Journal of Central European Agriculture, 2012, 13(3), p.554-562 DOI: 10.5513/JCEA01/13.3.1088

MIXING AS CCP IN THE PRODUCTION OF INDUSTRIAL FEED

PROCES MIESZANIA JAKO CCP W PRODUKCJI PASZ PRZEMYSŁOWYCH

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ABSTRACT

In the presented research the technology for producing industrial feed in a working fodder plant was analysed, taking the stage of mixing as CCP, in which there is a threat for the quality of the product. The research of assessment of mixing process quality was conducted in compliance with the ASAW standard which describes test procedures for measuring the mixing ability of batch mixers with the use of microtracers. The following mixers were used in the research: mixers used for all mash mixtures and premixes. Before determining the efficacy of the mixing process, the analysis of the technological structure for the production of industrial feed was conducted taking into account a point in which there is a threat for the quality of the product. The conducted research aimed at determining the homogeneity of mixtures with the use of microtracers allows to state that this method is useful for the analysis of the mixing process in production plants. It allows quick reactions during the technological process, at the same time eliminating production of mixtures of nonstandard parameters.

KEYWORDS: feed, microtracers, mixing

STRESZCZENIE

W prezentowanych badaniach analizowano technologię produkcji pasz przemysłowych w działającej wytwórni pasz, określając charakterystyczne punkty, w których istnieje ryzyko zagrożenia jakości produktu. Badania oceny jakości procesu mieszania przeprowadzono zgodnie ze standardem ASAE, opisującym procedury testu dla pomiaru zdolności mieszającej mieszarek cyklicznych przy użyciu mikrowskaźników. Badaniom poddano mieszarki do produkcji mieszanek pełnoporcjowych oraz do premiksów. Przed przystąpieniem do oznaczania skuteczności procesu mieszania, dokonano analizy schematu technologicznego wytwarzania pasz przemysłowych z uwzględnieniem punktów, w których istnieje zagrożenie jakości produktu. Przeprowadzone badania określania homogenności mieszanek przy użyciu mikrowskaźników pozwalają stwierdzić, że metoda ta jest przydatna do analizy procesu mieszania w zakładach produkcyjnych. Pozwala ona na szybkie reagowanie w trakcie trwania procesu technologicznego eliminując produkcję mieszanek o niestandardowych parametrach.

SŁOWA KLUCZOWE: mieszanie, pasze przemysłowe, mikrowskaźniki

STRESZCZENIE SZCZEGÓŁOWE

Jednym z ważniejszych etapów produkcji pasz przemysłowych jest proces mieszania. Decyduje on o jednorodności mieszanki, co w konsekwencji wpływa na jakość końcową paszy.

W zależności od układu technologicznego w zakładzie urządzenia odpowiedzialne za przeprowadzanie procesu mogą występować w różnych miejscach linii produkcyjnej:

- mieszanie wstępne, rozumiane również jako produkcja tzw. zaprawy. Polega ono na rozmieszaniu części komponentów występujących w niewielkich ilościach, w celu dokładniejszego ich rozprowadzenia po włączeniu do ostatecznej mieszanki,
- mieszanie wszystkich składników zgromadzonych w urządzeniu mieszającym w celu uzyskania produktu w formie gotowej,
- mieszanie składników sypkich z komponentem w stanie ciekłym.

Czas mieszania surowców jest różny i zależy od bardzo wielu czynników, począwszy od składu surowcowego, a kończąc na typie mieszarki, w której jest prowadzony proces. Może on wynosić od 1.5 min do 5 i więcej minut. Dlatego dla każdego typu mieszarki jak również składu surowcowego należałoby określić czas optymalnego mieszania. Należy podkreślić, że aby uzyskać w pełni homogenią mieszankę musi być przestrzegany ściśle określony czas mieszania. Zarówno skrócenie czasu mieszania jak również jego wydłużenie może prowadzić do produkcji mieszanki o złej jakości. Ważnym jest, aby cały układ związany z dozowaniem i naważaniem tak był zgrany z procesem mieszania, by nie następowały przerwy w pracy mieszarki.

W prezentowanych badaniach analizowano technologię produkcji pasz przemysłowych w działającej wytwórni pasz, analizując etap procesu mieszania jako punkt CCP, w których istnieje ryzyko zagrożenia jakości produktu. Przed przystąpieniem do oznaczania skuteczności procesu mieszania, dokonano analizy schematu technologicznego wytwarzania pasz przemysłowych z uwzględnieniem punktów, w których istnieje zagrożenie jakości produktu.

Badania oceny jakości procesu mieszania przeprowadzono zgodnie ze standardem ASAE, opisującym procedury testu dla pomiaru zdolności mieszającej mieszarek cyklicznych przy użyciu mikrowskaźników. Zgodnie z tą procedurą z każdej porcji (szarży) pobierano 10 prób, a pomiar powtarzano trzykrotnie dla każdej mieszanki w danej mieszarce.

Uzyskane wartości współczynnika zmienności są dość rozbieżne, co świadczy, że jakość mieszania jest niedostateczna. Przeprowadzone badania określania homogenności mieszanek przy użyciu mikrowskaźników pozwalają stwierdzić, że metoda ta jest przydatna do analizy procesu mieszania w zakładach produkcyjnych. Pozwala ona na szybkie reagowanie w trakcie trwania procesu technologicznego eliminując produkcję mieszanek o niestandardowych parametrach.

INTRODUCTION

In Poland the feed industry has been undergoing constant changes for many years and consequently a number of enterprises have to adjust to the current situation on the market. In order to compete both on the domestic and European markets Polish enterprises have to produce safe food of high quality which meets customers' expectations. It is necessary to introduce Quality Management Systems to make sure that an enterprise controls the safety of the produced food (Kwiatek and Korol, 2004; Matuszek and Tukiendorf, 2008). The most important Quality Management Systems which are applied in the enterprises of the food industry include:

- Good Hygienic Practice – GHP
- Good Manufacturing Practice – GMP
- Hazard Analysis and Critical Control Points – HACCP.

Despite constant improvement of methods for control and supervision of food production and significant progress in fighting animal diseases, new food health threats arise (Królczyk and Tukiendorf 2008).

In the HACCP system the provision of safety and high quality of healthy food is achieved by undertaking special control in these places which are crucial in the aspect of hygienic threats and in which a decrease of health quality of produced food can occur. The system consists in conducting an analysis of all threats both biological, physical and chemical, which may become the reason of health quality decrease of produced food, and indicating which points at each stage of food production are "critical" for the health safety of the final product. These points are described as critical control points (Critical Control Point CCP) and they should be under constant supervision.

The most important elements of the HACCP system are:

- identification of possible threats,
- assessment of their significance,
- estimation of their probability (the risk of occurrence)
- definition of methods for their elimination.

One of important stages of production of industrial feed is the process of mixing. It determines homogeneity of the mixture, which consequently influences the final quality of feed (Heidenreich and Strauch, 2000).

Depending on the technological structure in a production plant appliances responsible for conducting the process may be installed in different places of the production line:

- initial mixing, also understood as the production of the so-called dressing. It consists in mixing part of components which occur in small amounts in order to precisely distribute them after including them in the final mixture,
- mixing all ingredients collected in a mixing appliance in order to achieve a ready-made product,
- mixing loose ingredients with the liquid component (Laurent et al. 2002).

The time of mixing resources is different and depends on many factors from resource composition to the type of mixer in which the process is conducted. It can range from 1.5 min to 5 and more minutes. For each type of mixers and resource compositions the time of the optimal mixing should be determined. It should be stressed that in

order to achieve a fully homogenous mixture strictly determined time of mixing should be obeyed (Arratia et. al., 2006; Zhang et. al., 2011). Both shortening and lengthening the time of mixing may lead to producing a mixture of bad quality. It is important that the whole structure connected with dosing and fertilising be harmonious with the process of mixing, so that there are no stoppages in the work of the mixer (Ciftici and Ercan 2002; Putier 2001).
In the presented research the technology for producing industrial feed in a working fodder plant was analysed, taking the stage of mixing as CCP, in which there is a threat for the quality of the product.

MATERIALS AND METHODS

The research of assessment of mixing process quality was conducted in compliance with the ASAW standard which describes test procedures for measuring the mixing ability of batch mixers with the use of microtracers. According to this procedure from each portion (production batch) 10 samples were taken and the measurement was repeated three times for each mixture in a given mixer (Siiriä and Yliruusi 2009).

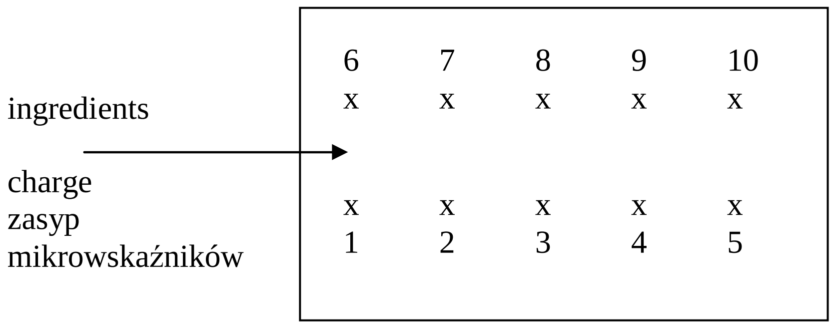

Fig. 1. Points of sampling
Rys. 1. Schemat pobierania prób

The following mixers were used in the research: mixers used for all mash mixtures and premixes. A single-shaft ribbon premix mixer with two counter-twist ribbons with the diameter of 900, 600 mm and capacity of 1.5 m^3. Rotational speed of the stirrer is 36 rev·min^{-1}. Loading time depends on the adopted method of loading, the recommended mixing time is 3 min. Unloading time is 2 min.
The AMA mixer – is typical of a commonly used structure of a dosing and mixing line. The standard capacity of one chamber is 0.5 m^3. The mixture in both mixers was dosed automatically, the mixing time recommended by the producer is 5 min.

According to the standards on animal feeding stuffs mixers should be characterised by the capability to mix:

- for the production of all mash mixtures (mixing capability 1:10000) coefficient of variation ≤ 15%,
- for the production of premixes (mixing capability 1:100000) coefficient of variation ≤ 10%.

The achieved measurement results were tested statistically to determine the coefficient of variation as a value for the assessment of mixing process quality based on criteria.

RESULTS AND DISCUSSION

Before determining the efficacy of the mixing process, the analysis of the technological structure for the production of industrial feed was conducted taking into account a point in which there is a threat for the quality of the product.

Description of the production technology

The resource is supplied to a production plant by vehicle transport. At the delivery point the volume of the transported resource is calculated, documentation is checked, and the level of resource contamination is marked. Next, the resource is directed to a charging basket, from where it is directed to silos. Internal transport is conducted with the use of redler conveyors and worm conveyors. Before the next stage, which is computer weighing out, fodder materials are grounded (grains of different types of cereals, corn). This process is conducted in hammer mills. Mixing materials is conducted in a ribbon mixer for premixes or in a double-chamber AMA mixer. After weighing out liquid additives, for example fats or enzymes, are sprayed under pressure with a pump to the mixer. The next stage is granulation. Cooling is done in a horizontal cooler. A ready-made product is loosely stored in silos, from which it is transported with car fodders or is packed in bags. Many magnetic barriers are placed in the line for the production of fodder mixture.
The flow chart of production is presented in fig. 2.

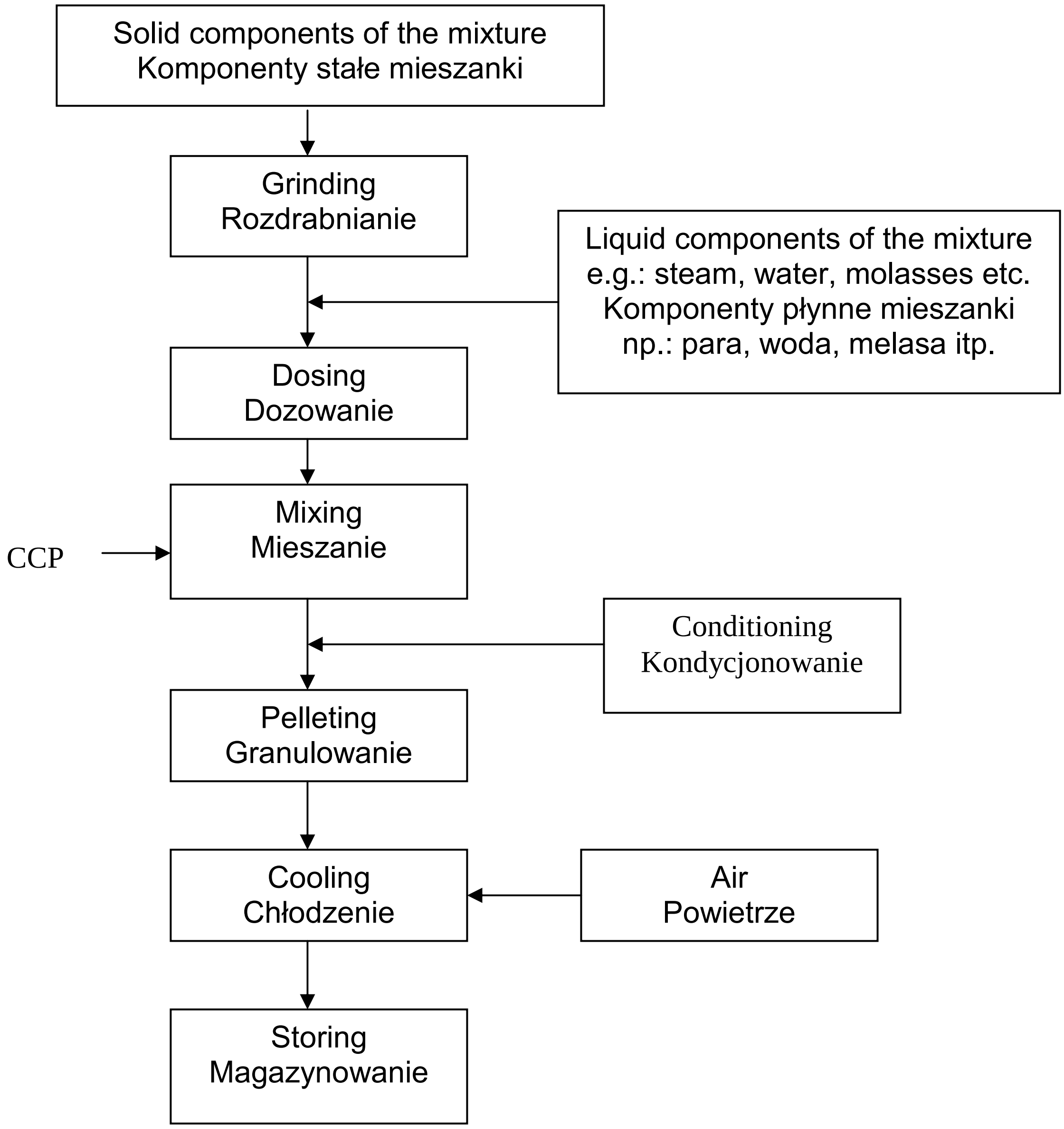

Fig. 2. The flow chart of production of granulated feed
Rys. 2. Schemat produkcji pasz granulowanych

In table 2 the results from measuring the efficacy of mixing for the AMA mixer are given.

Table 1. The number of particles of the microtracers in consecutive samples (according to repetitions), taken during unloading the AMA mixer
Tab. 1. Liczba cząstek mikrowskaźnika w kolejnych próbach (według powtórzeń), pobranych w trakcie rozładunku mieszarki AMA

Sample No. Nr próby	Repetitions, Powtórzenia I	II	III
1	95	85	65
2	76	91	79
3	86	89	80
4	90	98	102
5	71	111	83
6	85	84	88
7	100	85	77
8	94	90	74
9	78	102	101
10	90	95	113
Mean, Średnia	86,5	93	86,2
SD	9.1924	8.641	14.808
%CV	10.627[a]	9.2914[a]	17.179[b]

Values in rows denoted with different letters are significantly different at p≤0.05.

As it results from table 1 the achieved values of the coefficient of variation are quite discrepant, especially results form the III repetition differ form two other results, which are in the upper range of permissible variation limits. The CV results from the third repetition prove that the quality of mixing is insufficient.
In table 2. The results from measuring the efficacy of mixing for the premix mixer are presented.

Table 2. The number of particles of the microtracers in samples according to repetitions for the premix mixer
Tab. 2. Liczba cząstek mikrowskaźnika w próbach według powtórzeń dla mieszarki dla premiksów

Sample No. Nr próby	Repetitions, Powtórzenia		
	I	II	III
1	93	107	81
2	86	82	114
3	96	100	99
4	110	106	96
5	127	86	144
6	102	97	99
7	118	115	100
8	79	116	114
9	86	112	68
10	87	97	96
Mean, Średnia	98.4	101.8	101.1
SD	15.629	11.622	20.371
%CV	15.883[a]	11.416[b]	20.15[c]

Values in rows denoted with different letters are significantly different at $p \leq 0.05$.

In the research of a ribbon mixer for premixes the value of the coefficient of variation is also discrepant. The obtained results indicate the need to refine the parameters of the mixing process

CONCLUSIONS

Evaluation of the mixing process using microtracers allows to formulate the following conclusions:

1) efficiency of mixing process in the test mixers for the mixing times assumed coefficients of variation was different,

2) the mixing process determines the final quality of the resulting pellets and should be monitored.

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