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Poultry Housing Tips

DOL 53 Ammonia Sensor

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In November of 2016 a field study was initiated examining the accuracy, repeatability, and reliability of the DOL 53 ammonia sensor on a commercial broiler farm. The ammonia sensor showed promise during the initial study flocks, but there were issues with accuracy at higher ammonia levels as well as with sensor life with a number of the sensors tested (*DOL 53 Ammonia Sensor...A First Look.* Poultry Housing Tips. Vol. 30 No. 1). Over the next two years the manufacturer worked to address quality control and manufacturing issues and testing of updated sensors continued.

Four of the latest generation of the DOL 53 sensor were installed on a commercial broiler farm in September of 2018. The sensors were placed together, two feet above the inside drinker line, approximately half-way along the length of a 40' X 500' house. Approximately 25,000 chicks were placed and grown to a weight of approximately 4.5 lbs in the house each flock. The house utilized built-up litter which was treated with liquid alum (Al+Clear Liquid A7) approximately four days prior to all chick placements which, along with maintaining a relative humidity below 60%, tended to keep ammonia levels very low during the first couple weeks of the flock.

The four ammonia sensors were connected to a data logging system which recorded ammonia levels measured by each of the sensors every five minutes. During the first study flock, ammonia levels were also measured using a high-accuracy photoacoustic ammonia meter (MSA Chillgard RT NH3 Monitor). Since there was a very high level of agreement between the four DOL 53 sensors and the photo acoustic meter (+/- 3 ppm), it was decided to forego the use of the photoacoustic unit for the long-term evaluation of the DOL 53 sensors and instead the accuracy of the sensors would be checked at the end of subsequent flocks using a 50 ppm (+/- 2%) certified calibration gas. In February, 2020 the accuracy of the sensors was also evaluated using an 8 ppm (+/- 5%) certified calibration gas.

Figure 1 illustrates the ammonia concentrations indicated by the four sensors over the course of a flock approximately 17 months after installation. There was a very high level of agreement between the four sensors. The average standard deviation in ammonia concentrations between the four sensors over the course of the flock was +/-0.5 ppm. The level of variation between sensors was affected to some limited extent by house ammonia levels. During the first few weeks of the flock when ammonia concentrations were at their lowest, the variation between sensors was +/-0.4 ppm (st.dev). During the last few days of the flock, higher ammonia concentrations tended to result in an increase in the amount of variation between the sensors to +/-1.5 ppm (st. dev).

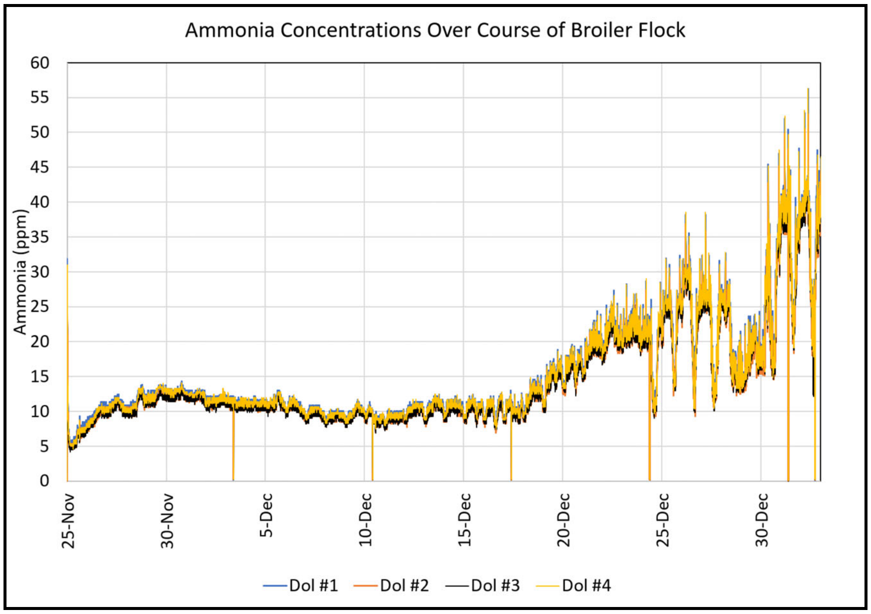

Figure 1. Broiler house ammonia concentrations as indicted by the four DOL 53 ammonia sensors

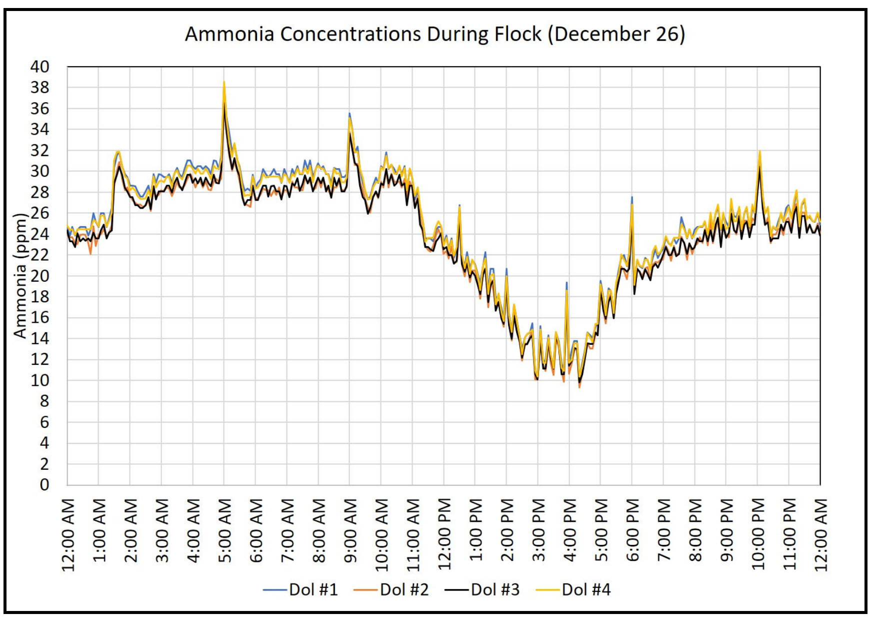

Figure 2. Broiler house ammonia concentrations indicated by the four DOL 53 ammonia sensors on December 26, 2019

Figure 2 provides a good illustration of not only how consistently similar the measurements made by each of the four sensors were at any given point in time, but the sensitivity of the sensor as well. Over the course of the day, the four ammonia sensors were reading within 2 ppm of one another with an average variation of 1 ppm or less. To stimulate bird activity, the farm manager increased house light intensity for approximately 30 minutes five times each day. The increased light intensity resulted in increased bird activity, and a corresponding increase in ammonia concentration. The four ammonia sensors were not only sensitive enough to detect this momentary increase in ammonia, but all responded essentially identically.

The ammonia sensors were left in the house between all flocks and only removed from the house when the litter treatment was applied. To avoid damage during the catching and clean-out process, the sensors were raised to the ceiling. The sensors were left in the house between flocks not only to challenge the durability of the sensor, but also to evaluate how well the sensors would respond to very high ammonia levels not typically seen when birds are present.

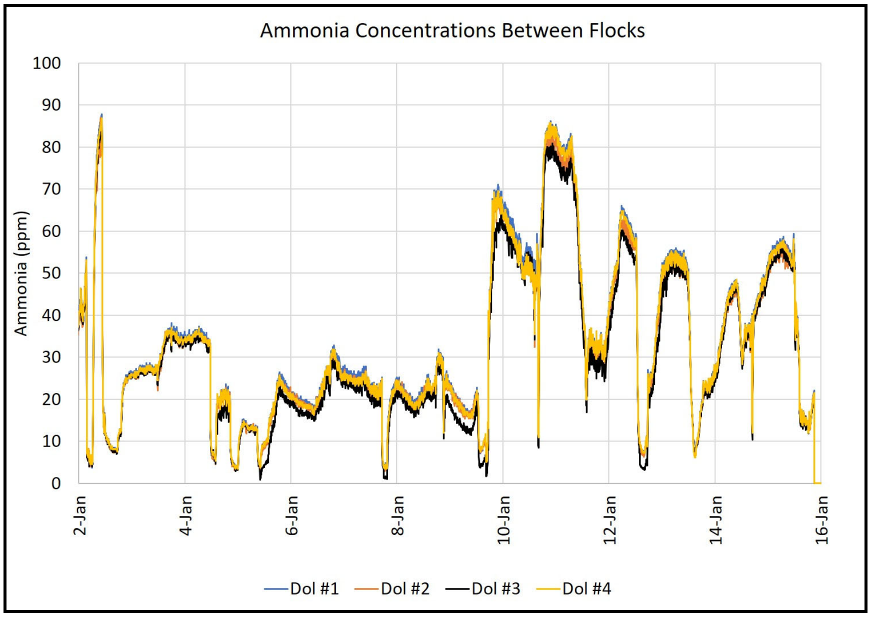

Figure 3. Broiler house ammonia concentrations indicated by the four ammonia sensors between flocks

Ammonia concentrations between December and January flocks ranged between 5 ppm and 90 ppm (Figure 3). There was always at least one exhaust fan operating intermittently at night which kept ammonia levels within the measurable range of the sensors (0 - 100 ppm). During the day, multiple exhaust fans were used to promote litter drying, which resulted in dramatically lower ammonia concentrations. The four ammonia sensors responded well to the dramatic diurnal variations in ammonia concentrations. As seen during the flock, higher ammonia concentrations tended to result in slightly increased differences in the readings between the four sensors. When ammonia concentrations exceeded 60 ppm, the standard variation between sensors increased to +/- 2.5 ppm.

	50 ppm (+/- 2%) calibration gas	8 ppm (+/- 5%) calibration gas
DOL #1	54 ppm	8.4 ppm
DOL #2	53 ppm	8.5 ppm
DOL #3	54 ppm	8.7 ppm
DOL #4	55 ppm	9.2 ppm

Table 1. Ammonia accuracy check (2/13/2020)

Table 1 shows how the four sensors responded to the application of the 50 ppm as well as 8 ppm calibration gasses in February of 2020 (sensors were 18 months old). The 50 ppm calibration gas used had a listed accuracy of +/- 2%, which meant the concentration of ammonia in the tank was between 49 and 51 ppm. The sensors indicated the ammonia concentration of the test gas was between 53 and 55 ppm, which was on average approximately 3 ppm higher than that indicated by the calibration gas supplier. The 8 ppm calibration gas had a listed accuracy of +/-5%, which meant the concentration of the ammonia in the tank was between 7.6 ppm and 8.4 ppm. The ammonia sensors indicated the concentration to be between 8.4 and 9.2 ppm, on average approximately 0.4 ppm higher than that indicated by the calibration gas supplier. This calibration test, as well as previous tests conducted during the 18-month test, found the accuracy of the four DOL 53 ammonia sensors very close to the manufacturer's listed accuracy of +/- 1.5 ppm.

After 18 months of operation, the ammonia sensors continue to operate extremely well. The relatively minor variations in measurements between sensors at typical poultry house ammonia levels from a bird performance/welfare standpoint are insignificant. The same can be said about the slightly higher ammonia concentration readings indicated by the sensor when checked using 50 ppm and 8 ppm calibration gasses. As to sensor life, to date there have not been any issues with premature sensor failure. It was noted with earlier versions they began to fail (indicating ammonia levels 5 ppm or more lower than they actually were) 24 and 30 months after installation, which is roughly the manufacturer's stated life of the sensor. It must be noted that as with any sensor, it is important that the accuracy of an ammonia sensor is checked from time to time with a certified calibration gas. How frequently a sensor should be checked depends on how it is being used. The more important the accuracy of the reading (ie. research, certification for specific animal welfare standard, etc.), the more often the sensor should be checked. For general use, it would probably be best to check the accuracy of an ammonia sensor a couple of times a year.

The question of course is whether ammonia sensors need to be installed in all poultry houses. Ideally, yes, but installing an ammonia sensor in every house on a farm would be costly. The initial unit and sensing element would likely cost approximately $1,000. The sensing element would then need to be replaced every couple of years at a cost of approximately $500. What would likely be a better return on investment would be to install an ammonia sensor in one house (possibly two) on a farm. Generally speaking, ammonia levels tend to be similar among houses on a farm because they tend to be managed similarly. So if the ammonia is high in one house, generally speaking, it will be high in all the houses on a farm. Will there be differences among houses? Of course, but house ammonia levels will tend to be similar enough that corrections in the ventilation rate in one house could be applied to the others on a farm.

Though there are a number of lower-cost, hand-held ammonia measuring devices on the market today, a controller-based sensor that can continuously monitor ammonia accurately has a number of advantages. First, as can be seen in Figure 1, ammonia concentrations can vary dramatically from day to night. So though ammonia levels may be 10 - 20 ppm during the day when farm managers are most likely to be present, late at night when ventilation rates are lower and no one is present, ammonia concentrations easily reach 30 ppm or higher. A modern controller equipped with an accurate ammonia sensor would not only record the maximum ammonia concentration at night, but could turn on exhaust fans to bring excessive ammonia concentrations down to acceptable levels. Secondly, one of the most important aspects of having access to continuous ammonia readings is the "calibration" of a farm manager's ammonia-sensing abilities. When someone says the ammonia concentration is high (or low) what does that really mean? From a bird performance/health and welfare standpoint, there are specific levels of ammonia that are problematic. Someone's perceived "low ammonia level" could actually be harmful to the birds, while another person's "high level of ammonia" in reality might not present a problem for the birds. When a manager can go into a house multiple times a day, and compare what they smell to what the ammonia concentration the house's controller is indicating, over time they will end up with the ability to put a reasonably accurate numeric value to the ammonia concentration they are sensing in each of the houses on their farm.

It is important to keep in mind that it is probably not best to operate exhaust fans based off an ammonia sensor, even if it is accurate. The key to minimizing ammonia levels in a poultry house is to minimize the formation of ammonia, not ventilating to get rid of it, and ammonia formation is best minimized by minimizing litter moisture. Therefore, to control ammonia we need to control humidity, which in turn controls litter moisture. The lower the litter moisture, the less ammonia produced and the healthier and more productive the birds. So though it is very beneficial to know ammonia levels in a poultry house, it is actually more important to have a humidity sensor in a house. Using a humidity sensor, and ventilating a house to maintain a humidity between 40 and 60%, will keep litter moisture, as well as ammonia levels, to a minimum.

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