METROLOGY for HYDROGEN VEHICLES

HYDRAITE

Impurities beyond the scope of ISO 14687

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Workshop on hydrogen quality and flow metering for hydrogen fuel cell vehicles

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Overview

- Motivation
- Work plan
- Results
- Outlook

Motivation

- The actual ISO 14678-2 considers contaminants, which are originated from hydrogen production processes.
- Especially impurities originated by the HRS are not covered.
- Recently beside the known impurities included by the ISO 14768-2 new potential contaminants from HRS technology like oil, grace, lubricants etc. have been found in the hydrogen fuel.
- Information on the potential sources, impact of the fuel cell and measures for mitigation of the risk of contamination of the hydrogen fuel are required.

Workplan – what has been done

- Detailed questionnaire,
- Literature survey and
- Interviews

  with HRS component suppliers, HRS manufacturer and operators etc. for gathering information regarding
  - maintenance and service plans incl. cleaning materials etc.,
  - used materials at „events“ like commissioning, repairs etc. and
  - implemented materials in HRS components (compressors, sealing etc.)
- Discussion with OEMs etc. at 1st Hydraite Workshop

Results

- Detailed information regarding maintenance practices could not be gathered.
- Lubricants, solvents and cleaning agents have been mentioned such as
  - Acetone,
  - Mobil DTE 10 Excel 68,
  - 10 W 40 and
  - Tramos oxygen cleaner and
  - Steamclean HPC NF
- Also ionic liquids but without further specification
- Purging with N_2 and H_2 is performed partly manually after maintenance works at the H_2 lines. Neither sufficient H_2 drying nor the H_2 quality are checked after those events.

Results

Impurities introduced by HRS components, manufacturing & maintenance

Component	Pot. poisonous ingredient
Sealing gasket	Si (Silicon)
Cooling, Refrigerants	Freons ($C_4Cl_4F_6$)
Compressor	Oil component
Compressor	Ionic liquids
New SS tubing	Particulates
Valves	Particulates
Seals	Particulates
Filter	Particulates
Polymeric coating	Delaminated Coating components (Me, Carbon, Cl, P, Silicon, S)
Sealing	Sulphur vulcanised FKM, EPDM with carbon black as filler

Process	Source of Pollution	Pot. poisonous ingredient
Piping	Insufficient cleaning after manufacturing	O_2, N_2
Piping	Insufficient drying after manufacturing	H_2O
Piping	Insufficient cleaning after manufacturing	Particulates
Piping	Residues lubricant	Oil, sulphur
Piping	Residues detergent	Surfactant, sodium salt, acetone, alcohol, sodium hydroxide
Maintenance, commissioning	Incomplete flushing	N_2,O_2,CO_2
Maintenance	Residues lubricant	Oil, sulphur
Maintenance	Residues detergent	Surfactant, sodium salt, acetone, alcohol, sodium hydroxide
New SS tubing	Used lubricants	Sulphur compounds

Results

- Residues of lubricants can be the source of various contaminants.
  - Paraffins, sulfur compounds and numerous metal compounds
- Stable coatings are a major challenge for high pressure applications.
- Polymeric materials are subject to special stresses in high pressure hydrogen applications (swelling and deforming).
- Interactions of surface-active surfactants (detergent) with system components are difficult to predict. By nature, these are capable of covering surfaces.
- Ionic liquids are another class of substances that needs to be monitored.

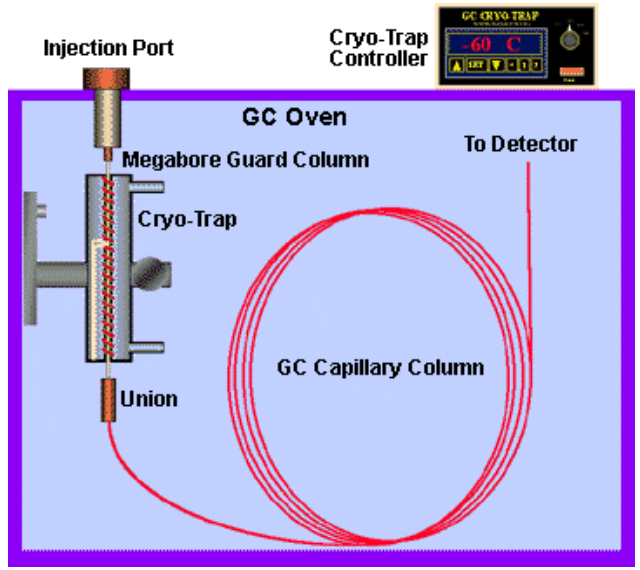
Results

- Assumption can be made that if there are present
  - ionic surfactants,
  - traces of oils or
  - nonionic surfactants

  they accumulate in the particle filters in a crystalline manner. However, the particle filters are not barriers to such substances.
- Currently it is not possible to estimate with what probability and with what concentration these substances can occur.
- Therefore, the risk posed by such substances cannot be conclusively assessed. This requires more analysis and practical research.

Outlook

- Identification of suitable wide-scope analysis important to detect and identify new impurities like
  - GC-MS or IC or
  - Component specific analysis of particulates with SEM etc.
- Ideally: pre-concentration of samples with
  - Thermal desorption
  - Pd membrane separation
  - Cryo-focussing
- Analysis of hydrogen samples from HRS for quantification



Outlook

- Risk analysis of further H2 production and purification process like
  - Production from biomass
  - Hydrogen as by-product Chlor-alkali electrolysis
- FC measurements for analysis for the impact
- Measures and recommendations for mitigation of the risk of contamination of the hydrogen fuel

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THANK YOU

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