HYCAL™

Hydrogen Analysis & Control

EMC

HYCAL™

market leading solution

hydrogen analysis & control

Unique selling points

- **Accurate**
- Repeatable
- Rapid
- Portable
- Hydrogen Control
- In-house Calibration
- Economic

Accurate

Comparison with offline standards such as LECO RH402

ppm	ppm	ppm	LECO	Hycal	Agreement
Sample A	Sample B	Average	ml/100g	ml/100g	%
0.182	0.182	0.182	0.20	0.20	100.0
0.164	0.199	0.182	0.20	0.20	100.0
0.160	0.160	0.160	0.18	0.19	95.0

Almost identical agreement

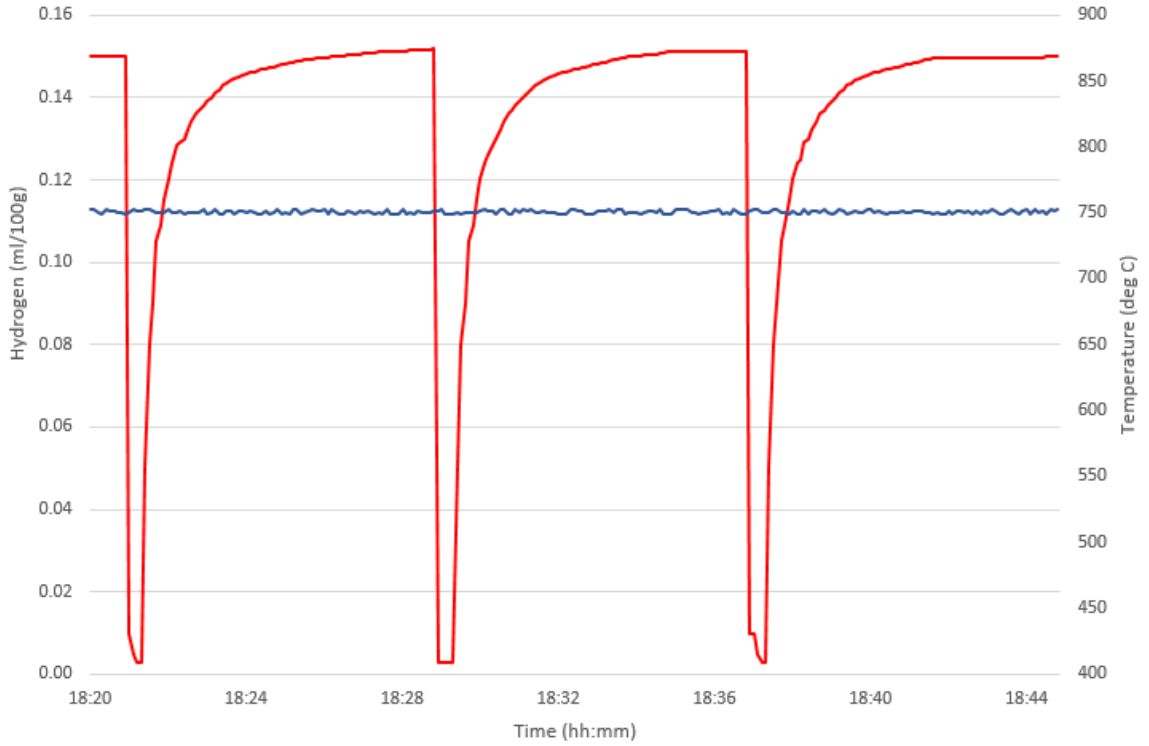
Accurate

100% Calibration in hydrogen test furnace

1mV resolution (A&B constants) provide < 0.005 ml/100g accuracy

Repeatable

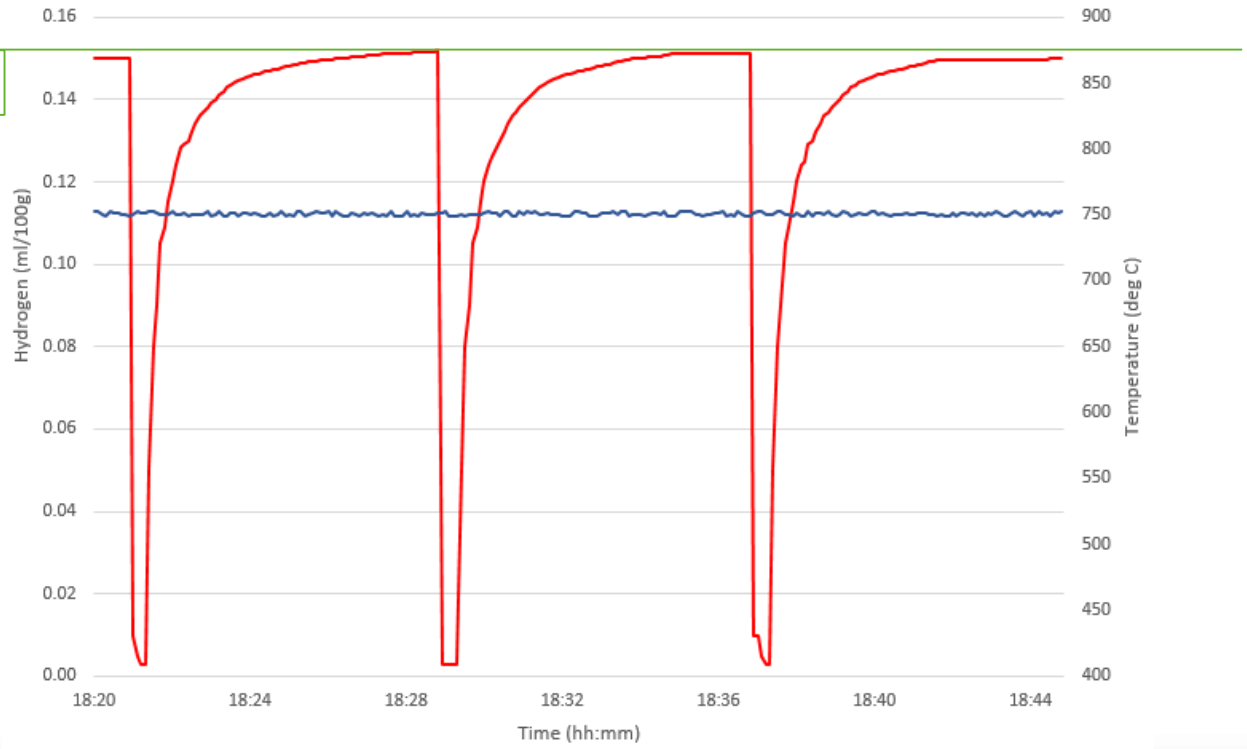
Successive measurements virtually identical…



Repeatable

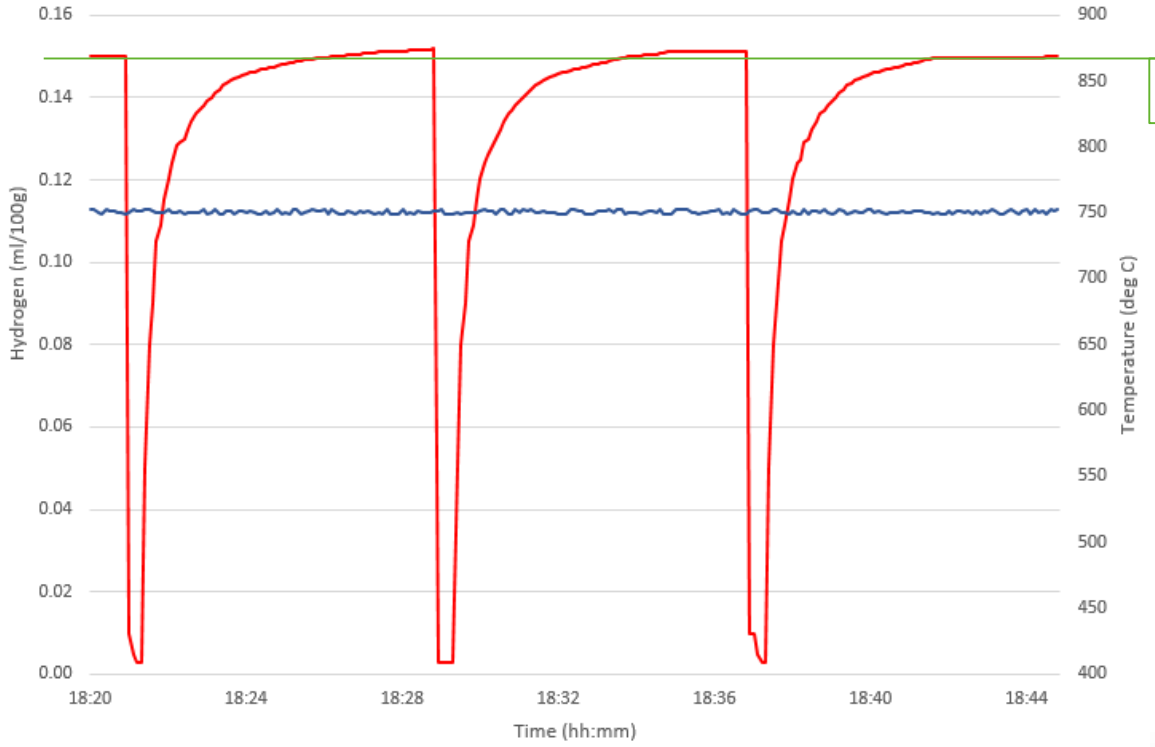
from the highest reading in a series…

0.155 ml/100g



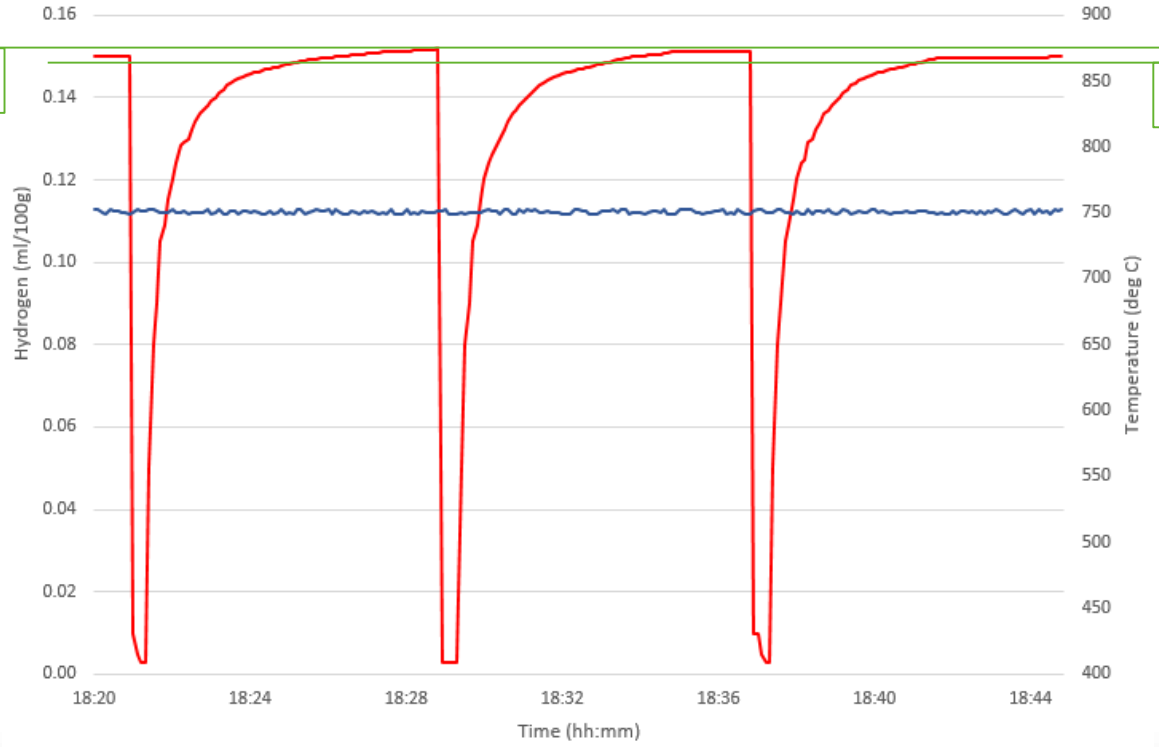
Repeatable

to the lowest…



Repeatable

0.155 ml/100g

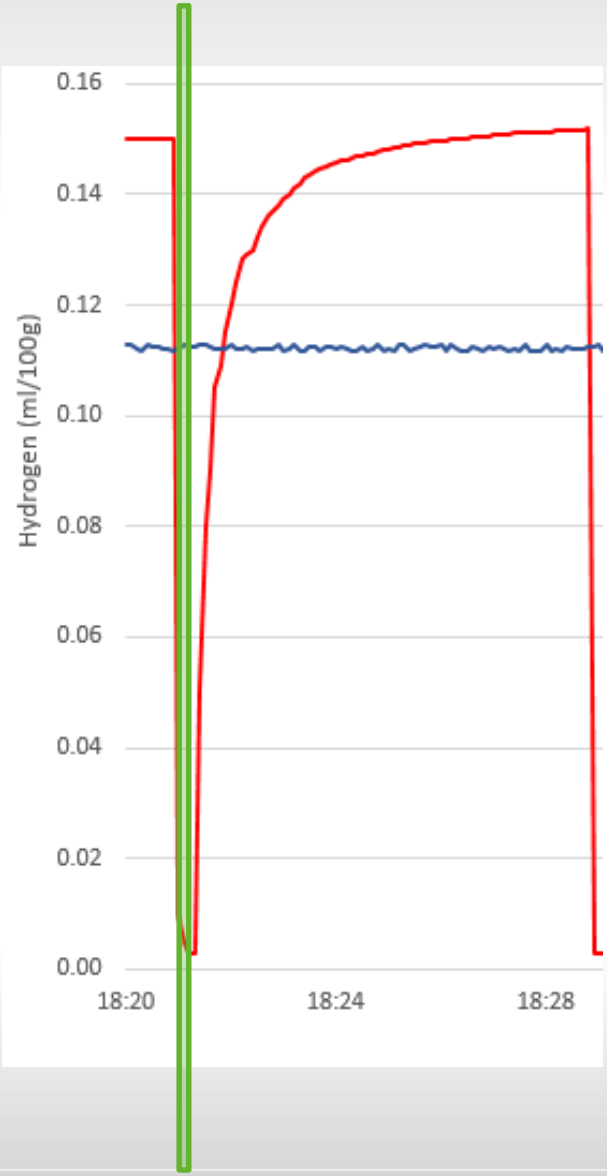


0.150 ml/100g

...within a range of 0.005 ml/100g

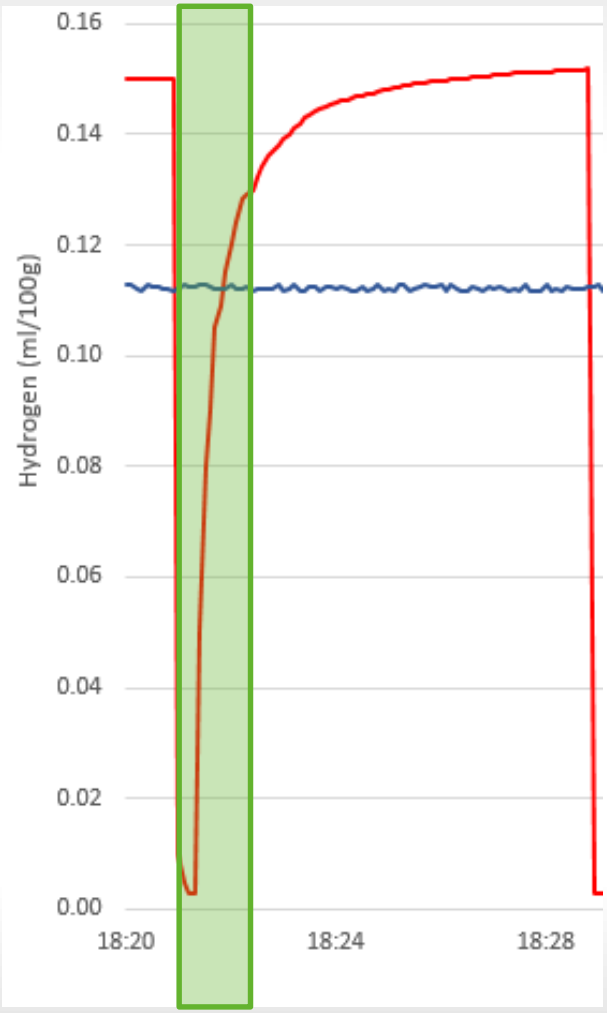
Rapid

Purge gas to start measurement…



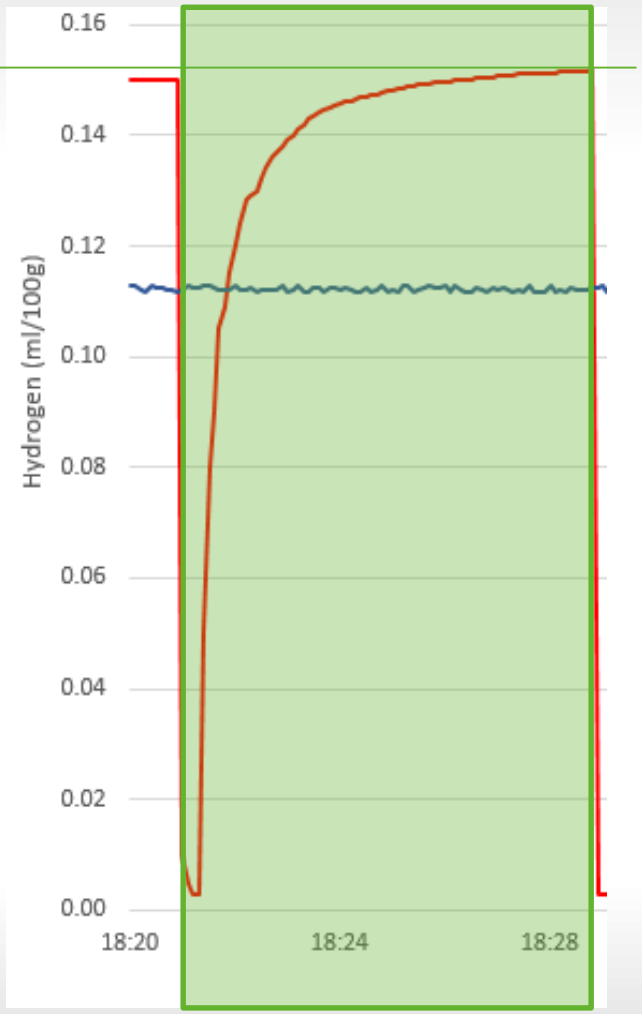
Rapid

Purge gas to start measurement…



90% final value known within 3 minutes…

Rapid

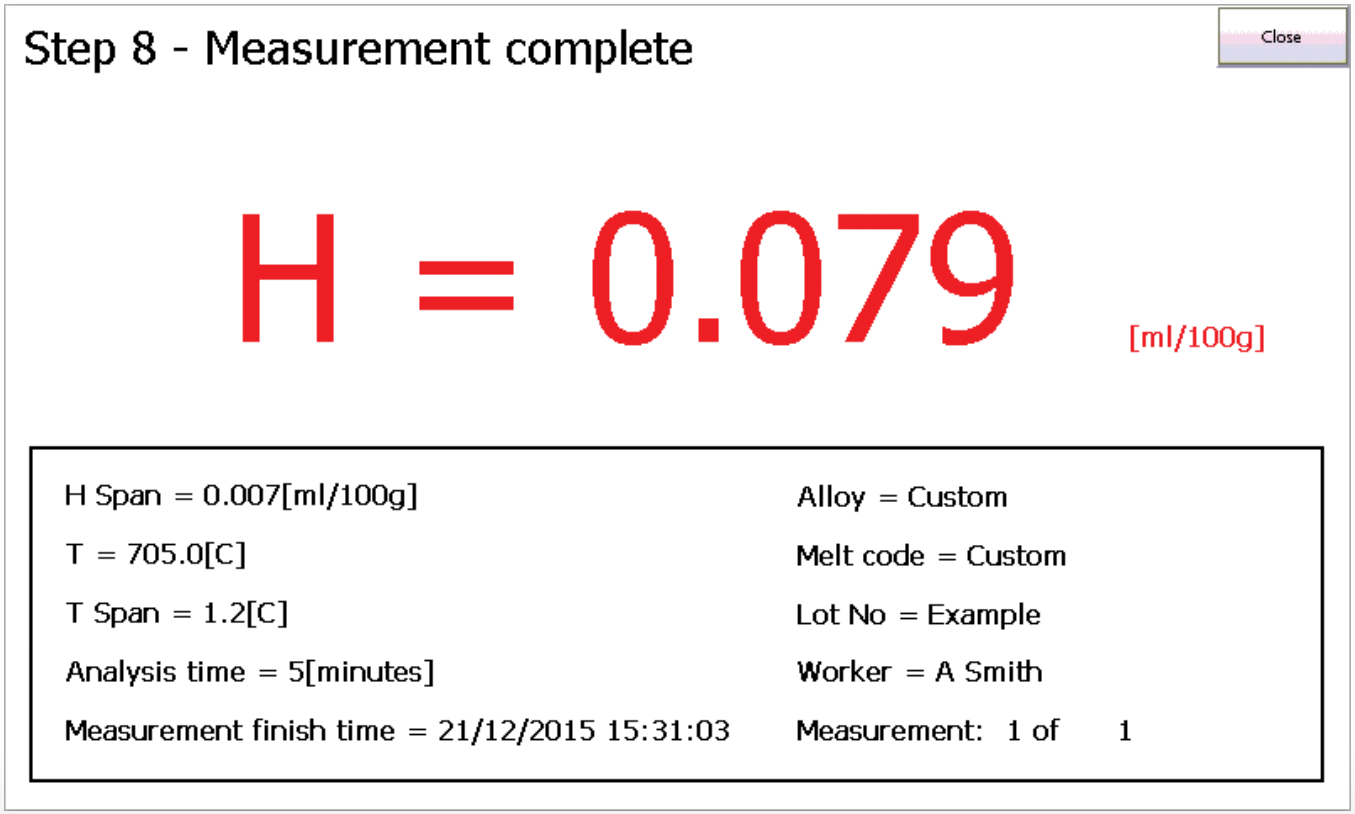


Final result given when 'gradient' stable <0.003ml/100g/min…

Final result typically between 5-10 minutes…

Rapid

Final result printed on-screen with batch details and statistics



Indicators / alarms can be configured if within specification

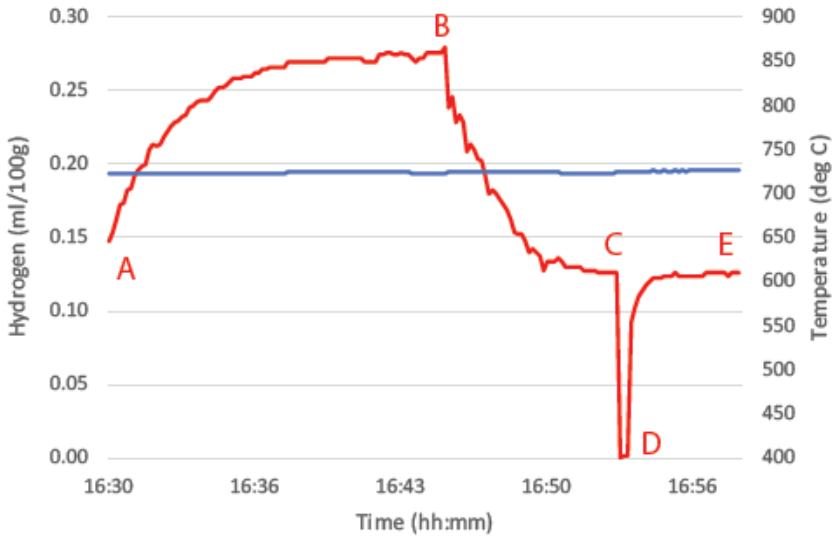
Portable

Easy to carry. Battery powered. Plug and Play

Product	Dimensions (mm)	Weight (kg)
HYCAL	340 (L) x 226 (H) x 223 (D)	9.2

Hydrogen Control

Real-time analysis + digital comms…



…enables rotor speed and gas flow to be controlled

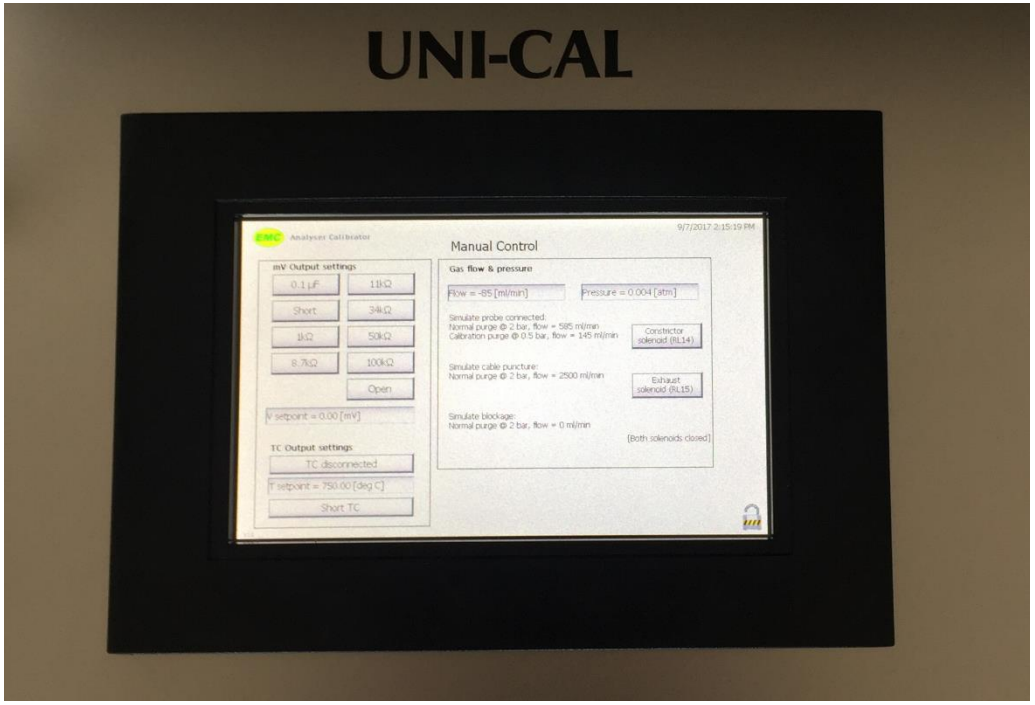
In-house Calibration

Hycal calibrator (Unical) does the travelling…

…tests all functions including gas system

In-house Calibration

Download certificate by USB…



…ISO certificate and sticker immediately available

Economic

Due to long life of probe (100 measurements / 20 hours)…

…cost per measurement lower than competing technologies

Economic

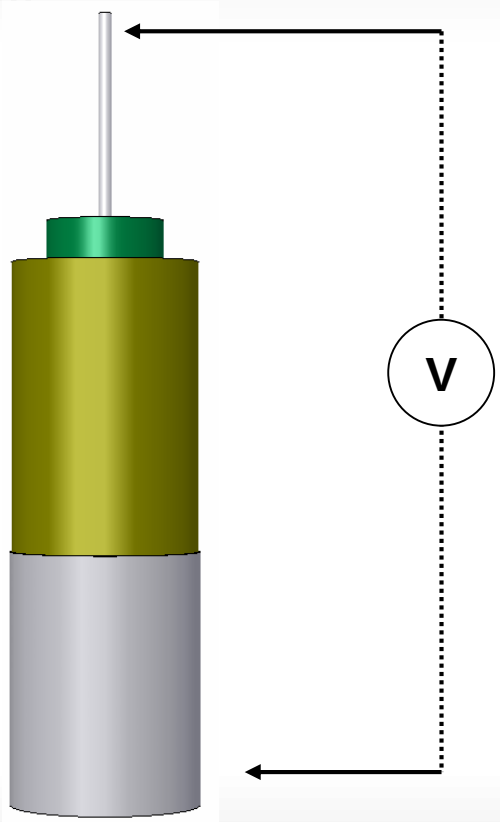
- Optimize degassing conditions
- Reduce N2 / Ar consumption
- Reduce scrap
- Improve productivity
- Reduce degassing consumables

Source

- Manufactured by EMC in the U.K.
- Technology from Cambridge University

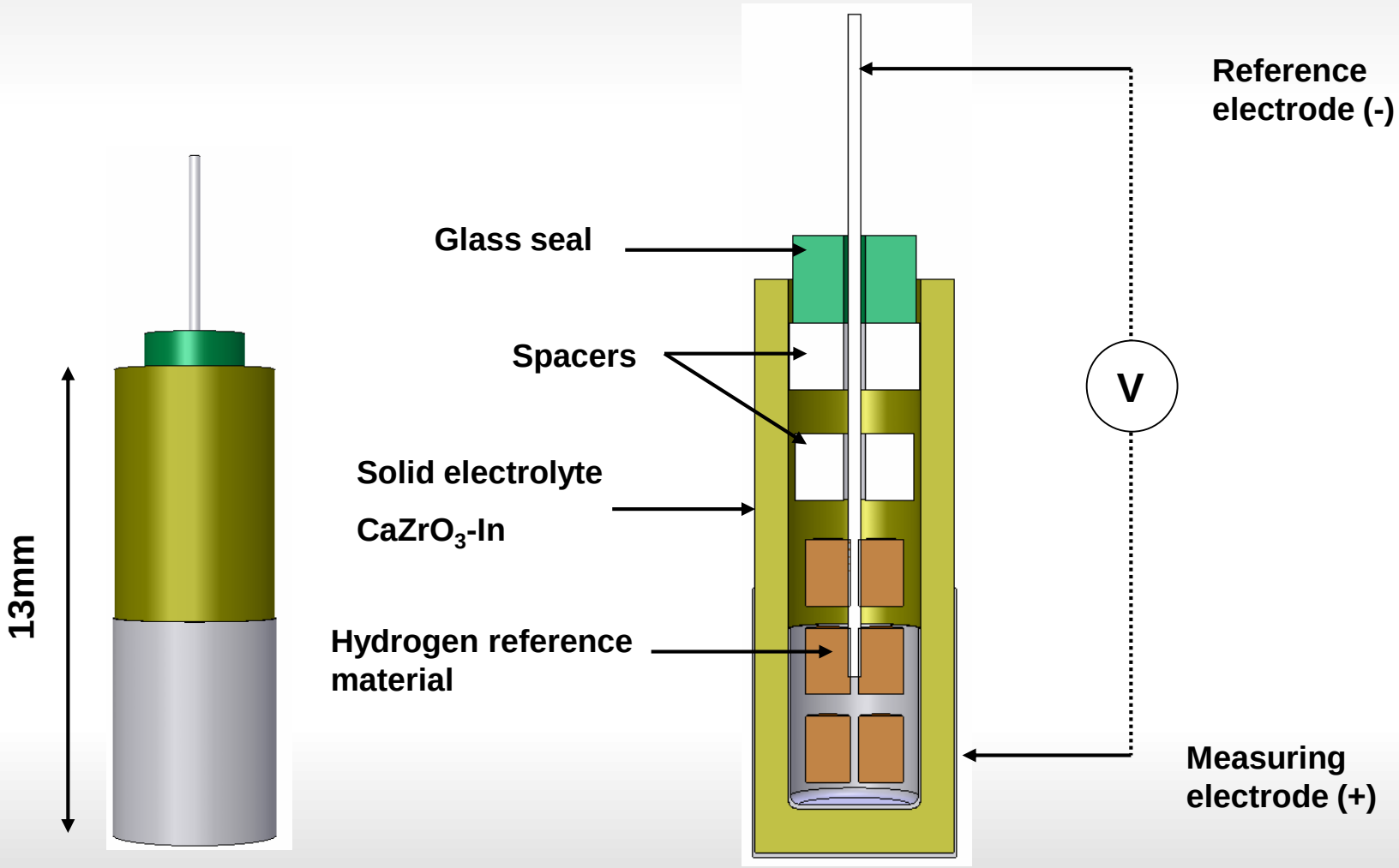
How does it work?

Ceramic sensor generates mV…

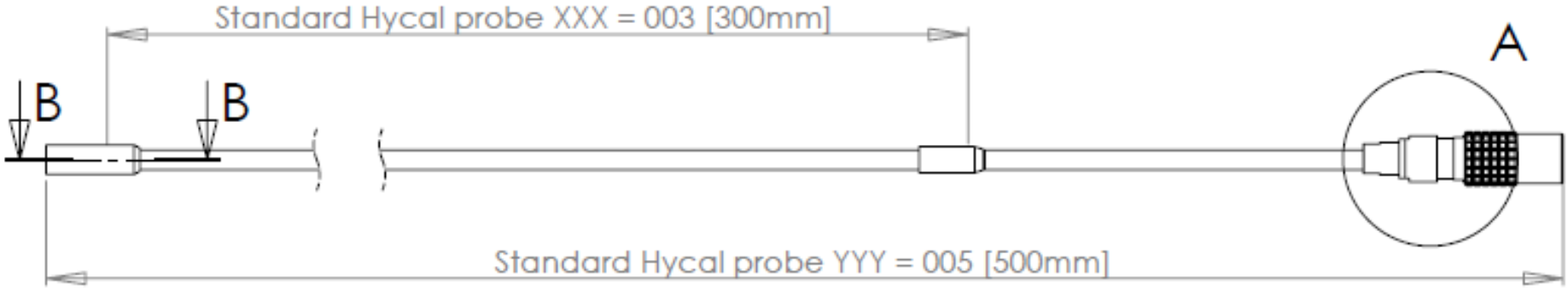


…dependent on ratio of pH_2 between internal and external of sensor

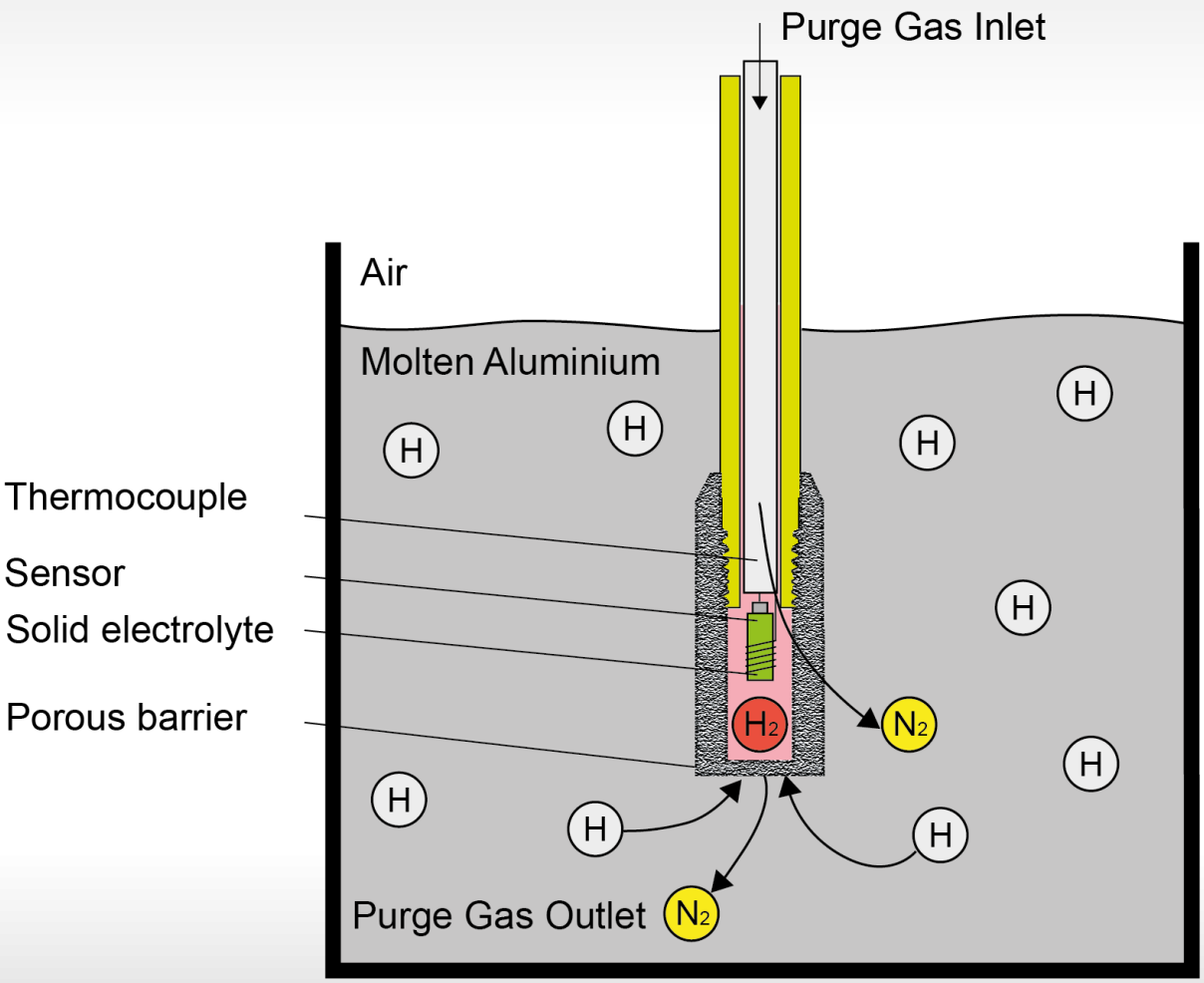
Sensor Construction



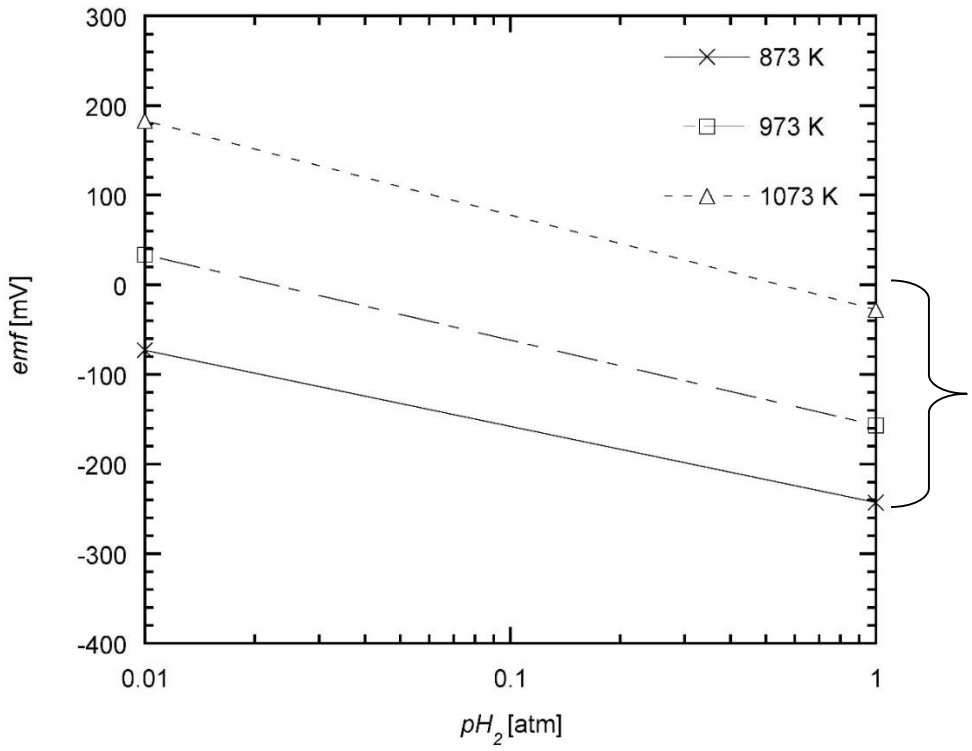
Probe Construction



Measurement schematic



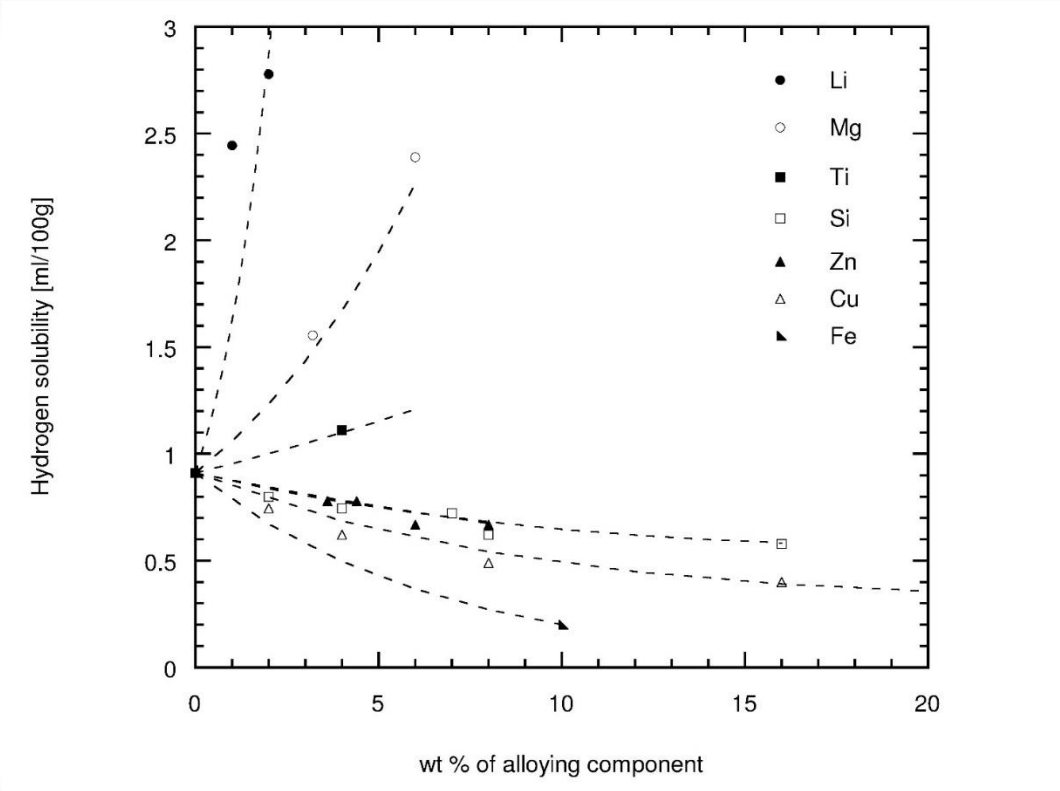
Sensor response in hydrogen gas



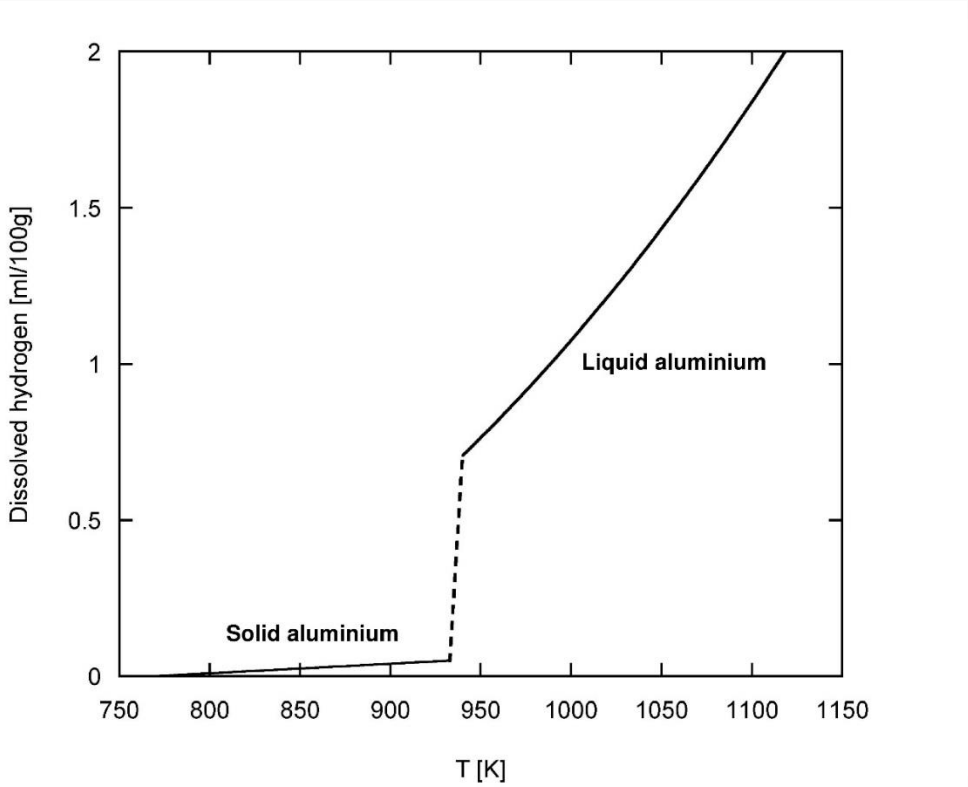
Temperature dependence mainly due to reference

Calibration of reference hydrogen level is required

Solubility of Alloy Components



Solubility vs Temperature



Summary of Inputs

Sensor constant A

Sensor constant B

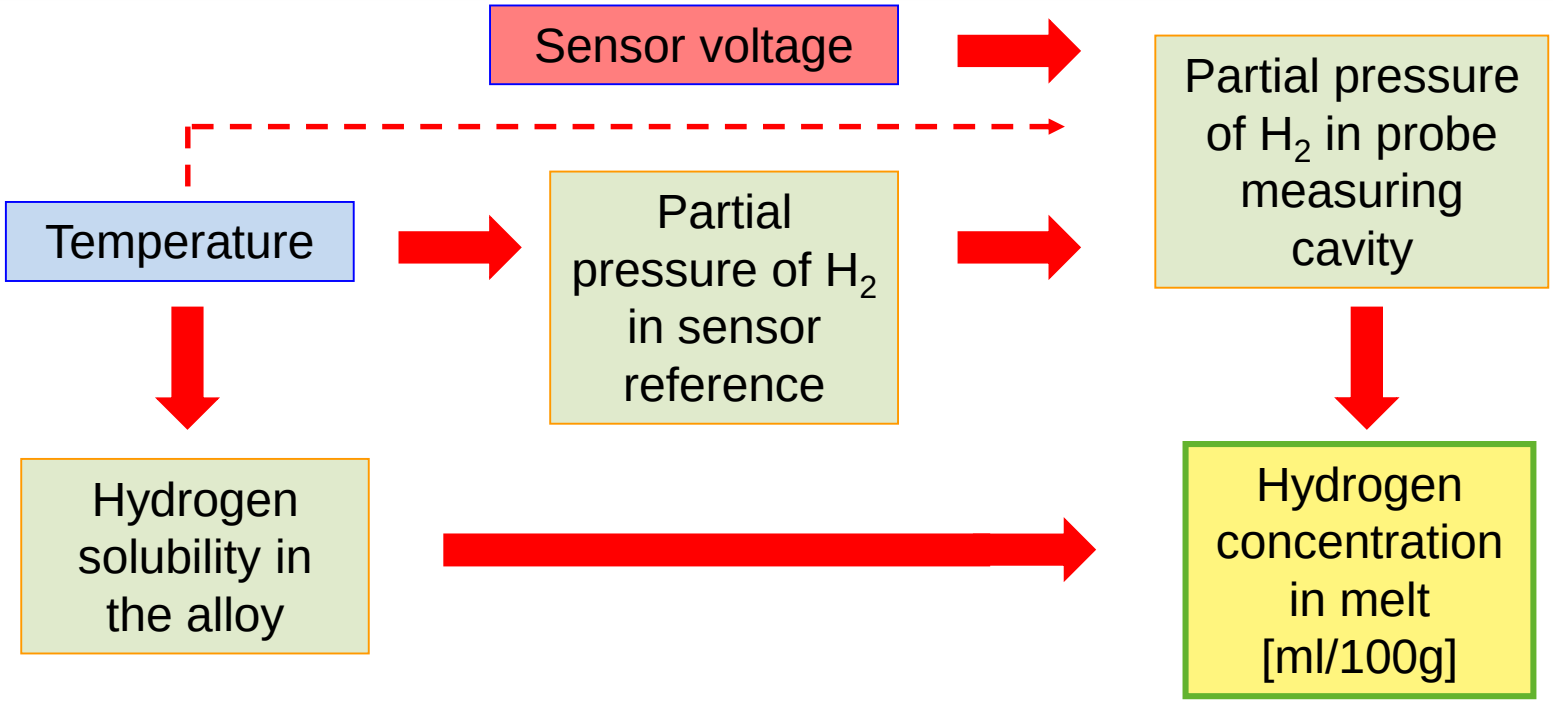
Calibrates reference hydrogen and its temperature dependence

Alloy constant C

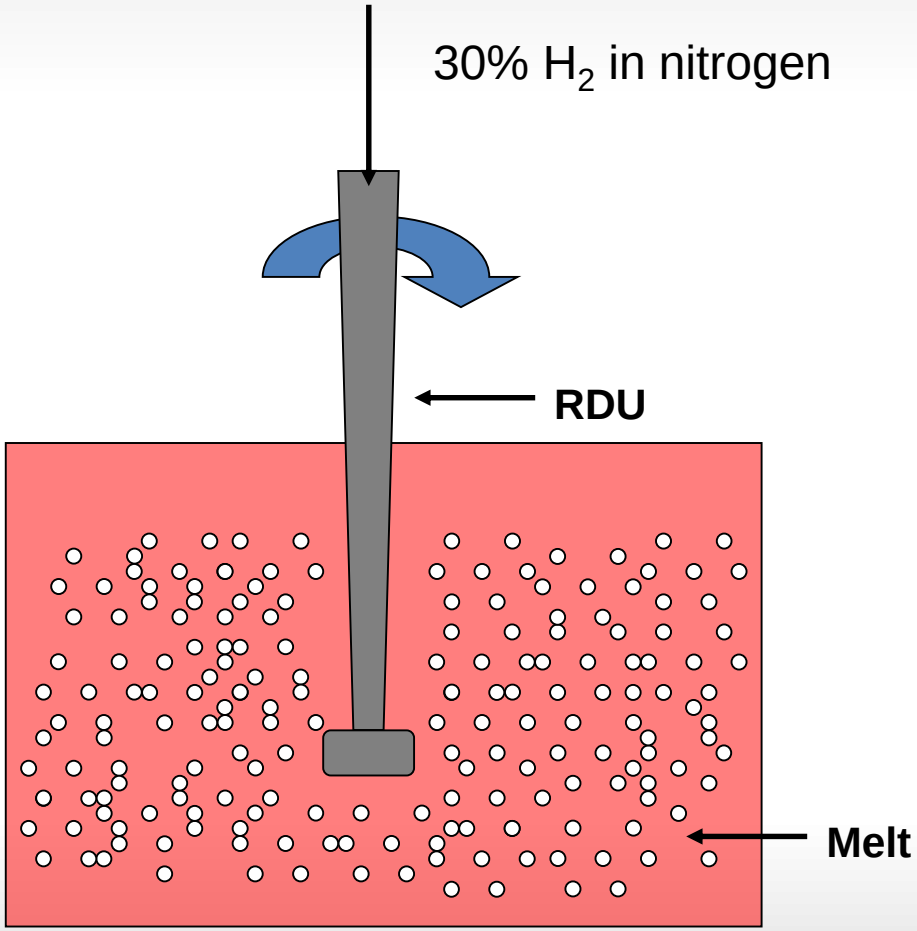
Alloy constant D

Calibrates for hydrogen solubility in the alloy and its temperature dependence

Summary of Measurement



100% probe testing

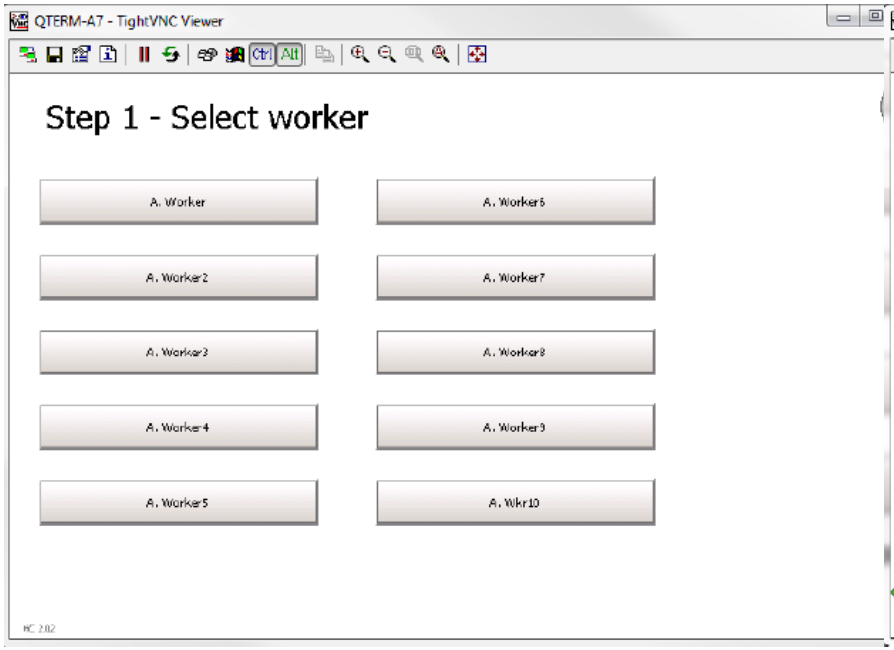


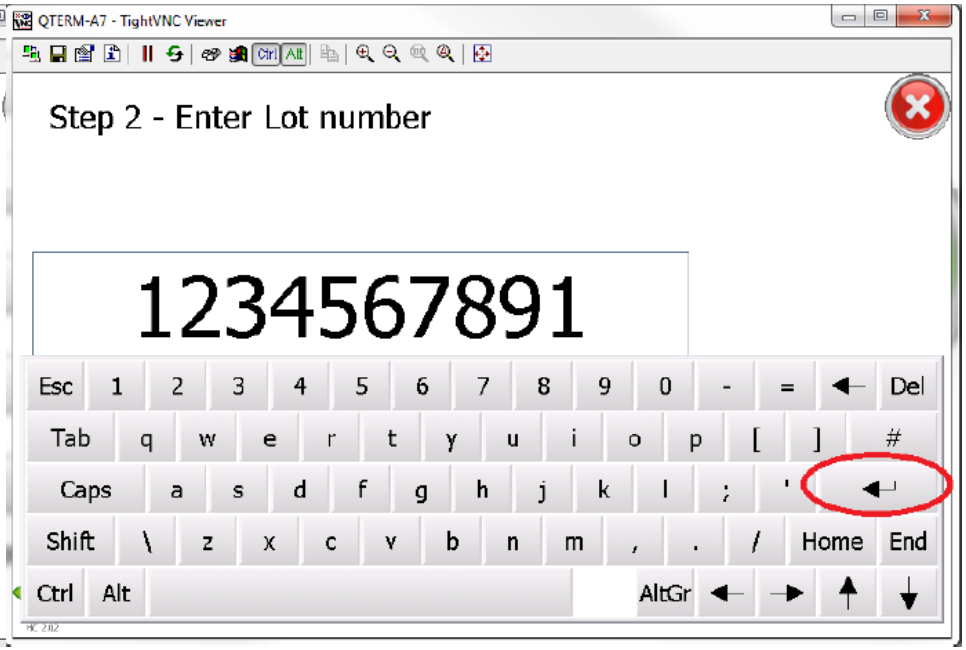
Bring melt into equilibrium with a known hydrogen partial pressure

$$\frac{1}{2}H_2 \rightarrow H_{Al}$$

Hydrogen content [ml/100g] can be calculated from alloy solubility data

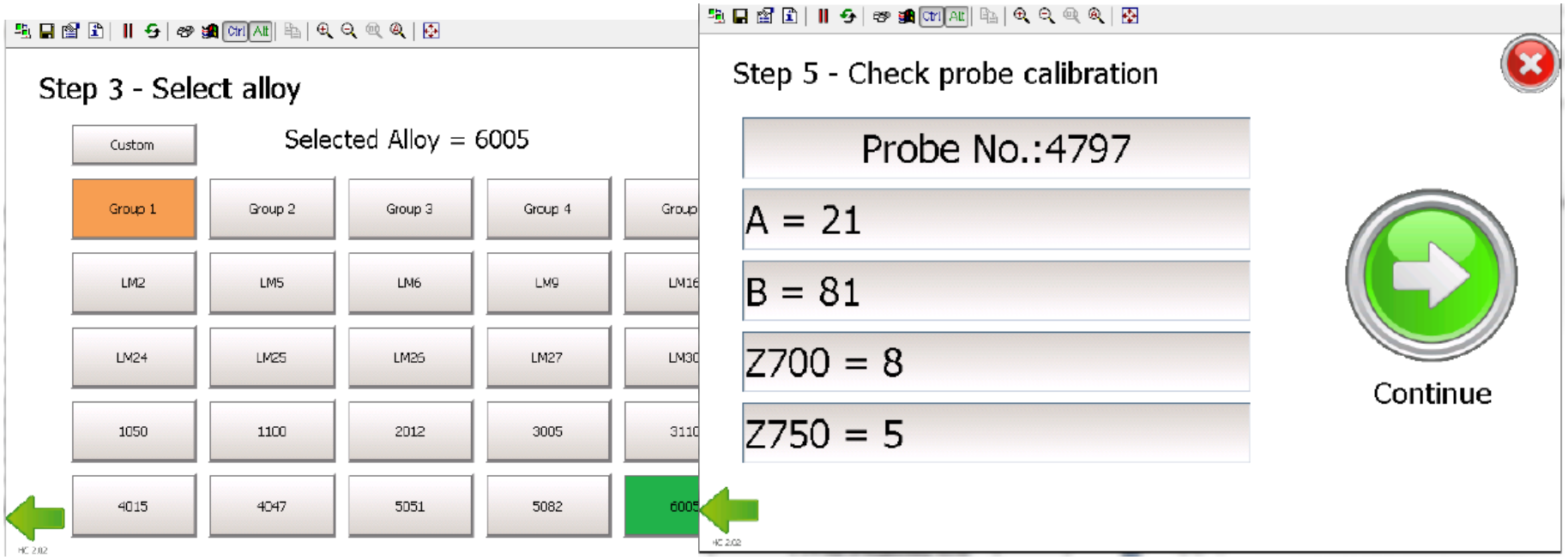
Analyser Software





...simple touchscreen interface in local language

Analyser Software



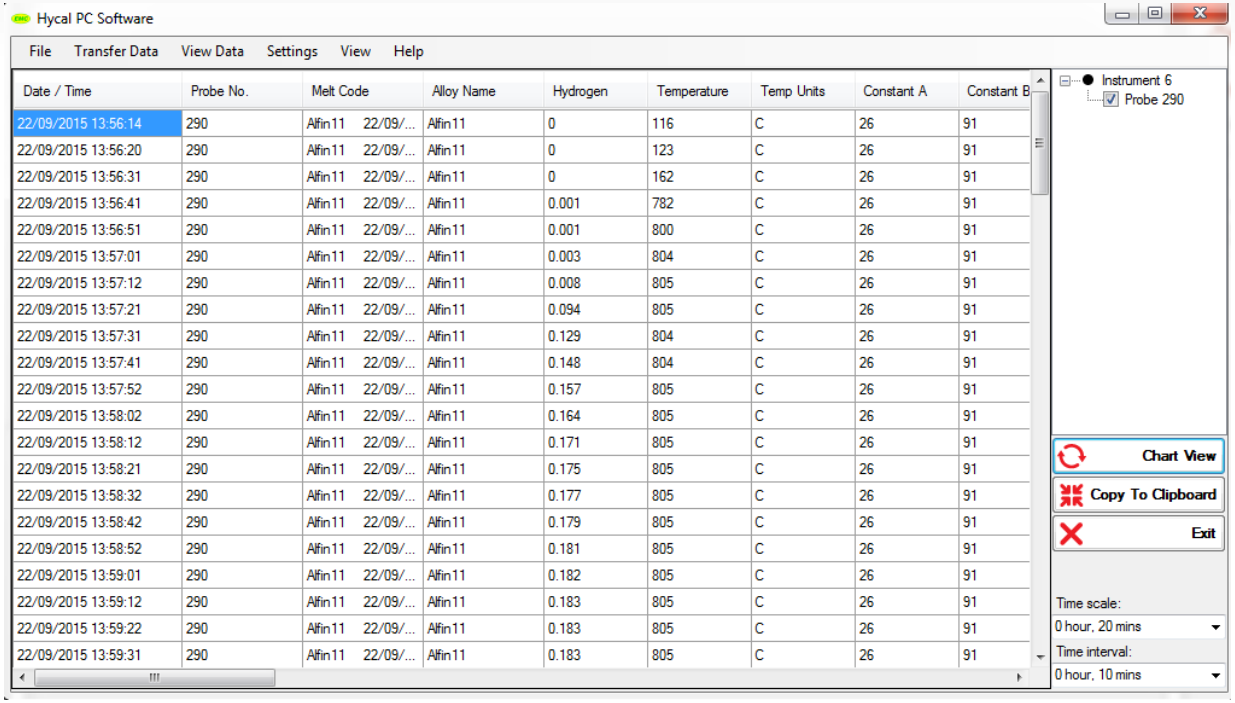
...gated input guides operator through every step

PC Software

Data downloaded via USB or Ethernet…

…and imported into PC software

PC Software

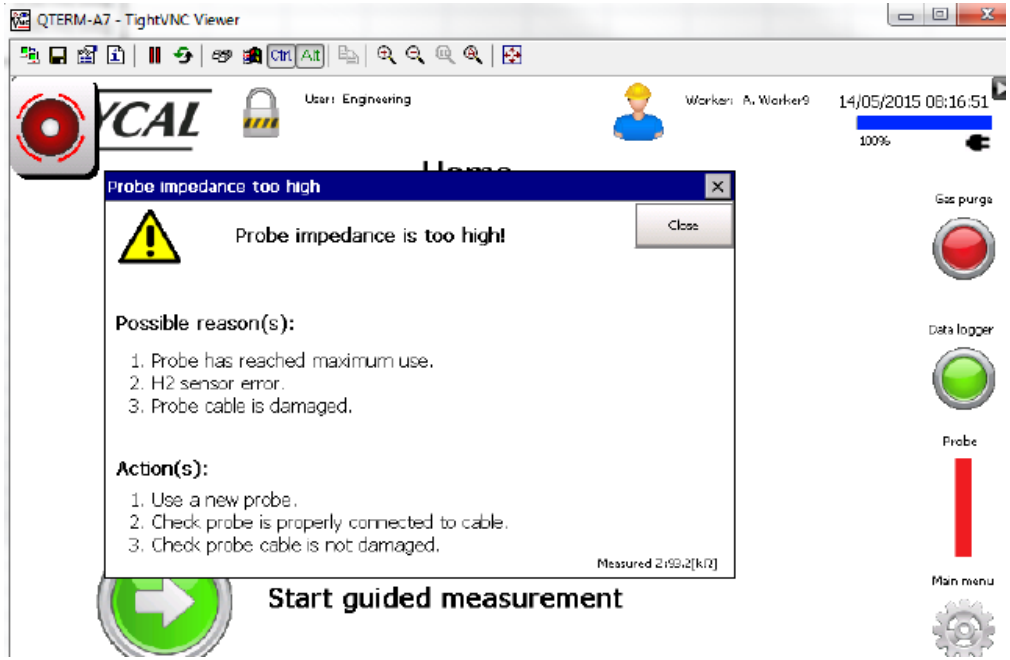


Date / Time	Probe No.	Melt Code	Alloy Name	Hydrogen	Temperature	Temp Units	Constant A	Constant B
22/09/2015 13:56:14	290	Alfin11 22/09/...	Alfin11	0	116	C	26	91
22/09/2015 13:56:20	290	Alfin11 22/09/...	Alfin11	0	123	C	26	91
22/09/2015 13:56:31	290	Alfin11 22/09/...	Alfin11	0	162	C	26	91
22/09/2015 13:56:41	290	Alfin11 22/09/...	Alfin11	0.001	782	C	26	91
22/09/2015 13:56:51	290	Alfin11 22/09/...	Alfin11	0.001	800	C	26	91
22/09/2015 13:57:01	290	Alfin11 22/09/...	Alfin11	0.003	804	C	26	91
22/09/2015 13:57:12	290	Alfin11 22/09/...	Alfin11	0.008	805	C	26	91
22/09/2015 13:57:21	290	Alfin11 22/09/...	Alfin11	0.094	805	C	26	91
22/09/2015 13:57:31	290	Alfin11 22/09/...	Alfin11	0.129	804	C	26	91
22/09/2015 13:57:41	290	Alfin11 22/09/...	Alfin11	0.148	804	C	26	91
22/09/2015 13:57:52	290	Alfin11 22/09/...	Alfin11	0.157	805	C	26	91
22/09/2015 13:58:02	290	Alfin11 22/09/...	Alfin11	0.164	805	C	26	91
22/09/2015 13:58:12	290	Alfin11 22/09/...	Alfin11	0.171	805	C	26	91
22/09/2015 13:58:21	290	Alfin11 22/09/...	Alfin11	0.175	805	C	26	91
22/09/2015 13:58:32	290	Alfin11 22/09/...	Alfin11	0.177	805	C	26	91
22/09/2015 13:58:42	290	Alfin11 22/09/...	Alfin11	0.179	805	C	26	91
22/09/2015 13:58:52	290	Alfin11 22/09/...	Alfin11	0.181	805	C	26	91
22/09/2015 13:59:01	290	Alfin11 22/09/...	Alfin11	0.182	805	C	26	91
22/09/2015 13:59:12	290	Alfin11 22/09/...	Alfin11	0.183	805	C	26	91
22/09/2015 13:59:22	290	Alfin11 22/09/...	Alfin11	0.183	805	C	26	91
22/09/2015 13:59:31	290	Alfin11 22/09/...	Alfin11	0.183	805	C	26	91

...choice of Chart or Spreadsheet view

Diagnostics

Continuous background diagnostics



Key markets

Disclaimer

Environmental Monitoring and Control Limited does not warrant the accuracy, completeness or usefulness of any information contained within this document. All warranties, representations, terms and conditions (statutory, express, implied or otherwise) as to quality, condition, description, merchantability, fitness for purpose, or non infringement are hereby expressly excluded.

Environmental Monitoring and Control Limited shall in no event be liable for any direct, indirect, consequential or punitive damage of any kind from any cause arising out of the reliance on or use or inability to use this document or its contents, including without limitation, loss of profits, or goodwill or business interruption.

Environmental Monitoring and Control Limited is not liable for the content from third-party sources and accepts no responsibility for the accuracy, reliability or completeness of information contained therein.