



# Analysis of hydrogen quality

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# Hydrogen for vehicles

PEMFC

STANDARD  
ISO/DIS 14687-2

ISO/DIS 14687-2	Maximum impurity concentration (in $\mu\text{mol/mol}$ unless stated)			
Component	Types I & II Grade D	Type I Grade E Cat.1	Type I Grade E Cat. 2	Type I Grade E Cat. 3
Water	5	non-condensing at ambient conditions	non-condensing at ambient conditions	non-condensing at ambient conditions
Total hydrocarbons compounds as methane basis	2	10	2	2
Oxygen	5	200	200	5
Helium	300	400000	400000	1000
Nitrogen	100	400000	400000	1000
Argon	100	400000	400000	1000
Carbon dioxide	2	included in total non-hydrogen gases' (max 50 % mol/mol)	included in total non-hydrogen gases' (max 50 % mol/mol)	2
Carbon monoxide	0,2	10	10	0,2
Total sulphur compounds	0,004	0,004	0,004	0,004
Formaldehyde	0,01	3	0,01	0,01
Formic acid	0,2	12	0,2	0,2
Ammonia	0,1	0,1	0,1	0,1
Total halogenated compounds	0,05	0,05	0,05	0,05
Particulate concentration	1 mg/kg	1 mg/kg	1 mg/kg	1 mg/kg



Compounds	Current situation				Possible developments			
	Detection limit	Analysis Method	Sampling method	Detection limit	Development	Analysis Method	Sampling method	Detection limit
Water	5	OFCEAS	In gas cylinders and 10 times dilution in nitrogen	30	Acquire an instrument as Proceas Multigas	OFCEAS	in pressurized cylinder	5
Total hydrocarbons compounds as methane basis	2	GC/FID +ev. TD/GC/MS	Gas bags +ev. on adsorbent C300	2	-	-	-	-
Oxygen	5	GC/TCD with He as carrier gas	Gas cylinders	30 (but coeluates with Argon)				
Helium	300	GC/TCD with H2 as carrier gas	Gas bags or gas cylinders	300				



Compounds	Current situation				Possible developments			
	Detection limit	Analysis Method	Sampling method	Detection limit	Development	Analysis Method	Sampling method	Detection limit
Nitrogen	100	GC/TCD with He as carrier gas	Gas cylinders	100	-	-	-	-
Argon	100	GC/TCD with He as carrier gas	gas cylinders	100	-	-	-	-
Carbon dioxide	2	GC/TCD with He as carrier gas	gas cylinders	2	-	-	-	-
Carbon monoxide	0,2	GC/MS	Gas bags or gas cylinders	5				
Total sulphur compounds	0,004	TD/GC/MS			Acquire an instrument as Proceas Multigas	OFCEAS	in pressurized cylinder	0,004 (H2S)
Formaldehyde	0,01	HPLC/UV-Vis	DNPH cartridge	0,01	Acquire an instrument as Proceas Multigas	OFCEAS	in pressurized and treated gas cylinder	0,1

Compounds	Current situation				Possible developments			
	Detection limit	Analysis Method	Sampling method	Detection limit	Development	Analysis Method	Sampling method	Detection limit
Formic acid	0,2	Ion exclusion chromatography	Purge and trap in alkaline buffer solution	0,2				
Ammonia	0,1	HPLC/conductivity detector	Silica gel treated tube	0,1	Acquire an instrument as Proceas Multigas	OFCEAS	in pressurized and treated gas cylinder	0,1
Total halogenated compounds (excl. HCl and Cl <sub>2</sub> )	0,05	TD/GC/MS	Carbotrap 300	0,05				
Particulate concentration	1 mg/kg	-	-	-	Method development needed			



## Conclusions Hydrogen Quality :

- The detection limits are probably to low
- The standard could need to be updated.
- In the current situation, at least 10 different analyses will need to be performed to cover 12 of the 14 parameters to verify. In stead we could have a Multipel-analyzer that takes 5 parameters a time. This would be cheaper.



# Hydrogen Prize estimation for left-over streams

<b>Hydrogen from electrolysis 2012</b>	<b>38-47SEK /kg</b>
<b>Hydrogen from electrolysis 2030</b>	<b>33-38 SEK/kg</b>
<b>Left over hydrogen from Swedish Chemical Industry (estimation from interviews)</b>	<b>15-20 SEK/kg</b>

Source: Fuel Cell and Hydrogen Joint undertaking, "Study on development of water electrolysis in the EU"





Tack för uppmärksamheten!