Calibration of Evidential Breath Analyser for South African Law Enforcement

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Introduction

- Breathalysers are devices that measure alcohol content absorbed from the mouth, throat, stomach and lungs through exhaled breath.
- Breathalysers were introduced to South Africa in 1997.
- Used by the law enforcement of South Africa to monitor drinking and driving on the roads.
- NMISA’s mandate to establish national measurement standards.
Introduction continued

- Calibration is guided by the SANS 1793:2013 which is an adoption of International Organisation of Legal Metrology OIML R 126 “Evidential breath analysers”
Objective of EBA

- Legal limit for breath alcohol content:
  - 0.24 mg/L for licenced drivers
  - 0.1 mg/L for professional drivers
Apparatus

Nitrogen gas cylinder

Evidential breath analyser

Water bath

simulator

Temperature probe

Certified reference material
Certified Reference Material

Certificate is accepted by South African courts

Gravimetrically prepared by NMISA certified using potassium dichromate oxidative titrimetric method

NMISA ISO 17025 and ISO Guide 34 accredited

Certificate is accepted by South African courts
Traceability

SI unit (kg)

Ethanol CRM

EBA calibration

Field Measurement
Calibration of EBA

Calibration is guided by the use of SANS 1793:2013

Calibration is done using certified reference materials of ethanol solution

Breathalysers are calibrated at concentrations 0 mg/L, 0.1 mg/L, 0.24 mg/L and 0.8 mg/L of ethanol solution

Ten measurements are taken at each concentration to determine the repeatability of the instrument
Flow dry gas through known concentration of ethanol solution

Gas bubbles produces known concentration of wet gas

Wet gas is fed into the EBA

EBA identifies and gives a read out of the observed concentration through the sensors

The results are compared to the SANS specifications

**Dubowski equation:**

\[
C_{\text{air}} = 0.04145 \times 10^{-8} \times \exp(0.06583t)
\]

where \( t \) is the temperature in °C

\[
C_{\text{air}} = 0.3886 \times 10^{-8} \text{CH}_2\text{O}
\]
Calibration of EBA

- Standard deviation of all mass concentration shall be less than or equal to one third of the maximum permissible error.
- Maximum permissible errors for calibration are as follows:
  a) 0,02 mg/L for all mass concentrations less than 0,4 mg/L
  b) 5% of the measurand concentrations less than 0,4 mg/L, and less than or equal to 2,0 mg/L
  c) 20% of the measurand concentration for all mass concentration greater than 2,0 mg/L

SANS 1793:2013 Specifications
Important calibration factors

- Accuracy
- Repeatability
- Accuracy of temperature sensor
Repeatability results for both sensors

method validation standard deviations < SANS Specifications
# Accuracy

Comparison of concentration averages and SANS specifications.

<table>
<thead>
<tr>
<th>Concentration (mg/L)</th>
<th>Average from repeatability results</th>
<th>SANS Specifications (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IR Sensor</td>
<td>EC Sensor</td>
</tr>
<tr>
<td>0.100</td>
<td>0.097</td>
<td>0.108</td>
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<td>0.151</td>
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<td>0.241</td>
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<td>1.008</td>
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<tr>
<td>1.510</td>
<td>1.520</td>
<td>1.462</td>
</tr>
<tr>
<td>2.004</td>
<td>2.040</td>
<td>1.925</td>
</tr>
</tbody>
</table>
Conclusion

The measurement traceability of breath alcohol testing is imperative since the measurement results from the calibration have a direct impact on the justice system and road safety in South Africa. Driving under the influence of alcohol is treated as a criminal offense in South Africa, hence standards that are validated and traceable are required to ensure that the EBA are accurate and reliable.
Acknowledgements

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Thank You