Ex: A silty soil containing (14%) moisture was mixed in a large muller mixer with (10% wt) of a tracer consisting of dextrose and picric acid . After 3min. of mixing 12 random samples were taken from mix and analyzed colorimetrically for tracer material . The measured concentrations in the samples were in weight percent tracer .

10.24 , 9.3 , 7.94 , 10.24 , 11.08 , 10.03 , 11.91 , 9.72 , 9.2 , 10.76 , 10.97 , 10.55 . Calculate the mixing index (I_P) , and the standard deviation (S) ?

Solution :

For this test

μ=0.1 ,N=12

$$\bar{x} = \frac{\sum x_i}{N} = \frac{10.24+9.3+\cdots+10.55}{12} = 10.16\%$$

$$I_P = \frac{\sigma_0}{s} \sqrt{\frac{0.1(1-0.1)(12-1)}{0.1251028-(0.101617*1.2194)}}$$

=28.8

The standard deviation from eq. (*) is 0.0104, which is 10.2% of $\bar{x}$.

Mixing of dry powders

1. Mixing index in blending granular solids (I_s)

With granular solids the mixing index is based , not on conditions at zero mixing , but on the standard deviation that would be observed with a completely random , fully blended mixture .

$$\sigma_e = \sqrt{\frac{\mu_p(1-\mu_p)}{n}} \qquad (1)$$

For granular solids , the mixing index (I_s) is defined as (σ_e/S)

$$I_s = \frac{\sigma_e}{s} = \sqrt{\frac{\mu_p(1-\mu_p)(N-1)}{n\sum_{i=1}^{N}(x_i-\bar{x})^2}} \qquad (2)$$

Where :

I_s = mixing index for granular soilds .

σ_e= equilibrium value for complete mixing of granular solids .

μ_p = true a verage number fraction of tracer particles .

n = number of particles in spot samples .

2. Mixing index at zero time

The equilibrium standard deviation for complete mixing (σ_e) is used as a reference with granular solids . With pastes the reference in the standard deviation at zero mixing σ_0 . Mixing index at zero mixing time for granular solids is :

$$I_{s,0} = \frac{\sigma_e}{\sigma_0} = \frac{1}{\sqrt{n}} \qquad \text{----------(3)}$$

3. Rate of mixing

For short mixing time the rate of change of I_s is directly proportional to (1 – I_s) or

$$\frac{dI_s}{dt} = k(1 - I_s) \qquad \text{-------------(4)}$$

k = constant

The equilibrium value of (I_s) is 1 ; therefore the driving force for mixing at any time can be considered to be ($1 - I_s$) .

$$\int_0^t dt = \frac{1}{k}\int_{I_{s,0}}^{I_s} \frac{dI_s}{1-I_s}$$

$$t = \frac{1}{k}\ln\left(\frac{1-I_{s,0}}{1-I_s}\right)$$

$$sub.\ for\ \ I_{s,0} = \frac{1}{\sqrt{n}}$$

$$t = \frac{1}{k}\ln\left(\frac{1-\frac{1}{\sqrt{n}}}{1-I_s}\right) \qquad \text{------------(5)}$$

Eq.(5) can be used to calculate the time required for any desired degree of mixing , provided k is known and unblending forces are not active .