**Ex1 :** **Chemical analysis for type of cement as shown in table :**

1. What is the type of cement?
2. Is the cement accepted with limitation of portland cement? And where used?

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide** | **CaO** | **SiO2** | **Al2O3** | **Fe2O3** | **MgO** | **SO3** | **Na2O** | **K2O** |
| **%** | 64 | 21 | 5 | 3 | 3 | 2.8 | 0.6 | 0.6 |

**Sum of oxide = 100 %**

**C3S = 4.07(CaO) – 7.60(SiO2) – 6.72(Al2O3) – 1.43(Fe2O3) – 2.85(SO3)**

C3S = 4.07(64) – 7.60(21) – 6.72(5) – 1.43(3) – 2.85(2.8) = 55%

**C2S = 2.87(SiO2) – 0.754(C3S)**

C2S = 2.87(21) – 0.754(55) = 18.8%

**C3A = 2.65(Al2O3) – 1.69(Fe2O3)**

C3A = 2.65(5) – 1.69(3) = 8.2%

**C4AF = 3.04(Fe2O3)**

C4AF = 3.04(3) = 9.1%

**L.S.F =** $\frac{CaO -0.7(SO\_{3})}{2.8(SiO\_{2})+1.2 \left(Al\_{2}O\_{3}\right)+0.65 ( Fe\_{2}O\_{3})} $**........... (0.66-**1.02)

L.S.F = $\frac{64-(0.7\*2.8)}{2.8(21)+1.2 \left(5\right)+0.65 ( 3)}$ = 0.9 (o.k)

***L.S.F. is limited between 0.66-1.02 معامل التشبع يجب ان يكون***

*Lime Saturation Factor*

1- This type of cement is O.P.C because the percentage of the four major compounds is identical with the percentage of major compounds for O.P.C. also, the L.S.F value is also identical to that L.S.F of Ordinary Portland Cement.

1. This type of cement use in constructions when there is no exposure to sulfates in the soil or groundwater.

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Ex2: **Chemical analysis for type of cement as shown in table:**

1. What is the type of cement?
2. Is the cement accepted with limitation of portland cement?

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide** | **CaO** | **SiO2** | **Al2O3** | **Fe2O3** | **MgO** | **SO3** | **Na2O** | **K2O** |
| **%** | 36.2 | 12.6 | 3 | 1.56 | 2 | 1.45 | 1.53 | 0.43 |

**Sum of oxide = 58.8 %**

**L.O.I = 100 -**$\sum\_{}^{}Oxide$*مجموع الاكاسيد*

**L.O.I = 100 – 58.8 = 41.2 %**

**New Oxide Value =** $\frac{old Oxide value }{sum of oxide}\*100\%$

$\left[CaO\right]$**new =** $\frac{36.2 }{58.8}\*100\%$**= 61.2%**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide** | **CaO** | **SiO2** | **Al2O3** | **Fe2O3** | **MgO** | **SO3** | **Na2O** | **K2O** |
| **%** | 61.6 | 21.4 | 5.1 | 2.7 | 3.4 | 2.5 | 2.6 | 0.7 |

**Sum of oxide = 100 %**

**C3S = 4.07(CaO) – 7.60(SiO2) – 6.72(Al2O3) – 1.43(Fe2O3) – 2.85(SO3)**

C3S = 4.07(61.6) – 7.60(21.4) – 6.72(5.1) – 1.43(2.7) – 2.85(2.5) = 42.8%

**C2S = 2.87(SiO2) – 0.754(C3S)**

C2S = 2.87(21.4) – 0.754(42.8) = 29.1%

**C3A = 2.65(Al2O3) – 1.69(Fe2O3)**

C3A = 2.65(5.1) – 1.69(2.7) = 9%

**C4AF = 3.04(Fe2O3)**

C4AF = 3.04(2.7) = 8.2%

**L.S.F =** $\frac{CaO -0.7(SO\_{3})}{2.8(SiO\_{2})+1.2 \left(Al\_{2}O\_{3}\right)+0.65 ( Fe\_{2}O\_{3})} $**........... (0.66-**1.02)

L.S.F = $\frac{61.6-(0.7\*2.5)}{2.8(21.4)+1.2 \left(5.1\right)+0.65 ( 2.7)}$ = 0.9 (o.k)

* (Al2O3/ Fe2O3) = 1.889 > 0.66 (o.k)
* Percentage of Mgo = 3.4% < 5% (o.k)

1- This type of cement is O.P.C because the percentage of the four major compounds is identical with the percentage of major compounds for O.P.C. also, the L.S.F value is also identical to that L.S.F of Ordinary Portland Cement.

2- This type of cement use in constructions when there is no exposure to sulfates in the soil or groundwater.

Ex3: A type of cement it contains (2/3 limestone and 1/3 clay) and the percentage of oxides in each material as in the table below

1. What is the type of cement?
2. Is the cement accepted with limitation of portland cement?

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide %** | **CaO** | **SiO2** | **Al2O3** | **Fe2O3** | **MgO** | **SO3** | **Na2O** | **K2O** |
| **Lime Stone**  | 50 | 2 | 2 | 1 | 3 | 1 | 0.5 | 0.5 |
| **Clay** | 15 | 45 | 6 | 2 | 4 | 1 | 0.5 | 0.5 |

Sol:

Sum of lime stone oxide = 60 %

Sum of clay oxide = 74 %

L.O.I $\left[lime stone\right]$= 100 - $\sum\_{}^{}Oxide\left[lime stone\right]$ = 100 – 60 = 40 %

L.O.I $\left[clay\right]$= 100 - $\sum\_{}^{}Oxide\left[clay\right]$ = 100 – 74 = 26 %

New Oxide $\left[lime stone\right]$ = Old Oxide $\left[lime stone\right]$ \*$\frac{^{2}/\_{3}}{1- L.O.I \_{Lime stone}}$

New Oxide $\left[lime stone\right]$ = Old Oxide $\left[lime stone\right]$ \*$\frac{^{2}/\_{3}}{1- 0.4}$

**New Oxide** $\left[lime stone\right]$ **= Old Oxide** $\left[lime stone\right]$ **\* 1.11**

New Oxide $\left[clay\right]$ = Old Oxide $\left[clay\right]$ \*$\frac{^{1}/\_{3}}{1- L.O.I \_{clay}}$

New Oxide $\left[clay\right]$ = Old Oxide $\left[clay\right]$ \*$\frac{^{1}/\_{3}}{1- 0.26}$

**New Oxide** $\left[clay\right]$ **= Old Oxide** $\left[clay\right]$ **\* 0.45**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Oxide %** | **Lime Stone**  | **Clay**  | **New. Oxide) Lime**  | **New. Oxide) Clay**  | **Sum. Oxide %** |
| **CaO** | **50** | **15** | 55.56 | 6.76 | **62.32** |
| **SiO2** | **2** | **45** | 2.22 | 20.27 | **22.49** |
| **Al2O3** | **2** | **6** | 2.22 | 2.7 | **4.92** |
| **Fe2O3** | **1** | **2** | 1.11 | 0.9 | **2.01** |
| **MgO** | **3** | **4** | 3.33 | 1.8 | **5.13** |
| **SO3** | **1** | **1** | 1.11 | 0.45 | **1.56** |
| **Na2O** | **0.5** | **0.5** | 0.56 | 0.23 | **0.79** |
| **K2O** | **0.5** | **0.5** | 0.56 | 0.23 | **0.79** |

Sum. of Oxide = 100 %

**C3S = 4.07(CaO) – 7.60(SiO2) – 6.72(Al2O3) – 1.43(Fe2O3) – 2.85(SO3)**

C3S = 4.07(62.32) – 7.60(22.49) – 6.72(4.92) – 1.43(2.01) – 2.85(1.56) = 42.3 %

**C2S = 2.87(SiO2) – 0.754(C3S)**

C2S = 2.87(22.49) – 0.754(42.3) = 32.6 %

**C3A = 2.65(Al2O3) – 1.69(Fe2O3)**

C3A = 2.65(4.92) – 1.69(2.01) = 9.6 %

**C4AF = 3.04(Fe2O3)**

C4AF = 3.04(2.01) = 6.1 %

**L.S.F =** $\frac{CaO -0.7(SO\_{3})}{2.8(SiO\_{2})+1.2 \left(Al\_{2}O\_{3}\right)+0.65 ( Fe\_{2}O\_{3})} $**........... (0.66-**1.02)

L.S.F = $\frac{62.32-(0.7\*1.56)}{2.8(22.49)+1.2 \left(4.92\right)+0.65 ( 2.01)}$ = 0.872 (o.k)

**Type of cement is O.P.C**

Ex4: After conducting a chemical analysis for a type of cement, it was found that the percentages of oxides in the raw materials used in the cement manufacture, as shown in the table below.

1. What is the type of cement?
2. Is the cement accepted with limitation of portland cement?

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide %** | **CaCO3** | **SiO2** | **Al2O3** | **Fe2O3** | **MgCO3** | **SO3** | **Alkali** | **H2O** |
| **Lime Stone**  | 82 | 2 | 2 | 3 | 8 | 1.5 | 1 | 1.6 |
| **Clay** | 26 | 44.5 | 4 | 4 | 8 | 1.5 | 1 | 6 |

**CaCO3 CaO + CO2**

**molecular weight) CaO) = (16\*1)+(40\*1) = 56**

**Weight of CaO (Lime) =** $\frac{56\*82}{100}$ **= 45.92 %**

**Weight of CaO (Clay) =** $\frac{56\*26}{100}$ **= 14.56 %**

**MgCO3 MgO + CO2**

**molecular weight) CaO) = (16\*1)+(24\*1) = 40**

**Weight of MgO (Lime) =** $\frac{40\*8}{100}$ **= 3.2 %**

**Weight of MgO (Clay) =** $\frac{40\*8}{100}$ **= 3.2 %**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide %** | **CaO** | **SiO2** | **Al2O3** | **Fe2O3** | **MgO** | **SO3** | **Alkali** | **H2O** |
| **Lime Stone**  | 45.92 | 2 | 2 | 3 | 3.2 | 1.5 | 1 | 1.6 |
| **Clay** | 14.56 | 44.5 | 4 | 4 | 3.2 | 1.5 | 1 | 6 |

Sum. of lime stone oxide = 60.22 %

Sum. of clay oxide = 78.76 %

L.O.I $\left[lime stone\right]$= 100 - $\sum\_{}^{}Oxide\left[lime stone\right]$ = 100 – 60.22 = 39.78 %

L.O.I $\left[clay\right]$= 100 - $\sum\_{}^{}Oxide\left[clay\right]$ = 100 – 78.76 = 21.24 %

New Oxide $\left[lime stone\right]$ = Old Oxide $\left[lime stone\right]$ \*$\frac{^{2}/\_{3}}{1- L.O.I \_{Lime stone}}$

New Oxide $\left[lime stone\right]$ = Old Oxide $\left[lime stone\right]$ \*$\frac{^{2}/\_{3}}{1- 0.3978}$

**New Oxide** $\left[lime stone\right]$ **= Old Oxide** $\left[lime stone\right]$ **\* 1.107**

New Oxide $\left[clay\right]$ = Old Oxide $\left[clay\right]$ \*$\frac{^{1}/\_{3}}{1- L.O.I \_{clay}}$

New Oxide $\left[clay\right]$ = Old Oxide $\left[clay\right]$ \*$\frac{^{1}/\_{3}}{1- 0.2124}$

**New Oxide** $\left[clay\right]$ **= Old Oxide** $\left[clay\right]$ **\* 0.423**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Oxide %** | **Lime Stone**  | **Clay**  | **New. Oxide) Lime**  | **New. Oxide) Clay**  | **Sum. Oxide %** |
| **CaO** | 45.92 | 14.56 | 50.84 | 6.16 | **57** |
| **SiO2** | 2 | 44.5 | 2.21 | 18.83 | **21.04** |
| **Al2O3** | 2 | 4 | 2.21 | 1.69 | **3.9** |
| **Fe2O3** | 3 | 4 | 3.32 | 1.69 | **5.01** |
| **MgO** | 3.2 | 3.2 | 3.54 | 1.35 | **4.89** |
| **SO3** | 1.5 | 1.5 | 1.66 | 0.63 | **2.29** |
| **Alkali** | 1 | 1 | 1.11 | 0.42 | **1.53** |
| **H2O** | 1.6 | 6 | 1.77 | 2.54 | **4.31** |

Sum. of Oxide = 99.97 % (O.K)

**C3S = 4.07(CaO) – 7.60(SiO2) – 6.72(Al2O3) – 1.43(Fe2O3) – 2.85(SO3)**

C3S = 32.2 %

**C2S = 2.87(SiO2) – 0.754(C3S)**

C2S = 36.1

**C3A = 2.65(Al2O3) – 1.69(Fe2O3)**

C3A = 1.9 %

**C4AF = 3.04(Fe2O3)**

C4AF = 15.2 %

**L.S.F =** $\frac{CaO -0.7(SO\_{3})}{2.8(SiO\_{2})+1.2 \left(Al\_{2}O\_{3}\right)+0.65 ( Fe\_{2}O\_{3})} $**........... (0.66-**1.02)

L.S.F = 0.829 (o.k)