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Online Field Inspection Manager (OFIM)Grid inspection web service

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The increasing spread of Web 2.0 technologies and broad availability of powerful mobile terminal devices today opens up new options to measurement laboratories for use when performing grid inspections. To use these opportunities a powerful web service has been developed, which supports measurement laboratories when performing grid inspections, from the initial planning steps through to delivering results to customers. Apart from many years of own grid inspection experience, the feedback from pilot customers also flowed into the development. The early involvement of lead users in the development process provided to be a valuable measure to tailor the system to practical requirements in the best possible way.
By using a central online platform, in interaction with a mobile application for smart phones, a large number of processes can be automated and optimized by using the OFIM service.
As a result, a large part of the time-consuming and work-intensive manual tasks required to date are no longer necessary, which not only leads to a noticeable efficiency increase but also to higher data quality and data integrity. This is achieved by providing extensive tools for the planning, implementation and evaluation of grid inspection projects. Apart from the responsible measurement laboratory, plant owners, the approving authorities and local residents can benefit from this. The possibility of flexibly adapting the system creates the basis by which future requirements can be taken into account and the scope of functions steadily extended.

1. Introduction

The performing of grid inspections to determine odour immissions in the vicinity of plants is covered by VDI Guideline 3940 (2006) Part 1. Trained odour inspectors are deployed to record odour detection at different inspection points at different times of the day and night over a period of 10 min each. 60 samples are recorded at each inspection point at 10s intervals. The frequencies of the detected odours are then determined according to the concept of the "odour hour" and are statistically analysed.
Performing grid inspections to date has posed a large number of challenges for the responsible measurement laboratories. They begin with a time-consuming and work-intensive planning phase in coordination with plant owners and the approving authorities before the project starts. In addition, a large amount of coordination and administrative work arises for the measurement laboratory employee responsible for the project, over the entire life of the project, to ensure the inspections are performed in conformity with the guidelines.
The still widespread practice of paper inspection records for recording the data has two serious inherent disadvantages. The first disadvantage represents the greatest risk to the data integrity.

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Information from lost or incomplete records cannot be restored due to lack of redundancy. The second serious disadvantage results from the fact that much valuable time is lost between the sending of the records to the measurement laboratory and the availability of the information to the person responsible for the project (project manager). This in turn consequently leads to a delay in the evaluation and delivery of informative results to the client.
The fact that even in the age of web applications and an increasing spread of powerful mobile terminal devices, these grid inspections are still primarily carried out on inspector's paper records, indicates a large optimisation potential and throws up the question why a satisfactory technical solution has been unable to establish itself. To answer this question, it is necessary to take a closer look at the workflows involved in a grid inspection.

2. Workflows for grid inspections

A grid inspection can be divided into the three phases: planning, implementation and evaluation. During the planning phase, site plans and map materials are used to define the inspection points and the grid areas for the evaluation area. The odour characters that can occur in the evaluation area are determined with the help of an emissions register. The data collected during the grid inspection must be representative for the entire year, according to the requirements of VDI Guideline 3940 (2006). Therefore, attention must be paid to the time and organisational planning, to ensure a balanced allocation of the inspection dates regarding scheduled time, weekdays and odour inspectors. The odour inspectors deployed for the project must be selected, trained and familiarised with the work according to the requirements of EN 13725 (2003) before the project begins.
The implementation phase includes assigning and coordinating the odour inspectors and ensuring the scheduled inspections are performed in conformity with the guidelines. As soon as the data collected during an inspection has been sent by an inspector and is available to the employee responsible for the project, they must perform a plausibility check, so that the validated data can then be incorporated in the evaluation.
The results are generally evaluated by transferring the data from the inspection records into prepared tables, where it can be analysed and statistically evaluated. The results are usually delivered to the client with the sending of the inspection report after the end of the inspection period. In individual cases it is also agreed that an interim report will be provided.
The weak points, which result to date from the lack of use of efficient technological solutions in grid inspection projects, are explained in the following.

3. Optimisation potential in the workflows

Experience shows that a large amount of time and work is required during the planning phase, in order to collate the data required from various information sources and media for preparing the inspection schedule. The extraction of information from different sources always involves a media break and at an early stage results in the slowing down of further processing of the information.
The deployment and organisation of trained odour inspectors, most of whom do this work as a spare-time job, presents additional challenges for the measurement laboratories. Inspections must be scheduled, adjusted and statistically spread uniformly among the odour inspectors for the entire project period. The measurement laboratory is also obliged to monitor that the inspectors perform the inspections properly by performing regular checks.
Therefore, organisation and coordination of the inspections requires fast and reliable communication between the measurement laboratory and the inspectors deployed. It must also be possible to respond at short notice to changes in inspection dates or times or cancelled or missed inspections, in order to minimise changes to the inspection schedule. The organisation of replacement personnel is an additional task for the project manager.
From the named points, a larger amount of work results for the administration of current projects. Following an inspection by an odour inspector, they must first send the records to the measurement laboratory, which in many cases is done by post. On arrival of the inspection records they must then be

manually transferred into digital documents by the responsible employees of the measurement laboratory so that the statistical evaluation can be started. The human factor, especially where there are a large number of records, is an additional potential source of errors that can have a negative effect on the quality of the results.

The digital documents in turn only form the basis for the preparation of interim and final reports, from which problems can be identified and possible measures can be derived. The time required for manual evaluation is therefore a decisive factor, which significantly limits the possibility of providing prompt results to the client.

The delivery of a final report to the client, from which the results of the inspection can be seen, also always only represents a consideration of the past. In several cases an interim report is supplied, in order to obtain initial findings on the actual odour immissions situation during the course of the project. This means that in general it is not possible to directly trace odour immissions to emissions-critical plant processes. In turn, this means that it is not possible for the plant owner to quickly initiate corrective actions to improve the emissions situation.

4. Initial tests on technical solutions

The problems explained above were identified early in the past and led to the development of initial solutions. For example, in 2003, Ecoma GmbH offered an inspection system for pocket PCs. These pocket PCs could be operated with an input pen via a resistive display and were equipped with a GPS receiver, in order to record position data of the inspectors at the inspection points during the inspections.

The MF3 inspection system was developed in order to enable the measurement laboratories to digitally record the data in the field. One object was to create an option, more efficient with regards to time, for implementing the inspection projects. By connecting the pocket PCs to a computer, inspection results, weather information of the inspectors and GPS position data of the inspection could be transferred via an export function.

High procurement costs of approx. 1,300 € per system and the fact that the devices had to be evaluated again centrally in the measurement laboratory after the inspection had been completed, meant that the added value tended to be low compared to carrying out inspections with paper records. This solution was also limited to only recording the inspection data and the export. Both the planning phase of the grid inspection, administration of the implementation and the necessary further processing of the data for the purposes of evaluation remained unaffected by the solution. It became clear that the available technologies were not attractive in price terms and their options for optimising the processes involved in grid inspections were too limited.

5. . Technical options in the age of Web 2.0

The increasing spread of broadband internet connections and efficient web applications in recent years mean that new options are now available for dealing with the known problems. This development also benefits from the broad availability of powerful and cost effective mobile terminal devices with the possibility of mobile internet use. These provide the basis for the development of comprehensive and efficient online systems, which enable interaction between web applications and mobile applications.

Therefore, at the beginning of 2010, a development project of an online system for grid inspections named “MF4” was started which was later renamed OFIM (Online Field Inspection Manager). This combines the available Web 2.0 technologies, in order to create a solution that supports measurement laboratories from the initial planning steps through to delivery of results to clients.

It is based on a central online platform, operated on a web server. Access by web browser enables users to log into the system from anywhere and to manage their own grid inspection projects. When new inspection projects are created, the user can carry out all the necessary planning steps via the system. This includes creating and grouping various odour characters, the definition of inspection points and grid areas on the basis of digital map material and the definition of inspection routes.

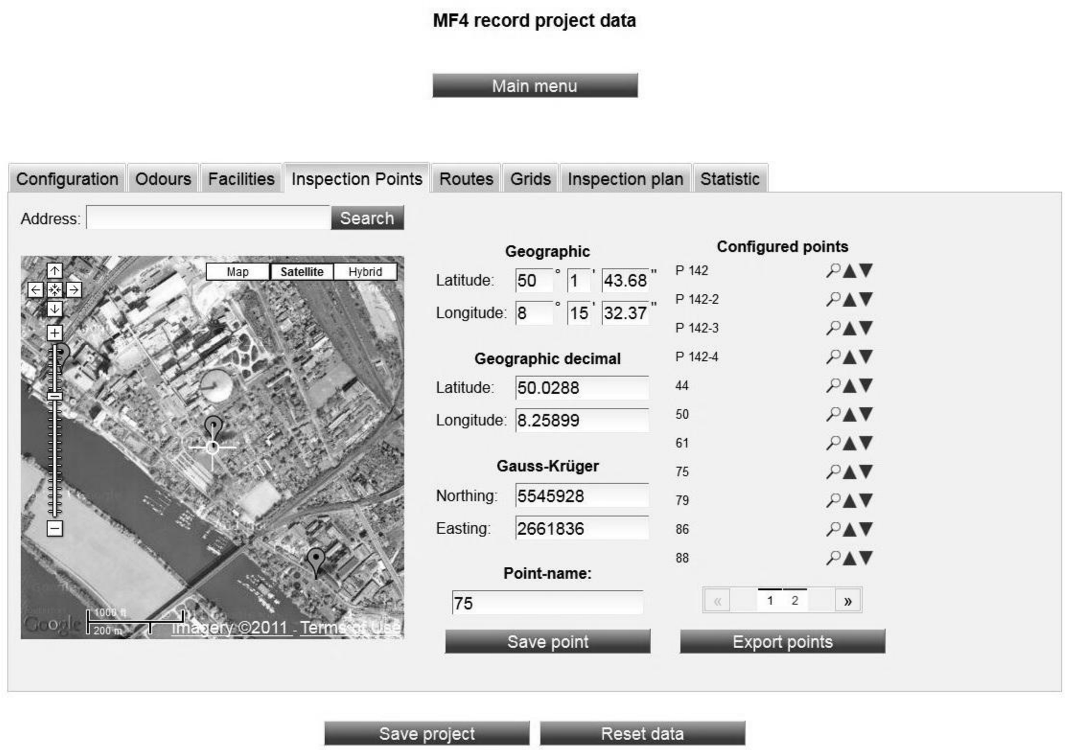

Figure 1: Inspection point management in the OFIM web application

If grid points defined during the planning are not accessible for inspection, they can be relocated online within a very short time. Figure 1 shows an example of inspection point management with the OFIM web application.

Predefined and individual inspection schedules conforming to VDI 3940 (2006) can then be automatically created. The time scheduling and personnel organisation aspects of the inspections are also dealt with centrally via the online platform.

The inspectors can examine the planned inspection dates via a web access to the system and can register for participation. The final assignment of the inspection dates continues to be made by an employee of the measurement laboratory who is responsible for the project, to ensure the necessary statistical spread of the deployed inspectors.

When they examine the inspection schedule, users can then see immediately, which inspectors are available on which days. With the assignment of the inspection date, the system automatically sends a confirmation e-mail to the inspectors. This substantially reduces the administrative work of the measurement laboratory, required for the assigning of the inspection dates and personnel coordination, which until now has been done manually by phone and e-mail.

The mobile application “Odour Inspector” for smart phones with the Google Android™ operating system is used by the odour inspectors to digitally record data during their inspections. Figure 2 shows an example of the user interface of the Odour Inspector mobile application during an inspection.

Figure 2: User interface of the Odour Inspector mobile application

A major advantage compared to the earlier inspection system for pocket PCs is that today, thanks to mobile internet connections, smart phones can be managed decentralised. For the measurement laboratory, this means that the mobile terminal devices can be kept by the inspectors for the entire inspection period and do not have to be collected before the inspection or returned to the measurement laboratory for evaluation.
The inspectors use a user-friendly interface to download the necessary project data on the day of the inspection, which is updated daily. During the inspection they use GPS positioning to find out whether or not they are at the correct target coordinates. This is used by the measurement laboratory as an additional option for regular inspector control, as required in VDI 3940 (2006). The inspection results are transmitted to the online platform via the smart phone's internet connection. This means that the results are in the system immediately after the inspection and are available to the project manager and the results can be evaluated promptly. The evaluation of the inspection results is fully automatic, which means there is no need for manual evaluation by the project manager. The system not only provides a detailed view of individual inspection results for the user, but also a comprehensive overall view for a defined viewing period. With the selection of the required viewing period, various results are made available to users in tabular and graphic form on a map.
From the graphic display of the results, the immission frequencies of the grid areas for the selected period can be examined at a glance. Following a plausibility check of the results data by the project manager, it can be marked as validated. Two functions provided for the delivery of results reports offer considerable added value, not only for the measurement laboratory but also or the client.
An online access can be made available to the client via the system, which enables clients to examine validated results data for their project at any time. If the plant processes are recorded at the same time, it is possible to quickly draw conclusions regarding emission-critical processes, which facilitates prompt initiation of measures to improve the emissions situation. If direct examination by the client is not required or not wanted by the authorities, the system offers exporting of the results data, which can be used to prepare reports for submission.
During the development of the OFIM system, the early involvement of lead users played an important role, enabling customer feedback to be obtained during the development and customer requirements to be incorporated into further development. Two laboratories were involved in the development and provided valuable information throughout the process. Through short development cycles for the delivery of new software versions, their practical suitability could be tested quickly.
The development of the OFIM clearly showed how use of the system can create added value, which all parties involved in the project benefit from. Through the automation of processes and central

management of their projects, measurement laboratories are able to achieve clear savings with regard to time and personnel deployment. The digital recording of the data and automated evaluation also prevent transmission errors of manual evaluation and increase data integrity as well as the quality of the delivered results. Location-independent access to projects and results enable project managers to carry out the grid inspection administration work outside of their office too. By accessing the schedule management, the odour inspectors deployed can clearly reduce the coordination work for the project manager and the inspectors are supported in implementing the inspections through the use of mobile terminal devices. Apart from the measurement laboratories, clients and approving authorities also benefit from the availability of results data entered and updated on a daily basis, as they can obtain an ongoing overview of the odour immissions situation during the project.

6. Future prospects and possibilities for further development

The OFIM inspection service is currently successfully being used in grid inspection projects all across Europe. The current status already shows how the use of Web 2.0 technologies supports measurement laboratories with the determination of odour immissions and can help to increase the efficiency of grid inspection workflows.

By feeding in weather data from local weather stations, in future, additional relevant project data can be incorporated in the online inspection system. Further valuable information would be provided by incorporating the complaints. Here the local residents in the vicinity of the plant could be given the opportunity to register their odour complaints using an online form. Annex D of VDI Guideline 3883 (2003) part 1 provides an example of how such an assessment of odours and the recording of odour nuisance by the residents with the help of questionnaire techniques could look like.

By actively involving residents and central control of the complaints, a comprehensive complaints management solution could be produced. Central collation and evaluation of validated inspection results and correlating residents' complaints could give plant owners an opportunity to take measures to reduce odour immissions in the neighbourhood. This could be an initial approach to solving future complaints situations between plant owners and local residents through cooperative and fact-based dialogue, with the objective of achieving good and trustworthy neighbourhood relationships.

7. Conclusions

The studies show that Web 2.0 technologies offer a variety of new ways to track, evaluate and monitor odour immissions. Faster acquisition of data, improved data quality, instant availability of results and a new level of transparency are the main advantages that can be achieved through the use of these technologies. The ongoing trend towards data transparency on the internet will not stop at odour immissions and complaint situations caused by odour nuisance. A wide range of data including air quality is already being monitored and publicly available on the internet. Authorities as well as plant owners will have to adapt to this trend and find ways to contribute to this development. Gathering live information on plant emission data, weather data, factual results on odour immissions as well as resident complaints could deliver valuable information on the correlation between those factors in the future.

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