DfRSoft Example 1 High Temperature Accelerated life Test

Here we will use the traditional Arrhenius model with a conservative estimate for the activation energy parameter in the model as a basis of providing an acceleration factor estimate. The model is described by

$A_T=Exp[(E_a / K_B)*(1/T_{stress} - 1/T_{use})]$

Notation:

T_{stress} =Test Temperature (^oK)

T_{use}=nominal use temperature (^oK)

E_a=activation energy: 0.7 eV

K_B = 8.616x10^{-5} eV/^{o}K (Boltzmann's constant)

$$A_T = Exp\left\{\frac{E_a}{K_B}\left[\frac{1}{T_{Use}} - \frac{1}{T_{Stress}}\right]\right\}$$

$$Ln(t_f) = C + \frac{E_a}{K_B T}$$

Notation

A_T=Temperature acceleration factor
T_{stress}=Test temperature (°K)
T_{use}=Use temperature (°K)
E_a=Activation energy
t_f= 8.6173x10^{-5}eV/°K(Boltzmann's
C=constant)

EXAMPLE: Using the HTOL Model

Estimate the test time to simulate 10 years of life in an HTOL test. The activation energies for the potential failure modes are unknown. Therefore, assume a conservative value of 0.7 eV for the activation energy. The device junction temperature rise is measured to be 15^{o}C above ambient. The test temperature is +110^{o}C and the nominal use temperature is +40^{o}C.

SOLUTION: Since the junction temperature rise is 15^{o}C, then the actual use and test temperatures are

T_{use}=15^{o}C + 40^{o}C = +55 ^{o}C

T_{Stress}=15 ^{o}C + 110^{o}C = +125 ^{o}C

From Figure 9.2, the acceleration factor is

A_T= Exp {(0.7 eV/8.6173x10^{-5} eV/^{o}K)×[1/(273.15+55) - 1/(273.15+125) ^{o}K]} = 77.6

From Equation 9.1, the test time to simulate 10 years of life (87,600 hours) is

Test Time=Life Time/A_T=87600/77.6=1,129 hours

Solution Using DfRSoft is Shown Below. Go to Work sheet Called "Acceleration Factors" use modules in Cell A8 area

Enter numbers in Green Area

ARRHENIUS TEMPERATURE ACCELERATION FACTOR MODEL

Enter Model Parameters	ENTER Value	Default Values	Results Failure Rates	RESULTS Time
Activation Energy	0.7	0.7 eV	At	Acceleration
Use Temp. (deg C)	55	85	125C	Factor
Stress Temp (Deg C)	125	150 C	FITs	(Unitless)
Failure Rate (FITs) at 55 C	100	MTTF=10000000	7765.845237	
No. Test Hours	1,129		MTTF=128769	77.65845237
Results implies test is equivalent to ---->		10.00872063	= Years in the field	

10 Year Equivalent

Acceleration Factor 77.66