Hassan Elhussein and Herman Van den Weghe, Vechta

The Effect of Internal Parameter on the Dust Concentration in Broiler Houses

The results of this study indicate that light has a significant effect on total dust concentration. The total dust concentration in the light period was two times more than in the dark period. The results show that the level of total dust concentration varies significantly for different days of measurement. It should be noted that, although the levels of dust concentration vary, there is no direct correlation between dust concentration and days.

Mr. Elhussein was Master Student and Prof. Dr. Ir. Herman Van den Weghe is Head of the Department for Process Engineering at the Research Centre for Animal Production and Technology, Driverstraße 22, 49377 Vechta,
e-mail: hweghe@fosvwe.uni-vechta.de

Keywords

Broiler, airborne dust, air quality

The objectives of this study were to determine the dust generation in broiler houses and to investigate the influence of factors on the dust concentration level. The dust is one of the main pollutions in the air of broiler houses. Increasing interest in animal welfare and the awareness of the effect of dust on human and animal health were registrated [1, 2].

Material und Methods

Materials

The experiment was conducted in a commercial house. It was carried out during the period October to November 1995. In this experiment 29 000 white Broiler Chicks (ROSS) were used. The windowless building had an inside area of 75.6 m • 16.52 m and a height of 2.85 to 4.66 m. The wall and roof unit area thermal conductance were 0.56 W/m^{2}K and 0.51 W/m^{2}K, respectively. The birds were kept on a concrete floor that was covered with a 2 to 3 cm layer of straw.

The building was mechanically ventilated using eleven fans (Multifan 6D71, Multifan, The Netherlands) located along its rear end. A negative pressure ventilation was produced by these fans, each of which was capable of moving 4.31 m^3/s of air. The air was forced into the house through slotted inlets along the top of both side walls of the building. Each side was attached with 21 slotted inlets, each of which had an area of 33.3 cm• 124.6 cm. The areas of the inlet openings were kept constant. The hinged baffle at the inlets directed the airflow along the ceiling. The house was equipped with four heaters (Ermaf Erma 15 V, Thermaflex company, Germany) which were located in the middle at a height of 2.29 m above the floor. Each heater needed 3.5 m^3/h natural gas to produce 33 kWh heat. The heated air produced by the heaters (1700 m^3/h/heater) was directed away from the centre of the building. The building was also provided with five mixing fans (Multifan 4D50) placed at the ceiling. The air mixing fans were used for better air distribution in the building. Each fan was capable of producing 2.2 m^3/s of air. The building was supplied by an automatic through feeding system. The feeders were attached to pipes in four rows, each row containing 75 feeders. Nipple drinkers attached to pipes in five rows, each containing 120 drinkers, were used. A computer (Hölscher and Leuschner, Emsbüren, Germany) was used to control and monitor temperature, relative humidity, lighting time, heating time, weight of the birds and amount of feed and water consumed. Operation of the ventilation fans was also controlled by the computer. The light intensity in the building was kept constant at 70 Lux in the animal range during the light-on phase. The total dust concentration was measured using TEOM Series 1400a PM-10 Monitor instrument (Rupprecht& Patashnick, USA) which is a real-time device for measuring the concen-

Growth day	Management
28	0:00 to 3:00 h and 12:00 to 15:00 h light was turned off. 16:00 h straw was distributed. 2:00 to 2:30 h, 3:00 to 5:00 h and 14:00 to 17:00 h food was supplied.
32	0:00 to 3:00 h and 12:00 to 15:00 h light was turned off. 2:00 to 2:30 h, 3:00 to 4:45 h and 14:00 to 16:15 h food was supplied.
34	0:00 to 3:00 h and 12:00 to 15:00 h light was turned off. 2:00 to 2:30 h, 3:00 to 5:00 h and 14:00 to 16:00 h food was supplied.
36	0:00 to 3:00 h and 12:00 to 15:00 h light was turned off. 22:30 to 0:30 h 7176 broilers were removed and light was turned off. 2:00 to 2:30 h, 3:00 to 4:30 h and 14:00 to 17:00 h food was supplied.
38	0:00 to 3:00 h and 12:00 to 15:00 h light was turned off. 2:00 to 2:30 h, 3:00 to 3:50 h,14:00 to 15:45 h and 19:00 h food was supplied.
40	0:00 to 3:00 h and 12:00 to 15:00 h light was turned off. 2:00 to 2:30 h, 3:00 to 4:00 h,6:30 to 7:10 h and 14:00 to 17:30 h food was supplied.

Table 1: Time plan for light, food supply and other management during the experiment

Table 2: LSM and Standard Error (SE) of total dust concentration (µg/m^3) for days at several growth days (n = 288)

Growth day	LSM*	SE
28	3668.88^{cd}	249.49
32	4290.64^{bc}	249.49
34	5241.67^{a}	249.49
36	3598.34^{d}	249.49
38	4511.71^{b}	249.49

* Means with the same letter are not significantly different.

Table 3: LSM and Standard Error (SE) of total dust concentration (µg/m^3) for light on and off (n = 288)

Light label	LSM*	SE
ON	5542.12^{a}	144.05
OFF	2598.11^{b}	346.91

* Means with the same letter are not significantly different.

Table 4: LSM and Standard Error (SE) of total dust concentration (µg/m^3) at different time intervals throughout the day (n = 288)

Light intervals	LSM*	SE
1	4108.01^{bc}	386.51
2	4049.56^{bc}	315.59
3	6453.8^{a}	386.51
4	4012.14^{bc}	386.51
5	3648.17^{bcd}	386.51
6	2777.31^{de}	386.51
7	3849.10^{bcd}	386.51
8	4177.31^{bc}	315.59
9	5650.46^{a}	386.51
10	4400.06^{b}	386.51
11	3198.08^{cde}	386.51
12	2516.90^{e}	386.51

* Means with the same letter are not significantly different.

tration of particles smaller than 10 µm diameter. The TEOM-Series 1400a PM-10 Monitor was composed of two major components: the TEOM Sensor Unit and TEOM Control Unit (and the systems sample inlet). The gravimetric results, quantified as µg/m^3, were reported as dust concentration or total dust concentration without differentiating between particle size fractions [3].

Methods

The TEOM instrument for dust measuring was positioned randomly in the first quarter of the house, where the concentration of dust in this section was assumed to be maximum because the exhaust air was at the other end of the building. The PM-10 inlet filter was mounted 2.2 m above the floor and nearly in the middle of the side walls. The monitor of the TEOM was programmed to store the data from the TEOM sensor unit in the memory of the instrument every 30 minutes. The data was analysed using a computer. The dust concentration was measured in 6 days during the period from the 27th to the 41st growth days, namely the 28th, 32nd, 34th, 36th, 38th and 40th growing days. The inside filter of the TEOM was changed in the days directly before the measuring days. A description of the light plan, feed supply plan and other factors which could influence the dust concentration is given in *Table 1*.

The four sensors (Pt 100) for measuring the temperatures were located in different positions in the building. All of the sensors were mounted 70 cm above the floor. The temperatures were measured in 28 days during the period from the 9th to the 40th growth day (12th, 13th, 27th and 35th growth days failed). The control unit was programmed to store the measured data every 30 minutes during the whole period.

Results

The results of dust were reported as dust concentration in µg/m^3 without differentiating between particle size fractions. The data was separated into days, which represented the data in days, light on and off, which represented the data in the lightness and darkness phases, and intervals which represented the data throughout 24 h time intervals. Due to unbalanced design, the data was analysed with procedure GLM to determine the effect of days, light and intervals on dust concentration. In general, analysis of variance showed highly significant effects of all the variables ($p<0.001$).

Effect of day

49 readings were used in the analysis to estimate the Least-Squares estimates of marginal Means (LSM) of dust for each day. The LSM and their Standard Errors (SE) for the six days are shown in *Table 2*. The highest value of dust was attained on the third day and the lowest on the sixth day.

Effect of light

From 76 readings in the dark phase (light off) and 212 readings in the light phase (light on) the LSM of dust for the two labels are shown in *Table 3*. The difference between the two labels was highly significant ($p<0.001$). The LSM of dust in the light period clearly increased (2 times) more than that in the dark period.

Effect of time throughout the day (intervals)

24 readings were used to estimate LSM of dust for the intervals shown in *Table 4*. Each interval represented a two hour time interval. The intervals were in ascending order in such a way that the 24 h period was represented by the twelve consecutive intervals. The highest value of dust was attained in the third interval and the lowest in the twelfth interval. The multiple comparison t-test between the means ($p<0.05$) are also shown in the Table 4. A clearer representation of mean dust concentration throughout a day is shown in *Figure 1*.

Literature

[1] *Pedersen, S.*: Time based variation in airborne dust in respect to animal activity. In: Livestock and Environment IV – Fourth International Symposium, University of Warwick Coventry, England, 6 – 9 July 1993

[2] *Van Wicklen, G. L., T. L. Foutz, F. N. Rowland* and *M. G. Powell*: Determining harmful respirable particle concentrations for broiler chickens. Paper No. 944025, written for presentation at the 1994 ASAE International Summer Meeting, Crown Centre, Kansas City, Missouri, USA, 19 – 22 June 1994

[3] *Driemer, J.* and *H. Van den Weghe*: Messung der Schwebstaubkonzentration in Stallungen. LANDTECHNIK 52 (1997), H. 6, S. 252 – 253

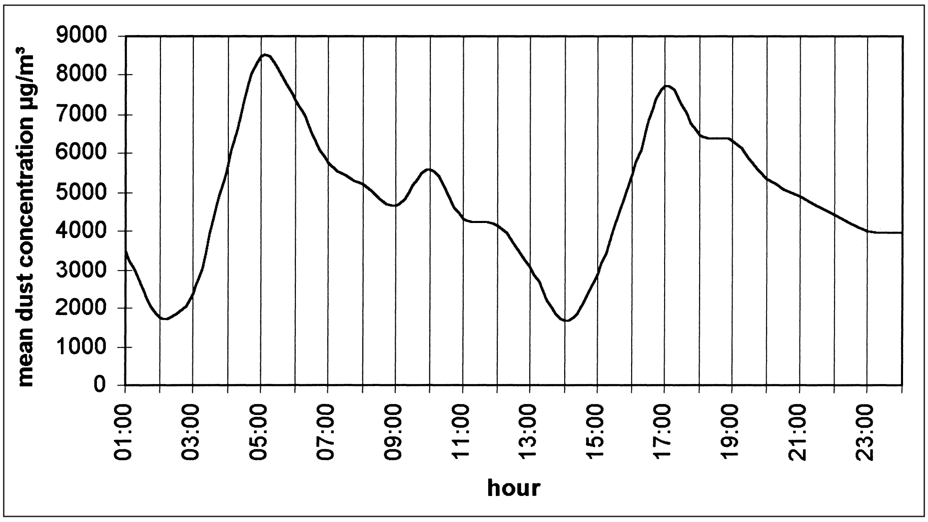

Fig. 1: Mean dust concentration throughout 24 h time intervals for the 6 measuring days