CREATE AND EVALUATE A TEMPERATURE MONITORING SYSTEM IN THE CONDITIONER IN PELLETED FEED.

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ABSTRACT

This project has been conducted in New Zealand in 1999, as a requirement for feed production companies to control salmonella in feed by Ministry of Agriculture and Fisheries (MAF). Feed is the most important factor in poultry production enterprises because of its impact on cost and health.

It takes the feed about two minutes to reach the 80 ºC. The feed could be recycled if didn't reach the 82-83 ºC planned. Steam temperature was stable and around 130 ºC. This temperature could be optimized to reduce energy cost without affecting the pelleting process through tracing the feed in temperature (ingredients) one can say, that some of the steam is entering to the feed-in tube and raising the feed-in temperature to 46-50 ºC. The regular incoming feed temperature was between 20-25 ºC. The die temperature was 92 ºC, and cooler temperature for the feed out was 20 ºC.

Key words: Feed, Salmonella, pelleted feed, feed temperature, conditioner temperature, poultry feed.

INTRODUCTION

Salmonella could be controlled in the conditioner when producing pelleted feed for poultry (Broilers, Turkey) or other animals. Feed temperature control in the conditioner is (Coony *et al*., 2010) one of the ways to eliminate salmonella and other bacteria in the feed manufacturing process (Himathongham *et al*.1996) practically and economically. The temperature range 80-85.7 °C (McCapes *et al*., 1988) is affective to kill bacteria in the conditioner (Lake *et al*.,2005). The duration of the temperature is important as well (Africa Fernandez, 2003). Increasing the temperature above this range may drop feed nutritional value (Silverside, 1999) and may reduce the feed energy value (Creswell and Bedford, 2006). Increasing the retention time may affect the productivity of the feed mill. Lower temperature could not affect bacteria present in the feed (John Payne, 2001). Therefore it is essential to know what temperatures are in the conditioner (Peter Cressey, 2011), and or there are temperature differences in the conditioner. Monitoring feed temperature in two locations (in and out) is not enough to have a clear picture about the temperature in the conditioner. Because

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temperatures are usually varies from location to location in the conditioner especially with unstable run. Suggested pelleting feed temperature above 85 °C should be avoided.

Types of conditioners and coolers

There are two major types of conditioners. The first one is that, the steam pipe connection is from the topside as well as the feed in tube. The second type is that the steam pipe is connected to the conditioner from bottom, and the feed in tube from top. Both of them may have retention plate installed at the end of conditioner cylinder.

In the same time there are two types of coolers as well. First type is the counter flow cooler, where the air penetrates the feed from bottom to the top. The second one is the tower cooler. The air comes from the sides and exits from the bottom. Where the first one the sir comes from bottom and exits from top.

Objectives

1- Design and implement temperature monitoring system in the feed mill.
2- Monitoring the feed temperature in the die will not exceed 92 °C.
3- Monitoring feed temperature inside the conditioner not the steam temp.
4- Access to the system from any location through the internet.
5- Display the data graphically and digitally by using Microsoft Office.

METHODS AND MATERIALS

This project has been conducted in New Zealand in 1999, as a requirement for feed production companies and to Salmonella control from Ministry of Agriculture and Fisheries (MAF). The temperature in the conditioner must be 82.2 ºC in all parts of the conditioner (Wong , 2003). The system has to give a clear picture about the feed temperature during production.

Instrumentation

To monitor inside temperature of the conditioner, depending on the length of the conditioner and the rotating mixing paddles inside the conditioner up to eight probes are needed in different locations to adequately collect data without damaging the probes. Locations of the probes are very important and critical to understand what is happening inside the conditioner. Many activities need to be clarified first; the connection of the steam pipe to the conditioner is one of them. Some conditioners are connected at the top others at the bottom. Probes should be placed in locations where the feed is moving, not the steam flow. This means that we are measuring the feed temperature not the steam temperature. Figure 1 gives an idea about the locations of the probes. A data logger has been used with 46 channels, the data logger connected to the internet though out a modem to monitor the temperature and the data from any place in and out New Zealand. Probes used were thermocouples type T, installed though out the feed mill, to the control room, where the data collected and used to verify temperature pattern in all locations and to compare to the planned temperature according to MAF.

The probe locations are as follow: -

1. Feed temperature, measures the feed (ingredients) temperature in the feed pipe connected to conditioner. (Probe 1 Figure 5).
2. Steam in temperature, measures the steam temperature in the steam pipe connected to the conditioner Probe S.
3. Bottom right feed temperature. (conditioner)
4. Topside temperature to detect steam movement. (conditioner)
5. Bottom left feed temperature. (conditioner)
6. Bottom middle side feed temperature before exiting the conditioner.
7. Feed out conditioner temperature, feed exiting the conditioner.
8. Feed out the die temperature; feed temperature leaving the die to the cooler.

Also we need at least 3 to 4 probes in the cooler to detect the feed temperature entering and leaving the cooler. It is important to monitor feed temperature going to the feed storage bins. The above-suggested locations will give a good indication about the feed temperature and feed movement. Regarding to the movement of the feed and the steam distribution of probes was critical to reflect the correct and good mixing of the feed ingredients together and with the steam coming to the conditioner without any separation.

Probe S will give us a clear idea about the steam temperature getting in the conditioner. Some times the steam temperature varies or fluctuates, and we are assuming that it is correct temperature.

Probe 1 will give the temperature of the feed ingredients coming in the conditioner. This probe should always read lower temperature (20-30°C), because there is no heating done to the feed ingredients in previous stages.

Probes 2-6 will give an indication about the feed temperature changes and also how the feed is moving in the conditioner based on temperature changes. These probes should read temperatures range 80-85°C.

The topside probe 4 is an important probe in detecting steam flow especially in conditioners where the steam pipe is connected at the top. This probe will be at the left side of the feed in tube. If the temperature is in the range, then the flow is good, but if the temperature is low then the steam is entering the feed in tube, and it needs to be adjusted. See below diagram.

Probe 7 gives the feed temperature leaving the conditioner. The temperature is just like in the conditioner.

Probe 8 gives the pelleted feed temperature left the die (press). This temperature is usually above all temperature probes readings, because of the pressure extracted on the feed and also the flow of the steam. This temperature could reach 92°C, but it is for very short duration.

Selecting method for adequate probes

Selecting the right probe type and the adequate probe design is essential to collect valid data. Placing the probes in the conditioner is another important task. Probes should be in the place between the pedals of the rotating shaft. This is very delegate work and should be done by professionals.

Missing one millimetre may destroy the prob. We should put in mind there is high temperature, feed moving and pedals rotating in the conditioner. The probes should withstand all of this. Probe should have the following specifications.

Probe design

1. Stainless steel body with raged smooth finish for easy cleaning.
2. It should be fitted in a plastic or Teflon insulation plug to eliminate heat transfers for conditioner body temperature.
3. Thermocouple or RTD probes could be used (preferably RTD).
4. The range of the probe could be 0-120 °C, and for the steam up to 200°C.

The plastic plug should have the following specifications.

1. Very hard plastic, but not to be damaged when mounted in the conditioner.
2. High temperature resistance.
3. Easy to shape and work with. See figure 1 for more details.

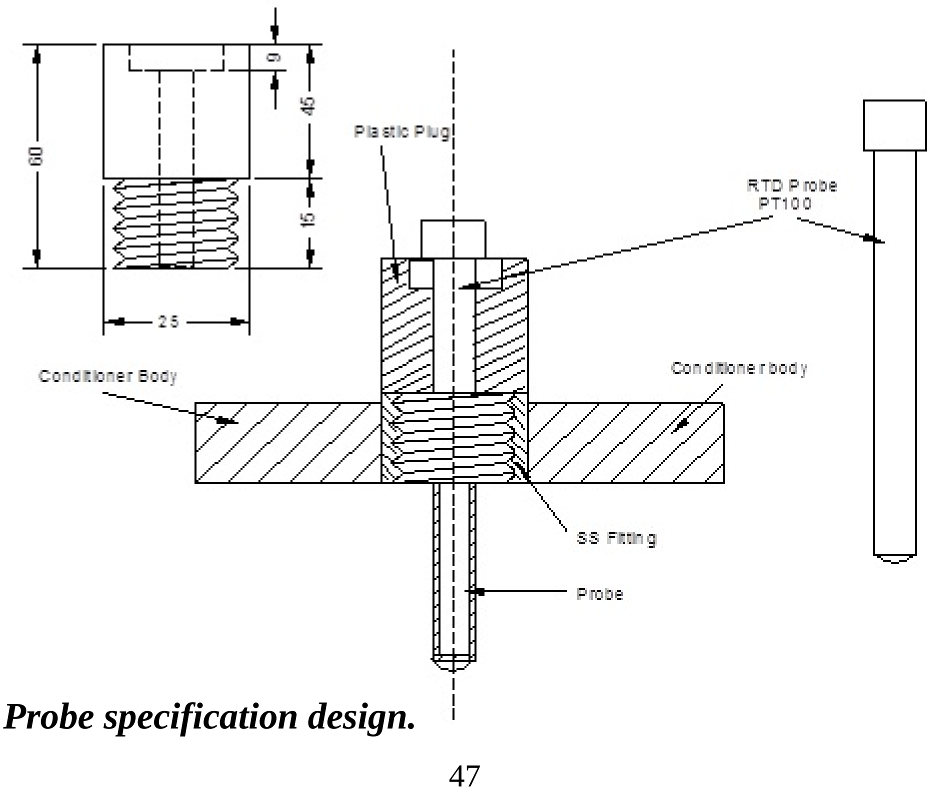

Figure1. ***Probe specification design.***

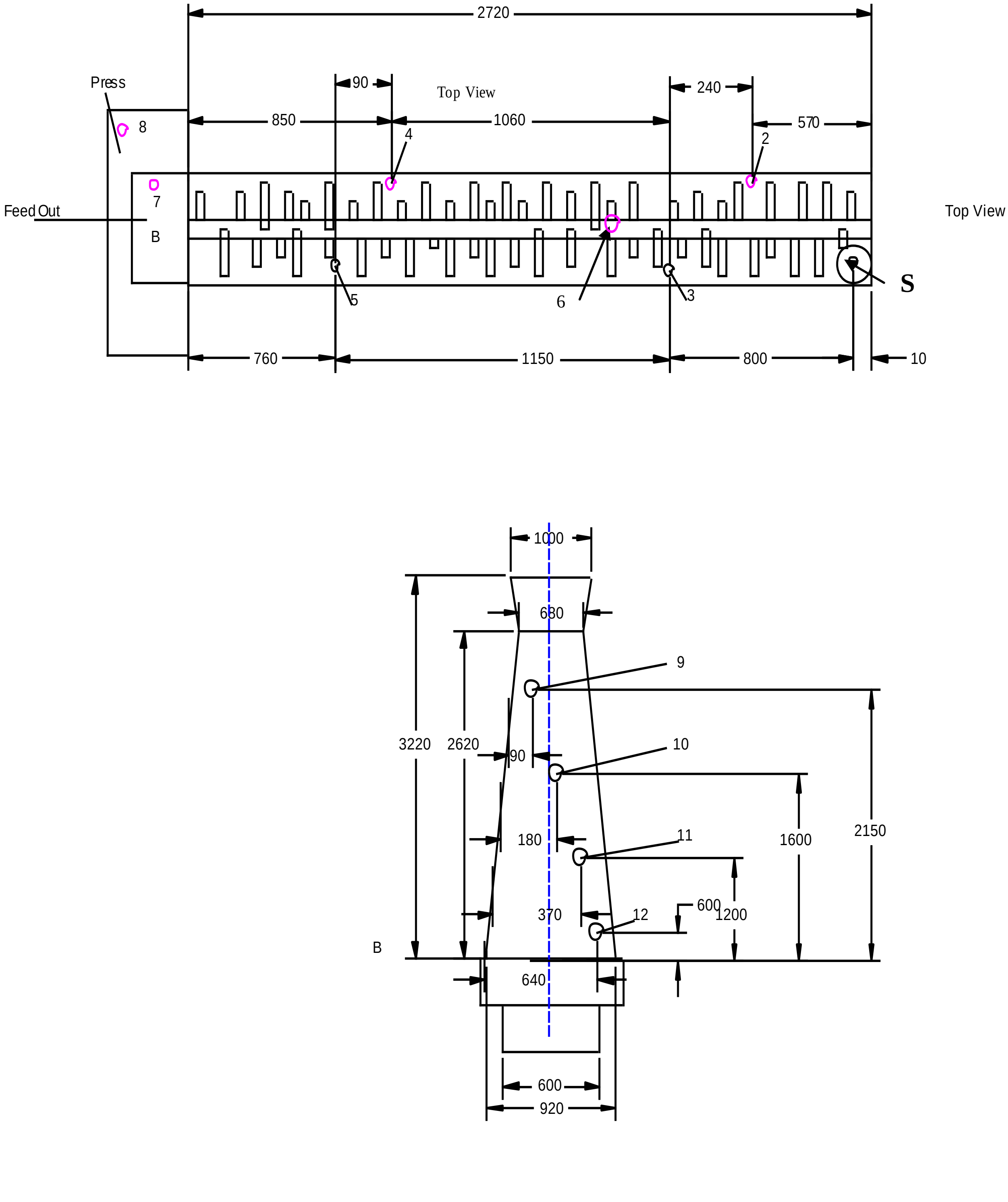

Figure2. ***Probes Placements and dimensions of the conditioner and coolers Numbers 2-8 are temperature probes in conditioner and 9-12 are temperature probes in the cooler.***

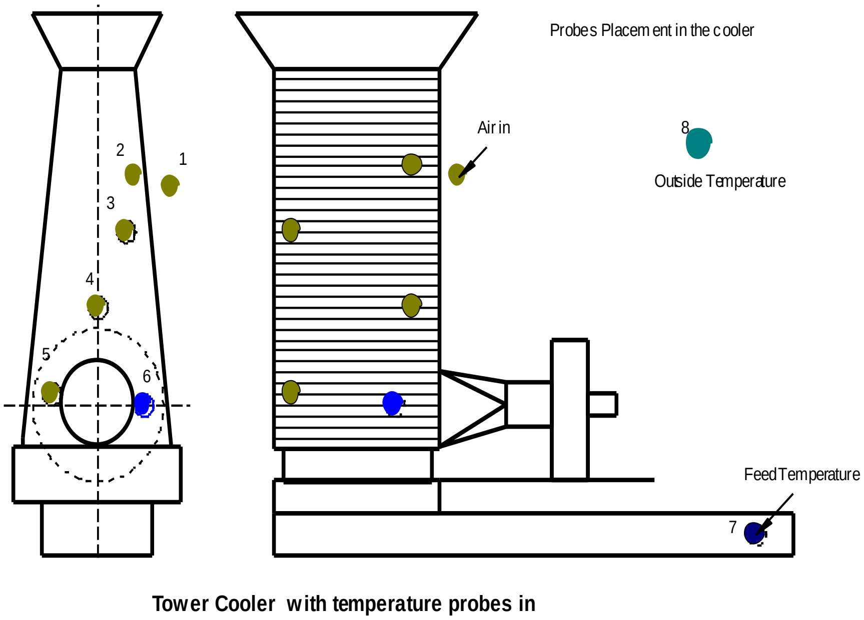

Figure 3. Tower cooler with temperature probes places.

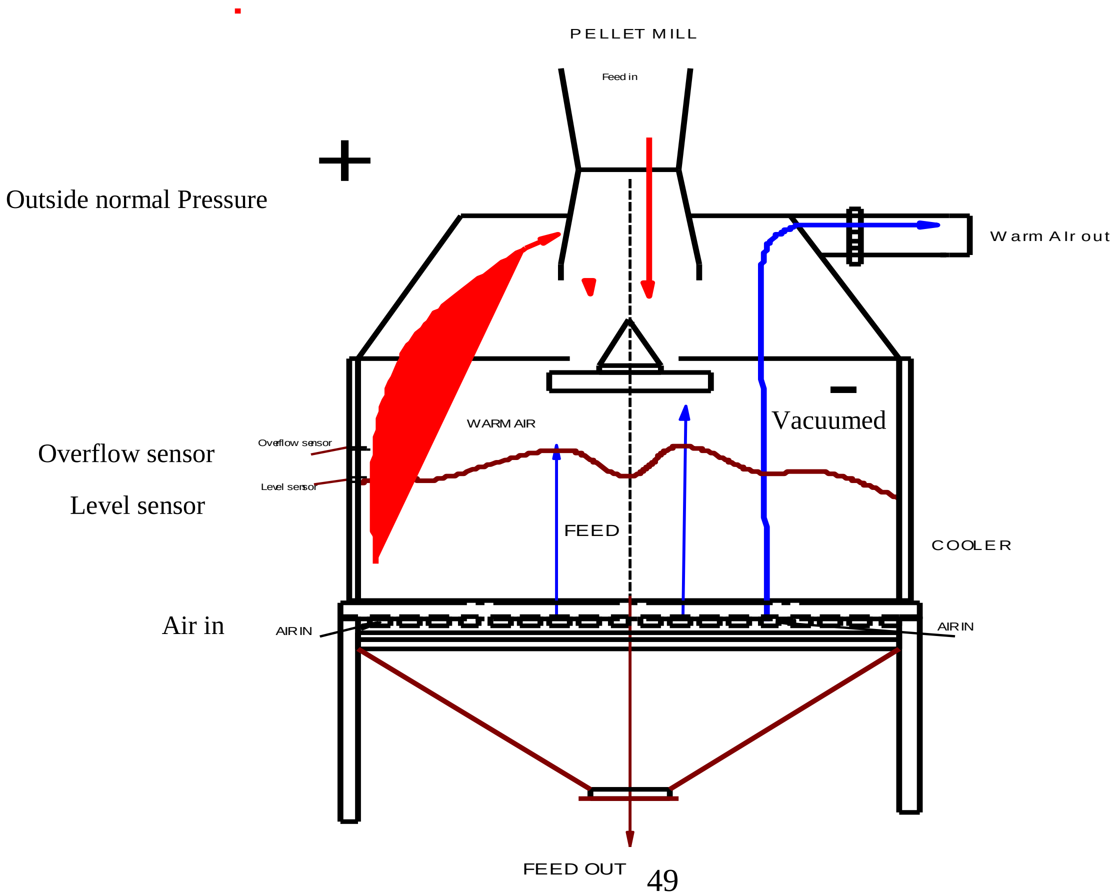

Figure 4. ***Counter flow coolers showing air flow from bottom to top.***

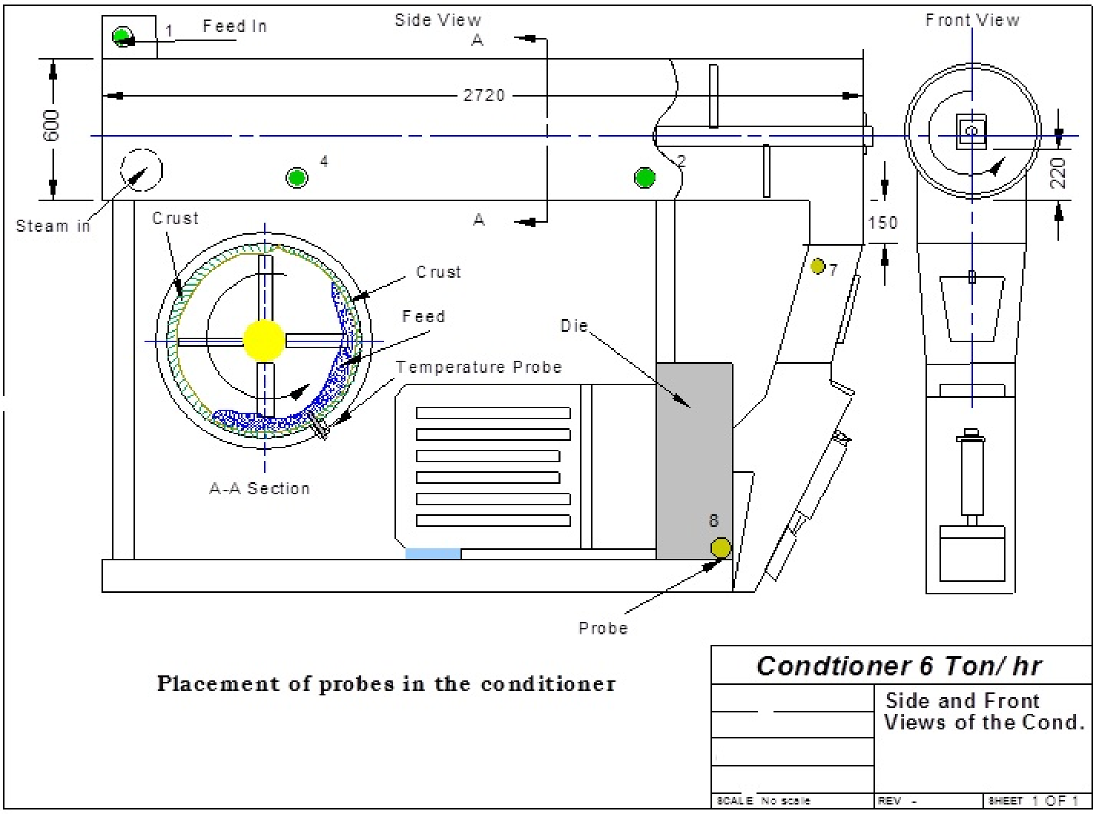

Figure 5. ***Placement of the probes in the conditioner.***

Rules for probes temperature understanding

Understanding the information from the data loggers; first we need to set the standards or rules for temperature goals inside and outside the conditioner. After that, we can monitor the temperature levels to achieve the bacterial control (Salmonella) or quality control (Williman, 2009). In general there are three groups or sets of temperatures we are looking for.

1. First is the low temperature group, which is the feed (mixed ingredients) temperature before the conditioner (in the mixer or in the feed in tube). The temperature range is 20-25 °C. It depends on storage and outside temperature as well.
2. Second is the high temperature group, which is feed temperature in the conditioner. The temperature range is 80-85 °C. The die temperature could reach 92°C if above temperature is maintained (Ryszard Kuling, 2008).

3. Third is the warm to cold temperature group, which is the feed (pelleted) temperature in the cooler. The temperature range is 20-75°C. See figure 6.

The temperature categories and levels in the conditioner

The next step is to monitor and control the feed temperature in these ranges and analyze the results. Figures 7, 8, 9.

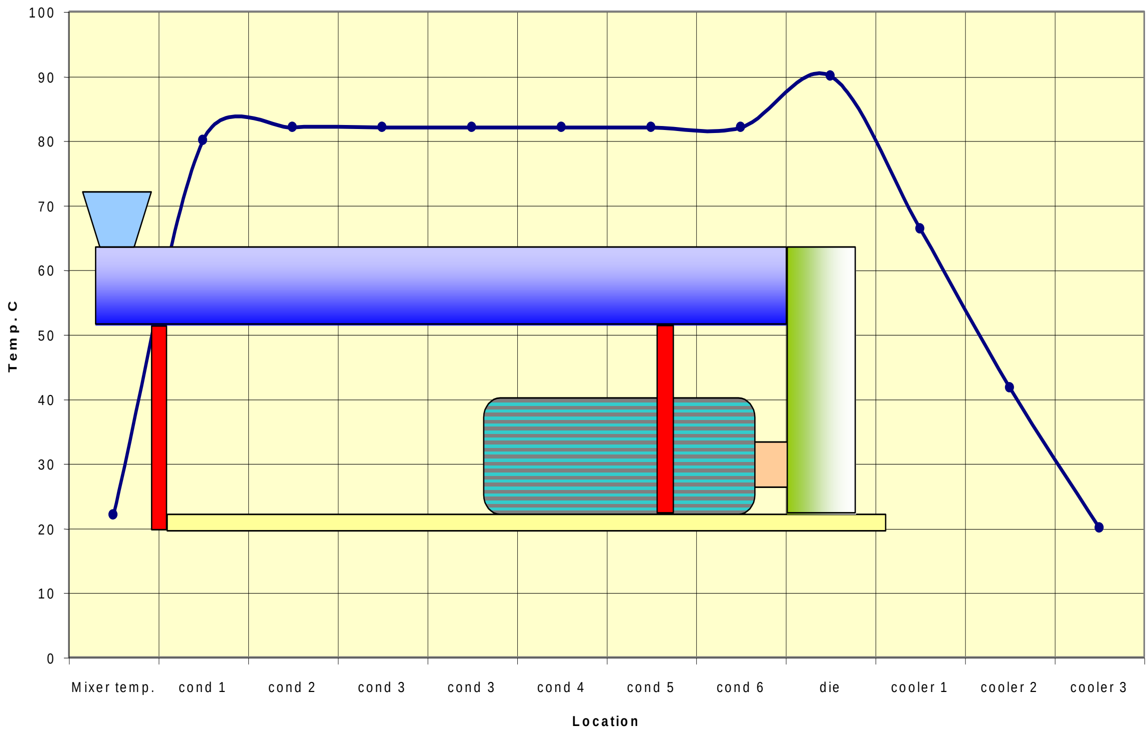

Figure 6. ***Standard feed temperature in the conditioner.***

1. If the temperature of group 1 is higher than 30ºC.

☑ This means that the steam is running to the feed mixer or to the feed tube. The temperature may reach 50ºC. This happens a lot especially with conditioners having their steam pipe connected from the topside after the feed in tube, and also with other steam tube connection if the steam flows is restricted in the conditioner (more stem than the conditioner can handle). This situation could emerge when

☑ The die is chocked-full with feed,

☑ Bad start up or interrupted runs.

Then the conditioner temperature will drop below the standard range.

2. If the temperature of group 2 is lower than the range. This means

☑ Some of the steam is running to the feed in tube.

☑ Steam temperature is not enough to keep the conditioner temperature in the range.

☑ Steam is not mixing with feed ingredients properly; steam pressure is low.

☑ Probes may be faulty.

3. If the temperature of group 2 is higher than the range. This means.
   - ☑ The amount of steam is high.
   - ☑ Probes are exposed to direct steam flow.
4. If the temperature of group 3 is above the standard range. This means
   - ☑ Over flow or temperature sensors are not working properly.
   - ☑ The vacuum in the cooler is not set properly.
   - ☑ Flow of feed is very high (feed is not losing heat or not cooling).
   - ☑ Exhaust duct is not clean (feed particles build up on the sides).

RESULTS AND DISCUSSION

There are two things to look at in the run. First is the startup temperature reaches the desired temperature. Second is the run or batch temperature. See Figure 7. It takes the feed about two minutes to reach the 80 ºC planned temperature. During that time 150-200 Kg (depend on conditioner capacity) of feed passes through the conditioner without reaching the desired temperature of 80-85 ºC. This feed could be recycled so no feed will be allowed to go to the storage bins without reaching the planned or targeted temperature. Steadiness of the run has a great influence on the feed temperature in the conditioner. The more stops (On and off) in the run the more unstable temperature in the conditioner, and more feed going to the bins without reaching the planned temperature. This situation could be bad if salmonella was present in the feed or feed ingredients. This also means salmonella positive feed is been used to grow birds. The birds will be infected with salmonella whatever the bio-security is. Vaccination may help in situation like this.

The batch run temperature is the most important factor affecting feed temperature. Figure 7 is showing the ideal run and the correct temperature in the conditioner. Looking at the graph from top, the steam temperature is stable and around 130ºC. This temperature could be optimized to reduce energy cost without affecting the pelleting process. To optimize temperature is to keep the temperature of the conditioner at its desired temperature and in the same time minimizing the heat loss from the conditioner to the room, where environmental temperature is usually lower. Insulating the conditioner by proper insulation will reduce or prevent heat loss, which keeps the conditioner temperature stable and that will reduce extra heat to keep the conditioner at its required temperature.

Press (die) temperature is also stable and it is between 90-93 ºC. The Inside conditioner temperature (all probes) is in the same safe range of 82-83 ºC.

The retention time in the cooler has also an important role in keeping the temperature longer. The top part of the cooler holds the feed temperature at 70-75 ºC for about 5 minutes. This time allows the temperature to penetrate to the core of the feed pellet. The temperatures of the cooler are also in the safe range.

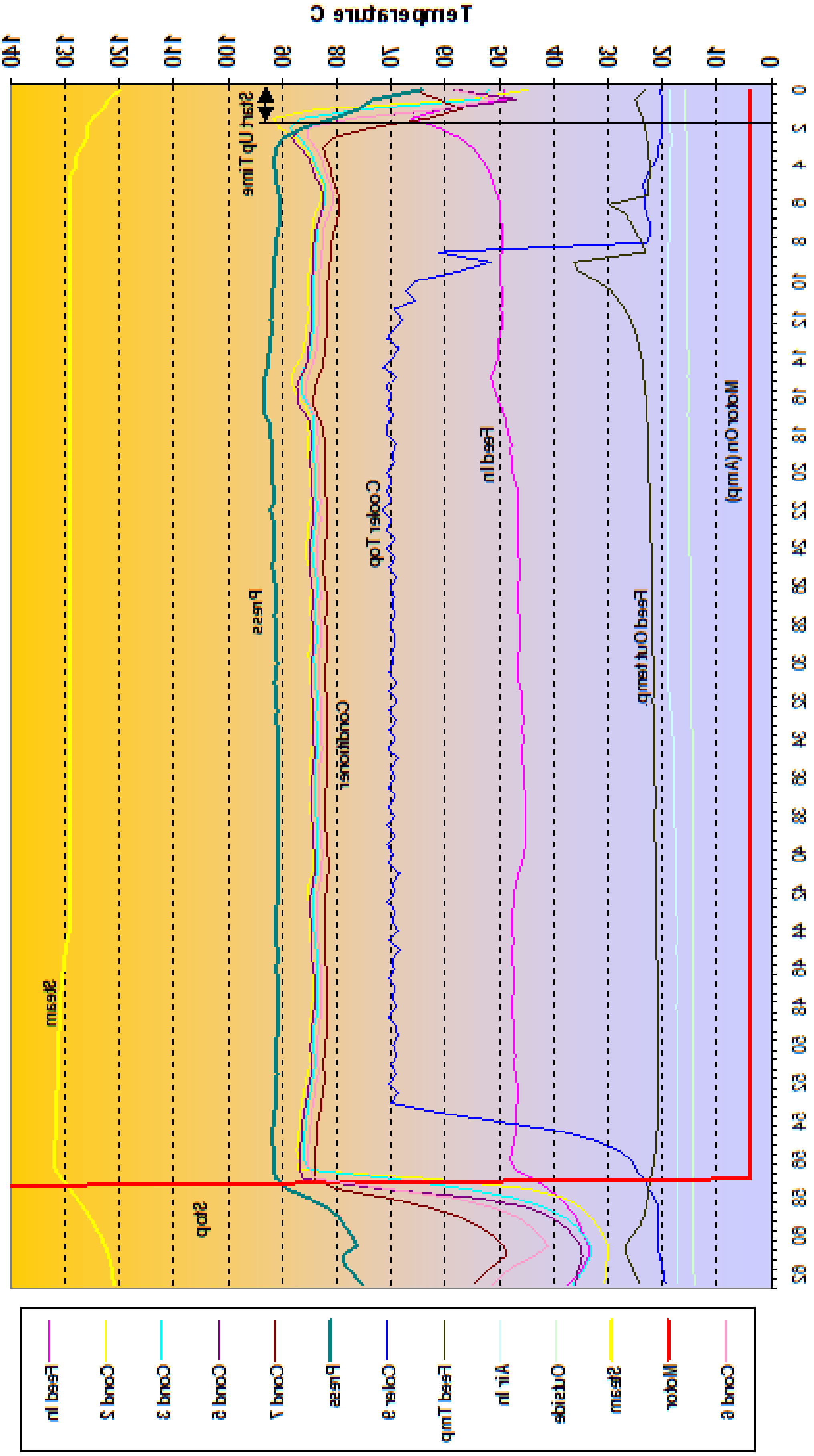

Figure 7. Feed Temperature control in the conditioner and the tower cooler over time.

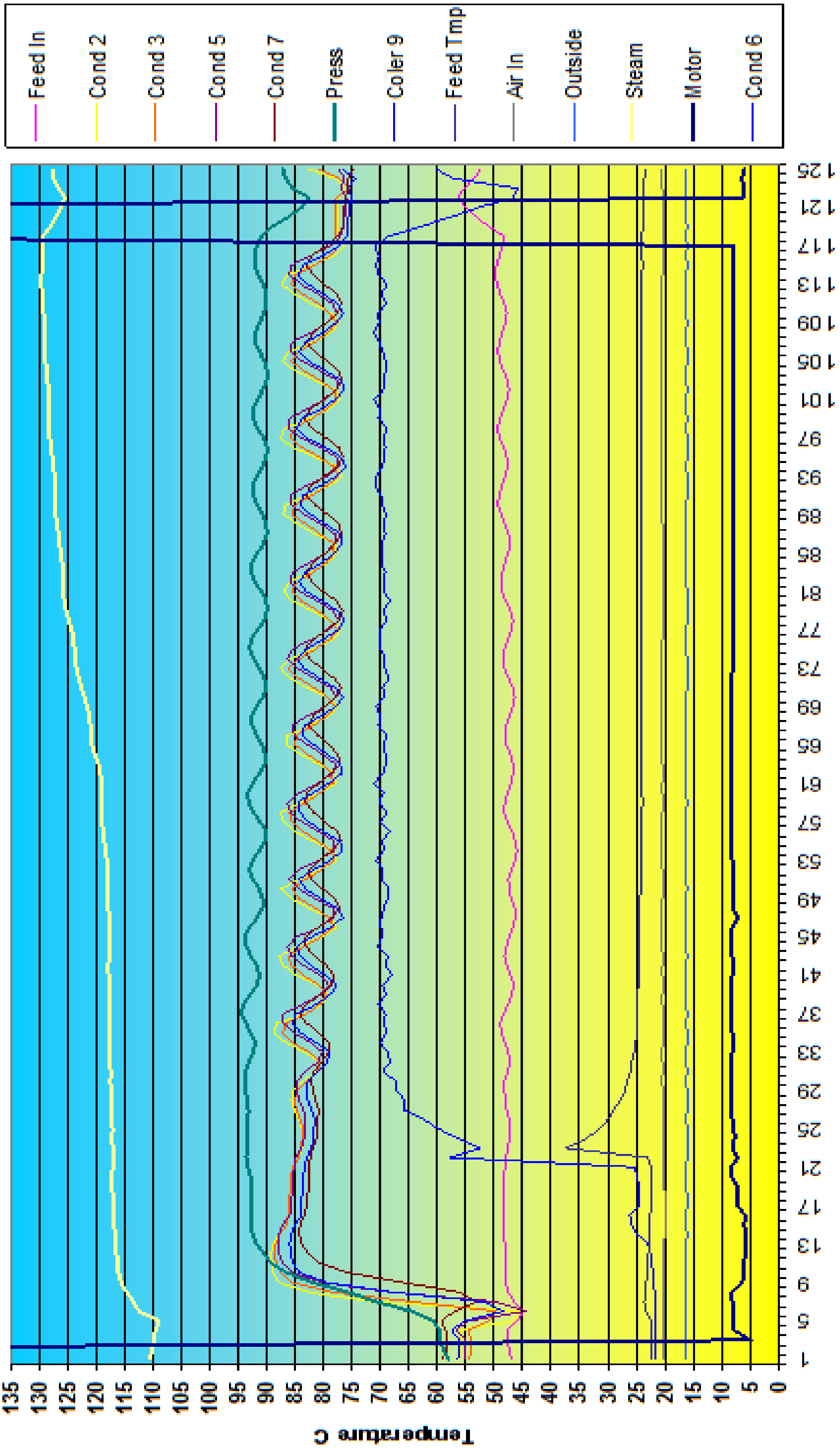

Figure 8. *Feed flow control and temperature change over time.*

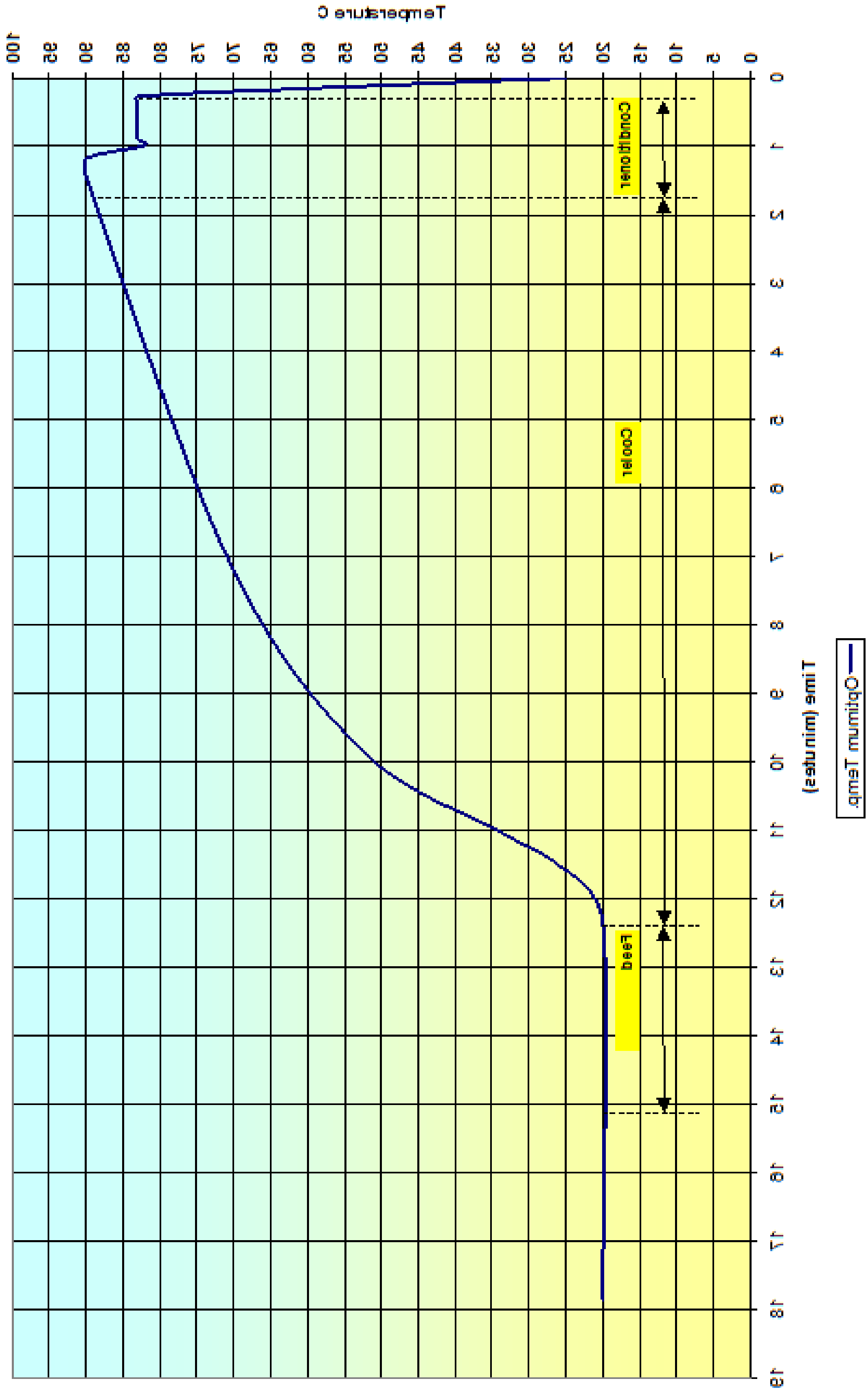

Figure 9. Feed retention temperature in the conditioner and cooler.

Press (die) temperature is also stable and it is between 90-93 ºC. The Inside conditioner temperature (all probes) is in the same safe range of 82-83 ºC.
The retention time in the cooler has also an important role in keeping the temperature longer. The top part of the cooler holds the feed temperature at 70-75 ºC for about 5 minutes. This time allows the temperature to penetrate to the core of the feed pellet. The temperatures of the cooler are also in the safe range. The top cooler temperature (probe 9) is around 70ºC, the more we drop to the end of the cooler the more the temperature will drop, until it reaches 21.8ºC (feed temperature leaving to the storage bins).
Also we can recognize that the air temperature could raise 3-4 º C inside the feed mill that is from the outside temperature (outside temperature 14.9 º C, air temperature entering the cooler is 18.9 º C). With air temperature rising relative humidity will decline (dryer air). This will dry the feed faster and losses moisture as well.
Tracing the feed in temperature (ingredients) one can say, that some of the steam is entering to the feed-in tube (*feed coming from the top, and the steam from bottom*) and raising the feed-in temperature which supposed to be around 25 ºC. The incoming feed temperature is between 46-50 ºC. Steam going backward may cause problems in pipes and could cause condensation or crust formation on the sides. Losing steam to the incoming feed tube means there is not enough steam in the conditioner to reach the required temperature, and also means there is a problem in the system must solved and find out why the steam going back instead going in to conditioner. Figure 8 shows the temperature changes when the batch was controlled for feed mass flow.
One of the serious problems in cleaning conditioners is the crust formation inside the conditioner figure 8. This problem is caused by the water condensation on the body of the conditioner especially in cold weather, when there is not enough time to preheat the conditioner before producing feed.

The crust will trap small particles from feed and form a thick paste. This paste is not just trapping minerals and vitamins it may also be a good place for toxins and bacteria growth as well.
The objectives of the project have been met and pelleted temperature was according to authority guidelines in New Zealand, figure 9**.**

Recommendations

1- To increase feed temperature at start-ups a retention plate may be placed in the conditioner or fully computerised system could be installed to monitor and control the start-up temperature in the conditioner at stops and start periods.

2- The temperature difference between outside and conditioner temperature is large, and to reduce that is to insulate the conditioner by proper and practical insulation to prevent crust formation and reduce heat loss.

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أنشاء وتقييم نظام مراقبة لدرجات الحرارة في مكيف العلف الحبيبي .

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المستخلص

تم هذا العمل في عام 1999 في نيوزيلاند بطلب من وزارة الزراعة و الثروة السمكية النيوزيلاندية لمراقبة السلمونيلا في العلف كأجراء لمصنعي الاعلاف للتأكد من ان درجة الحرارة في مكيف العلف الحبيبي تكون 82 ° م في كل الاوقات و في جميع الاماكن داخل المكيف العلفي. إن العلف هو أهم عامل في إنتاج الدواجن وذلك بسبب أثره على أوزان الطيور و بالتالي على تكاليف الانتاج والصحة بصورة عامة.

يستغرق العلف حوالي دقيقتين للوصول الى °80 م. إذ يمكن إعادة تدوير العلف إلذي لم يبلغ 82-°83 م . أن التوقفات المستمرة اثناء عملية الانتاج له تأثير سلبي وكبير على ثبات درجات حرارة العلف في مكيف العلف. يحتاج العلف للوصول الى درجة حرارة °80 م الى حوالي دقيقتين .وعند عدم وصول درجة حرارة العلف المخطط لها الى 82- 83 °م فأنه يعاد تدويره . كانت درجة الحرارة البخار مستقرة اثناء العمل، وهي حوالي 130 °م. بالامكان جعل درجة حرارة مكيف العلف مثالية لتقليل تكلفة الطاقة دون التأثير على عملية تصنيع العلف. من خلال تعقب درجة حرارة العلف إذ يمكن القول أن بعض من البخار يدخل في أنبوب التغذية للعلف مما يؤدي الى أرتفاع في درجة حرارة خليط العلف الداخل (النازل) لمكيف العلف الحبيبي الى 46-50 °م . ان درجة حرارة العلف الداخل لمكيف العلف الحبيبي كانت بين 20-25 °م. أما درجة الحرارة في قالب الحبيبات كانت 92 °م . و درجة الحرارة العلف الخارج من صندوق التبريد العلفي كانت 20 °م.

الكلمات المفتاحية: علف . علف حبيبي. درجة حرارة العلف. درجة حرارة مكيف العلف الحبيبي. علف الدواجن