The design of control system of livestock feeding processing

Juna Sihombing, Humala L. Napitupulu and Juliza Hidayati

Politeknik Teknologi Industri Medan, Magister Program and Doctor Of Industrial Engineering, Faculty Of Engineering. Universitas Sumatera Utara, Medan, Indonesia

E-mail: junasihombing_88@yahoo.co.id, humala_n@yahoo.com, rivaijuliza@gmail.com

Abstract. PT. XYZ is a company that produces animal feed. One type of animal feed produced is 105 ISA P. In carrying out its production process, PT. XYZ faces the problem of rejected feed amounts during 2014 to June 2015 due to the amount of animal feed that exceeds the standard feed quality of 13% of moisture content and 3% for ash content. Therefore, the researchers analyzed the relationship between factors affecting the quality and extent of damage by using regression and correlation and determine the optimum value of each processing process. Analysis results found that variables affecting product quality are mixing time, steam conditioning temperature and cooling time. The most dominant variable affecting the product moisture content is mixing time with the correlation coefficient of (0.7959) and the most dominant variable affecting the ash content of the product during the processing is mixing time with the correlation coefficient of (0.8541). The design of the proposed product processing control is to run the product processing process with mixing time 235 seconds, steam conditioning temperature 87 ^{0}C and cooling time 192 seconds. Product quality 105 ISA P obtained by using this design is with 12.16% moisture content and ash content of 2.59%.

1. Introduction

In the face of competition with competitors, product quality must be one focus of the company. The existence and development of enterprises must support the high quality of the product. Product quality can see from a large number of products that don't meet the standards of quality set forth (rejects). Therefore quality improvement should make so that the number of product rejects can reduce.

One type of product produced by PT. XYZ is a type of 105 ISA P feed destined for laying chicken. By the observations that have been made against production data during 2014 to June 2015 showed a feed with a quality that does not meet the quality standard company (rejected feed). Rejected feeds definitely resulted in losses for the company, namely: cannot sell products that have been manufactured, Increased of production costs due to the need to cultivate the product return rejects to meet the company's quality standards, disruption of the schedule which resulted in not satisfy customer requests in the following period. A high number of rejected feeds should seek for handling so that the rejected feed quantities can drive by finding the cause of denied on livestock feed produced.

The mixing time is affecting the quality of animal feed. The mixing time is too short will yield a mixture are not homogeneous, but if the mixing time is too long, will result in segregation. The temperature of the steam condition too high will cause decomposition on livestock feed [19]. The quality of the product which produced by a company of a certain size. Feed quality can give by the temperature, by the steam cooler, cooling time during the cooling process. High water vapor conditions will cause decomposition in animal feed. Steam temperature control of the steam that flows from the boiler steam is stable. The conditioning process will be optimal at conditioning is 552kpa with temperature 93,3^{0}C [22]. The cooling time becomes very critical for the pellet process. Pellets that do not cool properly will degrade the quality due to the temperature difference between the outer layer of pellets (colder) with the inside of the pellet (hotter). But pellets that cool down too quickly, more air and heat will be removed from the surface of the pellets compared to capillaries. It follows the pellet become brittle. While it feels cold the old pellet will difficult to dry, so the pellets will move easily to abrasion. The quality of the product which produced by a company of a certain size. Feed quality can give by the temperature by the steam cooler, cooling time during the cooling process [22]. The conditioning process is carried out with the help of a steam boiler which directs into the feed mixture. Steam conditioning temperature is the temperature of vapor released through the conditioning to form the strength and endurance of the texture of the finished product. The conditioning process will be optimal if the moisture content of the material ranges from 15 - 18% [14].

The literature above shows that there are several factors will affect the quality of feed. Therefore, to get the food with high quality, it is necessary to trace each factor that affects the quality, to obtain the design of the process control of animal feed processing.

2. Methods

In this study, product specifications produced by PT. XYZ can see in Table 1.

Table 1. Chicken Feed Specification Type 105 ISA P Layer PT. Gold Coin - Indonesia Medan Mill.

No	Nutritional Content	(105) Poultry Layer
1	Crude protein,%	16.0-18.0
2	Coarse fiber, Max%	6.0
3	Rough fat, Min%	3.0
4	Moisture, Max%	13.0
5	Ash, Max%	3.0
6	Calcium, %	3.0-4.2
7	Phosphor, %	0.6-1.0
8	Stripes, %	0

Variables affecting product quality are mixing time, steam conditioning temperature and cooling time. The limit value of each variable on space the processing at PT. XYZ is the mixing time range in the mixing process is at 230 - 245 seconds.

Steam conditioning temperatures in the production process are carried out at a temperature range of 75 - 90^{0}C. Cooling time is done in the range 180 - 215 seconds.

The data collected are data of production process and product quality during 2014 to June 2015. Rejected feeds caused by dappled, too high moisture content, and too high ash content on the product. Processing data is done by stages:

a. Determination of the most Dominant Defects
b. Regression Calculation.
c. Calculations of Correlation Coefficient Value
d. Calculations of the optimum value of processing condition.

3. Results and Discussion

3.1. The dominant defect in the process of feeding type 105 ISA P

Determination of the dominant defect can be done using a Pareto diagram as can be seen in Figure 1.

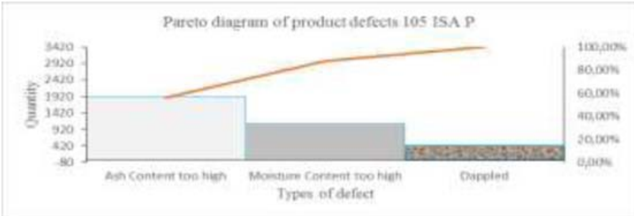

Figure 1. Pareto diagram of product defect 105 ISA P.

The most dominant type of flawed causing rejected feed is too high ash content (56.14%), moisture content is too high (31.58%).

3.2. Determination of the appropriate Regression Type
Regression on data processing involves two parameters of product quality, i.e., moisture content and ash content. The results of regression calculations on the processing for moisture content can see in Table 2.

Table 2. Regression calculation result in processing process for moisture content.

Variable	Method approaching scatter pattern		SEE		~~Selected~~ Method	F Calculated selected Method	F Table	Result of Hypothesis Test
	Method 1	Method 2	Method 1	Method 2				
Mixing time (seconds)	Quadratic	Exponential	0.6317	1.0330	Quadratic	0.3739	4.0427	H0 accepted
Steam Conditioning temperature (^{0}C)	Quadratic	Linear	1.0049	1.0170	Quadratic	0.9765	4.0427	H0 accepted
Cooling Time (seconds)	Quadratic	Exponential	0.9282	0.9878	Quadratic	0.8829	4.0427	H0 accepted

In Table 2., it can be seen for moisture content, the corresponding regression with mixing time data pattern is the quadratic and exponential method, steam conditioning temperature is the quadratic and linear method, and in cooling time is the quadratic method and exponential method. The regression method chosen for each variable in the process of processing is the quadratic method, because the standard error estimate (SEE) value is lower than the other method, and the value of F arithmetic <, F table so that the hypothesis test results show that H0 is accepted. The results of regression calculations on the processing process for ash content can see in Table 3.

Table 3. Regression calculation result in processing process for ash content.

Variable	Method approaching scatter pattern		SEE		Selected Method	F Calculated selected Method	F Table	Result of Hypothesis Test
	Method 1	Method 2	Method 1	Method 2				
Mixing time (seconds)	Quadratic	Exponential	0.3059	0.5798	Quadratic	0.2783	4.0427	H0 accepted
Steam Conditioning temperature (^{0}C)	Quadratic	Linear	0.5252	0.5738	Quadratic	0.8377	4.0427	H0 accepted
Cooling Time (seconds)	Quadratic	Exponential	0.5431	0.5681	Quadratic	0.9139	4.0427	H0 accepted

The value of the largest correlation coefficient in ash content, it shows that ash content is dominantly influenced by mixing time, temperature steam conditioning and cooling time compared with moisture content. So the optimum conditions that will use are: mixing time 235 seconds, temperature steam conditioning 87^{0}C, and cooling time 192 seconds.

3.3. Determinations of the correlation value.
The correlation coefficient denotes the relationship between the independent variable and the dependent variable. The value of the correlation coefficient of each independent variable to the dependent variable can see in Table 4.

Table 4. The Correlation Coefficient Value

No	Variable	Moisture Content	Ash Content
1	Mixing time (seconds)	(0.7959)	(0.8541)
2	Steam conditioning temperature (^{0}C)	(0.2685)	(0.4498)
3	Cooling time (seconds)	(0.4565)	(0.3834)

3.4. Determination of optimum condition of processing process

The value of the optimum condition is calculated by the formula:
The optimum value = (- b) / 2c
To obtain the optimal conditions for each independent variable, it is selected based on the value of moisture content and the most critical ash content as a design proposal as can see in Table 5.

Table 5. The Quality of products with Optimum Conditions The process of feed processing 105 ISA P

Variable	Regression coefficient on each Process						Optimal condition of processing process	Product quality	
	Moisture content			Ash content				Moisture content (%)	Ash conten t (%)
	A	B	C	A	B	C			
Mixing time (seconds)	1361.8318	(11.4993)	0.0245	814.1631	(6.9016)	0.0147	235	11.50	2.23
Steam Conditioning temperature (^{0}C)	115.3058	(2.3530)	0.0134	118.1571	(2.6627)	0.0153	87	12.17	2.49
Cooling Time (seconds)	456.3358	(4.6293)	0.0121	218.5119	(2.2482)	0.0059	192	12.03	2.59

3.5. Proposed Design of Process Control of Animal Feed Processing.

The value of process capability is determined after obtaining the control limit for the process of animal feed processing that is in mixing, conditioning, and cooling process. The boundary value of process control and process capability index value can see in Figure 2. The controls limit value is obtained by substituting equation for each process on the moisture content and the ash content with mixing time value, steam conditioning and cooling time temperature so that can see whether the control limit value The old process can still be used or not.

Through this calculation can also be obtained the value of control level for the resulting product can meet the predetermined standards of animal feed with the maximum moisture content of 13% and maximum 3% ash content. The Capability index for each variable calculation for mixing time with moisture content. Index capability, data out of control with each process control interval, before using process control processing and after using process control can see in Table 6 and Table 7.

Table 6. The Value of process capability index, process control limit and number of data out of control after using optimal conditions in feed processing process.

Processing Process	LCL & UCL	After using design process control											
		Moisture content					Ash Content					Data out of control	
		STDEV	CP	Cpu	Cpl	Cpk	STDEV	CP	Cpu	Cpl	Cpk	Moisture content	Ash content
Mixing	229 - 242(seconds)	0,3894637	5,5632061	0,938706	10,187706	Cpu 0,9387	0,2210447	2,2619857	0,7991185	3,724853	Cpu 0,7991	3	3
Conditioning	82- 92 (^{0}C)	0,1380826	15,691088	1,7020649	29,680111	Cpu 2,0762	0,1425178	3,5083333	0,824625	6,1920416	Cpu 0,8246	7	5
Cooling	185 - 200 (seconds)	0,265484	8,1611957	0,8542848	15,468107	Cpu 0,8543	0,128916	3,8784944	0,7075221	7,0494668	Cpu 0,7075	19	19

In table 5 and table 6 it can be seen that there is an increase in process capability value, decreasing the amount of out of control data using the old limits of control with new limits of control in each processing process

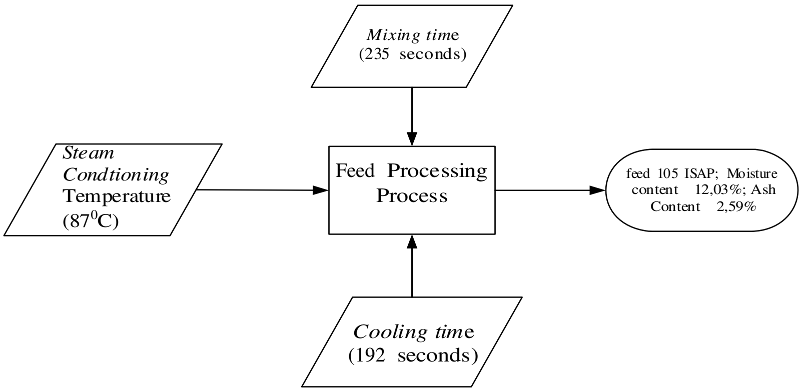

Figure 2. Design Model of Process Control, of Processing Products 105 ISA P

By applying the proposal design of control process processing is expected to produce animal feed with the ash content of 2.59% and moisture content of 12.17%, so that rejected feed can minimize in number.

4. Conclusions

The conclusions that can take after doing this research are as follows:

a. The design of the proposed product processing control for PT. XYZ is run to the production process with the mixing time about 229 - 242 seconds in the mixing process, the temperature steam conditioning temperature about 82 - 92^{0}C in conditioning stage, and the cooling time of 184 -200 seconds, in the cooling process to obtain the quality of ISA P 105 standard feeding, that is maximum moisture content of 13% and maximum ash content of 3%.

b. The Feed quality 105 ISA P optimal can be obtained by running the production process at mixing time on 235 seconds in the mixing process, 87^{0}C steam conditioning temperature at conditioning stage, and cooling time on 192 seconds in cooling process with feed 105 ISA P quality obtained with moisture content of 12.16% and ash content of 2.59%.

c. Using the obtained design is expected to increase Cpk = 0.34476 to 0.9387 (moisture content), Cpk = 0.3051 to 0.7991 (ash content) in the mixing process, Cpk = 0.2389 to 2.0762 (moisture content), Cpk = (0.0534) to 0.8246 (ash content) in conditioning process and increase of Cpk = (0,1274) to 0,8543 (moisture content), Cpk = (0,1474) to 0.7075 In the cooling process, but when viewed from the value of Cp in each process, where Cp > 1 then the whole process has been able to produce maximum moisture content 13% and ash content maximum 3%.

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