



1. Purpose

There is a difficulty to predict the durability of materials because of the need to consider the many conditions needed to estimate its durability. Yet, we have to know a material's durability to use it. Degradation of materials is one of chemical reaction, so we can know its durability from heat degradation. Generally Arrhenius's method is used to estimate the durability of materials.

The relationship between speed of chemical reaction and temperature is shown as follows by S. A. Arrhenius in 1889.

$$K = A \exp(-E_a/RT) \dots\dots\dots (1)$$

K: velocity constant
 R: gas constant
 T: absolute temperature
 A: frequency factor
 E_a: activation energy

To estimate materials durability, expression (1) leads expression (2).

$$\ln(t) = E_a/(RT) + \text{const.} \dots\dots\dots (2) \quad t: \text{hours}$$

Expression (2) means, logarithm of time "t" proportional to (1/T). So, promoted test results at high temperature can estimate life of materials at normal condition. We choose half-life of material's elongation data to estimate durability of ADEKA ULTRASEAL® (CURED TYPE).

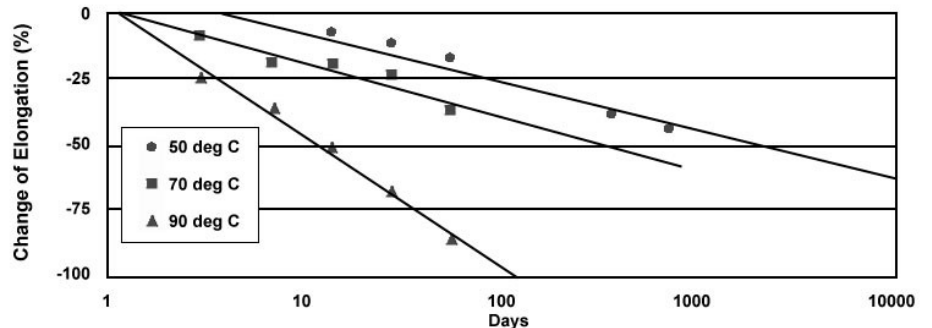
2. Promoted Degradation Test

Testing condition is shown at table 1.

Table 1) Testing Condition

| Test Item | Elongation |
|----------------|-------------------------|
| Temperature | 50, 70 and 90 degrees C |
| Predict Method | Half-life of elongation |
| Testing Method | JIS K 6251 |

Result—Fig. 1) Relationship between change of elongation and days



We can read half-life of elongation from Fig. 1) as follows, Expression (3) - (5) show approximate expression of change of elongation and days data.

$$y = -7.9349 \ln(x) + 10.58 \dots\dots\dots (3)$$

$$y = -8.8244 \ln(x) + 1.348 \dots\dots\dots (4)$$

$$y = -21.382 \ln(x) + 2.3709 \dots\dots\dots (5)$$

y: change of elongation
x: days

| Temperature—(Deg C) (Deg F) (K) | Days | t (hrs) |
|---------------------------------|-------|---------|
| 90/194/363 | 12 | 278 |
| 70/158/343 | 337 | 8,078 |
| 50/122/323 | 2,069 | 49,646 |

3. Predict of Material's Life

Expression (2) and Table 1 show relationship of ln (t) and 1/T as follows.

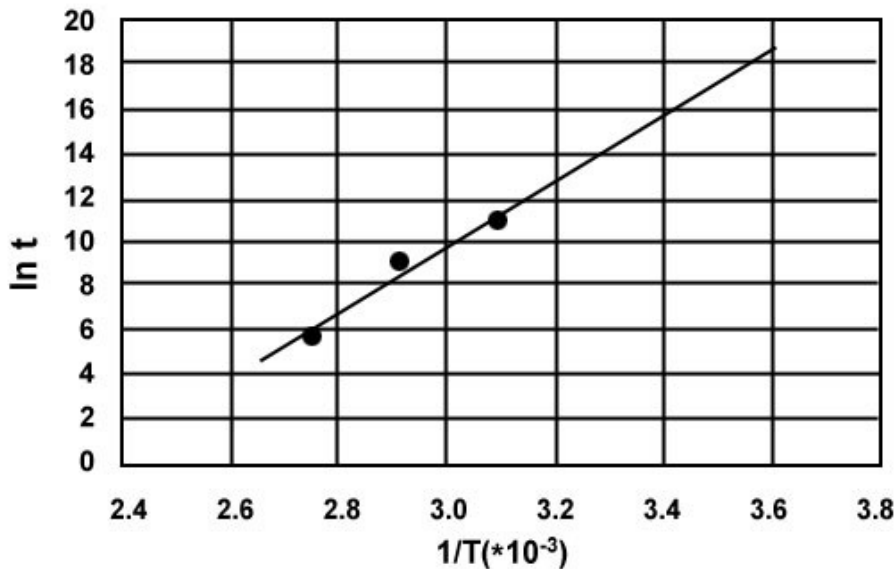


Fig. 2) Relationship between ln (t) and (1/T)

$$\ln (t) = 15.094 * (1/T) * 10^3 - 35.626 \dots\dots\dots (6)$$

Expression (6) leads durability of ADEKA ULTRASEAL® (CURED TYPE) at 20 - 30 degrees C as follows.

Table 2) Durability of ADEKA ULTRASEAL® (CURED TYPE)

| Temperature—(Deg C) (Deg F) (K) | Predicted Durability (years) |
|---------------------------------|------------------------------|
| 20/68/293 | 908 |
| 25/77/298 | 383 |
| 30/86/303 | 166 |

This predict method results degradation time at controlled conditions so the data does not estimate durability at actual condition. Materials are used in many kinds of conditions so its durability is different in many cases. But this durability data is useful to know that ADEKA ULTRASEAL® (CURED TYPE) has good degradation resistance ability.