

European parallel Tar Measurement and the latest Experience from R&D Projects for the Support of a new Tar Measurement Guideline

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Introduction

Thermal conversion of biomass generates a combustible gas which contains more or less solid and liquid contaminants in the shape of dust (ash, soot) and organic compounds (tars). Both types of contaminants are unwanted since they do harm to the environment, to the health of living beings and to engines which could be connected to the gasification process. For most contaminants, including dust, well-developed and well-tried measurement techniques exist, but not regarding sticky substances such as tar or the combination of tar and dust. Various laboratories and workers in the field of biomass gasification have developed their own measurement methods which are hardly comparable, because even the expression “tar” has different definitions. In order to promote the use of a renewable energy source for co production of heat and power based on biomass gasification, it is necessary to develop an undoubted measurement method to be able to describe the impurities in producer gas.

On this background the members of the Gasification Task of the IEA Bioenergy Agreement, the US DoE and the DGXVII of the European Commission took the initiative to develop a Tar Protocol. At a joint meeting in Brussels in March 1998 it was decided to develop two sampling and analysis protocols. One for the use on small-scale, fixed bed, engine based systems and the other for large-scale plants. The two draft protocols were presented at the 10th European Biomass Conference in Wuerzburg. Here it was also decided to test some frequently used measurement methods against each other.

The parallel measurement of tar and particulates in Denmark

The Danish Energy Agency took the initiative to carry out a parallel test of different tar measurement methods. The project aimed at a better understanding of the applicability of various measurement methods for different types of gasifiers and to show the comparability of the measurement results. The project was funded by national funds from Denmark, Switzerland and The Netherlands. The following laboratories participated in the test:

- ?? BTG Biomass Technology Group, The Netherlands
- ?? Danish Technological Institute, Denmark
- ?? Verenum Research, Switzerland
- ?? Technical Research Centre of Finland (VTT), Finland

The tests were carried out in November 1998 on a 5 MW updraft gasifier and a 1 MW downdraft gasifier. The samples were taken closely to each other so that uniform sampling conditions could be expected. As far as possible, the samples were taken simultaneously. The four participating laboratories used their own methods and measurement equipment both during sampling and during the analysis.

In general, gravimetric principles were used to measure dust and “heavy tar” and gaschromatography were used to determine the amount of “light tar”. The results of the parallel measurement indicate that the concept “heavy tar” and “light tar” require a more exact definition. Disagreement was most conspicuous in connection with gravimetric measurement methods and among results from the updraft gasifier. Various conditions of evaporation have resulted in various data for “heavy tar”. But in general there was good agreement between the determined concentrations of individual tar compounds in the “light tar” except the lightest compounds such as benzene and toluene.

Measurement of particulates: In the updraft raw gas between 150 and 8260 mg/Nm³ of particulates were found. It is obvious that there are two interpretations of the “dust

content” in the raw gas and they are one order of magnitude from each other. A possible reason for this disagreement could be that the high values contain tar that sticks to the particulates. Danish Technological Institute heats the collected particulates to 450 °C in an inert atmosphere (at which temperature all tar evaporates or decomposes) to ensure that the dust measurement does not contain tar. In the cleaned gas the same disagreement appeared. DTI measured from 16 to 44 mg/Nm³. BTG and Verenum found from 172 to 316 mg/Nm³.

The dust measurements on the down draft gasifier show greater agreement although the differing results are still unacceptable. In the raw gas measurements range from 510 mg/Nm³ to 1146 mg/Nm³. The reason why the dust measurement results are more uniform when sampled on a downdraft gasifier is because less tar sticks to the particulates on this type of gasifier.

Heavy tar measurements: There is compliance between the measurements of the 3 laboratories. The measurements of DTI are factor 2 above the other measurements. The reason is obviously different evaporation methods.

- ?? BTG evaporates at 105 °C until the weight change is minimal.
- ?? Verenum evaporates over a heated water bath at 85 °C and vacuum at 10-20 mbar until visible smoke formation appears.
- ?? VTT evaporates at 105 °C for 1 hour.
- ?? DTI evaporates with rotating evaporator at 25 °C and vacuum at 200 mbar.

Naturally, this leads to varying results.

The measurements on the downdraft gasifier show totally different results. VTT did not measure heavy tar on this type of gasifier so only measurements from 3 laboratories are available. Verenum and DTI carried out measurements in the raw gas in the same order of magnitude. BTG’s results are with 6 and 10 g/Nm³ one factor 3 and one factor 20, respectively, above Verenums and DTI’s results. In the cleaned gas the same disagreement was found.

Light tar measurements: There is compliance between the GC results of specific compounds. However, the sum of the light tars cannot be compared as the laboratories use different definitions.

R&D activities for the support of a new Tar Protocol

As it appears from the above, some improvements are still required both regarding the design of the sampling train and the methodology. Based on the experience of this parallel test and two earlier draft protocols (developed on the initiative of IEA, EU and US-DoE) it was decided to develop one Tar Protocol. Currently the European Commission has accepted a proposal on development of this Protocol under the 5th Framework Programme. The Protocol will be optimised by means of a review round by a group of experts and through R&D activities carried out parallel to the EU project.

The four participants in the parallel measurement project are carrying out national R&D projects in order to eliminate the weak spots of the measurement method and to find a more environmentally friendly solvent than DCM, which previously has been applied in the majority of the used measurement methods. DTI has examined methoxypropanol, isopropanol, ethanol with DCM as a reference solvent in a large series of measurements in the updraft gas. The results of this examination which are being terminated at the moment will be presented at the conference. Furthermore, recently developed sampling equipment will be mentioned together with tests regarding sampling of tar at solid adsorbents. Currently the work regarding the latter is on-going.