3A1.2 FIRST ORDER DECAY (FOD) MODEL – BASIC THEORY

The basis for a first order decay reaction is that the reaction rate is proportional to the amount of reactant remaining (Barrow and Gordon, 1996), in this case the mass of degradable organic carbon decomposable under anaerobic conditions (DDOCm). The DDOCm reacted over a period of time *dt* is described by the differential equation 3A.1.1:

EQUATION 3A1.1
DIFFERENTIAL EQUATION FOR FIRST ORDER DECAY

$$d(DDOCm) = -k \bullet DDOCm \bullet dt$$

Where:

DDOCm = mass of degradable organic carbon (DOC) in the disposal site at time *t*

k = decay rate constant in y^{-1}

The solution to this equation is the basic FOD equation.

EQUATION 3A1.2
FIRST ORDER DECAY EQUATION

$$DDOCm = DDOCm_0 \bullet e^{-kt}$$

Where:

DDOCm = mass of degradable organic carbon that will decompose under anaerobic conditions in disposal site at time *t*

$DDOCm_0$ = mass of DDOC in the disposal site at time 0, when the reaction starts

k = decay rate constant in y^{-1}

t = time in years.

Substituting *t* =1 into Equation 3A1.2 shows that at the end of year 1 (the year after disposal), the amount of DDOCm remaining in the disposal site is:

EQUATION 3A1.3
DDOCM REMAINING AFTER 1 YEAR OF DECAY

$$\text{At } t = 1, \quad DDOCm = DDOCm_0 \bullet e^{-k}$$

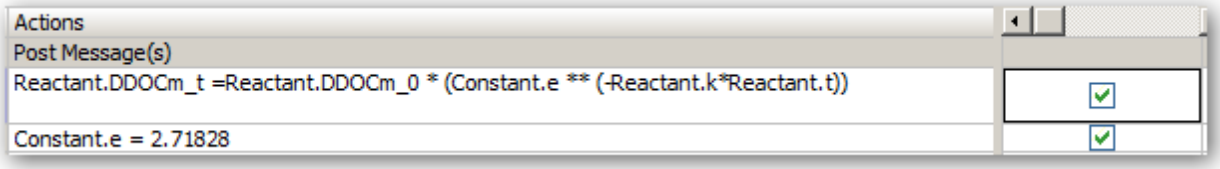
Sample Data

Note – at the end of year 1 the initial 100 will have decomposed to 90.5

TABLE 3A1.1
NEW FOD CALCULATING METHOD

year	DDOCm disposed	DDOCm accumulated	DDOCm decomposed
0	100	100	0
1	100	190.5	9.5
2	100	272.4	18.1
3	100	346.4	25.9
4	100	413.5	33.0
5	100	474.1	39.3
6	100	529.0	45.1

Equation 2A1.2 Expressed in Corticon



Result from Corticon = 90.48