



Designation: C1733 – 17

Standard Test Method for Distribution Coefficients of Inorganic Species by the Batch Method¹

This standard is issued under the fixed designation C1733; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

As an aqueous fluid migrates through geologic media or contacts an engineered material, certain reactions occur that are dependent upon the chemistry of the fluid itself and upon the chemistry and geochemistry of other fluids and solid phases with which it comes in contact. These chemical and geochemical interactions affect the relative rates at which chemical species in the migrating fluid (such as ions) travel with respect to the advancing front of water. Processes of potential importance in retarding the transport of chemical species in the migrating fluid (movement of species at velocities less than the ground-water velocity) include ion exchange, adsorption, complex formation, precipitation (or coprecipitation, for example Ba^{2+} and Ra^{2+} co-precipitating as a sulfate), redox reactions, and precipitate filtration. Partitioning may be caused by processes that include adsorption, precipitation, and coprecipitation that cannot be described easily by equations and, furthermore, these solute removal mechanisms may not instantaneously respond to changes in prevailing conditions and may not be entirely reversible.

An empirical ratio known as the *distribution coefficient* (K_d) is defined as:

$$K_d = \frac{\text{Mass of solute on the solid phase per unit mass of solid phase}}{\text{Mass of solute in solution per unit volume of the liquid phase}}$$

and has been used to quantify the collective effects of these processes for the purpose of modeling (usually, but not solely, applied to ionic species). K_d is used to assess the degree to which a chemical species will be removed from solution (permanently or temporarily) as the fluid migrates through the geologic medium or contacts a solid material; that is, K_d is used to calculate the retardation factor that quantifies how rapidly an ion can move relative to the rate of ground-water movement.

This test method is for the laboratory determination of the K_d , which may be used by qualified experts for estimating the retardation of contaminants for given underground geochemical conditions based on a knowledge and understanding of important site-specific factors. It is beyond the scope of this test method to define the expert qualifications required, or to justify the application of laboratory data for modeling or predictive purposes. Rather, this test method is considered as simply a measurement technique for determining the degree of partitioning between liquid and solid, under a certain set of conditions, for the species of interest.

Justification for the K_d concept is generally acknowledged to be based on expediency in modeling-averaging the effects of attenuation reactions. In reference to partitioning in soils, equilibrium is assumed although it is known that this may not be a valid assumption in many cases.

The K_d for a specific chemical species may be defined as the ratio of the mass sorbed per unit of solid phase to the mass remaining per unit of solution, as expressed in the above equation. The usual units of K_d are mL/g (obtained by dividing g solute/g solid by g solute/mL solution, using concentrations obtained in accordance with this test method).

Major difficulties exist in the interpretation, application, and meaning of laboratory-determined K_d values relative to a real system of aqueous fluid migrating through geologic media (1)². The K_d concept is based on an equilibrium condition for given reactions, which may not be attained in the natural situation because of the time-dependence or kinetics of specific reactions involved. Also, migrating solutions always follow the more permeable paths of least resistance, such as joints and fractures, and larger sediment grain zones. This tends to allow less time for reactions to occur and less sediment surface exposure to the migrating solution, and may preclude the attainment of local chemical equilibrium.

Sorption phenomena also can be strongly dependent upon the concentration of the species of interest in solution. Therefore, experiments performed using only one concentration of a particular chemical species may not be representative of actual in situ conditions or of other conditions of primary interest. Similarly, experimental techniques should consider all ionic species anticipated to be present in a migrating solution, in order to address competing ion and ion complexation effects, which may