The management of occupational exposure to Carbon monoxyde emission in poultry farming

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Summary

Poultry farming are quasi-industrial sector in agriculture, where in order to keep the temperature enough high for the chickens, gas heating is generally used. This gas heating leads to carbon monoxyde emission, and the workers inhaling it can develop acute and chronic intoxication. As there is a great variability within individual sensitivities, it is quite impossible to define a threshold.

In the French regulation, there's only an time weighted average limit value of 50 ppm, when frequent situations are dealing with 300/400 ppm.

The presentation will discuss the different possible measures to reduce exposure at a reasonable level (ventilation, heater modification and maintenance, other modes of heating), it will also describes the difficulties encountered to implement these measures both technically and economically. It will also present the on going discussions with representatives of the profession.

Poultry farming is more and more intensive, it requires systematically heating at the beginning of each production. When the chickens arrive in the poultry houses, they are one or two days old. They are very fragile and extremely sensitive to physical stress.

Chicks require high temperature and each species needs a specific temperature level .For example, for the chickens, 31 to 33 degrees Celsius are needed, for the turkeys 32 to 34 degrees Celsius, for the guinea-fowls 33 to 35 °C. It is absolutely necessary to avoid any daily temperature deviation higher than 2°C.

All the physical conditions (hygrometry, air speed, air renewal) also play an important role on the health of the chicks. In a part, in the first weeks of the life of the chicks, it's recommended that the air speed doesn't exceed 0.1 metre by second, any airstream is harmful for them. In an other part, air renewal is an important factor to give enough oxygen to the chicks and it is clearly defined according to the size of the poultry house and the number of chicks in it.

So the challenge for poultry farmers is to heat enough, to renew the air a little but not too much to have as little mortality among the small chickens as possible.

Poultry houses are often long buildings (20 to 80 meters long, 15 meters large for example, 3 to 5 meters high). So it's difficult to heat them to obtain an ambient temperature as homogeneous as possible. The heating equipment is traditionally made of a lot of gas heaters which can be located from 1.2 metre high to 2.5 metre high upon the chicks . For example, 30 gas heaters are usually used for a surface of 1000 cubic meters. The ventilation is also regulated by curtains on the sides of the poultry house.

In order to answer to those very strict conditions and for the improvement of the costs of production, poultry houses have been built to be particularly tight, and the management of the ventilation systems is going to be more and more refined.

Toxicity of carbon monoxyde

The gas heating, under some conditions that we will see afterwards, can lead to carbon monoxyde production. It's due to incomplete combustion.

As a matter of interest, carbon monoxyde is an odourless and a colourless gas which binds to haemoglobin. Therefore, it competes with oxygen and in consequence tissues lack of oxygenation. Toxic effects are dose- and duration-dependent, the symptoms can be light like headache or nausea but can also lead to death. Carbon monoxyde is more toxic for human than for poultry. It seems that chicks are not as sensitive as human and

another reason is that the density of carbon monoxyde is lightly lower than the one of the air. The poultry, which is a few centimetres high on the floor is less exposed than the workers.

The table below gives toxic effects in relation to carbon monoxyde concentrations.

CO (ppm)	Duration of exposition	Effects
Human		
50	8h	Nothing
200	2h	Light effects
1000	1h	Nausea, extreme tiredness
	2h	Death
4000	1h	Death
10000	1 mn	Death in a few minutes
Chicks		
160	7 days	No apparent effect
600	30 mn	Toxic (loss of weight)
2000 to 3000	1h 30 to 2h	Death

But it's also proved that there are some individual features which are a bad influence on the toxicity : people who have coronary disease for example, fetus is particularly sensitive....Tobacco smoking also has an influence. As there is a great variability within individual sensitivities, it is quite impossible to define a threshold.

It's the reason why, in France, the legal authorities have only defined an occupational exposure standard which is an average value for long exposure during a working day (8 hours) : 50 ppm, but no limit value for shorter exposures. US standards accept a maximal exposure limit at a level of 400 ppm for short term exposure (mean value on 15 min) and time weighted average limit value of 25 ppm for exposure 8 h a day.

Some data

Last four winters, there was an increase of the number of accidents of farmers in poultry houses : 15 accidents, 25 intoxication and one death. These data are stemming from private insurance for individual farmers. Statistics of the MSA for agricultural salaried workers don't find much intoxication (a few acute poisoning a year) in this occupational branch but with sometimes 1 death (in 1993). Poisoning control centres are an other source of data. For example, in Rennes in Brittany which is an important area of poultry farming, five accidents have been recorded in 1994 with 12 affected people.

It's also thought that a lot of slight intoxication are not known because of the non specificity of the symptoms and the possibility of mistake with self limited illnesses as upper respiratory tract infection or food poisoning.

Analysis of the accidents and measurements in live stock buildings

In a part, the inquiries about accidents or intoxication have brought to light some constant factors:

- They happened in very tight and big houses (often old-designed), with manual adjustment of the ventilation.
- They are recorded in winter with low outside temperature making the farmers heat more and quicker their live-stock buildings.
- The weather was generally windy , so the curtains were closed at the maximal level.
- The poultry production was at the beginning, when young chicks need the highest temperature. The farmer try to heat the building as far as possible for economic reasons, this practice leads to an increased concentration of carbon monoxyde.
- Gas heaters were old and often low maintained or covered with dust.

In the other part, beside accidental context, measurements have been carried out in poultry houses by occupational services in MSA or by agricultural federations. The lataest examples of results are summarised just below, keeping in mind that 50 ppm is the only average value in France:

Organism	Number of examined buildings	Number of buildings with more than 50 ppm and maximal CO concentration
MSA (1997)	352 buildings :	44 (600ppm)
ITAVI (1999)	51 buildings	8 (350ppm)

Perception of the risk

What is the most surprising is that, even in the facilities where there was an accident in the past, nobody seems to be assess the risk at the right level. The workers often aren't informed about the hazard.

Otherwise, poultry houses are located in the west of France where unemployment rate is high. When the workers know the risk, they sometimes prefer to keep their job and take the risk than to be unemployed. Furthermore, they can't directly act themselves on the management of the ventilation or the regulation of the heating. When it's possible, they seek an advice from their occupational physician or hygiene engineer, they try to change their own work organisation. When they move from one live-stock building to another, they take a breath of fresh air, that brings them some oxygen.

For farmers or employers, the problem is different, priority is given to economic reasons. The possible measures of reduction of the risk are often economically unbearable for a very small firm.

Proposed solutions and encountered difficulties

Many levels of action can be investigated in this type of problem:

- New live-stock buildings are studied to be less tight, without being harmful for the chicks. The idea is feasible for new poultry houses. But it's impossible for the existing buildings to be destroyed and rebuilt. And the excessive cost of modifications and their failures in the tightness of existing buildings often make the idea given up.
- More applicable is the management of the ventilation. The studies have showed that it's necessary to obtain an air renewal percentage of 20 % of the building per hour, that is 0.8 m3 per hour per m2. The management of the closing of the curtains is also very important to reduce the airstreams but to maintain a sufficient aeration of the building. The depollution of carbon monoxyde is caught between the poultry health and the human health.
- Another factor is the quickness of the heating at the beginning of the production. Quicker the farmer heat his building, higher will be the CO concentration in the air. So progressive heating of the poultry house in successive stages over a period of 36 to 48 hours was shown to be preferable to rapid heating. Of course, the energy cost is not the same!!!
- It is also important to keep gas heaters well-maintained and not defective. It seems that an age up to 5 years for the heating equipment is a factor of high carbon monoxyde production. But the price of one new gas heater is about 80 Euros (there are about 30 in a building) and this is a strong limit for farmers to replace them. The heating equipment makers are thinking about new systems which could produce less CO, but the problem of the cost is always the same. In an other part, prevention advice speak about general good practices of maintenance, but there actually are no real precise advice about the type of maintenance, its rhythm, the way of removing the dust from the heaters…
- Furthermore, the buildings should be equipped with carbon monoxyde analysers, which could prevent severe intoxication But the problem is that a sound alarm is activated when a predefined level is reached (for example 200 ppm) and this noise stress the chicks and make them die. It's why the workers stop the alarm as soon as it rings. The real level of carbon monoxyde is never really known because the duration of measurement is not sufficient.

In conclusion, this is an example of the difficulties that can be encountered in small firms with a lot of technical and economic constraints.

In MSA, after the first analysis of the problem, we are going to realise very simple information documents for the workers to be sure that they know the risk. The second target will be the general practitioners ; actually, it has been proved that the diagnosis is often problematic because of the non specificity of the symptoms of the intoxication.

In a second time, we are going to involve safety engineers and occupational physicians in being equipped of analysers, and in measuring as often as possible CO level in poultry houses. Then, it will be possible for them to give to the farmer and the workers some information about the prevention of the risk.

At last, we are working with heating equipment maintainers to give more precise and practical advice, that could reduce at low price the concentrations of CO in the air.