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Evaluation of novel measurement methods for line inspection in gas networks – EvaNeMeL

Final report

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Management Summary

In recent years, the relevant DVGW Codes of Practice and associated information sheets for carrying out and evaluating the above-ground inspection of natural gas pipelines have been revised. In addition, measurement technology and data processing (digitisation) have developed constantly. For the above-ground inspection of buried pipelines in the distribution network through inspections and drives, new measurement methods are increasingly being used. In the EvaNeMeL research project, these new measurement methods were evaluated both theoretically and through experimental investigations. Five vehicle-mounted measurement systems and three hand-held remote gas detection methods were investigated. The results demonstrate the performance of the novel methods against a benchmark and also to serve as a basis for a subsequent supplement to the DVGW rules and regulations for above-ground inspection. The benchmark was an experienced “Gasspuerer” (gas safety personnel) who carried out a walk-through with a probe-based PortaFID M3K in parallel to the experimental investigations. This established walk-through of buried pipelines results in a high level of safety for the public gas supply.

Within the framework of technology screening, both measuring principles and the novel methods for above-ground methane leakage detection in buried pipelines were considered. For the detection of methane, the TDLAS principle (diode laser) was used by all the eight measuring systems examined. This laser method is sensitive to the specific measuring wavelength of methane (= 1.65 µm) and has no relevant cross-sensitivities. Three of the vehicle-mounted measurement systems (category B) each had eight low-mounted gas intake nozzles across the entire front of the vehicle. This allows driving above the pipeline and viewing the pipeline route. These measurement vehicles are already covered under DVGW Code of Practice G 465-1. Two other vehicle-mounted systems (category C) included high-precision wind measurements, besides the measurement of methane and ethane concentrations for the specification of natural gas. In post-processing, the software correlates the gas measurement data with the wind data and uses it to calculate the probable location of the leakage. These measurement systems are also intended to detect leaks located away from the pipeline route. A category C measuring system also calculates the probable volume flow from the detected leaks and "estimates" the resulting methane emissions into the atmosphere. The three remote gas detection devices (category A) are active laser devices already mentioned in the DVGW regulations for detecting gas leaks in exposed pipelines.

Extensive experimental investigations with all measuring systems were carried out both in field tests and in the urban environment. In the test fields, underground leakages were simulated with a volume flow of 15 l/h and the above-ground release was recorded by the benchmark. Figure 1 summarises the results of the inspections on the two test fields. There, the respective leakage point was driven over by a vehicle-mounted unit in the centre and passed on the left and right. Especially on the sealed area (test field 1), the limits of the five vehicle-borne systems became apparent, as no gas cloud could stabilise here due to wind and the streaky gas leakage (joints). The number and depth of the intake nozzles also played a role in the recovery rate. On the open-pored meadow surface, a gas cloud stabilised within the vegetation. Of all five measurement systems, the highest leakage recoveries were achieved in the central and downwind crossing cases. The measuring systems with integrated wind measurement could locate the two leaks on the test fields even when driving around the test area (not over the pipeline route)

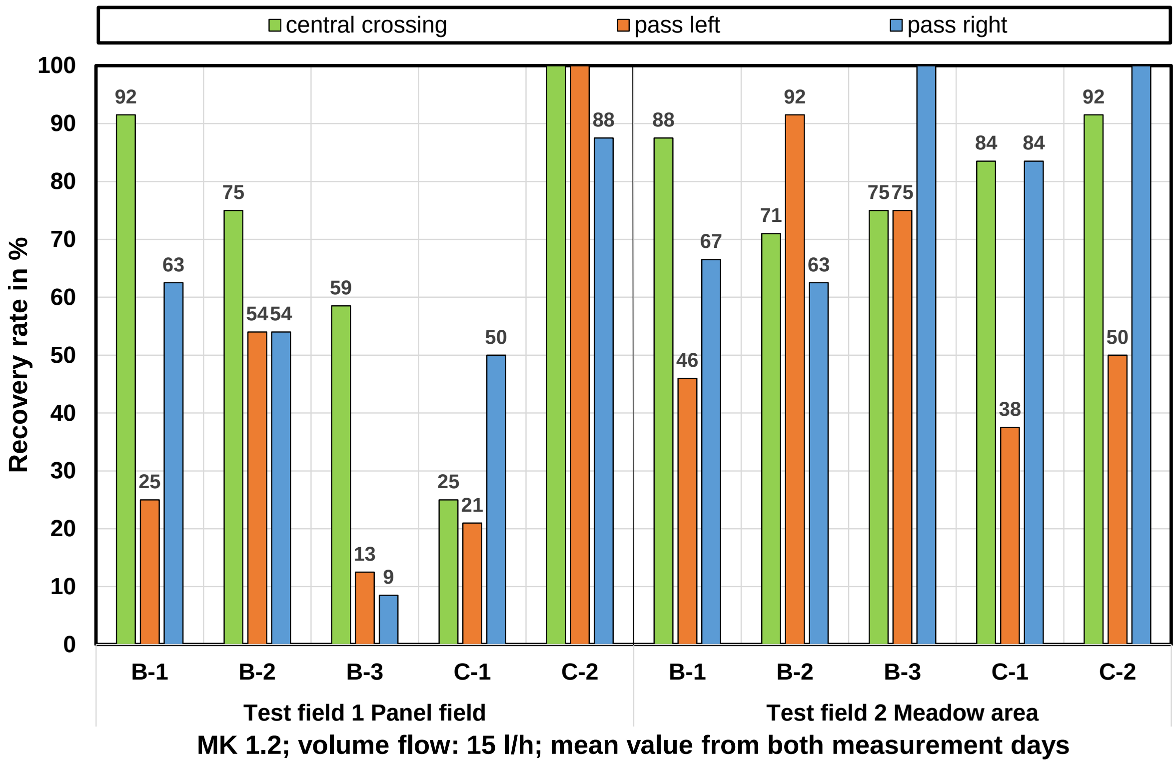

Figure 1: Summary of the results of the tests on the test fields

The results of the vehicle-mounted measurement systems in two practical tests in urban environments are summarised in Figure 2. The detection points, the percentages refer to the leakages detected by the benchmark specified in DVGW-G 465-1. The category B and C-2 demonstrated a maximum leakage recovery of 58% in the 3.3 measurement campaign. This was probably because of the higher number and deeper mounted gas intake nozzles of these systems. For these four systems, the proportion of false indications was also reduced compared to the 3.1 measurement campaign. False indications are those reported by the respective measuring systems that cannot be confirmed by the benchmark. The percentage of false indications is calculated based on the total number of reported indications. The measurement system C-1 demonstrated neither good recovery nor a reduction of false indications in the practical tests for above-ground verification. Cat C systems showed low methane concentrations because of a methane sensitivity of 1 ppb, which led to false indications.

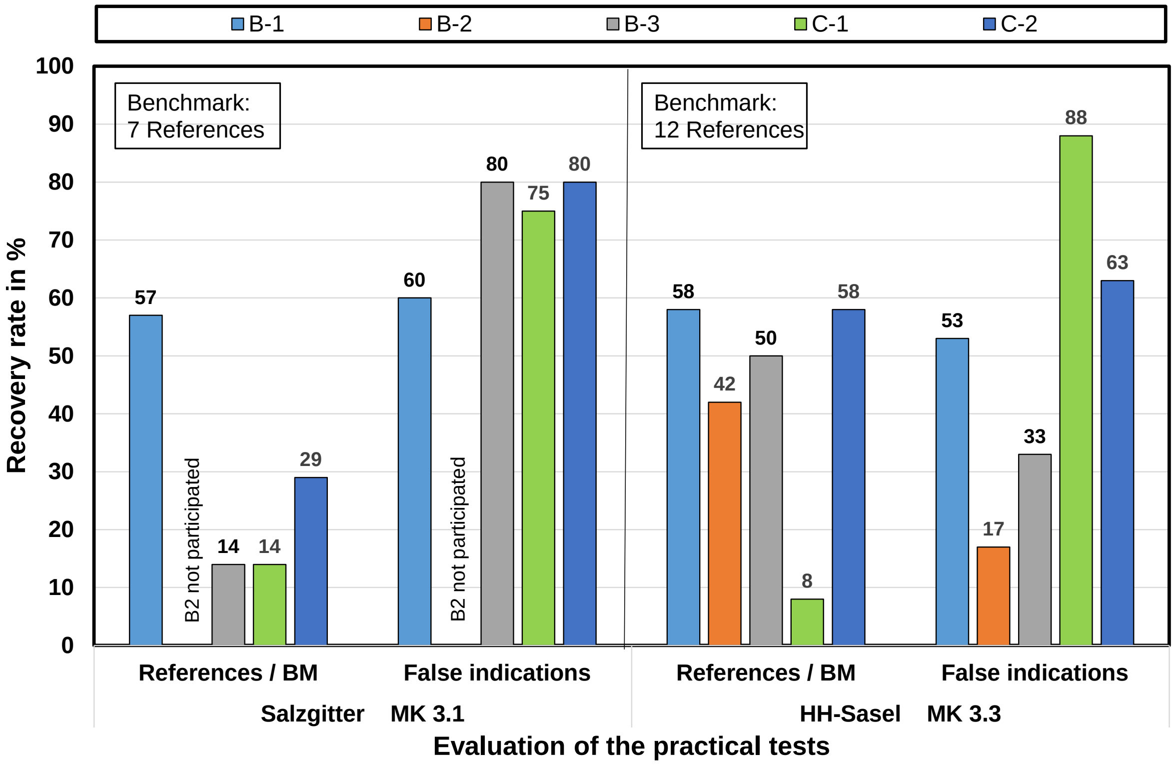

Figure 2: Summary of the results of the urban walk-throughs

If essential general conditions are observed, the vehicle-borne measuring systems can aid established inspection techniques in the future. To determine the leakages, all systems must be driven through the area several times according to the respective work instructions. These inspections can occur both during the day and at night. The weather must be considered. Both on the test fields and in the practical tests, it has been shown that a moderate wind is necessary to detect the leakages. A suitable vehicle speed for inner-city areas (parked vehicles, narrow streets) was determined to be approx. 15 km/h. Speeds of up to approx. 30 km/h were possible for the vehicles, whereby the traffic-related conditions must always be considered. The experimental investigations did not include driving on transport pipelines, where a higher vehicle speed might be possible. A gas intake installed low and across the width of the vehicle improved the detection of the leaks. Detection was possible with all five measurement systems when driving directly over or on the downwind side of the leak. However, the leakage recovery was not high, especially for the unknown leakage points in the practical tests, with a maximum of 58 % in relation to the benchmark. Through integrating wind measuring instruments, the vehicles of the cat C can also locate leaks away from the pipeline route. These two systems can also automatically determine the origin of the gas through parallel ethane measurement. This and the high sensitivity of the measuring systems led to a high proportion of false indications in the above-ground inspection, some of which were not checked for plausibility by the personnel. The personnel experienced in above-ground verification (Cat. B) could minimise false indications. With all systems, post-processing of the recorded raw data is possible. Here, the number of false indications can be reduced through possible software adjustments. A high number of false indications leads to a high workload for the gas safety personnel to verify the leakages indicated by the inspection. There is potential for improvement in leak recovery and in the training of personnel to classify false indications.

The three hand-held (active) remote gas detection methods showed high sensitivity to methane and no cross-sensitivities to other atmospheric gases. These devices could detect distant leaks from exposed pipelines. Scanning an area was facilitated by the use of the spotter or, in one case, a camera. When using it, it should be noted that the spot size increases with distance and that a suitable reflective surface must be available. The detection of an open leakage with a volume flow of 10 l/h and a distance of 25 m was possible with all three devices. As already specified in DVGW Code of Practice G 465-1, the hand-held remote gas detection devices can serve as a supplement for the probe-based gas concentration measuring devices during the inspection. For example, this includes house connections in non-accessible front gardens or open pipes under bridges and on installations.

The results will serve as the basis for a project group (PK) "G 465". The project group will revise or supplement the DVGW Code of Practice G 465-1 and DVGW Code of Practice G 465-4. The conditions of use (e.g., travel speeds) for the proper above-ground inspection of buried pipelines of the new measurement methods investigated here are to be described or specified. The vehicles of category C pursue a novel approach (methane/ethane measurement and wind data acquisition) and are currently not yet covered by the regulations. Requirements for the measurement technology, the implementation and the evaluation (e.g. personnel) should be specified.

Table of contents