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ODOUR EMISSIONS FROM INTENSIVE PIG FARMS

Extended abstract

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Background

Odour is a local problem but is an issue that is becoming increasingly important as the livestock industry expands and as ever increasing numbers of rural residential developments are built in traditional farming areas, bringing residential areas closer to livestock farms. The increase in number of farm neighbours is expected to lead to increased attention to odour as an environmental issue. Odour can be emitted by stationary sources, such as from storage, and can also be an important emission during farm activities, such as landspreading, depending on the spreading technique applied. Its impact increases with farm size. Dust emitted from farms contributes to odour transport. In areas with a high density of pig production, plumes from one farm can potentially transfer diseases to other farms (Valli et al., 2008).

Odour emissions can give rise to problems with neighbours. Emissions of odour are related to many different compounds, such as mercaptans, H_2S, skatole, thiocresol, thiophenol and ammonia, but although not all compounds that are involved have been identified yet (BREF, 2013).

Generally, housing systems vary mainly based on the proportions of fully – slatted, partly – slatted or solid (concrete) floors. Directive 2008/120/EC of 18 December 2008 lays down minimum standards for the protection of pigs and, among other things, imposes a maximum width of openings in concrete slatted floors according to the type of pigs (Council Directive, 2008). In addition, the ventilation of pig housing varies from manually controlled natural systems to fully automated fan – based systems. With dynamic systems, the distribution of air can be accurately adjusted by means of valves, positioning of the fans and diameter of the air inlets. Natural ventilation depends more on the natural fluctuations of the outside air temperature and on the wind. In the Northern of Italy, the pig houses are generally characterized of fully – slatted floors with natural ventilation. In this paper, we collected odour samples in more kinds of intensive pig farms, to understand which permit lower odour emissions, in relation with BAT.

We can use emission factors of different livestock farms in more than one situation. In first place they are used to valuate odour impact of farms in project for which it is not possible make measures. The odour impact calculated using a standardized procedure is used by the authorizer to determine the sustainability of the work. The emission factors are important not only before the construction but also when the farm is working: I mean in the monitoring plan. Sometimes the EIA monitoring plan is not developed with the proper attention, sometimes it is remanded to a later stage that is not well defined. This is true especially for those impacts with difficult evaluation. It is so that in monitoring plan we'll find all those impacts for which it was not possible to quantify the amount and therefore the monitoring plan will be a list of measures to assess those impacts that could not be estimated beforehand. The livestock farms could fall in this trap because of the absence of information about odour emissions or because we don't have a good database for emission factors

Use the monitoring plane to assess unknown impacts is a practice that should be avoided. Assess the unknown impacts would not be a cheap practice, in particular for odorous impacts for which the verification of the disorder is complex, costly and not free of uncertainties. Furthermore, actions to mitigate after construction of the livestock farm, are likely to be expensive because structural rather than management. For odour impact, in particular, the

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monitoring plan should be oriented to the verification of the emission factors rather than of entries, leaving the extent of these only as a last step of a procedure that involves, firstly, the verification of the expected emissions.

This procedure, which is currently a work in progress, was created by ARPA FVG for monitoring plans for farms which give rise odour impacts unsustainable. The basic idea is to proceed in stages aimed at identifying the sources of the odour impact and act with mitigation measures oriented and calibrated. The early stages of this procedure are of managerial type and provide for verification of the "factors" which are actually implemented (e.g. how much pigs.) If the odor remains we pass to the subsequent stages which provide for the control of the emission factors used for the preventive estimation. The control is performed by means of olfactomety measures directly in the company in order to identify any specificity or errors in the emission factor used by the literature. The transition to the next phase is in the case in which the mitigations implemented not solved the problems. Only the final phase includes measures of odour directly to the receptor. Therefore, the method is based on a solid assessment of the emission factors of the system to be used as a preventive measure and to be controlled afterwards. The test results can help to implement the emission factors database which should be built.

Objectives

The main objective of this work is to obtain odour emission factors for intensive pig farms and understand, with the application of dispersion models, which is the odour dispersion in the surroundings of a plant. The experimental data are collected in several intensive pig farms, with the method of dynamic olfactometry (CEN, 2003). Then we used a dispersion model, such as Calpuff, to evaluate odour dispersion in the surrounding of every intensive pig farms and compared our results with report of smell of resident people.

The main objective of this work is to obtain odour emission factors and understand which kind of facility and ventilation permit lower odour emission, in relation with BAT.

Outline of the work

This work is divided in three main parts:

- The first part covers samples collection at several intensive pig farms with dynamic olfactometry. Results are expressed in ou_E/m^3, in compliance with EN 13725.
- The second part covers validation of olfactometric results, with application of dispersion models. The results obtained are compared with report of smell of resident people.
- The third part reports results of animal house measurements. Results are expressed as odour emission referred per animal (ou_E/s/ap, as explained in BREF, 2013). Results obtained in our Laboratory are compared with standards, that are illustrated in BREF (2013).

Methods

This paper presents the results of the olfactometric analysis which are realized in several intensive pig farms. The results are elaborated to obtain emission factors which described the odour emission in function of the type of pig houses and ventilation. In general, European Standard EN 13725:2003 is the method used for monitoring of odour emissions.

The method is based on odour detection by trained human assessors by using a specific apparatus (olfactometer) of diluted gas samples at progressive degree of concentration, until the same threshold response is elicited as from the reference odour (n-butanol). The odour concentration is expressed in European odour units ou_E/m^3. In this case, we collected several odour samples with a vacuum sampler. In every type of intensive pig farms, measurements were made at the exhaust outlet of the air exchange fans or, if there was natural ventilation, at air outlets. The numbers are also used as input in dispersion models, such as Calpuff. CALPUFF is a puff Lagrangian dispersion model, in which the conservation equations of mass are written and solved by reference to emission releases called puff, which approximates the continuous emission. The equation for each puff is determined from the wind field. This wind field is calculated using a meteorological pre-processor (CALMET), which uses as input data, the data coming from the meteorological and mapping refer to the concerned site and for the simulation period. The output file of CALMET is processed by CALPUFF, together with the emissions data to get the desired concentration field. For the development and evaluation of results, the document of Regione Lombardia has been taken as reference (Regione Lombardia, 2012).

Results and discussion

This paper presents odour emission factors for intensive pig farms. The data were collected in several intensive pig farms. In the Northern of Italy, pig houses are generally characterized of fully – slatted floors with natural ventilation. We collected odour samples in intensive pig farms with:

- Fully – slatted floor (FSF) with deep pit: a deep pit lies under a fully – slatted floor with concrete slats. The slurry manure is removed at variables intervals, usually every fattening period, or even less frequently (BREF, 2013). In the case of forced ventilation, the air introduced removes gaseous components emitted by the stored slurry manure. Exhaust air is normally expelled through side wall vents.

- Fully – slatted floor with a vacuum system: on the bottom of the pit under a fully – slatted floor, outlets are placed that are connected to a discharge system moving the slurry to the external storage units (Fig. 1). Slurry is discharged by opening a valve in the main slurry pipe. A slight vacuum develops and allows for a through slurry removal, better than by gravity alone. A depth of slurry needs to be obtained before the system can operate properly to allow the vacuum to develop and empty more slurry (BREF, 2013).

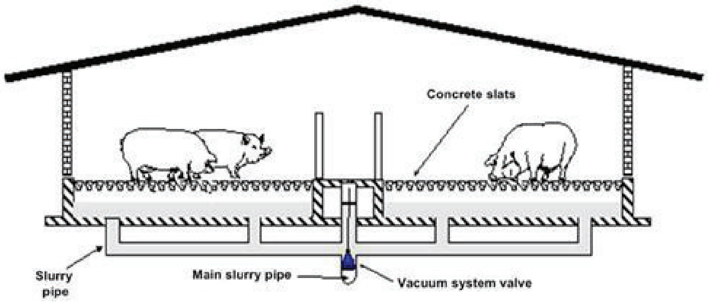

Fig. 1. Fully – slatted floor with vacuum system (BREF, 2013)

After the data collection, using dynamic olfactometry, we used the numbers as input in dispersion models. The mathematical modeling of emissions, based on assumptions made for the source, anemometry data, weather and terrain can evaluate the dispersion of odors. The dispersion models use complex algorithms to simulate the transport and kinetic pollutants in the lower atmosphere where the air is more affected by pollution. To achieve this, the models require input data divided into the following categories:

- meteorological data: wind (direction and intensity), temperature and humidity, atmospheric stability;
- mapping data: topography, cartography, land use;
- emission data: geometry and location of emission sources, type of polluting and mass flow.

The choice of model is often made based on the characteristics of the plant, defined as the set of elements that characterize a specific application. Based on the guidelines of the UNI 10796 (2000), a scene can be described based on five elements:

- spatial scale: computational domain for the dispersion. Can be distinguish between microscale applications (up to 1 km), local scale (up to 10-20 km), mesoscale (up to 100-200 km) and large-scale (up to 1000-2000 km);
- time index: short-term application (from minutes to days), medium term (from one hour to one week) long-term (seasonal and annual);
- geographical area: simple site (flat, uniform spatial features) or complex site (complex terrain, not constant spatial characteristics);
- types of sources: point, linear or aeral;
- simulated species: odour.

Fig.2 shows the odor dispersion model of the actual situation for a livestock facility with 1.100 fattening pigs, pointing out the values of 1.3 and 5 ou_E/m^3 reported by the Guideline of the Lombardy Region (Regione Lombardia, 2012).

The results of dispersion model are compared with reports of smell of the resident people. Results of the comparison between simulated and experimental data show that model is capable to predict satisfactory the odour dispersion on the surrounding of a plant. After that, we calculate odour emission factors. Results are expressed as odour emission referred per animal (ou_E/s/ap, as explained in BREF, 2013).

This paper presents the emission factor for intensive pig farms. We analyzed pig houses with fully – slatted floor. Our results differentiate the kind of ventilation used in the f intensive pig farms: the ventilation of pig housing vary from manually controlled natural systems to fully automated fan – based systems. With dynamic systems, the distribution of air can be accurately adjusted by means of valves, positioning of the fans and diameter of the air inlets. Natural ventilation depends more on the natural fluctuations of the outside air temperature and on the wind.

All the analyses referred to natural ventilation were conducted in the summer time. We compared results of our laboratory with values quoted in BREF, 2013. The data are similar and confirm that the measurements were conducted in a right way.

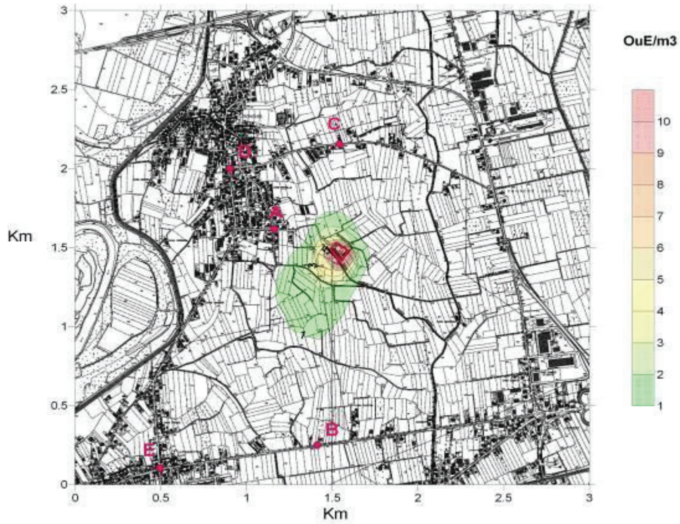

Fig. 2. Odour dispersion on the surrounding of a plant

Table 1. Odour emission factors for intensive pig farms.

Description	*Odour calculated by our Laboratory (ou_E/s/ap)*		*Odour (ou_E/s/ap) (BREF, 2013)*
	Forced ventilation	Natural ventilation	
Fully – slatted floor with deep pit – fattening pigs	5.8	10.6	6.5
Fully – slatted floor with vacuum system – Weaned piglets	1.4	5.8	3
Fully – slatted floor with vacuum system – fattening pigs	13.1	_	7
Fully – slatted floor with vacuum system – gestating sows (individual)	–	6.3	6

Concluding remarks

This paper presents the results of the olfactometric analysis which are realized in several intensive pig farms. The results are elaborated to obtain emission factors which described the odour emission in function of the type of pig houses and ventilation.

We compared results of our Laboratory with values that are quoted in BREF, 2013. The data are similar and we understand that, to minimize the diffusion of odour emissions from pig housing system, it is possible to select a suitable ventilation system, with low air velocity at the floor level.

Keywords: dispersion models, dynamic olfactometry, fattening pig houses, livestock facilities, odour emission

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