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Equipment and Products

SUPERCONDUCTING HGMS FOR BRAZIL

Carpco Inc. have announced that they received three new contracts for the supply of their Cryofilter superconducting magnetic separators, all from Brazilian kaolin producers. The orders have been secured from Rio Capim Caulim (RCC), the joint venture between Mendes Junior Participacoes and Amberger Kaolinwerke of Germany; Para Pigmentos SA (formerly Rio Capim Quimica SA; and Caulim da Amazonia SA (CADAM), which has ordered its second Cryofilter for the production of its Amazon 88 and amazon 90 products. The new cryofilters are expected to be shipped and installed in the second half of 1995, and will take the total number of units operating to eight.

SUPERPARAMAGNETIC POLYMER MATERIAL

Researchers at the Faculty of Engineering, University of Nagoya have developed a superparamagnetic particle/polymer hybrid material suitable for production of magnetic sensors. A new synthesis technique was used for first producing the iron–including molecule, or organic molecular bonding, then these molecules were polymerised and joined. This solid–state superparamagnetic substance was produced by applying the polymerization technique used in the process of producing ethylene from ethylene monomer. The superparamagnetic material, when exposed to a magnetic field, is magnetized in linear relation to the applied magnetic field, and loses its magnetism when the magnetic field is removed. This is an ideal property for incorporation in a magnetic sensor which measures the intensity of the external magnetic field by utilizing the magnetization intensity.

MAGNET PROGRESS AT CERN

In December 1994 a 35–metre string of powerful LHC prototype superconducting magnets ran at CERN for 24 hours at 8.36 Tesla, the magnetic field required to hold LHC's 7 TeV protons in orbit around the 27–kilometre ring. LHC's superconducting bending magnets, now planned to be 14.2 metres long, will operate at a field of 8.36 Tesla, the highest ever used in an accelerator. This will be achieved by cryogenics working at superfluid helium temperature of 1.8 K.
In preparation for the tests, the string (two dipole bending magnets together with a quadrupole of the type needed to focus the LHC beams) first briefly attained the 12 350 A current corresponding to the 8.36 T magnetic field. A second tests repeated the achievement, with the current holding steady for 24 hours before being raised to a level corresponding to just above 8.9 T.

A CRUSHER WITH MAGNETS FOR WASTE MATERIAL

Eintech co. Ltd. (Japan) have developed a fine crusher with magnets. After the crusher reduces the construction waste material, magnets are used to separate reinforcing steel and steel scrap. Only a single vehicle suffices for mounting the crusher so the cost is reduced. Furthermore, since fine scrap can be recovered at the work site with lifting magnets the efficiency of the process is improved considerably. The crusher is essentially a conventional fine crusher fitted with magnets at its head part. It can be mounted on virtually any type of backshoe, has an overall length of about 2.2 metres, width 50 cm and weighs 2.1 tonnes. Its tip crushing force is 60 tonnes.

$Sm_2Fe_{17}N_x$ PERMANENT MAGNET SINTERED

A joint research group at the Tokyo Institute of Technology and Tokai University has succeeded in sintering the $Sm_2Fe_{17}N_x$ (SFN) permanent magnet which, although believed to be the most powerful magnet, is difficult to sinter into a block form. The $Sm_2Fe_{17}N_x$ composition, discovered in 1990 independently by Asahi Chemical Industries (Japan) and J.M.D. Coey et al. (Ireland), can potentially produce a theoretical energy product of 60 MGOe or higher, which is on the same level with NdFeB magnet, the most powerful permanent magnet commercially available. The Curie temperature of the SFN magnet is 750 K or more, which is higher than that of the NdFeB magnet (590 K). It is therefore expected to be applied at enhanced temperatures.

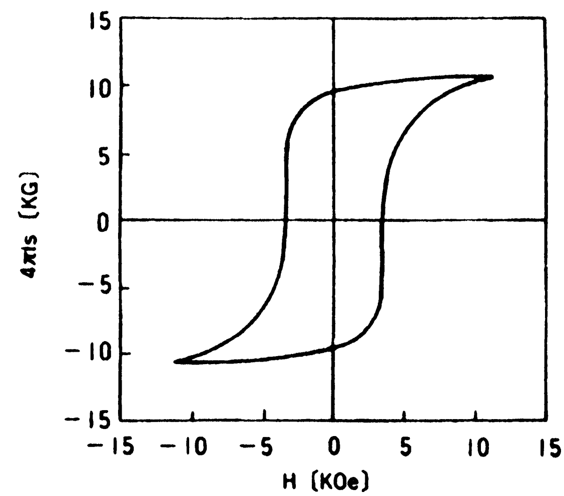
Rare-earth Magnet	Curie Temperature (K)	Saturation magnetisation (kG)	Theoretical value of (BH)max (MGOe)
$SmCo_5$	998	11.4	32
Sm_2Co_{17}	1,193	12.5	39
$Nd_2Fe_{14}B$	592	16	64
$SmTiFe_{11}$	597	12.2	37
$NdTiFe_{11}N_{0.8}$	740	>14	>49
$Sm_2Fe_{17}N_3$	750	15-16	>60

Although exhibiting good properties, the SMN magnet material cannot be produced by the conventional process which involves a series of steps such as alloy dissolution, heat treatment, crushing, compaction and sintering, because it the metal–gas reaction process called nitridation. The overall process is controlled by the sintering to form a solid magnet. It was thus considered that such a material could be used for lower–grade bonded magnets only. This results from its instability at high temperatures causing decomposition during the sintering process.

The Tokai University–Tokyo Institute of Technology research group performed the impact compression of nitrided Sm_2Fe_{17}, successfully sintering the magnet for the first time in the world. They found that the nitridation would proceed even at nitrogen pressure of 1 atm or less, in the temperature range from 623 to 673 K, and the composition exhibits the most desired magnetic properties at the N/Sm_2Fe_{17} concentration ratio close to 3. The powder used to produce the magnet thus has composition $Sm_2Fe_{17}N_3$. In preparation of the magnet, the composition and heat treatment must carried out accurately, in order to produce a monolithic alloy composition of Sm_2Fe_{17} which is then nitrided.

The normal sintering process, requiring high temperature, will decompose the starting powder while it was shown that the sinter can be produced by nitridation at lower temperature for a short time, by attempting the impact sintering. The process uses an explosive–type gas gun consisting of a mold that holds the magnetic powder and a unit which discharges a flyer to effect the impact compression of the powder. Pure $Sm_2Fe_{17}N_3$ composition of uniform structure and adequate particle size is compressed in a magnetic field and then sealed in a copper capsule.

The capsule is placed in a mold and then hit by the flyer discharged from the gun for sintering. Temperature of the powder increases when it is hit by the flyer moving at the speed of 1 to 1.5 km/s, and then then quenches rapidly. Such a process completes sintering without causing decomposition. The magnet thus produced has the maximum density of 7.6 kg/m^3 which is fairly close to the intrinsic bulk density of 7.9 kg/m^3 estimated from the powder density. The $Sm_2Fe_{17}N_x$ magnet thus produced has the maximum energy product of approximately 20 MGOe which is higher than that of the conventional bonded magnet. Magnetic properties of the impact–compressed SmFeN composition are shown in the Figure.



The sinter of even higher magnetic properties can be produced by further refining the impact sintering process.