Synthesis of manganese-zinc ferrite by powder mixing using ferric oxide from a steel mill acid recovery unit

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With the aim of producing fine-grained manganese-zinc ferrite at the end of a calcination process at moderate temperatures, this work consisted, at first, of an 'electrochemically designed' powder mixing by wet ball-milling a mixture of raw materials of manganese (MnO_2 or $MnCO_3$), zinc (ZnO or Zn^o) and iron (Fe_2O_3 granules produced by an acid recovery unit of a Brazilian steelmaker, milled to fine sizes using alkaline media). This mixing/milling resulted in solely submicron-sized particles for the mixture of MnO_2 + Zn^o + Fe_2O_3 in alkaline medium. These mixtures were submitted to calcination in air at two different temperatures: 900 and 1200°C. When the alkaline milled mixture of MnO_2 + Zn^o + Fe_2O_3 was calcined in air at 1200°C, the result was the formation of a manganese-zinc ferrite whose magnetic properties depended on the nature and concentration of the alkaline agent. When the alkaline milled mixture of MnO_2 + ZnO + Fe_2O_3 was submitted to calcination in air at 1200°C, the result was a well crystallized manganese-zinc spinel ferrite. The attempt to synthesize a manganese-zinc spinel ferrite by calcination in air at 1200°C from the powder mixture of $MnCO_3$ + ZnO + pre-milled Fe_2O_3 in aqueous solutions of NH_4OH was not successful and resulted in a multiphase material, with low saturation magnetization and initial permeability. Table 1 summarizes the main data on test-conditions and their results.The thermodynamics governing the behavior of the Mn-Zn-Fe-0 system during calcination has already been subject of a previous publication [1]].

Keywords**:** manganese zinc ferrites; ultrafine milling; synthesis; magnetic properties.

Table 1. Particle size distribution and BET surface area of the milled-mixed powder mixtures and magnetic properties after calcinations at 1200°C.

Nr.	Test-mixture Composition*	D_{90} (µm)	Surface Area (m^2/g)	M_s emu/g	M_s G	H_s (kOe)	H_c (kOe)	M_r (emu/g)	μ_i (emu/g) x100**
1	MnO_2+ZnO	8.45	9.7	32.7	4109	4.45	0.29	19.8	1.034
2	MnO_2+ZnO, AD1	6.63	6.7	38.9	4888	5.63	0.30	25.7	8.833
3	MnO_2+ZnO, AD2	6.60	7.8	37.0	4849	4.30	0.25	20.8	5.393
4	MnO_2+ZnO, AD3	5.16	10.6	35.0	4398	5.75	0.28	21.5	5.943
5	$MnCO_3$+ZnO, AD1	5.14	7.2	35.7	4486	6.36	0.32	23.2	3.718
6	MnO_2+Zn^o, AD2	3.74	10.1	34.6	4348	5.18	0.33	21.7	4.237
7	MnO_2+Zn^o, AD3	3.80	14.4	40.1	5039	1.26	0.24	25.6	6.983

* All compositions contain additionally Fe_2O_3; AD1 = 1M NaOH; AD2 = 0.5M NaOH; AD3 = 100%NH_4OH. ** For H = 1Oe.

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