Nd}_2\textit{O}_3 with a cleanness \(99-98\%\) the additional extraction cleaning is needed.

Processing of wastes of production of magnetic alloys \textit{NdFe}(\textit{Co})\textit{B} and REM-\textit{Fe} ligatures of on fluoride technology with the use of magnetic separation is considered in work \cite{8}. Fundamental possibility of making of magnetic faction is shown as a REM-containing concentrate with extraction of REM to \(60\%\) from remaining content in the slags of the restoration melting of fluorides of metals.

In the laboratory of «Ames» (USA) the simple and cheap method of extraction of neodymium from scrap by molten magnesium is offered \cite{9}. Scrap break and fall asleep in molten magnesium at a temperature \(800\) °C. Here a neodymium dissolves in an alloy, and iron and boron remain in a hard kind. Alloy \textit{Mg-Nd} use in a casting production.

Process of extraction of neodymium from \textit{NdFeB}-magnets scrap by extraction from fusion it was studied also in work \cite{10}. Changeable parameters at self-control of scrap at the temperature of \(800\) °C: time of self-control and largeness of scrap. It was set that at the increase of time of self-control to \(50\) minutes and to the sire of scrapa \(5\) mm the quantity of the extracted neodymium grew to \(24.2\%\).

\textit{Conclusion.} Wastes of production and application of magnetic \textit{NdFeB} alloy are valuable secondary raw material of rare-earth metals. For their extraction there are use such piru- and hydrometallurgical technologies, as high temperature fluorination, calciumthermal renewal, extraction from fusion, burning, melting, lixiviating, hydrolysis, liquid extraction, electrolysis, chemical deposite.

\textbf{REFERENCE}


