THE ANALYSIS OF ETHANOL IN SHREDDER GASES

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Abstract

It has been established that post harvest deterioration of burnt cane results in the formation of ethanol. In South Africa the ethanol content of cane, as sampled through the Direct Analysis of Cane (DAC), is measured at factories. A procedure involving the continuous sampling and automated analysis of shredder gases is proposed in this short communication. Preliminary results show that the method can estimate the ethanol concentrations in cane consignments, but that the presence of moisture in the gases causes problems. Procedures to clean the gases are required.

Keywords: ethanol, cane deterioration, shredder gases

Introduction

In South Africa the deterioration of burnt cane and the resulting formation of ethanol have been investigated by Lionnet (1986), Lionnet and Pillay (1987, 1988) and by Cox and Sahadeo (1992). As a result of these investigations a number of factories measure ethanol concentrations in the incoming cane by analysing the DAC extracts. The results can then be related to specific cane consignments. Although the method works well, it depends on the availability of the DAC extract since all the consignments are not sampled routinely. Secondly, the extracts are not always analysed immediately and thus need to be labelled, preserved by freezing and stored before analysis by gas chromatography. The results are thus not available immediately for all the consignments.

The possibility of on line sampling and analysis of shredder gases was seen as an attractive solution. The main objectives were to sample all the consignments and measure the ethanol concentration in the gas within a few minutes.

Pilot plant tests

A gas detector/analyser was obtained from a commercial firm specialising in this type of equipment. It was modified to react to ethanol and calibrated to display the ethanol concentration of the gas in ppm. Fresh cane (about 4 kg) was shredded in a Waddell shredder, at the Sugar Milling Research Institute, and the shredder gases fed into the apparatus. A reading of 0 was produced. The shredder was stopped and opened; about 0,5 cm^3 of ethanol was added to the shredded cane, using a syringe and shredding started again. The gas analyser showed a reading of 40. The shredder was cleaned and burnt, deteriorated cane shredded. The gas showed a reading of 540 units on the analyser.

A calibration test was then carried out. Clean fresh cane was sub-sampled and each sub-sample shredded in the Waddell shredder with varying amounts of ethanol added. The gas analyser readings were taken when stable, which required about 3 minutes of shredding. The cane was then removed and analysed by the DAC procedures; an ethanol determination was also done on the extract. The results obtained are shown in Figure 1.

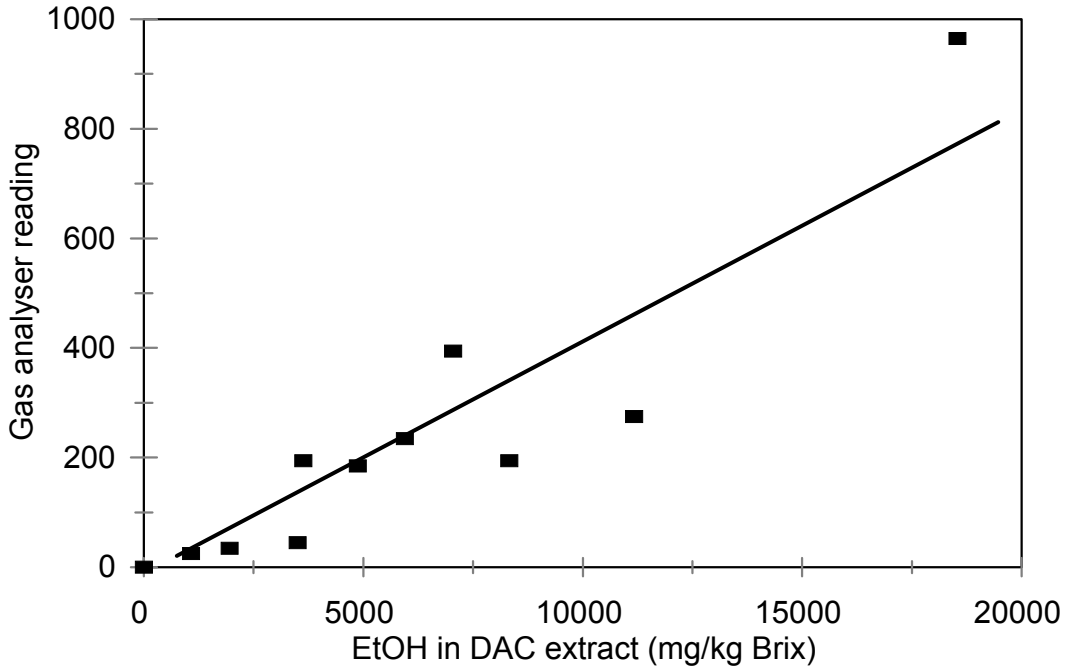

Figure 1. The relation between analyser reading and ethanol in extract

These results show that the gas detector can estimate ethanol in the cane over a range of 0 to about 20 000 mg per kg Brix. The precision could probably be improved if a temperature correction is included.

Tests on an industrial shredder

The equipment was installed to sample and analyse the gases from an industrial shredder. The results obtained on the first day of operation are in Figures 2 and 3.

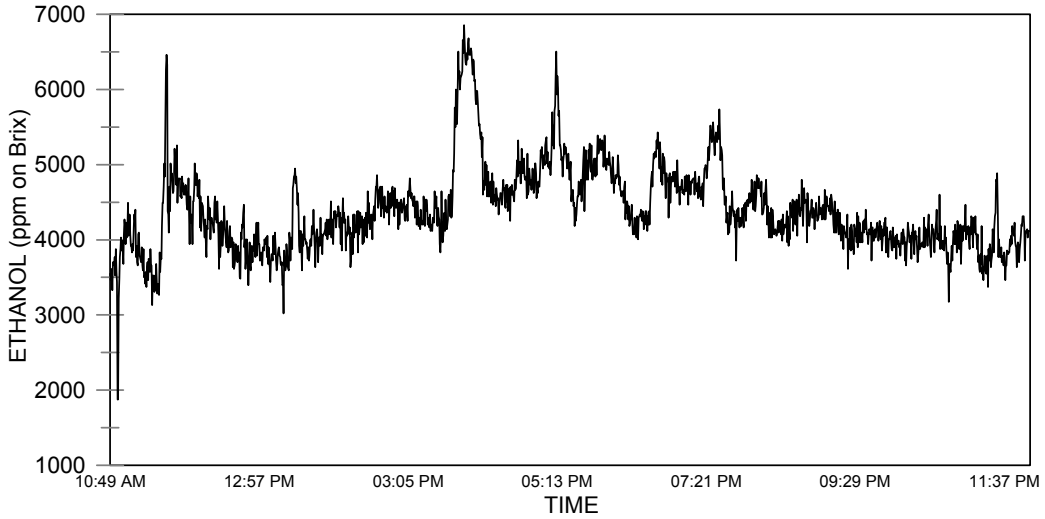

Figure 2. Actual readings from the gas analyser fitted to an industrial shredder

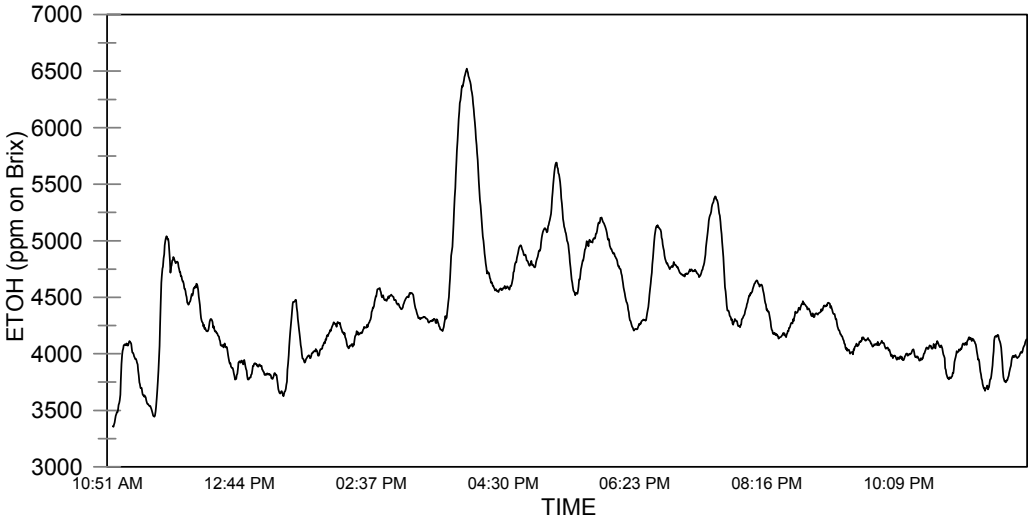

Figure 3. The readings from Figure 2 as a moving average

The results in Figures 2 and 3 show that the equipment is capable of sampling and analysing the shredder gas to estimate the ethanol concentrations in each cane consignment. The moving average procedure was selected to correspond to the average crushing time for a consignment which was about 6 minutes at that factory. The conversion of analyser reading to the concentration of ethanol in mg per kg Brix was based on the results obtained at the SMRI, as shown in Figure 1, and are thus very approximate. It would be possible however to establish a correlation at the factory by sampling and analysing the shredded cane being tested by the equipment.

The equipment worked well for relatively short periods of time, but was seriously affected when moisture accumulated in the sampling tubing and in the analysis chamber of the detector. The readings were then meaningless as the detector was now seeing an ethanol/water mixture which was not representative of the gas sample. Various cleaning procedures were investigated but none could be found to solve the problem before the 2001 / 2002 crushing season ended. This work will continue in the next season.

Other developments

The gas analyser used here is clearly capable of detecting and quantifying ethanol concentrations in burnt, deteriorated cane. It should be possible to modify the system to measure ethanol levels in loose or bundled wholestalk cane in vehicles, before the weighbridge. Some type of core sampling device would be needed to penetrate the cane mass, break the stalks and extract the gases surrounding the corer.

Acknowledgements

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