

Appendix 1: Experimental Calculations

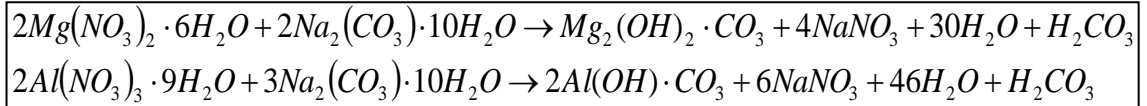
1.1 Calculations for amount of materials required to synthesis Mg-Al HTlcs

Materials	Symbol	MW (g/mol)
Mg(NO ₃) ₂ ·6H ₂ O	M	256.330
Al(NO ₃) ₃ ·9H ₂ O	A	375.010
Na ₂ (CO ₃) ₂ ·10H ₂ O	N	285.990

Mol Ratio

Mg	Na
2	1
Al	Na
1	1

Reaction Equations



Calculating amount of Mg(NO₃)₂·6H₂O and Al(NO₃)₃·9H₂O required

Mol Ratios (M/A), MR	0.5	1	2	3	4
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Total amount (M +A)	50 g
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Take: M = x A = y
 $x + y = 50 \text{ g}$
Eq (1)

Mol ratio	=	$\frac{x/256.330}{y/375.010}$
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$x = MR \cdot 256.330y / 375.010$

Mol Ratio (MR) =	0.5
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$x = 0.342 y$

Eq (2)

MR =	1
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$x = 0.684 y$

Eq (3)

Substitute **(2)** into **(1)**

Substitute **(3)** into **(1)**

1.342 y = 50
y1 = 37.264 g
x1 = 12.736 g

1.684 y = 50
y2 = 29.700
x2 = 20.300

$$\text{MR} = \frac{\quad}{\quad} = 2$$

$$x = 1.367 y$$

Eq (4)

$$\text{MR} = \frac{\quad}{\quad} = 3$$

$$x = 2.051 y$$

Eq (5)

Substitute **(4)** into **(1)**

$$\begin{aligned} 2.367 y &= 50 \\ y3 &= 21.123 \text{ g} \\ x3 &= 28.877 \text{ g} \end{aligned}$$

$$\begin{aligned} 3.051 y &= 50 \\ y4 &= 16.390 \\ x4 &= 33.610 \end{aligned}$$

$$\text{MR} = \frac{\quad}{\quad} = 4$$

$$x = 2.734 y$$

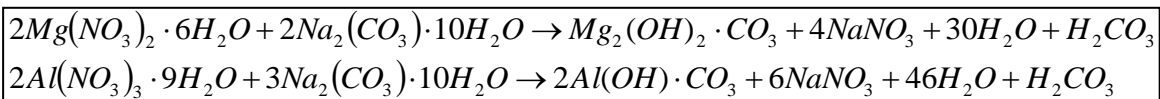
Eq (6)

Substitute **(6)** into **(1)**

$$\begin{aligned} 3.734 y &= 50 \\ y5 &= 13.390 \text{ g} \\ x5 &= 36.610 \text{ g} \end{aligned}$$

Calculation for amount of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ required

Equations



Mol ratios

Mg : Na	1	1
Al : Na	2	3

Materials	Symbol	MW (g/mol)
$\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$		256.33
$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	y	375.01
$\text{Na}_2(\text{CO}_3) \cdot 10\text{H}_2\text{O}$	z	285.99

Amount of Na₂CO₃·10H₂O required

Mg/Na = 1

$$\frac{x / 256 \cdot 33}{z_1 / 285 \cdot 33} = 1$$

x = 0.896 z₁

z₁ = 1.116 x

Al/Na = 0.67

$$\frac{y / 375 \cdot 01}{z_2 / 285 \cdot 99} = 0.67$$

z₂ = 1.138 y

Total Na₂CO₃·10H₂O (z) required

z = z₁ + z₂

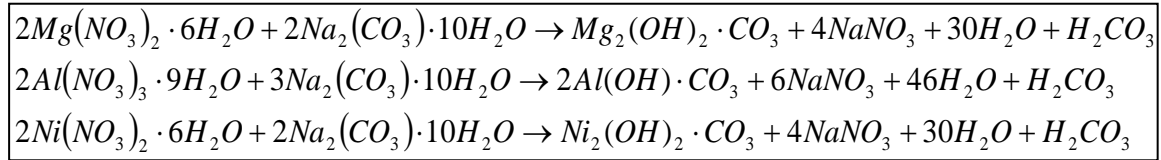
$$z = 1.116x + 1.138y$$

Materials Required :

Mol Ratio	M (g)	A(g)	N (g)	N (extra 10%)
0.5	12.736	37.264	56.620	62.282
1	20.300	29.700	56.453	62.099
2	28.877	21.123	56.265	61.891
3	33.610	16.390	56.161	61.777
4	36.610	13.390	56.095	61.704

1.2 Calculations for amount of materials required to synthesis Ni-Mg-Al HTlcs

Reaction Equation:



Materials	Symbol	MW (g/mol)
Mg(NO3)2.6H2O	x	256.330
Al(NO3)3.9H2O	y	375.010
Na2(CO3)2.10H2O	z	285.990
Ni(NO3)2.6H2O	w	290.810

Mol Ratio **Ni/Mg/Al** = **2:1:1** Total weight = 1242.62 g

Total weight used w+x+y 50 g

Weight for each material, w $\frac{\text{Molar ratio X MW}}{\text{Total weight}}$ X 50g

Fraction of total weight for each material

w = 23.403 g
 x = 10.314 g
 y = 15.089 g

Mol Ratio **Ni/Mg/Al** = **1:2:1** Total weight = 1178.48 g

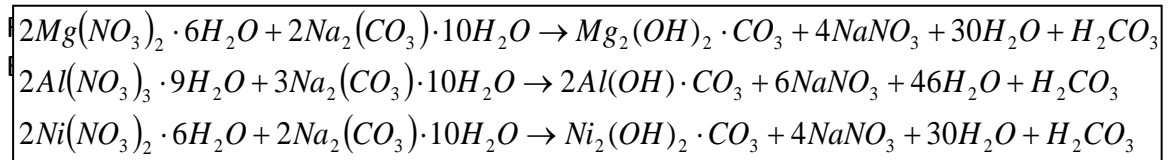
Total weight used w+x+y 50 g

Weight for each material, w $\frac{\text{Molar ratio X MW}}{\text{Total weight}}$ X 50g

Fraction of total weight for each material

w = 12.338 g
 x = 21.751 g
 y = 15.911 g

Calculation for amount of Na₂CO₃·10H₂O required



Mol ratios

Mg : Na	1	1
Al : Na	2	3

Materials	Symbol	MW (g/mol)
Mg(NO ₃) ₂ ·6H ₂ O	x	256.33
Al(NO ₃) ₃ ·9H ₂ O	y	375.01
Na ₂ (CO ₃) ₂ ·10H ₂ O	z	285.99
Ni(NO ₃) ₂ ·6H ₂ O	w	290.810

Amount of Na₂CO₃·10H₂O required

Mg/Na = 1

$$\frac{x / 256 \cdot 33}{z_1 / 285 \cdot 33} = 1$$

Al/Na = 0.67

$$\frac{y / 375 \cdot 01}{z_2 / 285 \cdot 99} = 0.67$$

x = 0.896 z₁

z₁ = 1.116 x

z₂ = 1.138 y

Ni/Na = 1.00

$$\frac{w / 290 \cdot 81}{z_2 / 285 \cdot 99} = 1$$

z₃ = 0.983 w

Total $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ (z) required

$$z = z_1 + z_2 + z_3$$

$$z = 1.116x + 1.138y + 0.983w$$

Materials Required :

Mol Ratio	Ni (g)	M (g)	A(g)	N (g)	N (extra 10%)
Ni/Mg/Al = 2:1:1	23.403	10.314	15.089	51.687	56.856
Ni/Mg/Al = 1:2:1	12.338	21.751	15.911	54.509	59.960