APPENDIX A: Co-precipitation process

A.) Data available:

Chemical	Molecular Weight, g / mol
$MgCl_2.6H_2O$	203.31
$CuCl_2.2H_2O$	170.48
$ZnCl_2$	136.29
$FeCl_3.6H_2O$	270.30
NaOH	40.00
Mg	24.31
Cu	63.55
Zn	65.38
Fe	55.85

B.) The calculation of the weight of chlorides:

Weight fraction of the principal element in the chlorides are:

1. For $MgCl_2.6H_2O$, weight fraction of Mg, $WF_{Mg} = \frac{24.31}{203.31} = 0.1196$

2. For $CuCl_2.2H_2O$, weight fraction of Cu, $WF_{Cu} = \frac{63.55}{170.48} = 0.3728$

3. For $ZnCl_2$, weight fraction of Zn, $WF_{Zn} = \frac{65.38}{136.29} = 0.4797$

4. For $FeCl_3.6H_2O$, weight fraction of Fe, $WF_{Fe} = \frac{55.85}{270.30} = 0.2066$

Let the mol % of MgO, CuO, ZnO in the MgCuZn Ferrites be x, y, and z respectively. For the stoichiometric composition, Fe_2O_3 is 50 mol % and x + y + z = 50 mol %. The number of mol of the oxides per mol of ferrites to be produced is as the following table:

Compound	Number of mol per mol of ferrite
MgO	0.02 x
CuO	0.02 y
ZnO	0.02 z
Iron oxide	1.00

Lets, W = Molecular weight

M = Molecular weight of the ferrites to be produced

$M = 0.02 \{ W_{Mg} x + W_{Cu} y + W_{Zn} z\} + W_{Fe_2O_4}$

$M = 0.4862 x + 1.271 y + 1.3076 z + 175.7$

C.) The theoretical weigths of element for the production of 50g ferrites:

1. For Mg = $50 [\frac{0.4862x}{M}]$
2. For Cu = $50 [\frac{1.271y}{M}]$
3. For Zn = $50 [\frac{1.3076z}{M}]$
4. For Iron = $50 [\frac{2(55.85)}{M}]$

D.) Weight of corresponding chlorides:

1. $MgCl_2.6H_2O = \frac{50}{0.1196}\left[\frac{0.4862x}{M}\right] = 203.261\left(\frac{x}{M}\right)$

2. $CuCl_2.2H_2O = \frac{50}{0.3728}\left[\frac{1.271y}{M}\right] = 170.467\left(\frac{y}{M}\right)$

3. $ZnCl_2 = \frac{50}{0.4797}\left[\frac{1.3076z}{M}\right] = 136.293\left(\frac{z}{M}\right)$

4. $FeCl_3.6H_2O = \frac{50}{0.2066}\left[\frac{2(55.85)}{M}\right] = \frac{27032.914}{M}$

E.) Selection of suitable composition:

Based on literature review, the following composition was selected:

x = 18 mol %, y = 12 mol % and z = 20 mol %

$Mg_{0.36}\,Cu_{0.24}\,Zn_{0.4}\,Fe_2O_4$ with M = 225.8556 g / mol

In order to produce 50g ferrites, the following weight of chemical was used:

1. Weight of $MgCl_2.6H_2O$ = 16.199 g
2. Weight of $CuCl_2.2H_2O$ = 9.057 g
3. Weight of $ZnCl_2$ = 12.069 g
4. Weight of $FeCl_3.6H_2O$ = 119.691 g

F.) General reaction:

$$MeCl_2 + 2FeCl_3 + 8NaOH \longrightarrow MeFe_2O_4 + 8NaCl + 4H_2O$$

Which, Me refer to Mg, Zn and Cu.

W_{NaOH} = 40 g/mol ; $W_{MeFe_2O_4}$ = 328.94 g/mol

Specific gravity for NaOH, S = 1.5 g/cc

Lets, P = Number of mol of $MeFe_2O_4$ of 50 g sample.

Therefore,

Number of mole of NaOH required to make 50 g sample = 8P

Amount of NaOH required to make 50 g sample = 8P x W_{NaOH} = Y

$$P = \frac{50}{328.94} = 0.152 \text{ mol}$$

Amount of NaOH required to make 50 g sample, T = 8P x W_{NaOH}

$$T = 8 \times 0.152 \times 40$$

$$= 48.64 \text{ g}$$

$$\text{NaOH volume} = \frac{T}{S} = \frac{48.64g}{1.5g/cc} = 32.427 \text{ cc}$$

Notes: Solution of NaOH normally just 50 % by valume.

Therefore, Actual NaOH volume required = 32.427 x 2

= 64.854 cc

APPENDIX B: Mixed oxide route

Selected chemical composition of ferrites:

$Mg_{0.36}\ Cu_{0.24}\ Zn_{0.4}\ Fe_2O_4$

Chemical	Molecular Weight, g / mol
MgO	40.30
CuO	79.55
ZnO	81.37
Fe_2O_3	159.69

Notes: MW stand for Molecular Weight

The weight of individual oxide such as following:

1. Weight of MgO = 0.36 x MW_{MgO}

   = 0.36 x 40.30

   = 14.508 g/mol

2. Weight of CuO = 0.24 x MW_{CuO}

   = 0.24 x 79.55

   = 19.092 g/mol

3. Weight of ZnO = 0.40 x MW_{ZnO}

   = 0.40 x 81.37

   = 32.548 g/mol

4. Weight of Fe_2O_3 = 159.69 g/mol

Total weight = 225.838 g/mol

50 g of ferrites required such as below:

1. $MgO = \frac{Weight\ of\ MgO}{Total\ weight} \times 50\ g$

$= \frac{14.508}{225.838} \times 50\ g$

$= 3.212\ g$

2. $CuO = \frac{Weight\ of\ CuO}{Total\ weight} \times 50\ g$

$= \frac{19.092}{225.838} \times 50\ g$

$= 4.227\ g$

3. $ZnO = \frac{Weight\ of\ ZnO}{Total\ weight} \times 50\ g$

$= \frac{32.548}{225.838} \times 50\ g$

$= 7.206\ g$

4. $Fe_2O_3 = \frac{Weight\ of\ Fe_2O_3}{Total\ weight} \times 50\ g$

$= \frac{159.69}{225.838} \times 50\ g$

$= 35.355\ g$

PUBLICATION

1. C. L. Chin, I. H. S. C. Metselaar, M. H. Koay, M. K. Lai, "Synthesis and Characterization of Magnesium-Copper-Zinc Ferrite by Co-Precipitation Process", Proceeding of the 2nd Technical Postgraduate Symposium, pp. 288-291, 2003.
2. C. L. Chin, I. H. S. C. Metselaar, M. H. Koay, M. K. Lai, "Densification and Electromagnetic Properties of Low Firing MgCuZn Ferrites", Proceedings of The Seventh Triennial AEESEAP Conference, pp. 305-310, 2003.
3. M. K. Lai, I. H. S. C. Metselaar, C. L. Chin, M. H. Koay, "Low Temperature Sintering of MgCuZn Ferrite With V_2O_5 Addition", Proceedings of The Seventh Triennial AEESEAP Conference, pp. 295-299, 2003.
4. M. K. Lai, I. H. S. C. Metselaar, C. L. Chin, M. H. Koay, "Effects of V_2O_5 Addition On MgCuZn Ferrite As Sintering Aid", Proceeding of the 2nd Technical Postgraduate Symposium, pp. 303-306, 2003.
5. M. H. Koay, I. H. S. C. Metselaar, M. K. Lai, C. L. Chin, "The Development And Analysis of Ternary Property-Diagrams On Magnesium-Copper-Zinc Ferrites", Proceedings of The Seventh Triennial AEESEAP Conference, pp. 265-269, 2003.
6. M. H. Koay, I. H. S. C. Metselaar, M. K. Lai, C. L. Chin, "Effect of Magnesium-Zinc Ratio On The Electromagnetic Properties of MgCuZn Ferrites", Proceeding of the 2nd Technical Postgraduate Symposium, pp. 297-301, 2003.