Technical Specification

GC-IRMS Analyzer for $\delta^{13}C$ and $\delta^{2}H$ in Natural Gas

1.1. Description

1.1.1. Name of investment : Gas Chromatography – Isotope-Ratio Mass Spectrometry Analyzer for $\delta^{13}C$ and $\delta^{2}H$ in Natural Gas

1.1.2. Investment location: UGS Division, Special Services Laboratory, CA PZZP, Plavecký Štvrtok 900 68, Slovakia

1.1.3. Reason of investment:

Operation of an underground gas storage needs to be a safe and reliable process. Therefore, any gas leakage must be identified regarding to its possible source. There are some methods how to distinguish between gases from caprocks and geological storage zones. They are based on chemical composition of the gases – contents and ratios of certain hydrocarbons and/or inert gases, obtained by chromatographic analysis. However, it will be more precise to use also stable isotope contents to assess the sources of the gas leakages. The isotope ratios $^{13}C/^{12}C$ and $^{2}H/^{1}H$ from methane as a main component or from other subsequent hydrocarbons are needed for classification of the gases - either from local natural horizons or from zones with the stored imported gas, because they came from different geological ages and various biogeochemical pathways of origin.

$\delta^{13}C$ and $\delta^{2}H$, i.e. change of content of heavier isotopes relative to light ones are calculated to standards of known isotopic composition (VPDB, VSMOW).

1.2. Required parameters

Gas Chromatography - Isotope-Ratio Mass Spectrometry (GC-IRMS) Analyzer appopriate to high precision measurement of the relative isotope abundances ^{13}C and ^{2}H in components of natural gas, with properties as follows:

- Split/Splitless Injector and Gas Sampling Valve & Loop
- Chromatographic separation of CO_2 and hydrocarbons (methane, ethane propane, i-butane, n-butane, i-pentane, n-pentane)
- Measuring isotopic ratio of $^{13}C/^{12}C$ and $^{2}H/^{1}H$ from individual peaks of carbon or hydrocarbon components
- Continuous flow mode interface.
- It must be possible to analyze $\delta^{13}C$ and $\delta^{2}H$ within one sequence, switching between oxidation and pyrolysis reactors must be automated. It must be possible to regenerate both reactors automatically.
- Verification possibility of system performance by reference gases
- High sensitivity electron impact self-aligning ion source, electron ionisation up to 150 eV. All ion source parameters to be set by the data system.
- The ion source parameters shall be automatically optimized, stored, and regularly used for specific gas configurations. Software package for checking diagnostic functions.

- Mass range at least 1 - 80 amu at full acceleration voltage, Mass resolution better than 110 m/∆m (10% valley).
- Sensitivity under continuous flow conditions of max 1500 CO_2 molecules per m/z 44. System Stability lower than 10 ppm on mass scale.
- H3+ Factor < 10 ppm/nA. Software must include a routine for H3+ correction during measurement of H_2
- Continuous flow mode precision:
  - $\delta^{13}C$ precision ≤ 0.06 ‰ linearity ≤ 0.02 ‰
  - $\delta^{2}H$ precision ≤ 0.40 ‰ linearity ≤ 0.20 ‰

1.3. PC hardware and software

- PC and flatscreen, colour printer
- Data acquisition software for continuous flow measurements and off-line data processing, with isotopic calibration and output sample δ values with respect to internationally accepted reference scales. Software shall permit automatic drift and blank corrections if required.

1.4. Packing

- For shipment the GC-IRMS shall be packed in accordance with international standards that are applicable for the shipment of this kind of equipment.

1.5. Quality Requirements

- The GC-IRMS shall be manufactured, shipped and installed in accordance with the Supplier' ISO quality assurance system or an equivalent quality assurance system.
- The Supplier shall document the compliance with this quality assurance system.

1.6. Installation, Testing and Acceptance

- The Supplier shall install the GC-IRMS at the Laboratory of UGS, NAFTA a.s., in Plavecký Štvrtok;
- The GC-IRMS, after installation, shall be tested by the Supplier together with the End-User to demonstrate that the performance meets the manufacturer's performance specifications and the minimum requirements specified herein.
- The results of the testing of the GC-IRMS shall be documented by the Supplier in an acceptance protocol that shall be signed by the End-User.

1.7. Training

- The Supplier shall provide one day training for a part of staff of the End-User in the operation and maintenance of the GC-IRMS at the End-User's location immediately after the installation of the GC-IRMS.
- The Supplier shall provide at least one complete sets of operation and servicing manuals and technical drawings in the English language.

1.8. Operating lifespan (assumed)

12 years