

Measuring particles in fattening pig housing

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Livestock contributes to the emission of particles in the atmosphere. Literature shows drastic differences between emission factors by animal category related to the measurement methodologies applied. Based on this observation, a project, called PAPOVIT, involving research and development organizations has been developed in order to (i) establish a measurement protocol strictly adapted to pig building conditions and (ii) calculate emission factors in relation with different housing systems. The first phase of this project, was organized in 3 successive steps. For the first two steps, list of requirements have been established in order to define the final step: the development of the protocol which will be applied on field conditions.

Step 1: Identification of specific conditions of fattening pig building

- Forced ventilation with regulation linked to temperature and age of pigs
- More or less easy access to inlet duct
- More or less easy access to extraction duct
- Manure storage inside building
- Ammonia concentrations: 0 to 50 ppm
- Relative Humidity: 70 to 100 %
- Outdoor temperature: -10 to +40°C
- Indoor temperature: 15 to 35°C



Step 2: Identification of the most suitable equipment

Literature review of 4 principles of measurement:

- gravimetric with collect on one filter (e.g. Derenda Low Volume Sampler)
- Impactors (e.g. Dekati PM₁₀ impactor)
- Beta radiation (e.g. Beta-Dust Monitor)
- Optical light scattering (e.g. Grimm spectrometer)

Equipment requirements:

- Adapted to breeding conditions defined in step 1
- Measurement of TSP, PM₁₀ and PM_{2,5} concentrations in the ambience/extraction duct and outside
- Continuous measurement
- Measurement of massic and particle concentrations
- Equipment weight < 15 kg

Step 3: Protocol development

After the analysis of littérature:

- Choice of the optical method (Grimm spectrometer)
- Coupled with gravimetric sampling (for the calculation of the C-Factor: conversion of PM number per fraction into massic concentration)

After several tests in field conditions:

- Sampling location: in the ambience, in the middle of the corridor (height ~ 1m)
- 3 campaigns per fattening period – 2 seasons (hot/cold) (Fig. 1)
- Recording and measurements per campaign (Fig. 2)
- CO₂ measurements for the determination of the ventilation rate linked with number of pigs and weight (CIGR Equation)
- PM emission expressed in g.h⁻¹

$$E = (C_{\text{indoor air}} - C_{\text{outdoor air}}) \times R$$

with
 C: concentration of particles in g.m⁻³
 R: ventilation rate in m³.h⁻¹

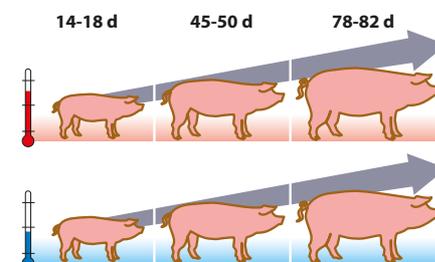


Figure 1: 3 campaigns per fattening period (d: days of presence of pigs)

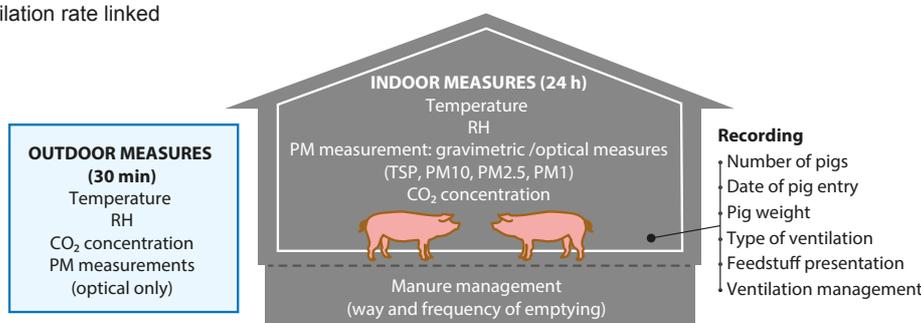


Figure 2: Measurements and recording per campaign

Conclusion and perspectives

This first part of the project has established a protocol specifically adapted to measure particles emitted by piggeries. After several blank tests, the protocol was ready to be used. In the second phase of the project, this protocol will be applied into commercial pig farms essentially located in Western France in order to determine TSP, PM₁₀ and PM_{2,5} emissions linked with the housing system.

