OK biobased - C14 Dating method

Information Document 529 (EN) – 19.10

1. What is carbon dating?

Carbon dating determines the age of an object.
It is often used to estimate the age of archaeological finds (like bones).

2. What is C14?

The C in C14 (correct chemical notation is ^{14}C) is the chemical symbol for the carbon element. The 14 refers to the number of particles in the nucleus (6 protons and 8 neutrons). C14 is produced when cosmic rays enter the atmosphere and occurs naturally in a constant concentration of $1.2x10^{-12}$ %.

C14 is radio-active and loses neutrons during its radiation thus changing into nitrogen, with 7 protons and 7 neutrons in the nucleus.

3. What is the principle of C14-dating?

Both fossil and renewable raw materials consist mainly of carbon (C). Carbon occurs in several forms, called isotopes. Isotope C14 is radioactive and occurs naturally in all living organisms (plants, animals ...) in a fixed concentration of $1.2x10^{-12}$ %.
At this concentration, the (radio) activity level of C14 is 100%.

Once an organism is no longer living, this concentration, and thus the activity rate, decays with a half-life of 5700 years. The C14-activity of an unknown substance can therefore determine how old the organism is (or rather how long it has been dead).

4. Why is C14 suitable for carbon dating?

Because of the fixed percentage of C14 in living organisms

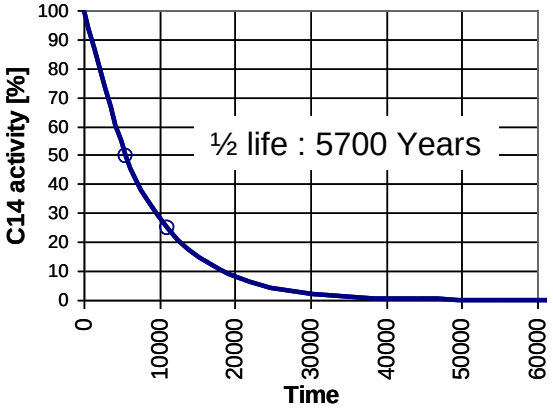
The atmosphere mainly contains carbon in the form of CO_2 molecules. Of all the CO_2 in the atmosphere, $1.2x10^{-12}$ % contains the isotope 14C.

Plants absorb CO_2 from the atmosphere during photosynthesis. Consequently, plants will have the same percentage of C14 as the atmosphere. Humans and animals take in carbon-14 by eating plants and they, in turn, also have the same percentage of C14 as the atmosphere.

Once an organism, whether plant, animal or human, dies, it takes in no more nutrients and therefore also no more C14.

All thanks to the half-life

C14 is an unstable radioactive isotope with a half life of about 5700 years. At the time of death, an organism has the same level of C14 as the atmosphere ($1.2x10^{-12}$ %), but as there is no longer any C14 intake, its percentage will be halved every 5700 years.



C14's fixed concentration of $1.2x10^{-12}$ % in the atmosphere can serve as a reference: at this concentration, the (radio) activity of C14 is 100%. After 5700 years, the activity is only 50% and after another 5700 years, only 25%. Fossil materials that have been around for millions of years will therefore show C14-activity of virtually 0%.

5. How is the C14-method applied to determine the percentage of renewable resources (% biobased)?

By determining the percentage of renewable materials (% bio-based) in an OK biobased product, we already know the age of the organic material.

- On the one side "young" carbon (0 to 10 years) derived from renewable raw materials (eg plants), with C14-activity of about 100%.
- On the other side "old" carbon (millions of years), derived from fossils with a C14 activity of about 0%.

We therefore don't use the C14 method to determine the age of the product (which would in fact be impossible because it is a mixture of different materials), but rather to determine the concentration of young (or renewable) materials in comparison with the concentration of old (or fossil) resources.

Example: If a product has a C14-activity of 80%, it means that the product consists of 80% renewable and 20% fossil carbon.