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English Version

Biomass gasification - Tar and particles in product gases - Sampling and analysis

Gazéification de biomasse - Goudron et particules dans les
gaz produits - Échantillonnage et analyse

Biomassevergasung - Teer und Staub in Produktgasen -
Probenahme und analytische Bestimmung

This Technical Specification (CEN/TS) was approved by CEN on 21 February 2006 for provisional application.

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Foreword

This Technical Specification (CEN/TS 15439:2006) has been prepared by Working Group CEN/BT/TF 143 “Measurement of organic contaminants (tar) in biomass producer gases”, the secretariat of which is held by NEN.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this CEN Technical Specification: Austria, Belgium, 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.

Introduction

The main contaminants in the product gases of biomass gasification are dust and soot particles, tars, alkali metals, acid gases and alkaline gases. Measuring techniques for these contaminants allow determination of the functioning of the gasifier itself, of the efficiency of the gas cleaning process and of the quality of the cleaned gas to be used in, for instance, a gas engine or gas turbine.

The development of this Technical Specification started out of the need for a reliable method for the measurement of tars. For most contaminants in product gases of biomass gasification, well-developed measurement techniques exist that are similar to techniques used for related technologies, such as coal combustion and coal gasification. For tars, however, no well-developed and widely used measurement techniques existed in these related technology fields. As some of the tars were (and are) seen as the major problem causing contaminants in biomass gasification, manufacturers and other workers in this field used a number of different sampling and analysis methods to determine the level of tars. As a result, comparison of data and definition of clear maximum allowable concentrations for tars was problematic. This formed an obstacle for market introduction of biomass gasification systems, as tars can cause damage or require an unacceptable level of maintenance.

This Technical Specification gives methods for sampling and analysis of tars and particles in product gases from biomass gasifiers operating under atmospheric or pressurised conditions. The sampling and analysis methods in this Technical Specification differ from most of the methods used for sampling organic compounds present in the gaseous emissions from various industrial processes such as flue gases or automobile exhaust gases. The differences are related to the fact that the levels of the organic compounds present in the gasification product gases exceed the levels found in flue gases generally by more than three orders of magnitude. Hence the methods described in this Technical Specification are not intended to be applicable for sampling organic compounds in trace concentrations (sub-ppm range).

The tar-containing biomass gasification product gas is formed by thermal decomposition of biomass at sub stoichiometric conditions (pyrolysis, gasification) and is typically used to produce electricity, heat, or gaseous or liquid biofuels. As tars from pyrolysis or gasification of coal are similar in nature compared to (high temperature) biomass gasification tars, coal tars can also be sampled and analysed with this Technical Specification.

Biomass in this Technical Specification is defined as material of biological origin excluding material embedded in geological formations and transformed to fossil¹⁾. The Technical Specification is developed for uncontaminated biomass, a term being defined in Clause 3 "Terms and definitions". Tests on accuracy and repeatability of the Technical Specification have been performed with uncontaminated biomass. The Technical Specification may also be used for tars produced from gasification of contaminated biomass and for tars produced from gasification of fossil fuels, however, in this case it is up to the user to assess to what extent the concentration and composition of the tars differ from gasification of uncontaminated biomass. Biomass gasifiers, as referred to in this Technical Specification, can be updraft fixed bed gasifiers, downdraft fixed bed gasifiers, stage divided gasifiers, fluidised bed gasifiers, entrained flow gasifiers and other types of gasifiers. Updraft and downdraft fixed bed, fluidised bed and entrained flow gasifiers are described in more detail in a background Technical Report [1].

¹⁾ This definition is the same as the definition of biomass in CEN TC 335 Solid Biofuels

1 Scope

This Technical Specification gives methods for sampling and analysis of tars and particles in order to determine the load of these contaminants in flowing biomass gasification product gases. The Technical Specification is applicable to sampling and analysis of tars and particles in the concentration range typically from 1 mg/m³ to 300 g/m³ (tars) and from 20 mg/m³ to 30 g/m³ (particles) at all relevant sampling point conditions (0 °C to 900 °C and 60 kPa to 6000 kPa (0,6 bar to 60 bar))²⁾,³⁾. Particle concentrations lower than 20 mg/m³ are outside the scope of this Technical Specification and can be measured according to EN 13284-1.

Application of this Technical Specification allows determination of five different parameters:

- A. The concentration of gravimetric tar in mg/m³;
- B. The concentration of individual organic compounds in mg/m³. This Technical Specification gives data on repeatability and reproducibility for the compounds listed in Annex B. The Technical Specification is also applicable for other organic compounds (e.g. those mentioned in Annex A), but repeatability and reproducibility have not been assessed for compounds other than those in Annex B;
- C. The sum of concentrations of identified GC-detectable compounds listed in Annex B;
- D. The sum of concentrations of all GC-detectable compounds with retention times in the range of benzene to coronene calculated as naphthalene (benzene excluded), given that this sum of concentrations can be determined.
- E. The concentration of particles in mg/m³.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9096	<i>Stationary source emissions – Manual determination of mass concentration of particulate matter</i>
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3 Terms and definitions

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

3.1

aerosol

suspension of solid or liquid particles in a gas

NOTE The term aerosol includes both the particles and the suspending gas. The particle size may range from about 0,002 µm to more than 100 µm.

3.2

biomass

material of biological origin, excluding material embedded in geological formations and transformed to fossil

NOTE This definition is the same as the definition of biomass in CEN TC 335 Solid Biofuels [7].

²⁾ In fact it is not correct to give a concentration or to give concentration ranges for "tar" (see also its definition in Clause 3). This Technical Specification is designed and has been evaluated for measurement of tar and particles in the following concentration ranges:

Gravimetric tar	500 mg/m ³ to 300 g/m ³
Sum of GC-detectable tars	1 mg/m ³ to 300 g/m ³
Particles	20 mg/m ³ to 30 g/m ³

The concentration range mentioned for gravimetric tar is a range based on a sampling time of 2 h. Lower concentration limits can be attained with proportionally longer sampling times (e.g. 100 mg/m³ with a sampling time of 10 h). Due to the determination method, it is recommended not to determine gravimetric tar below the concentration limit.

³⁾ The performance characteristics in Clause 14 are determined under atmospheric conditions. Under pressurised conditions, the Technical Specification as a whole has not been evaluated. However, sampling under pressurised conditions is based on relevant experience (relevant construction details of probes are mentioned in a background document [1]) and the analysis of the liquid samples is identical for atmospheric and pressurised gasification. Therefore, pressurised conditions are included in this Technical Specification.