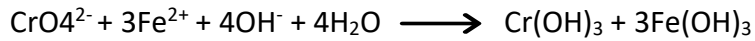




FERROUS SULPHATE FOR CHROMATE REDUCTION IN CEMENT

Chromium is an undesirable trace element in cement that can cause allergic reaction and dermatitis. Depending on the concentration and exposure time, hexavalent chromium ($\text{Cr}6+$) in cement can penetrate the human skin, resulting allergies which is called chromate dermatitis, and also it has been classified as carcinogenic. Hexavalent chromium which is water soluble, is unavoidable in cement depending on the raw materials used. In order to sustain human health and protect environment, chromium must be reduced in cement. Addition of ferrous compounds in cement to reduce hexavalent chromium element in cement is the most efficient and cost effective way of solution. By adding ferrous sulphate into cement, water soluble hexavalent chromium is converted to hardly soluble trivalent chromium which can not penetrate to skin.

The reaction of reduction is:



According to regulations cement and cement containing products have to ensure hexavalent chromium content below 2 ppm.

The efficient dosage of ferrous sulphate is chosen according to the amount of cement being manufactured and it can differ (generally between a range of 0,1 – 0,5 %) and depend on raw materials and way of its adding to cement.



The particle size, homogeneity of particle size, thermal stability, humidity and the type of ferrous sulphate affects the efficiency of the process and dosage rate. The product chosen in the reduction process must be free flowing form in order to attain efficient dosage and application. Thus the determination process of the right dosage should be carried out with laboratory and plant tests.

Ferrous Sulphate Monohydrate

Free flowing powder formed ferrous sulphate monohydrate is mostly preferred and suitable for pneumatic conveying in cement production. It is the most thermodynamically stable form of ferrous sulphate products.



Advantages of Ferrous Sulphate Monohydrate

- Due to fineness and homogeneity of particles, the surface area and efficiency of reaction increases
- Powder form makes it suitable for universal applications
- Thermally stable
- Low moisture content prevents agglomeration and caking problems

Ferrous Sulphate Heptahydrate and Tetrahydrate



Ferrous sulphate heptahydrate is a crystalline salt molecule containing 7 molecules of crystalline water and ferrous sulphate tetrahydrate is a crystalline salt molecule containing 4 molecules of crystalline water.

Due to their moisture content, they easily dissolve in water and can be applied in saturated solution form as chromate reducing agent. Ferrous sulphate heptahydrate and tetrahydrate can also be applied in crystalline form with a drying agent in clinker grinding process which results ferrous sulphate heptahydrate or tetrahydrate to dry and turn into monohydrate form in the finished cement.

Advantages of Ferrous Sulphate Heptahydrate and Tetrahydrate

- Easily and completely dissolved in water
- Clear solution due to low impurity
- Cost effective for chromate reduction in cement in case of low chromonium content



Chemical Composition	Ferrous Sulphate Monohydrate	Ferrous Sulphate Heptahydrate	Ferrous Sulphate Tetrahydrate
Formula	FeSO ₄ H ₂ O	FeSO ₄ 7H ₂ O	FeSO ₄ 4H ₂ O
Active Substance	min. %30 Fe	min. %19 Fe	min. %24,5

Physical Properties	Ferrous Sulphate Monohydrate	Ferrous Sulphate Heptahydrate	Ferrous Sulphate Tetrahydrate
Appearance	Slightly green-grey / free flowing powder	Blue-green crystalline	Greenish to greyish crystalline
Size	Powder	< 2 mm	< 2 mm

Heavy Metals	Ferrous Sulphate Monohydrate	Ferrous Sulphate Heptahydrate	Ferrous Sulphate Tetrahydrate
Cadmium (Cd)	< 10 ppm	< 10 ppm	< 10 ppm
Lead (Pb)	< 50 ppm	< 50 ppm	< 50 ppm
Mercury (Hg)	< 1 ppm	< 1 ppm	< 1 ppm
Arsenic (As)	< 5 ppm	< 5 ppm	< 5 ppm

