TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 15716

June 2008

ICS 75.160.10

English Version

Solid recovered fuels - Determination of combustion behaviour

Combustibles solides de récupération - Détermination du comportement de la combustion

Feste Sekundärbrennstoffe - Bestimmung des Verbrennungsverhaltens

This Technical Report was approved by CEN on 21 January 2008. 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 15716:2008: E

Contents

Page

Foreword

This document (CEN/TR 15716:2008) 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.

Introduction

Historically, SRF goes back to the oil crises approximately 30 years ago, when refused derived fuel (RDF) was promoted as a substitute low cost fuel. Contrary to that situation, the producers of SRF took the initiative for the implementation of a quality system to meet and guarantee specified fuel classification and specification parameters. Quality systems to check their production now exist in several EU member states and efforts are being made by CEN/TC 343 to develop European Standards for SRF [1].

The production and thermal utilisation (energy recovery) of Solid Recovered Fuels (SRF) from bio wastes, residues, mixed- and mono waste streams have significant relevance as a key component of an integrated waste management concept.

The implementation of SRF production in an integrated waste management concept demands a potential market for these products. Known proven markets are found in the European energy sector and in other more product-oriented sectors like cement or lime industry by substitution of fossil fuels. The capacities for co-utilisation of these products, to include utilisation in minor thermal shares, are enormous, especially in the new European member states as most of the energy production of these countries relies on fossil fuels.

A successful application of solid recovered fuel in power plants and industrial furnaces would require a thorough understanding of the fuel properties which include the combustion behaviour, emission potential, impact on facility etc. The determination of combustion behaviour which is the main focus of this document seeks to outline possible methods and procedures that can be adopted to analyse any given solid recovered fuel. An approach has therefore been outlined where the determination of combustion behaviour is categorised into four groups which combine to give a holistic impression of the combustion progress of SRF in both mono and co-firing systems (see Figure 1).

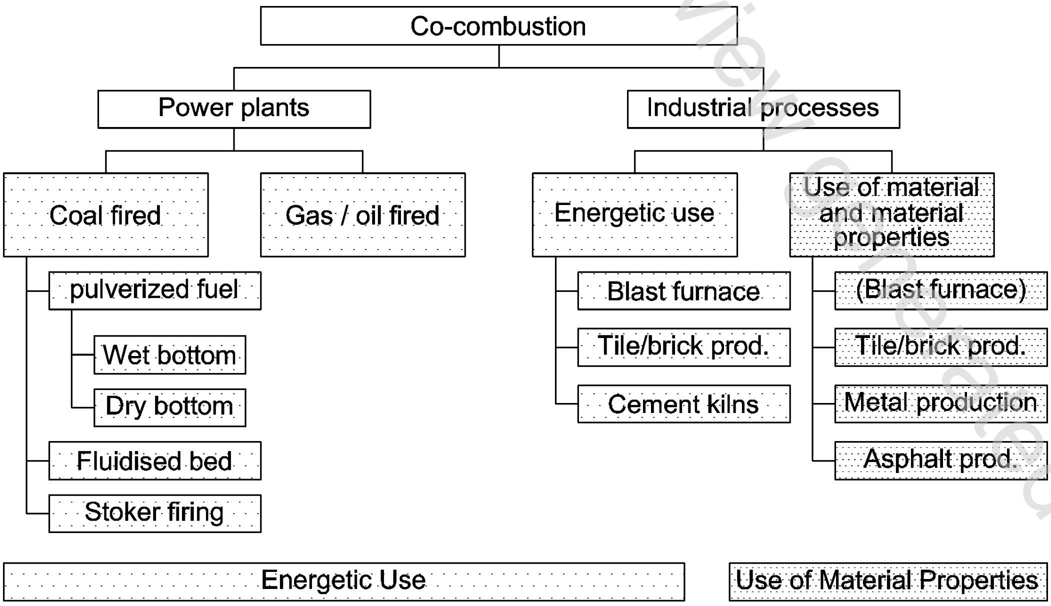


Figure 1 — Scheme to determine combustion behaviour of SRF

While there are standardised methods, such as from the American Society for Testing and Materials (ASTM) and the German Institute for Standardization (DIN Deutsches Institut für Normung e. V.), for determining combustion behaviour for primary fuels (e.g. coal), the process is not the same for SRF. At present, there are no standardised methods for SRF. Most of the available methods are in-house, usually designed for particular types of SRF, e.g. waste, or bio-residue fractions to suit a specific combustion system like grate firing, fluidised bed, pulverised fuel system, and cement kiln. Figure 2 gives an overview about the broad variety of

SRF utilisation routes using an example of co-combustion in power plants and industrial furnaces. Co-combustion also includes indirect co-firing systems such as gasification (Lahti, Zeltweg) and pyrolysis (ConTherm). While the environmental aspect of the thermal utilisation of SRF is very important, this report focuses only on the combustion aspect.

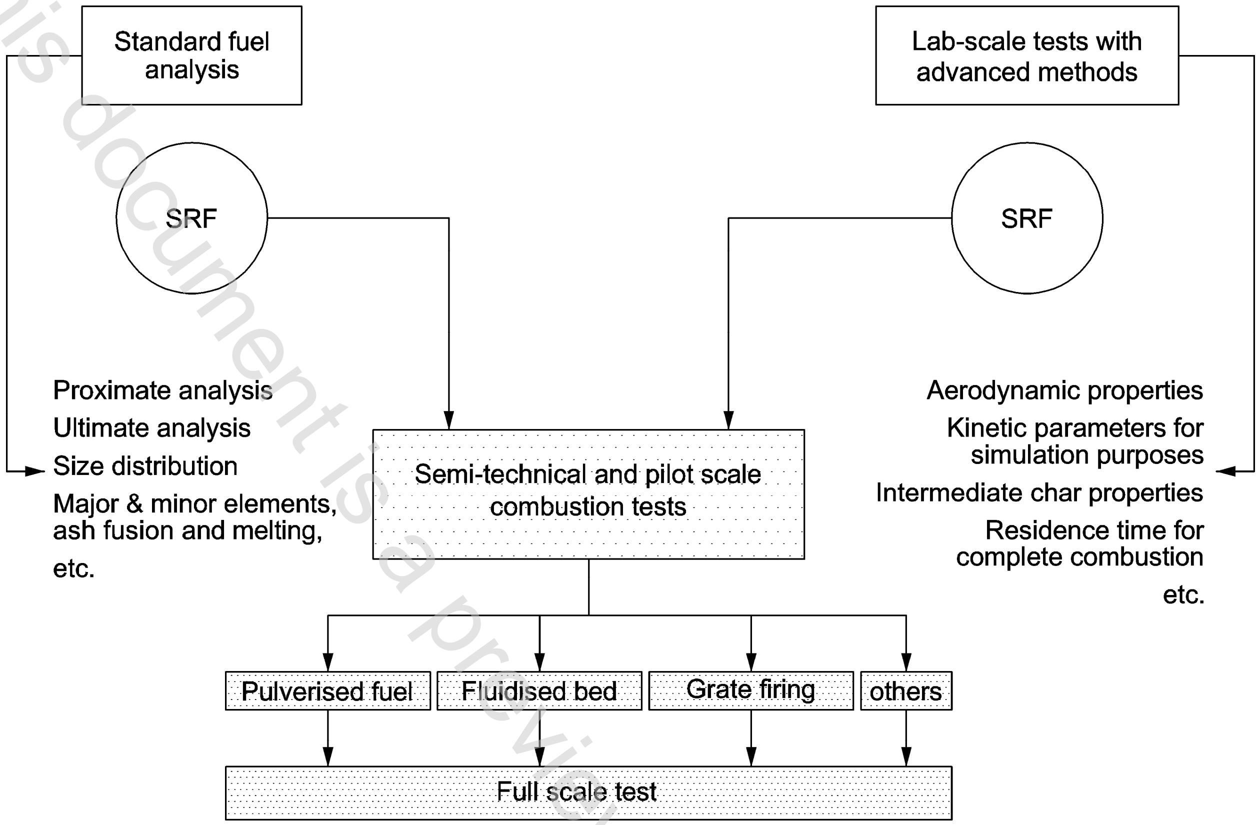


Figure 2 — SRF utilisation routes

Solid recovered fuel can be made of any combustible non-hazardous waste and processed to a quality that allows to classify it in accordance with CEN/TS 15359 and which fulfils specifications as agreed with the customer. Considering this, the main problem becomes obvious: How to define reliable methods to describe the combustion behaviour of solid fuels such as SRF, valid for all possible types of input material and combustion systems? A systematic approach adopted herein to determine combustion behaviour is outlined in Figure 1. It is grouped into four categories:

— standard fuel analysis;

— laboratory-scale tests with advanced methods;

— semi-technical and pilot-scale combustion tests;

— full-scale test.

In general, such a four-step procedure is an effective way to successfully integrate a new fuel in an existing power plant or an industrial furnace. In any case, full scale tests are the most reliable but very expensive with several bottlenecks (e.g. retrofits, permits, time, etc.) and that is the reason for the need to develop and standardise methods which are reliable, fast, and not expensive according to the various firing systems are essential. Besides the evaluation of parameters concerning combustion behaviour, the steps before full scale implementation also forms substantial basis to reliably evaluate other areas of major interest such as grinding and fuel feeding; slagging, fouling and corrosion; and lastly emissions and residues. The systematic evaluation of these additional topics requires area specific analyses, tests, and measurements.

Concerning combustion behaviour, the standard analysis of the SRF will determine the basic parameters about the combustible and incombustible matter. The amount of energy, the contents of water, volatiles, fixed-carbon, ash, and particle size will roughly dictate the type of the combustion system that is best suited. In addition to the standard analysis, a selected combustion system might require an advanced parameter analysis, if possible, with a close relation to case specific process parameters. Such a correlation will substantially enhance the reliability of transfer studies. An example, in the case of a pulverised firing system, is the maximum particle size required for a complete combustion in order to avoid fuel plummeting into the bottom ash.

Currently, the activities towards the combustion behaviour of SRF rely largely on standard analysis and laboratory-scale tests, which were originally developed with certain limitations and applicable to solid fuels such as lignite and hard coal. A common problem of these methods is that parameters related to SRF during combustion are not sufficiently covered. These methods make sure consistent quality of the SRF supply rather than to predict combustion performance. Therefore, the development of the so-called advanced test methods to fill the gap and amending existing test apparatus and measurement conditions is required.

The driving force to introduce SRF rests much on economic factors. In most cases, the end user will be either the operator of a power plant or an industrial furnace. The primary focus will be an unrestricted and reliable operation of the facility. One wants to assess the possible risks and dangers. In case of retrofits, the end user needs to calculate the required cost on modifications and operation. It can be assumed that due to possible operational risks such as corrosion, the plant operators will select the fuel with the most appropriate qualities. Such requirements are needed tools to control the quality of the SRF and to deliver them according to specification. As such, the knowledge of the combustion behaviour is an essential aspect for the commercialisation of SRF. It will allow the optimisation of the process and the assessment of possible risks and dangers prior to full-scale application.

Some methods and parameters will be introduced in the subsequent sections, but whatever methods are to be used in the future should be orientated towards the following aspects:

— reproducibility;

— repeatability;

— reliability;

— time efforts (rapid test methods);

— cost effectiveness;

— possibilities for automatic testing.

The authors summarise and refer to past and current activities trying to describe combustion behaviour of SRF. The idea is to identify a common and successful practice where various approaches converge.

1 Scope

This Technical Report gives a review on determination methods for exploring how different SRFs behave in different combustion systems, e.g. with respect to time for ignition, time for gas phase burning and time for char burn out, including information on technical aspects like slagging and fouling, corrosion as well as required flue gas cleaning for meeting the emission limit values induced by the Waste Incineration Directive (WID).

2 Combustion of solid fuels

2.1 Basis of solid fuel combustion

Combustion of fuels shall be considered both from theoretical and practical perspectives. The former can define combustion as the rapid chemical reaction of oxygen with the combustible elements of a fuel. While the later where the engineer is concerned with boiler design and performance might define combustion as the chemical union of fuel combustibles and the oxygen of the air, controlled at a rate that produces useful heat energy. The two definitions implicitly consider many key factors. For complete combustion within a furnace, four basic criteria shall be satisfied:

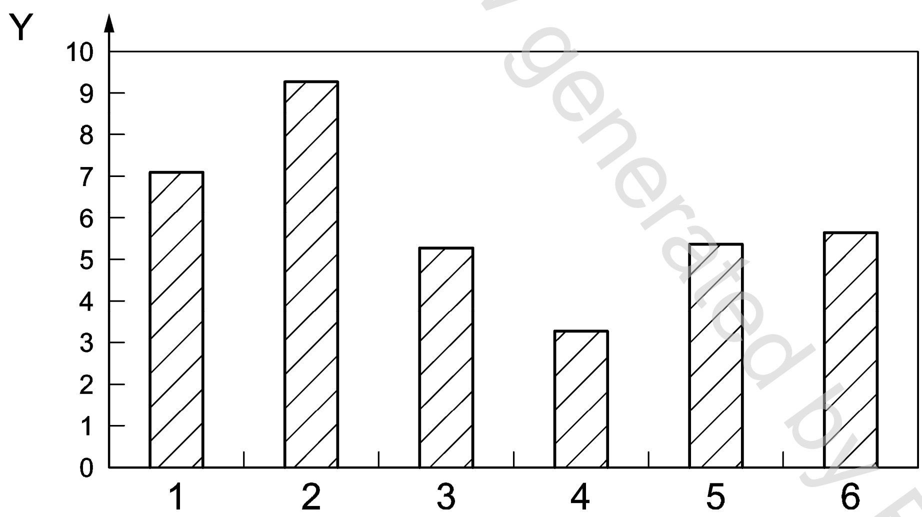
1) adequate quantity of air (oxygen) supplied to the fuel;

2) oxygen and fuel thoroughly mixed (turbulence);

3) fuel-air mixture maintained at or above the ignition temperature;

4) furnace volume large enough to give the mixture time for complete combustion.

Quantities of combustible constituents within the fuel vary by types. Figure 3 shows the significant change in the combustion air requirements for various fuels, resulting from changes in fuel composition. It illustrates the minimum combustion air theoretically required to support complete combustion.



Key

Y Stochiometric air demand in nominal cubic meter dry air per kilogram fuel

Figure 3 —Stoichiometric air to fuel ratio for some SRFs