TECHNICAL REPORT
RAPPORT TECHNIQUE
TECHNISCHER BERICHT

CEN/TR 15591

February 2007

ICS 75.160.10

English Version

Solid recovered fuels - Determination of the biomass content based on the ^{14}C method

Combustibles solides de récupération - Détermination de la teneur en biomasse, basée sur la méthode du C^{14}

Feste Sekundärbrennstoffe - Bestimmung des Gehaltes an Biomasse nach de ^{14}C-Methode

This Technical Report was approved by CEN on 1 January 2007. It has been drawn up by the Technical Committee CEN/TC 343.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. CEN/TR 15591:2007: E

Contents

Page

Foreword ... 3
0 Introduction ... 4
1 Scope ... 7
2 Terms and definitions ... 7
3 Symbols and abbreviations ... 7
4 Methods of measurement ... 8
4.1 Principle ... 8
4.2 Sampling ... 8
4.3 Transport and storage ... 8
4.4 Preparation of the test portion from the laboratory sample ... 9
4.5 Analysis by Proportional Scintillation-counter Method (PSM) ... 9
4.6 Analysis by Β-ionisation (proportional gas counting) (BI) ... 10
4.7 Analysis by Accelerator Mass Spectrometry (AMS) ... 10
5 Equipment and reagents ... 10
5.1 For the preparation of the test portion ... 10
5.2 For the analysis by PSM ... 11
5.3 For the analysis by Β-ionisation (BI) ... 11
5.4 For analysis by AMS (example from Utrecht University) ... 11
6 Procedure ... 11
6.1 For sampling ... 11
6.2 For the preparation of the test portion ... 12
6.3 Procedure for analysis ... 13
7 Calculations ... 13
7.1 General ... 13
7.2 Calibration ... 14
7.3 Example for the calculation of a RDF sample analysed with PSM ... 15
8 Uncertainty of measurement (PMS and BI measurements) based in Poisson statistics ... 15
9 Strengths and weaknesses ... 16
9.1 Comparison of ^{14}C based methods with SDM ... 16
9.2 Comparison of PSM, Gas Counting (BI) and AMS ... 17
10 Legislative aspects ... 17
10.1 General ... 17
10.2 Austria ... 17
10.3 The Netherlands ... 17
10.4 Finland ... 18
11 Conclusions ... 18
Annex A (informative) Origin of expertise present in the technical report ... 19
Annex B (informative) List of European lab's with radio carbon expertise ... 22
Bibliography ... 33

Foreword

This document (CEN/TR 15591:2007) has been prepared by Technical Committee CEN/TC 343 "Solid recovered fuels", the secretariat of which is held by SFS.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

0 Introduction

0.1 General

This document has been prepared as a result of the CEN/TC 343/WG 3 meeting in Amsterdam in April 2005. It summarizes the state of the art in ^{14}C-based methods applied to determining the biomass content of SRF; as of yet no technical CEN standards for the application of ^{14}C-based methods to determine biomass content are available. The purpose of this Technical Report is to present the information available on this subject at this moment to assess if an extension of the available methods for determining the biomass content of SRF is required, wanted and technically possible.

Analytically proven standards exist for determining the biomass content of SRF by manual sorting and by selective dissolution (CEN/TS 15440 [1]). In the Netherlands these methods are available as NTA (National Technical Agreement) and have been in use for some years. Important advantages of these standards are their applicability using basic laboratory equipment and available personnel. However, they are not applicable to all kinds of solid recovered fuels. The manual sorting method fails if the constituents of the sample are shredded too finely, if they are strongly intertwined or compressed or if they cannot be recognized visually. The selective dissolution method fails if biomass constituents are present that do not dissolve, or fossil components that do. Both methods fall short if fossil and biomass carbon are mixed at the molecular level. ^{14}C based methods do not use chemical or morphological properties of the sample but physical properties of the carbon atoms themselves. Because ^{14}C based methods are based on these physical properties they avoid the problems of manual sorting and selective dissolution methods. On the other hand they need more instrumentation and skilled personnel. They are proposed here as an addition to the manual sorting and selective dissolution methods because they resolve analytical problems that are otherwise irresolvable.

The application of ^{14}C based methods for similar purposes are not new [2] [3]. In this document the information available in Europe and the USA concerning biomass carbon content determination in solid recovered fuels with ^{14}C based methods is presented to give the reader background information about possibilities and drawbacks of these methods.

0.2 Basis of the ^{14}C method

The ^{14}C method is a well-known method in global use, for determining the age of carbon containing matter. ^{14}C is a radioactive isotope; its presence in the air is a result of the interaction of cosmic radiation and the nitrogen in the atmosphere (see Figure 1). Fossil carbon contains no ^{14}C, however a trace amount of ^{14}C is present in living matter. The ^{14}C isotope is quickly converted to $^{14}CO_2$ after formation and enters living matter when atmospheric $^{14}CO_2$ is converted in the biosphere by photosynthesis to sugars and further converted to e.g. cellulose. The concentration of ^{14}C in air is considered constant all over the world. In living material the concentration of ^{14}C is stable and in equilibrium with the air concentration. In dead material the concentration of ^{14}C slowly diminishes to zero as the radioactive ^{14}C isotope decays. Measuring the amount of ^{14}C in solid recovered fuels is the basis for determining biomass content based on the ^{14}C method.

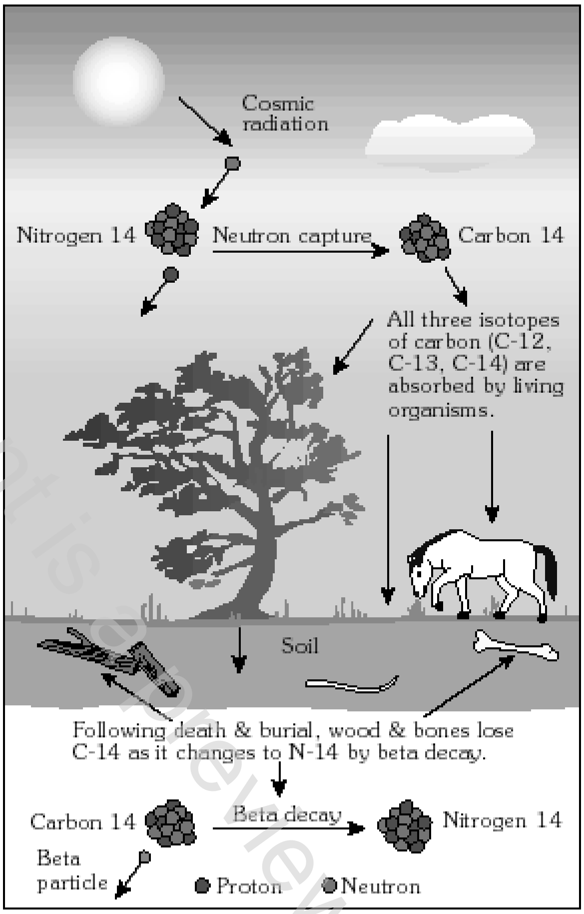

Figure 1 – Illustration of the basis of the ^{14}C method

Organic material is used for many purposes. One of the objectives is direct use as a fuel which is outside the scope of this report. However, after completing their primary use, many of these organic materials may ultimately be used in the form of solid recovered fuels.

Examples of organic materials in solid recovered fuels are:

— Packaging materials;

— Paper;

— Wood used in buildings;

— Kitchen waste;

— Waste (dung and offal) from the bio industry;

— Plastics;

— Car tires.

Carbon present in material produced by living organisms, immobilized as fuel in present times is called biomass. Carbon present in material produced by living organisms immobilized as fuel in a past geological era is called fossil fuel. The difference between the two is that CO_2 from biomass or biomass origin does not contribute to a higher concentration of CO_2 in the atmosphere as its carbon has been recently extracted from the atmosphere.

In solid recovered fuels, the combustible carbon originates from fossil (mainly in the form of plastics), mixed sources like rubber tyres and packaging materials, and from biomass origin (e.g. wood, paper). Authorities require that emissions of CO_2 from fossil origin by companies is made known, thus, in order to determine these companies, knowledge about the biomass content by total carbon content of mixed fuels should be acquired. For this reason, methods such as the solid dissolution method and ^{14}C method were developed.

International acceptance of a ^{14}C based method can be expected, as can be illustrated by the recent publication of ASTM, ASTM D 6866-05, Standard Test Method for determining the Bio based Content of Natural Range Materials Using Radiocarbon and Isotope Ratio Mass Spectrometry Analysis [2].

1 Scope

This Technical Report gives an overview of the suitability of ^{14}C-based methods for the determination of the fraction of biomass carbon in solid recovered fuels, using detection by scintillation, gas ionization and mass spectrometry.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
biodegradable carbon
mass fraction of the total carbon that is capable of undergoing biological anaerobic or aerobic decomposition under conditions naturally occurring in the biosphere

2.2
biogenic carbon
mass fraction of total carbon that was produced in natural processes by living organisms but not fossilized or derived from fossil resources

2.3
biomass carbon
equivalent to biogenic carbon

2.4
isotope abundance
fraction of atoms of a particular isotope of an element

2.5
repeatability
extent of the agreement between the results of subsequent measurements of the same quantity, performed under the same measuring conditions

2.6
reproducibility
extent of the agreement between the results of measurements of the same quantity, performed under variable measuring conditions.

3 Symbols and abbreviations

This Technical Report uses the following symbols and abbreviations:

^{14}C	Carbon isotope with an atomic mass of 14
AMS	Accelerator Mass Spectrometry
β	Beta particle, electron emitted during radioactive decay
BI	Beta Ionisation