Aerobic (or Anaerobic) Degradation in Aquatic Systems

|  |  |
| --- | --- |
| Report: | [Provide full citation. Provide the MRID (first) if the review is unilateral.] |
| Document No.: | [MRID ########] |
| Guideline: | [OCSPP 835.4300 (aerobic) or OCSPP 835.4400 (anaerobic)][If the study was conducted under a different guideline, state ‘Conducted by’ and provide the most relevant guideline(s) the study was conducted under. Then state ‘Reviewed by OCSPP 835.####.’ If this review is multilateral, also provide the guideline numbers under which participating agencies are reviewing the study.] |
| Statements: | [Indicate whether the study was conducted in compliance with FIFRA GLP standards and whether signed and dated Data Confidentiality, GLP Compliance, Quality Assurance, and Authenticity Certification statements were provided. If the study was not conducted in compliance with FIFRA GLP standards, indicate how not or why not.] |
| Classification: | This study is [provide classification and concise statement of any deficiencies that impacted the classification]. [If multiple classification terminologies are needed for multilateral reviews, list or tabulate them.] |
| PC Code: | [######] |
| Reviewer: | [Provide final reviewer(s)’s name Signature:and title.] Date: [Type date of signature.] |

**Executive Summary**

The [aerobic or anaerobic] transformation of [type of radiolabel]-labeled [test compound] was studied in [number of] H2O:sediment systems for [duration] days in a closed system in darkness at [temperature] ºC, water column pH [value], sediment pH [value] with a total organic carbon of [value] mg/L. [Indicate whether anaerobic conditions were maintained in sediment.] Microbial biomass determinations indicated the water sediment systems [were or were not] viable at study initiation and termination.

Overall mass balances for [system x and y] averaged [value]% of the applied radioactivity (%AR) and [value]%AR, respectively, ranging from [value to value]%AR. In the water column [test compound] ranged from [value]% at day 0 to [value]% at [value] days, while in sediment [test compound] ranged from [value]% at day 0 to [value]% at [value] days.

Observed DT50 values, calculated half-lives based on the harmonized NAFTA kinetics guidance (USEPA, 2011), and information on transformation products are listed in Table 1. [Describe whether a reasonable effort was made to maximize recovery of residues in sediment. If not, describe whether transformation kinetics calculations were performed for test compound plus unextracted residues as well as for test compound alone.] The amount of extracted radioactivity declined from [value]%AR at study initiation to [value]%AR at day [number]. Unextracted radioactivity increased to [value]%AR at day [number]. The total evolved CO2 and other volatile compounds amounted to [value]%AR and [value]%AR, respectively.

**Table 1. Results Synopsis: [Aerobic or Anaerobic] Aquatic Metabolism of [Test Compound] in the Total System**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Total System | Observed DT50 (days) | CalculatedHalf-life (days)Method | Model Parameters and Statistics | **Transformation Products**Common Name (maximum %AR A observed, associated interval) |
| **Major** | **Minor** |
| [H2O:Sediment System , # °C, pH #] | [value] | [value][method] | [value] | [name] (# %, # days) | [name] (# %, # days) |
| [H2O:Sediment System , # °C, pH #] | [value] | [value][method] | [value] | [name] (# %, # days) | [name] (# %, # days) |
| A AR means “applied radioactivity”[Model parameters include model variables; model statistics include Sc values, correlation coefficients, and p values.] |

[Half-lives and model parameters should be reported for the best fit kinetics model in accordance with the NAFTA kinetics guidance (USEPA, 2011). If multiple experiments were conducted per study condition using test compound with different radiolabel positions, calculate kinetics values for the combined data rather than for specific radiolabel positions.]

**I. Materials and Methods**

**A. Materials:**

**1. Test Material:** [Type of radiolabel]-labeled[test compound]
Specific radioactivity: [value] units

 Radiochemical purity: [percentage [HPLC or TLC]

 Chemical purity: [percentage (HPLC)]

 Batch number: [value]

 Solubility in water: [value] mg/L at [value] °C [If pH-dependent, list available values at each pH and temperature]

**2. Reference Compounds:** The following compounds were used in the analysis.

**Table 2. Reference Compounds**

|  |  |  |  |
| --- | --- | --- | --- |
| Applicant’s Code Name | Chemical Name | Purity(%) | Lot No. |
| [code name] | [chemical name] | [#] | [#] |
| [code name] | [chemical name] | [#] | [#] |
| [code name] | [chemical name] | [#] | [#] |
| Data were obtained from [page number] of the study report.[Provide other chemical information in the structure table.] |

**3. Water-sediment:** [Characterize any unique properties of water and sediment collection or storage conditions]. Water and sediment collection and characterization are summarized in **Table 3** and **Table 4**, respectively.

Table 3. Water:Sediment Collection and Storage

|  |  |
| --- | --- |
| Description | Water:Sediment System  |
| Geographic location |  |
| Pesticide use history at the collection site |  |
| Collection procedures  | Water: |  |
| Sediment:  |  |
| Storage temperature |  |
| Storage length |  |
| Preparation  | Water: |  |
| Sediment: |  |
| Data obtained from page [#] of the study report. |

[Repeat this table as needed for additional H2O:sediment systems.]

Table 4. Parameters for Characterization of Water:Sediment Samples

|  |  |  |
| --- | --- | --- |
| Parameter(unit) | Field Sampling/Post Handling | Stage of Test Procedure |
| Prior to Test | During Test | End of Test |
| Water |
| Temperature (ºC) | [#]  |  |  |  |
| pH  | [#] | [#] | [#] | [#] |
| TOC (mg/L) |  | [#] | [#]  | [#]  |
| O2 concentration (mg/L) | [#]  | [#]  | [#]  | [#]  |
| Standard redox potential (mV) |  | [#] | [#] | [#]  |
| Sediment |
| Sampling Depth (cm) | [range]  |  |  |  |
| pH | [#] | [#] | [#] | [#] |
| Particle Size Distribution | [%] sand (2000-50 μm)[%] silt (50-2 μm)[%] clay (<2 μm) |  |  |  |
| TOC (mg/L) |  | [#]  |  | [#]  |
| Microbial biomass (mg CO2/hr/kg dry wt.) |  | [#]  |  | [#]  |
| Standard redox potential (mV) |  | [#]  | [#]  | [#]  |

 [Repeat this table as needed for additional water:sediment systems. Indicate the use of any non-standard sampling instruments or methods. Standard redox potential values should be reported. If the standard hydrogen electrode was not used to measure redox potentials, then measured redox potential values should be corrected for the difference in electrode potential to produce standard values.]

**B. Study Design:**

1. **Experimental Conditions:** [Describe any unique characteristics of the study design, if

any.] **Table 5** summarizes the experimental conditions.

Table 5. Experimental Design

|  |  |
| --- | --- |
| Experimental Design | Details |
| Duration of the test  | [#] days |
| Water: |  |
| Type and size of filter used |  |
| Amount of sediment and water per treatment: |  |
| Water  | [#] mL ([#] mL associated with sediment, plus [#] mL added)  |
| Sediment  | [#] g dry wt. ([#] g wet wt., [#] mL) |
| Water/sediment ratio  | [#] mL: [#] g dry weight |
| Application rates: |  |
| Nominal  | [#] mg a.i./L |
| Actual  | [#] mg a.i./L |
| Number of replicates: |  |
| Control, if used |  |
| Treated |  |
| Test apparatus: |  |
| Type/ material/volume |  |
| Details of traps for CO2 and organic volatile, if any |  |
| If no traps were used, is the system closed? |  |
| Identity and final concentration (based on water volume) of co-solvent  | [#] ([#] μL/[#] mL) |
| Test material application method: |  |
| Volume of the test solution used/treatment |  |
| Application method (*i.e*.;, mixed/not mixed) |  |
| Any indication of the test material adsorbing to the walls of the test apparatus? |  |
| Microbial biomass/population of control units: |  |
| Water |  |
| Sediment  | [#] mg CO2/hr/kg dry wt. |
| Microbial biomass/population of treated: |  |
| Water |  |
| Sediment  | [#] mg CO2/hr/kg dry wt. |
| Experimental conditions: |  |
| Temperature  | [#] ºC |
| Continuous darkness (yes/no) |  |
| Other details, (if any) |  |

[Repeat this table as needed for additional water:sediment systems.]

1. **Sampling during Study Period:** [Describe any unique characteristics of sampling during

study period, if any.] **Table 6** summarizes sampling during the study period.

Table 6. Sampling during Study Period

|  |  |
| --- | --- |
| Parameter | Details |
| Sampling intervals (duration) |  |
| Sampling method |  |
| Method of collection of CO2 and organic volatile compounds |  |
| Sampling Intervals/Times |
| Redox potential in water layer |  |
| Dissolved oxygen in water layer |  |
| pH in water layer |  |
| Redox potential in sediment |  |
| pH in sediment |  |
| Other details, if any |  |

[Repeat this table as needed for additional H2O:sediment systems. Indicate the use of any non-standard sampling instruments or methods.]

1. **Analytical Procedures:** [Briefly describe the extraction method. An example follows.]

Separation of the Water and Sediment: The water layer was decanted and centrifuged (speed, interval), then triplicate aliquots ([#] mL) were analyzed for total radioactivity by LSC (report page number). Resulting solids were combined with the respective sediment sample.

Extraction/Clean Up/Concentration Methods: Water layer samples were analyzed directly by TLC (described below, report page number).

Sediment was transferred to a centrifuge beaker and extracted [value] times with [solvent] via [method] (*e.g.*, shaker) at speed ([value] rpm) for [duration]; extraction solvent volumes were [value] mL. Extract and sediment were separated by centrifugation [speed], [interval] (if reported); after which, the extract was decanted and filtered ([brand name] filter), and pore/mesh size (if reported). Extracts were combined and [#] of replicate aliquots ([value] mL) were analyzed for total radioactivity by [analytical method]. Aliquots of the extracts were analyzed directly by [analytical method].

Reflux extraction. Extracted sediment ([#] g) was further refluxed ([apparatus], [duration] boiling, [#] [duration] rinsing) and extracted with acetonitrile:water ([#]:[#], v:v, [#] mL; report page number). Duplicate aliquots ([#] mL) were analyzed for total radioactivity by LSC.

Aliquots of the acetonitrile (ambient) and reflux extracts were analyzed directly by TLC without concentration (report page number).

Total 14C Measurement: Total 14C residues were determined by summing the concentrations of residues measured in the water layers, sediment extracts, extracted sediment, filter papers and volatile trapping materials (report page numbers).

Determination of Unextracted Residues: Aliquots of acetonitrile-extracted sediment were air-dried, then homogenized (homogenizing equipment, report page number). Triplicate aliquots (*ca*. [#] g) were analyzed for total radioactivity by LSC following combustion.

Determination of Volatile Residues: Polyurethane foam plugs were extracted with ethyl acetate ([#] mL, report page number). Duplicate aliquots ([#] mL) of the extract were analyzed for total radioactivity by LSC.

To recover radioactivity (presumably, 14CO2) from the (substance, *i.e.*, soda lime), [value] % ( substance, *i.e.*, HCl) ([value] mL) was applied [method] to the (substance, *i.e.*, soda lime), ([value] g) with agitation via[method]. Released 14CO2 was purged (nitrogen, flow rate, if reported, *ca*. [duration] minutes) through ice-cooled [apparatus] (ratio if specified, [value] mL scintillation cocktail and quantified by LSC. Any dissolved 14CO2 in the water layer samples ([value] mL) and [14C]carbonates in the (duration)-day sediment samples ([value] g) were similarly recovered.

Total Radioactivity Measurement: Total 14C residues were determined by summing the concentrations of residues measured in the water layers, sediment extracts, extracted sediment, filter papers and volatile trapping materials ([report page number]).

Derivatization Method: [Describe derivatization method, if employed.]

Identification and Quantification of Parent Compound: Aliquots of the water layer ([#] μL) and sediment extract (aliquot volume. if reported) samples were analyzed using one-dimensional TLC on normal-phase plates (*i.e.*, silica gel) developed with methylene chloride:acetonitrile:acetic acid ([#]:[#]:[#], v:v:v, SS1; report page number). Following development, areas of radioactivity were detected and quantified using a (analyzer product name and number) Analyzer in conjunction with (software name) software (report page number)). Parent [14C][parent compound] was identified by co-chromatography with unlabeled reference standard visualized under UV light ([#] nm).

Identification of parent was confirmed in selected samples using one-dimensional TLC on reverse-phase plates (*i.e*., silica gel ) developed with acetonitrile: [#] M sodium chloride: trifluoroacetic acid ([#]:[#]:[#], v:v:v, SS2; report page number). Following development, areas of radioactivity were detected, quantified and identified as described above (report page number).

Identification and Quantification of Transformation Products: Transformation products were separated, quantified and identified using TLC as described for the parent compound (report page number).

Detection Limits (LOD, LOQ) for the Parent Compound: The limit of detection (LOD) was determined to be [%] of the applied radioactivity (%AR), with a limit of quantitation (LOQ) at [%]AR.

Detection Limits (LOD, LOQ) for the Transformation Products: For [method] analyses, the limit of quantitation (LOQ) was reported as *ca*. [value] % of the applied radioactivity, corresponding to *ca*. [value] μg/kg for parent and transformation products (report page number).

II. Results and Discussion

 **A. Data:**

Study results, including total mass balances and distribution of radioactivity, are presented in Table 7. [Indicate the results of any checks on aerobic or anaerobic conditions and viability of test soils. If applicable, report redox conditions.]

**B. Mass Balance:**

In [system x], recoveries ranged from [percentage] to [percentage] of the applied radioactivity (%AR). In the water column [test compound] ranged from [value]% at day 0 to [value]% at [value] days, while in sediment [test compound] ranged from [value]% at day 0 to [value]% at [value] days. In [system y], recoveries ranged from [percentage] to [percentage]AR. In the water column, [test compound] ranged from [value]% at day 0 to [value]% at [value] days, while in sediment [test compound] ranged from [value]% at day 0 to [value]% at [value] days. [If there is a large amount of unidentified radioactivity, mention it here. Indicate whether there was substantial loss of radioactivity by sorption to glassware or volatilization. Also mention if the mass balance meets guideline criteria.]

**C. Bound and Extractable Residues:**

The amount of extractable radioactivity declined from [percentage]AR at time zero to [percentage]AR at day [number] for [test compound]. Unextracted radioactivity increased to [percentage]AR at day [number]. [If unextracted residues were >10% of the applied, discuss whether the sediment extraction procedures were reasonable and whether the unextracted residues may include available residues.]

**D. Volatilization:**

Volatiles [were/were not] trapped. Volatile radioactivity, identified as evolved 14CO2, represented [percentage]AR at day [number] for [test compound]. [Add information regarding additional volatile chemicals as needed.]

|  |
| --- |
| Table 7. Transformation of [test compound] in [water:sediment system], Expressed as a Percentage of Applied Radioactivity |
| **Sampling Interval (days)** | Interval # | Interval # | Interval # | Interval # | Interval # | Interval # | Interval # | Interval # | Interval # | Interval # | Interval # |
| **Replicate Number** | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| [Parent compound] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |
| [Transformation product #1] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |
| [Transformation product #2] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |
| [Others] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |
| Extracted residues | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |
| Unextracted residues | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |
| CO2 | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |
| Volatile organics | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |
| Mass balance | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] | [#] |

[Repeat this table as needed for additional water:sediment systems. Note that individual replicate values are tabulated rather than means and standard deviations.]

**E. Transformation of Test Compound:**

Degradation of [radiolabel-test compound] in sediment was [gradual, rapid, or some other characterization]. The calculated half-life ranged from [x] to [x] days, as tabulated in Table 8 (calculated half-lives and model parameters for the best fit kinetics models are in bold). [Indicate the software used to determine model parameters. Indicate whether reviewer-reported half-lives are consistent with study-reported values and the relationship between calculated and observed values. Discuss any abnormalities observed in the data.]

[Images of kinetics calculation results using the R program may replace **Table 8**. R images should include the model parameters and statistics that are otherwise reported in **Table 8**.]

**Table 8. Transformation Kinetics of [Test Compound] in Total Aquatic Systems A, B**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Observed DT50 (days) | Observed DT90 (days) | CalculatedHalf-life(days) | Kinetics Model C | Model Parameters | Model Statistics |
|  [H2O:Sediment System , #°C, pH #] | [#] | [#] | [#] | SFO | C0=[#], k=[#] | SSFO=[#], r2=[#], p=[#] |
| [#] | IORE | C0=[#], k=[#], n=[#] | SIORE=[#], SC=[#], r2=[#], p=[#] |
| [#] | DFOP [if applicable] | C0=[#], g=[#], k1=[#], k2=[#],  | SDFOP=[#], r2=[#], p=[#] |
|  [H2O:Sediment System , #°C, pH #] | [#] | [#] | [#] | SFO | C0=[#], k=[#] | SSFO=[#], r2=[#], p=[#] |
| [#] | IORE | C0=[#], k=[#], n=[#] | SIORE=[#], SC=[#], r2=[#], p=[#] |
| [#] | DFOP [if applicable] | C0=[#], g=[#], k1=[#], k2=[#],  | SDFOP=[#], r2=[#], p=[#] |
| AData were obtained from [location of data in study report] and calculations in the attached Excel workbook [name(s) of worksheets, if needed]. See Attachment 3 for calculations.B Calculated half-lives and model parameters for the best fit kinetics models, in accordance with the NAFTA kinetics guidance (USEPA, 2011), are in bold.C Kinetics models: Single First-Order (SFO); Double First-Order in Parallel (DFOP), and Indeterminate Order Rate Equation (IORE). |

[Rows may be added for transformation product half-lives and DT50s as needed. Half-lives should be calculated following the NAFTA kinetics guidance (USEPA, 2011). If multiple experiments were conducted per study condition using a test compound with different radiolabel positions, calculate kinetics values for the combined data rather than for specific radiolabel positions.]

[Briefly summarize the transformation products per system in Table 9. If transformation product decline is observed over four time intervals, calculate a half-life and discuss the pattern of decline.]

**Table 9. Transformation Products of [Test Compound] in Total Aquatic Systems**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Transformation Product(s) | Maximum %AR Observed | Associated Interval | Final %AR Observed | Final Interval |
|  [H2O:Sediment System , #°C, pH #] | [common name] | [#] | [# d] | [#] | [# d] |
| [common name] | [#] | [# d] | [#] | [# d] |
|  [H2O:Sediment System , #°C, pH #] | [common name] | [#] | [# d] | [#] | [# d] |
| [common name] | [#] | [# d] | [#] | [# d] |

[If applicable, provide a description of the transformation pathway here, including a schematic as Figure 1.]

**[Figure 1. Aerobic/Anaerobic Aquatic Degradation Pathway of [radiolabel-test compound]]**

**III. Study Deficiencies and Reviewer’s Comments**

[This section is titled “Conclusions” in the original T2S template.]

[List any deficiencies with the study and any additional salient information. Results and conclusions contained in the Executive Summary are not repeated in this section.]

**IV. References** [List any references cited in the review.]

U.S. Environmental Protection Agency (USEPA). 2011. Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media. (Interim draft document dated Dec. 21, 2011.)

**Attachment 1: Chemical Names and Structures**

[A table (*i.e.*, structure table) of the chemical names, SMILES strings, CAS numbers, and structures of the test compound, all identified transformation products, and all reference compounds that were not identified in study samples should be either referenced as a separate, associated document or attached to the study review. Multiple versions of structures to show or not show radiolabeling and multiple versions of chemical names and SMILES strings should not be included in the table. Sources of data need not be included. However, formatting the structure table in conformance with the guidance for tabulating transformation product data for EFED ROCKS memoranda is recommended. This formatting includes table columns for MRIDs and associated study data such as maximum and final concentrations of transformation products and their intervals.

For multilateral reviews, chemical names, SMILES strings, structures, and CAS numbers are captured elsewhere in the Monograph[[1]](#footnote-1). Therefore these data are not attached to each study review within the Monograph. When the Monograph is split into individual reviews in EFED’s files, however, the Monograph’s structure table should be either referenced as a separate, associated document or attached to each individual review.]

[Sample structure table with the minimum information needed.]

|  |
| --- |
| **[Common name [list other common names] [if the same common name is used in different studies for different compounds, provide in parentheses the MRID associated with the common name for this compound.]]** |
|  |  |
| IUPAC Name: | [Provide one IUPAC name.] |
| CAS Name: | [Provide one CAS name.] |
| CAS Number: | [Provide if available.] |
| SMILES String: | [Provide one SMILES string.] |
|  |
| [Paste structure here.] |
|  |
|  |

[Sample EFED ROCKS memorandum format for structure tables.]



Attachment 2: Statistics Spreadsheets and Graphs



[Supporting electronic spreadsheet files should be inserted here (electronic attachment files should be electronically finalized as separate files as well). Electronic attachments should have the same file name as the Microsoft Word study review file with the addition of “Calc” for Excel workbooks and WinZip files, the addition of “Data” for Adobe Acrobat and Document Imaging files, and the addition of brief descriptors as appropriate for SigmaPlot Notebooks. Electronic attachment files should be compressed into a WinZip file when three or more are prepared for a study review.]

[Hard copies of a study review and any attachment sheets from separate electronic files should be printed and finalized together as one hard copy file.]

[The attached Excel file has three example spreadsheets for pe + pH, mass balance, and kinetics calculations.]

Attachment 3: Calculations

Calculations were performed by the reviewer using [indicate program(s) used for calculations] and the following equations. [The following equations are anticipated to reflect the NAFTA kinetics guidance as of January, 2012. If these equations are not current, they should be replaced by the applicable equations from current guidance.]

Single First-Order (SFO) Model

$C\_{t}=C\_{0}e^{-kt}$ (eq. 1)

where,

 Ct = concentration at time t (%)

 C0 = initial concentration (%)

 e = Euler’s number (-)

 k = SFO rate constant of decline (d-1)

 t = time (d)

The SFO equation is solved [with the Excel Solver] by adjusting *C0* and *k* to minimize the objective function (SSFO) shown in equation 9.

DT50 = natural log (2)/k (eq. 2)

DT90 = ln (10)/k (eq. 3)

Indeterminate Order Rate Equation (IORE) Model

$C\_{t}=\left[C\_{0}^{\left(1-N\right)}-\left(1-N\right)k\_{IORE}t\right]^{\left(\frac{1}{1-N}\right)}$ (eq. 4)

where,

 N = order of decline rate (-)

 kIORE = IORE rate constant of decline (d-1)

This equation is solved [with the Excel Solver] by adjusting *C0*, *kIORE*, and *N* to minimize the objective function for IORE (SIORE) (See equation 9). Half-lives for the IORE model are calculated using equation 5, which represents a first-order half-life that passes through the DT90 of the IORE model. (Traditional DT50 and DT90 values for the IORE model can be calculated using equations 6 and 7.)

$t\_{IORE}=\frac{log⁡(2)}{log(10)}\frac{C\_{0}^{1-N}\left(1-0.1^{(1-N)}\right)}{\left(1-N\right)k\_{IORE}}$ (eq. 5)

DT50 =  (eq. 6)

DT90 =  (eq. 7)

Double First-Order in Parallel (DFOP) Model

$C\_{t}=C\_{0}g^{-k\_{1}t}+C\_{0}\left(1-g\right)^{-k\_{2}t}$ (eq. 8)

where,

 g = the fraction of C0 applied to compartment 1 (-)

 k1 = rate constant for compartment 1 (d-1)

 k2 = rate constant for compartment 2 (d-1)

If *C0 x g* is set equal to *a* and *C0(1-g)* is set equal to *c*, then the equation can be solved [with the Excel Solver] for *a*, *c*, *k1*, and *k2* by minimizing the objective function (SDFOP) as described in equation 9.

DT50 and DT90 values can be calculated using equations 2 and 3, with k1 or k2 in place of k.

Objective Function: SFO, IORE, and DFOP are solved by minimizing the objective function (SSFO, SIORE, or SDFOP).

$S\_{SFO},S\_{IORE},or S\_{DFOP}=\sum\_{}^{}(C\_{model},t-C\_{d,t})^{2}$ (eq. 9)

where,

SSFO , SIORE, or SDFOP = objective function of kinetics model fit (%2)

n = number of data points (-)

Cmodel,t = modelled value at time corresponding to Cd,t (%)

Cd,t = experimental concentration at time t (%)

Critical Value to Determine Whether SFO is an Adequate Kinetics Model

If SSFO is less than SC, the SFO model is adequate to describe kinetics. If not, the faster of tIORE or the DFOP DT50 for compartment 2 should be used.

$S\_{c}=S\_{IORE}\left(1+\frac{p}{n-p}F\left(α,p,n-p\right)\right)$ (eq. 10)

where,

Sc = the critical value that defines the confidence contours (%2)

p = number of parameters (3 in this case)

α = the confidence level (0.50 in this case)

F(α, p, n-p) = F distribution with αlevel of confidence and degrees of freedom p and n-p

1. A Monograph is a collection of multiple study reviews and data summaries prepared by government agencies into a single document that follows an OECD format. Typically, Tier II Summaries prepared by industry are updated by government agencies based on agency-review and then placed within the Monograph. [↑](#footnote-ref-1)