The effects and management of improper incubation conditions

by Jiggs Killgore and Nicolas Neyra, Hubbard.

Incubator temperature and humidity profiles in single stage incubation are selected for proper embryo development, hatchability, and quality based on average conditions throughout the entire machine. Often little consideration is given for the tray level or zone effects that can commonly occur within most incubators that are on the market today. These differences in temperature throughout the machine can have a major effect on internal egg temperatures. Improper egg temperature can lead to problems with hatch of fertile, moisture loss, and retained yolk weights and chick quality in general.

Results from monitoring internal egg temperatures at transfer in our operation have shown that eggs in the top tray level are on average 0.32°F warmer than eggs in the bottom tray levels next to the floor. This difference in temperature has resulted in a better hatch of fertile from those trays.

The top 10 trays on the front and back of the incubator racks have on average a 2.60% better hatch of fertile than eggs from the bottom 10 trays. Therefore the goal is to monitor, control and reduce this difference in temperature from the top to bottom tray levels.

In addition, this top to bottom temperature difference results in an average of 0.246% greater moisture loss from the top trays as shown in Fig. 3.

Our studies have shown that a higher moisture loss leads to smaller retained yolks in hatched chicks. The moisture loss and retained yolk sac share an inversely proportional relationship as greater moisture loss leads to less retained yolk and less moisture loss leads to a greater retained yolk sac.

This difference in temperature has resulted in a better hatch of fertile from those trays. Therefore the goal is to monitor, control and reduce this difference in temperature from the top to bottom tray levels.

In addition, this top to bottom temperature difference results in an average of 0.246% greater moisture loss from the top trays as shown in Fig. 3.

Our studies have shown that a higher moisture loss leads to smaller retained yolks in hatched chicks. The moisture loss and retained yolk sac share an inversely proportional relationship as greater moisture loss leads to less retained yolk and less moisture loss leads to a greater retained yolk sac.

This leads us to believe that this moisture is lost from the yolk of the egg. This loss of retained yolk can cause the young chick to have less reserve during its post hatch fasting period (sexing, processing, delivery, etc.). A balance of proper internal egg temperatures during the entire incubation process must be achieved.

The internal egg temperature must be warm enough to maintain proper chick development, without creating too much moisture loss.

Day 1 to 10.
Internal egg temperature should be maintained at 99.5-100°F (37.5-37.8°C). The greatest challenge is reducing the single stage profile step program temperature as the embryos become the heat source for incubation.

Often temperature zones that are below target are created in the bottom tray level positions due to improper air circulation and the basic principle that heat rises.

Tray level monitoring

Rack and tray level monitoring is necessary to identify and correct possible temperature variances throughout incubation.

Egg temperatures at transfer and during incubation should always be taken and recorded at the top, middle, and bottom of the racks.

Recording embryo temperatures at each transfer ensures consistency of machine operations and establishes proper trends in the incubation process. Winter months require more heat at certain stages of incubation. Temperature modifications should be implemented after numerous internal egg temperatures are taken, monitored and recorded to show average embryo temperatures. After profile changes are made, repeating the monitoring process is required to ensure ideal incubation.

Internal egg temperature should be maintained at 99.5-100°F (37.5-37.8°C). The greatest challenge is reducing the single stage profile step program temperature as the embryos become the heat source for incubation.

Often temperature zones that are below target are created in the bottom tray level positions due to improper air circulation and the basic principle that heat rises.

Tray level monitoring

Rack and tray level monitoring is necessary to identify and correct possible temperature variances throughout incubation.

Egg temperatures at transfer and during incubation should always be taken and recorded at the top, middle, and bottom of the racks.

Recording embryo temperatures at each transfer ensures consistency of machine operations and establishes proper trends in the incubation process. Winter months require more heat at certain stages of incubation. Temperature modifications should be implemented after numerous internal egg temperatures are taken, monitored and recorded to show average embryo temperatures. After profile changes are made, repeating the monitoring process is required to ensure ideal incubation.

Continued on page 8
Examples of problems that can occur:

### Egg handling, farm and hatchery management:
- Internal egg temperature should be checked at top, middle and bottom trays as they are received.
- If received eggs are lower than 60°F (15.5°C) egg holding temperatures at the farm must be adjusted.
- Egg room temperatures should be adjusted to compensate for seasonal changes. Example: Egg room set point in summer 64°F (19.5°C); in winter 67°F (19.5°C).

### 1 Mortality range (day 1-3):
- Eggs must attain a temperature range of 100-100.5°F (37.8-38°C), as soon as possible at the on-set of incubation.
- Pre-warming eggs as part of the profile will enhance livability percentages and reduce late dead mortality as a result of mal-position or abnormal embryos.

### 2 Mortality range (day 4-7):
- Internal egg temperatures must stay within the 100-100.5°F (37.8-38°C) target at this time; monitor these temperatures closely at the tray levels especially.
- Seasonal set-point changes are needed to ensure proper internal egg temperatures are maintained.
- Consistent temperatures during transfer and egg set (in multi-stage machines) must be maintained.

### 3 Mortality range (day 8-14):
- Correct reduction in incubation temperatures must occur during this critical time period; before 9-10 days: 100-100.5°F (37.8-38°C) as the embryo moves from accepting heat to after 10 days to transfer: 99.5-100°F (37.5-37.8°C) to radiating heat.
- Closely monitor to identify trends, by flock, incubator, etc.

### 4 Mortality range (day 15-18):
- Must have consistent incubation at this stage, at all tray levels; monitor closely at transfer; all trays should be 99.5-100°F (37.5-37.8°C).
- Abnormal embryos are normally associated with too much heat: normally in the 1-3 day old age embryo development stage.
- Mal-positioned embryos usually indicate below recommended temperatures.
- Monitor the tray level position as these embryos will normally be in the bottom of the incubator.

### 5 Mortality range (day 19-21):
- Exceeded or did not attain the temperature goal of 99.5-100°F (37.5-37.8°C).
- Incorrect transfer schedules (19-19.5 days), transfer too soon: mal-position embryos (head-not-under-wing), transfer too late: excessive heat build-up.

---

**Table 1. Internal egg temperatures at rack and tray level positions (taken to establish the proper and current incubator profiles).**

<table>
<thead>
<tr>
<th>D/H</th>
<th>Rack 2</th>
<th>Rack 4</th>
<th>Rack 6</th>
<th>Rack 8</th>
<th>Rack 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T (°F)</td>
<td>TN</td>
<td>T (°F)</td>
<td>TN</td>
<td>T (°F)</td>
</tr>
<tr>
<td>(-)</td>
<td>88.0</td>
<td>7</td>
<td>100.4</td>
<td>14</td>
<td>100.4</td>
</tr>
<tr>
<td>0:00</td>
<td>100.7</td>
<td>7</td>
<td>99.8</td>
<td>14</td>
<td>99.7</td>
</tr>
<tr>
<td>1:18</td>
<td>100.5</td>
<td>7</td>
<td>99.6</td>
<td>14</td>
<td>99.6</td>
</tr>
<tr>
<td>4:00</td>
<td>100.3</td>
<td>7</td>
<td>99.3</td>
<td>14</td>
<td>99.4</td>
</tr>
<tr>
<td>5:18</td>
<td>100.0</td>
<td>7</td>
<td>99.1</td>
<td>14</td>
<td>99.3</td>
</tr>
<tr>
<td>9:12</td>
<td>99.8</td>
<td>7</td>
<td>99.2</td>
<td>14</td>
<td>99.3</td>
</tr>
<tr>
<td>10:18</td>
<td>99.5</td>
<td>7</td>
<td>99.5</td>
<td>14</td>
<td>99.4</td>
</tr>
<tr>
<td>12:00</td>
<td>99.2</td>
<td>7</td>
<td>99.2</td>
<td>14</td>
<td>99.3</td>
</tr>
<tr>
<td>13:00</td>
<td>98.9</td>
<td>7</td>
<td>99.2</td>
<td>14</td>
<td>99.2</td>
</tr>
<tr>
<td>14:00</td>
<td>98.7</td>
<td>7</td>
<td>99.0</td>
<td>14</td>
<td>99.0</td>
</tr>
<tr>
<td>15:18</td>
<td>98.6</td>
<td>7</td>
<td>99.9</td>
<td>14</td>
<td>99.7</td>
</tr>
<tr>
<td>16:18</td>
<td>98.4</td>
<td>7</td>
<td>101.0</td>
<td>14</td>
<td>100.0</td>
</tr>
<tr>
<td>17:18</td>
<td>98.2</td>
<td>7</td>
<td>99.8</td>
<td>14</td>
<td>100.0</td>
</tr>
<tr>
<td>19:06</td>
<td>98.2</td>
<td>7</td>
<td>100.0</td>
<td>14</td>
<td>99.9</td>
</tr>
<tr>
<td>19:12</td>
<td>98.0</td>
<td>7</td>
<td>101.0</td>
<td>14</td>
<td>99.9</td>
</tr>
<tr>
<td>19:18</td>
<td>97.8</td>
<td>7</td>
<td>99.4</td>
<td>9</td>
<td>99.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Set #</th>
<th>Temp</th>
<th>Day/hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>88.0</td>
<td>-00.06</td>
</tr>
<tr>
<td>2</td>
<td>100.7</td>
<td>00.00</td>
</tr>
<tr>
<td>3</td>
<td>100.5</td>
<td>01.18</td>
</tr>
<tr>
<td>4</td>
<td>100.5</td>
<td>04.00</td>
</tr>
<tr>
<td>5</td>
<td>100.3</td>
<td>05.18</td>
</tr>
<tr>
<td>6</td>
<td>100.0</td>
<td>09.12</td>
</tr>
<tr>
<td>7</td>
<td>99.8</td>
<td>10.18</td>
</tr>
<tr>
<td>8</td>
<td>99.5</td>
<td>12.00</td>
</tr>
<tr>
<td>9</td>
<td>99.2</td>
<td>13.00</td>
</tr>
<tr>
<td>10</td>
<td>98.9</td>
<td>14.00</td>
</tr>
<tr>
<td>11</td>
<td>98.7</td>
<td>15.18</td>
</tr>
<tr>
<td>12</td>
<td>98.6</td>
<td>16.18</td>
</tr>
<tr>
<td>13</td>
<td>98.4</td>
<td>17.18</td>
</tr>
<tr>
<td>14</td>
<td>98.2</td>
<td>19.06</td>
</tr>
</tbody>
</table>

**Table 2. Seasonal profiles changes are also necessary for proper incubation with the appropriate temperature, humidity and damper control parameters.**

<table>
<thead>
<tr>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

**Humidity control range**

| 1 | 0.0 | 00.00 |
| 2 | 5.5 | 91.2 |
| 3 | 10.35 | 10.18 |
| 4 | 30.50 | 14.00 |
| 5 | 45.65 | 15.18 |
| 6 | 60.90 | 17.18 |
Examples of problems that can occur during incubation as possible at the onset of incubation.

- Egg room temperatures should be monitored.
- Internal egg temperatures must stay within the 100-100.5°F (37.8-38°C) range to maintain proper internal egg temperatures and reduce late dead mortality.
- Mal-position (head over wing): First week incubation temperatures too cold or too hot. Transfer times are critical; the embryo must be in the correct (head-under-wing) position for the in ovo vaccination schedule.
- Navel buttons: Occur mainly on late hatching chicks; high heat/humidity index in the hatcher.
- A spread in hatch window contributes to the problem: 'cold chicks'. Improper air-flow volumes through hatcher during actual hatch can contribute to navel buttons. Chicks in the cold bottom trays have the highest percent of navel buttons.
- Red hocks: High humidity/low temperature throughout incubation: incubators and hatchers.
- The cooler bottom trays will lose less moisture. The highest percent of red hocks occur in the coolest tray level positions.
- Correct and uniform temperatures at all tray levels, is the most critical issue from the time the egg is received from the farm, during storage, and throughout incubation.
- Consistent monitoring is essential to produce viable chicks at hatch throughout incubation.
- Necessary profile or management changes must be implemented as soon as problems are discovered.

<table>
<thead>
<tr>
<th>Rack 1</th>
<th>Rack 3</th>
<th>Rack 5</th>
<th>Fan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack 2</td>
<td>Rack 4</td>
<td>Rack 6</td>
<td></td>
</tr>
<tr>
<td>Rack 7</td>
<td>Rack 9</td>
<td>Rack 11</td>
<td>Door</td>
</tr>
<tr>
<td>Rack 8</td>
<td>Rack 10</td>
<td>Rack 12</td>
<td>Door</td>
</tr>
</tbody>
</table>

Fig. 4. Moisture loss vs. retained yolk sac.

Fig. 5. Example of incubator racks positions (internal egg temperatures are routinely taken from different racks for monitoring at transfer or for establishing the correct incubation profiles).