KRMIVA

ADVANCE IN FEED TECHNOLOGY

NAPREDAK U TEHNOLOGIJI STOČNE HRANE

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INTRODUCTION

The feed industry throughout the world is undergoing quite different influences and according to the country and area we will find multiple divergent requirements.

Globally seen the animal livestock is not homogeneous, either in breed in nutritional behaviour. Feed raw ingredients vary widely, the political situation and governmental roles and laws are of influence, and more and more big consumer and retailer organisations have an influence on the feed industry and their products. Therefore, it is very difficult to speak in a generally about advances and developments in the feed industry. According to the situation and place there will be a different answer to the question, "What is an advance in feed manufacturing practice and technology".

A general requirement of today's feed industry is contained in one phrase, "Industrial feed manufacturing is the economical production of a high quality feed" Quality of feed being in regard to physical aspects, nutritive value, clean bacteriological status and accurately fitting for its purpose. In this paper we will therefore mainly concentrate on some new, really interesting and beneficial, technical and technological solutions meeting these main requirements.

Matters of interest are here especially

- new grinding systems,
- new mixing technology,
- pelleting innovations in regard to the problems of bacteria contaminated feed,
- expansion and extrusion technology,

FEED QUALITY AND BASIC REQUIREMENTS

Before we enter in detail into the different processes we must first go back and have a look at the basic requirements of a modern feed mill. These needs are so fundamental that they have to be observed from raw material purchase and intake through the whole feed manufacturing process to the output and transportation. Taken to the ultimate degree it also includes instructing the feed buyer and farmer.

Under these basic requirements we have to list:

- purchase of only quality raw ingredients of known, correct bacteriological state (first important step in reducing the chances of microbial infection)
- rigorous sampling and controlling of all raw materials taken into the plant. Reject if not meeting the set quality standards
- properly designed feed intake and storage facilities (loss, dust reduction, proper weather proofing, suitable buildings, soundly constructed)
- process equipment ensuring contamination free operation (low energy consumption, safety, reliability, ease of cleaning, avoidance of cross contamination)
- maintain, or better, raise the microbial status of feed during processing (addition of acids, thermal treatment)

W. Wetzel, Bühler, Switzerland – Švicarska.

- produce a good feed of guaranteed even quality
- reduce losses, shrinkage to the lowest possible (economic) level
- effective heat treatment of feed in order to obtain nutritional advantages and retain bacteriological feed status. (Universally applied for poultry feed, recommended for all other feed types where advantages are linked to heat treatment).

The above mentioned basic requirements should be taken into account when a new plant is built or if major changes in the various processes of existing plants are being considered. For existing plants and equipment not meeting the above general requirements the feed manufacturer should carry out a phased program over a period of time in order to raise at least the microbial status of such facilities.

2. GRINDING

When considering size reduction in the feed industry three important factors have to be taken into consideration:

- Grinding is the second biggest energy consumer and therefore the granulation of raw materials should only be as fine as necessary
- Granulation has to be suitable for consumption by the animal
- Grinding is a safety hazard (temperature, air)

Because of the importance of the above-mentioned factors in the processing of mixed feed they should be given the due consideration they deserve. In this paper a comparison will be made on the one hand between the possibilities existing with today's available technology and on the other a new processing possibility will be dealt with outlining the main features and advantages.

In regard to the size reduction the following machines are essentially used:

Features - Karakteristike	Hammer Mill - Čekićar	Roller Mill - Mlin na valjke	Vertical Rotor Mill Vertikalni rotorni mlin
Raw materials - Sirovina	all - sve	cereals, pellets žitarice, peleti	all - sve
Grinding system Sustav mljevenja	pre/postgrinding pred/poslije mljevenje	pregrinding predmljevenje	pre/postgrinding pred/poslije mljevenje
Air-assisted - Pomoću zraka	yes - da	minimal - minimalno	no - ne
Granulation Granulacija	fine to coarse fina do gruba	medium to coarse srednja do gruba	fine to coarse fina do gruba
Fineness - Finoća	considerable - znatna	little - mala	little - mala
Specific energy Specifična energija	high - visoka	low - niska	low to medium niska do srednja
Operation - Rukovanje	easy - lako	demanding - zahtjevno	easy - lako
Noise - Buka	high - velika	low - niska	medium - srednja
Wear - Trošenje	medium - srednje	medium to low srednje do nisko	medium to low srednje do nisko
Space - Prostor	large - veliki	medium - srednji	little - mali
Investment - Investicija	medium - srednja	high - velika	low - mala

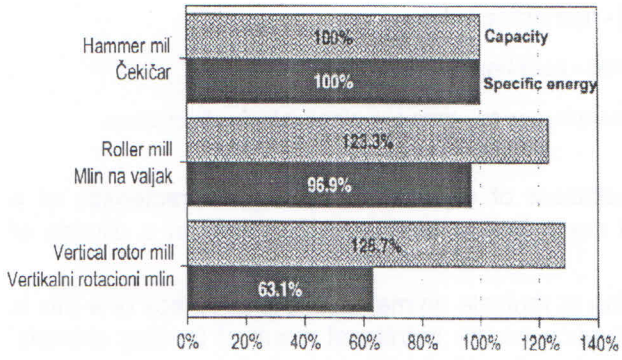
A grinding comparison between standard hammer mill and roller mill shows that both have some advantages but also many disadvantages. The vertical rotor mill on the other hand can be universally used and offers a lot of more advantages.

Tests undertaken at an International Institute showed that the vertical rotor mill in regard to

throughput, granulation curve and also energy consumption showed substantial advantages when compared to both the conventional hammer mill and the roller mill. The test results are shown in the next graphs.

Graph. 1. Comparison of different types of mills, influence on capacity and energy consumption

Grafikon 1. Usporedba različitih tipova mlinova, utjecaj na kapacitet i potrošnju energije

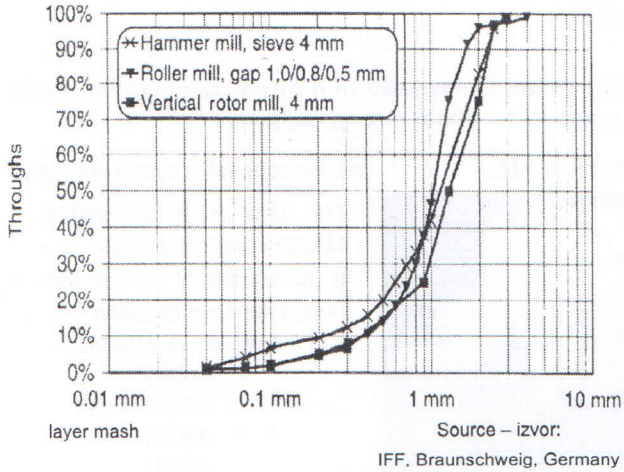


layer mash

Source – izvor:
IFF, Braunschweig, Germany

Graph. 2. System comparison of different mill types, influence on grist spectrum

Grafikon 2. Usporedba sustava različitih tipova mlinova, utjecaj na spektar meljave

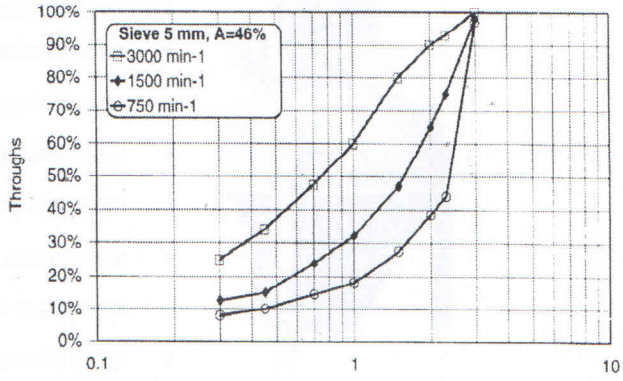


layer mash

Source – izvor:
IFF, Braunschweig, Germany

Graph. 3. "Vertica"-rotor mill, system advantages, influence of rotor speed on granulation

Grafikon 3. Rotomlin "Vertica", prednosti sustava, utjecaj brzine rotora na granulaciju

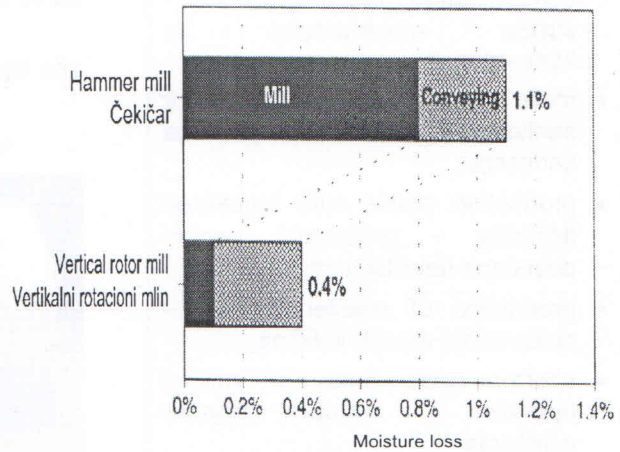


A correct grist spectrum is of not negligible influence on the pelleting process. Also here the new "Vertica" system has a positive influence with advantages in regard to optimal preparation of mash to be pelleted.

A further advantage of the "Vertica"-mill influencing directly the economy of a system is the lower moisture loss by grinding.

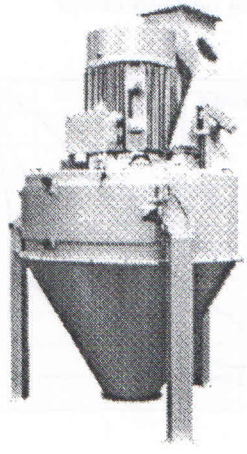
Graph. 4. "Vertica"-rotor mill, system advantages, influence on moisture loss by grinding

Grafikon 4. Rotomlin "Vertica", prednosti sustava, utjecaj na gubitak vlage meljenjem



Summarising the advantages of the "Vertica"-rotor mill gives a respectable list of advantages for an operator as listed hereafter:

Sažetak prednosti rotornog mlina "Vertiva" daje priličan broj prednosti za tehničara kako je ovdje navedeno:



The Vertica hammer mill covers modern requirements

Mlin čekićar "Vertica" pokriva moderne zahtjeve:

- no aspiration, no emission - nema aspiracije, nema emisije,
- no moisture and product losses - nema vlage i gubitka proizvoda,
- lower energy consumption - niža potrošnja energija,
- more uniform particle size - ujednačenija veličina čestica,
- lower noise level - niža razina buke,
- less space required - potrebno manje prostora,
- quick change of wearing parts - brza promjena istrošenih dijelova.

3. MIXING

There are certain specific prerequisites required of a modern mixed feed, if it is to be considered as being safe for both the animal and the consumer of animal products.

Of particularly great importance are therefore the homogeneity and the avoidance of cross contamination. One element of utmost importance in regard to fulfil these needs is the batch mixer. A modern mixer has to meet the following general rules more and more asked throughout the feed industry world-wide:

- more stringent regulations for contamination and segregation - strože mjere/propisi za kontaminaciju i segregaciju,
- more stringent regulations for sanitation - stroži propisi za sanitaciju,
- production plants with increased flexibility - proizvodni pogoni povećane fleksibilnosti,
- production of smaller batches - proizvodnja manjih količina,
- shorter cycle time for mixing operation - kraće vrijeme miješanja.

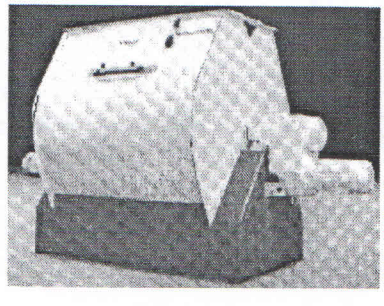
The coefficient of variation or quality characteristic of a mixed feed mash has to be better than 5 % at a dilution of 1:100.000.

According to multiple animal tests the accuracy of a mix is of great influence on the nutritional result of feeding animals, conversion rate etc. Here the mixer design, speed and technical characteristic of the rotor is of enormous influence.

The newly designed and to the market introduced speed-mixer of Bühler meets the afore mentioned conditions. Thanks to the special mixing geometry it is now possible to produce mixtures with a coefficient of variation of < 5% in 90 seconds. This fact allows us to build plants with shorter dosing/mixing-cycles thereby increasing the flexibility of feedmill installations. 20 batches per hour are possible, the mixer is a very small unit requiring smaller bins and hoppers less investment in the same throughput.

The Speedmix DFML is available in 4 sizes covering the whole range of 1 - 60 t/h mixing capacity.

"Speedmix" DFML



a new concept – nova koncepcija

The new mixer generation – Mikser nove generacije

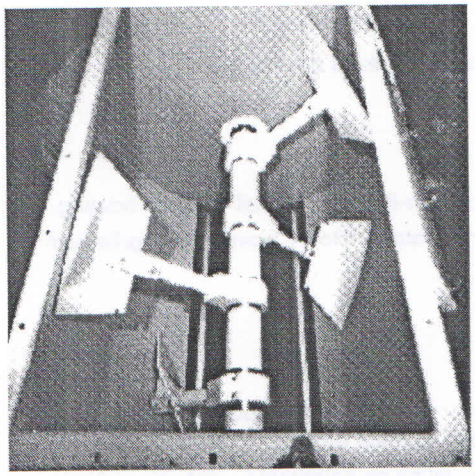
a revolutionary conception – revolucionarna zamisao

4 sizes – 4 veličine:

1000 l
2000 l
4000 l
6300 l

The "Speedmix" consists of the following main elements:

Speedmix DFML



Features - Karakteristike

- mixer housing mild or stainless steel - kućište miksera mekani ili nerđajući čelik,
- mixer outlet stainless - izlaz miksera nerđajući,
- cleaning door - vrata za čišćenje,
- shaft mounted gear - uređaj postavljen na šaht,
- adjustable and exchangeable paddles - pomične i zamjenjive lopatice,
- twin outlet flap, large opening, fast emptying - dvostruki preklop, veliki otvor, brzo pražnjenje,
- special sealing device - posebna naprava za zatvaranje.

The "Speedmix" DFML mixer can be applied for a wide range of various products (feeds, premixes, concentrates, food, pharmaceuticals etc.) meeting the following product characteristics:

granulation range:	max 3mm
density range:	approx. 0.5 t/m3
density of mixture:	max 1.0 t/m3
moisture:	max 18%

The advantages for the operator are summarised:
Prednosti za tehničara

good sanitation:	• reduced dead areas - smanjena mrtva područja,
dobra sanitacija:	• large cleaning door - velika vrata za čišćenje,
	• few mixing elements - malo elemenata za miješanje
low maintenance:	• exchangeable paddles - izmjenljive lopatice,
nisko održavanje:	• few parts - malo dijelova,
	• easy access - laki pristup
wide application:	• filling over whole length - punjenje po čitavoj dužini,
široka primjena:	• no restriction of nominal volume with high density products Partial filling possible (over 20% - nema ograničenja početne količine proizvoda visoke gustoće. Moguće djelomično punjenje (iznad 20%).

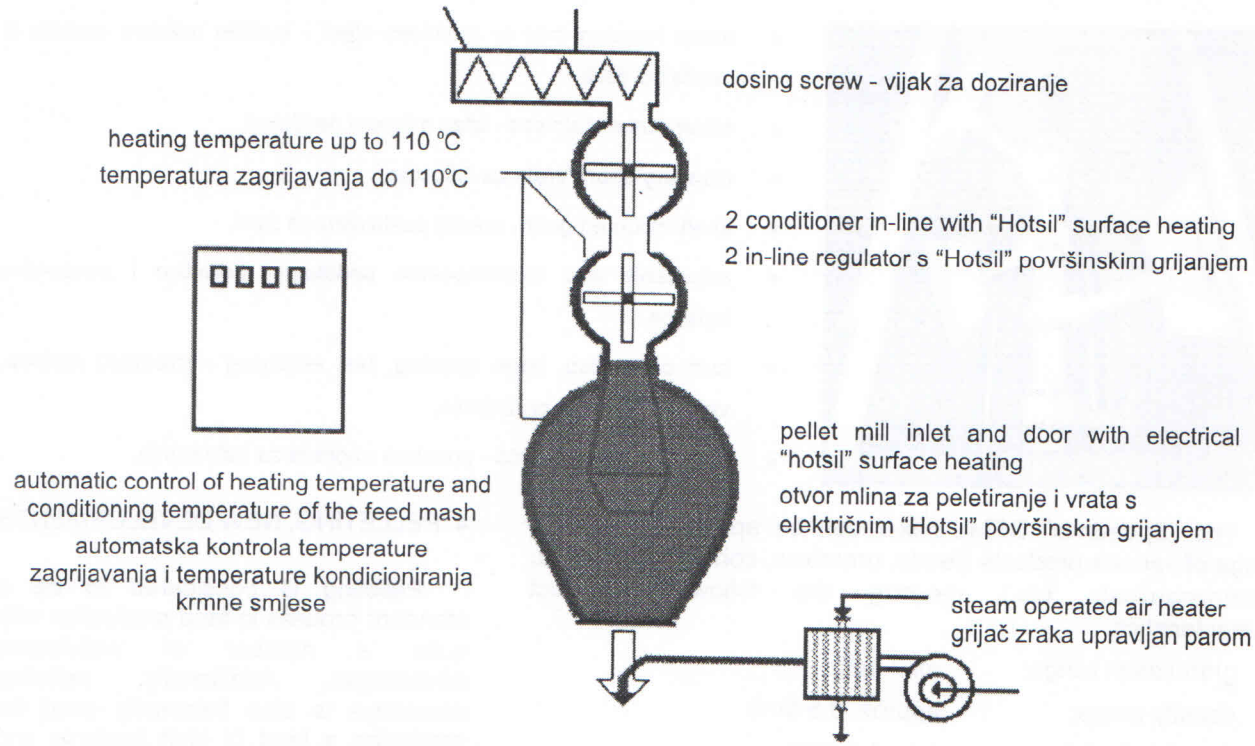
With all these advantages the "Speedmix" therefore has a great future and operates already successfully in over 60 plants throughout the world.

4. PELLETING, NEW DEVELOPMENTS

Pelleting is considered to be a standard process in feed production with quite a number of well-known advantages. Additionally, pelleting nowadays is also frequently used for producing a feed of high hygienic and quality standards making this process even more popular. The latest development in this field is the so called "Heat-Shield"-pelleting, improving the pelleting process even further.

Some years ago, in answer to the big problems a number of European countries were experiencing with Salmonella contaminated feed, a quick reaction from the feed industry was asked. Bülhler of Switzerland had pellet mills running in Scandinavia for many years that were specifically used for bacteria decontamination of doubtful raw ingredients like fish meal and others. These specially operated pellet mills proved very effective in reducing dangerous bacteria. Out of this experience the idea rose to further improve the pelleting process and make it safe for using as a decontamination tool for normal mass feed production. The "Heat-Shield"- application was born. The principle is simple, economical and above all effective.

Pelleting with "Heat-Shield", design characteristics
Peletiranje s "Heat-Shield"-om, karakteristike dizajna



The high temperature existing during the pelleting process is prolonged by double inline conditioners with electrically heated jackets forcing the added steam to condensate where it must; on the mash particles. The dangerous parts in a pellet mill, in regard to condensation, are the pelleting chamber, the inlet chute and the mill outlet with connection spout down to the cooler. These parts are also artificially heated to a point where condensation is excluded and Salmonellae cannot survive. The total package ensures, therefore, safe conditions allowing bacteria reduction to an interesting level in regard to clean feed. The advantages of the system are listed here:

- practical and easy to operate process for existing and new pelleting lines
- minimal investment needed
- no unnecessary "hard" conditions thereby avoiding the danger of harmful reduction of active, heat sensitive agents

Naturally, such processes have to be proven effective not only in theory but also in practice. The "Heat-Shield"-process therefore was tested under field conditions.

These tests were carried out in co-operation with a Swiss feed manufacturer together with Buhler under the supervision of IKMI (Institute for Clinical Microbiology and Immunology, St Gallen, CH). The bacteriological analyses were also made by this institute.

A test was carried out under practical conditions on a poultry feed utilising a Buhler pellet mill DPBA/132 kW, capacity 7.5 t/h, preconditioning 80 °C, roll gap setting at 0.3 mm and resulting pellet temp. of 84 °C. The feed had been contaminated with Enterococcus faecalis (ATCC 29212) to a contamination of 310.000 +/- 17.000 germs/g. This germ had been selected because results of comparable tests were available and because it has a higher resistance to heat than the invasive Salmonella enteritidis and Salmonella typhimurium.

The effect of the heat treatment by pelleting with "Heat-Shield" was found similar to test results after expander treatment and are as follows:

The destruction of Salmonella was certainly complete so that no Salmonella bacteria could be traced and the reduction of Enterococcus germs was at least in the range of five times 10∧3 to 10∧5. In 37 of 50 samples no germs could be found, but in 13 samples it was possible to trace 55 +/- 25 Enterococcus germs. A repeated additional testing of the positive samples after 5 days showed that no more Enterococci could be traced (<10 colony forming units/g). These tests proved, that this "gentle" thermal treatment led to a practically complete eradication of this strain of Enterococcus in spite of the higher heat resistance than Salmonella bacteria's.

Attention has to be paid to the need of necessary measures to avoid recontamination after heat-treatment. This is, by the way, necessary with any heating process applied for Salmonella decontamination of feed. Specially the following cooling process is critical in regard to the use of clean filtered cooling air. Equally, storage and transportation vehicles should be clean. A modest acid treatment to avoid recontamination of the treated feed can here be an adequate measure.

5. EXPANSION PROCESS

A more recently introduced process to the feed industry is expansion. Expanders are effective tools and have been working successfully since many years for the preparation of oil seeds prior to extraction. For the feed industry expansion is now a new easily applicable process of heat-treatment where up to now, the extrusion process played a leading role. Unfortunately, it proved not to be economically viable for standard use in mass feed production. With the possibility of expansion now already a reality for a large number of field applications this new process pushes extrusion into the background limiting it to special products and high intensive processing of feed.

During recent years the status of the expander in the feed industry has become clearer. The expander designs actually existing are identifiable in two main groups:

a) **simply designed** machines for pre-conditioning prior to pelleting. These expanders are characterised by limited process intensity. It is of utmost importance to evaluate the requirements of the market to make sure that increased profit is resulting in the long run. For a lot of applications, especially, if used only for bacteria control or improved pellet quality for poultry feed, Expander application is quite expensive especially if compared to other much cheaper alternative processes, like pelleting with heat-shield etc.

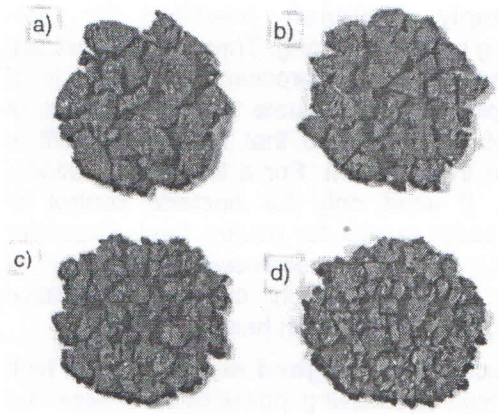
b) **specifically designed** expanders with high intensive feed processing possibilities. These are employed as an independent autonomous processing machine for the production of direct expandates. There already exists a wide field of multiple purpose applications with specific advantages. This more recent processing possibility offers, compared to non-thermally treated feed and specially mash feed, many advantages. The most important for the feed miller are:

- increased starch gelatinisation
- elimination or at least important reduction of anti-nutritive factors
- influence on palatability
- dustfree appearance of feed
- higher hygienic feed status
- structured feeds better suited to the needs of the animal
- improved protein value of the feed with better rumen protected proteins

For the farmer there are also, direct advantages:

- better feed intake due to improved palatability
- Feed structure optimally adjusted to the needs of the animal
- easier soup or liquid feed preparation due to high, instant water solubility
- positive influence in regard to animal health
- higher feed conversion rate

This new feed is available as shaped expandates direct from the expander outlet. The shape can be of various forms according to the type of the shaping die installed. By means of adapting certain operational parameters a direct influence on the shape and size of expandates is possible any time. The following pictures give you an idea of these possibilities.



Beef feed direct expanded by a "Condex"-Expander

bulk density 0.43 t/m3

8 mm slotted die

size varied by adapting outlet gap and knife speed by simple setting of production parameters on the control unit DFCE

a) 17 mm gap, 30% knife speed

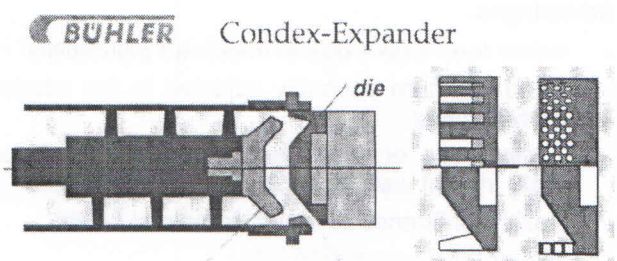
b) 17 mm gap, 50% knife speed

c) 14 mm gap, 50% knife speed

d) 14 mm gap, 70% knife speed

When direct expandates are required or when the product leaving the machine needs to be in a certain, more or less defined shape, a machine designed with additional shaping properties, or cutter element, is necessary. New feed forms for direct feeding (without additional pelleting) are possible; likewise this direct expansion process is applicable to intermediate and raw products needing high intensive processing. Expanders already exist which allow highly intensive operation under defined and automatically controlled processing conditions. The head and process screw elements can be adapted to the needs and specifications of the final product.

The characteristic design features are shown in the following figure



Patents existing and pending

In various European countries and Asia (and especially Japan), as well as in Brazil, an increasing number of expander installations are producing direct expandates fulfilling multiple nutritional tasks, producing interesting advantages for the producer. Some of the major advantages and possibilities are listed hereunder.

- better structured feed specifically adapted to the needs of the animal
- cheaper production of feeds substituting flakes (no drying process needed)
- high starch gelatinised piglet feed
- instant soup feed
- dust free feed as a complete ration, containing the necessary fibre fraction, or high energy and protein supplement feed (for rabbits, other rodents, horses, ruminants etc.)
- improvement of the protein value of a feed and also an increase in better rumen protected proteins for diverse ruminant feeds.

Likewise, expandates can be utilised for fish and dog feed, showing some interesting results.

Here, the expander process substitutes, in an economical way, the very expensive extrusion process hitherto needed and also the pelleting process, during which no sufficient nutritional improvement of the feed value had been possible.

As already mentioned, the economical viability of the expander process depends on the criteria that expansion is specifically employed in the production of feeds which cannot be produced by other, cheaper processing methods (i.e. pelleting etc.) or where combined efforts are desirable (nutritional improvement, bacteria control, reduction of anti-nutritive factors, dustfreeness etc.) Another, economically interesting aspect could be the use of cheaper raw materials that up to now could not be

incorporated into the feed, due to insufficient heat treatment or product shearing.

Up to now, only a small amount of the total feed production has been handled by an expander. However, this new process is rapidly gaining acceptance in various parts of the world and new expanded products are constantly being developed. Thermally treated mass animal feeds of hitherto unknown nutritional values are being introduced to the feed market. Therefore, without any doubt, the expander will become a standard machine for feed production in the near future.

We believe that a better knowledge and a more quantitative insight of the feed manufacturing processes on all levels of feed production are important. A structural approach to process accuracy in regard to avoidance of carry over of critical additives, in regard to the bacteriological stand point, in regard to responsible use of energy and in regard to minimising shrinkage and loss, is a prerequisite for the future. The described new solutions in feed processing are first steps toward this future goal, but adaptations in plant design, training the introduction of HACCP-plans (hazard analyses and critical control points), good manufacturing codes etc. will be tasks in the near future for the feed milling industry.

SAŽETAK

Industrija krmiva u čitavom svijetu podliježe prilično različitim utjecajima te će prema zemlji i području naići na različite zahtjeve.

Općenito gledano stoka nije homogena niti po pasmini niti po uzgoju, niti po ponašanju u svezi s hranidbom. Sirovi sastojci u hrani veoma se razlikuju, na njih utječu politička situacija i uloga vlada i zakoni, a sve više na industriju stočne hrane i njezine proizvode utječu veliki potrošači i organizacije trgovaca na malo. Stoga je vrlo teško govoriti općenito o napretku i razvoju industrije stočne hrane. Prema situaciji i mjestu razlikovat će se odgovor na pitanje: "Što je napredak u praksi i tehnologiji proizvodnje stočne hrane?"

Opći zahtjev današnje industrije stočne hrane nalazi se u jednoj izreci: "Industrijska proizvodnja stočne hrane je ekonomična proizvodnja vrlo kvalitetne krme." Kakvoća stočne hrane odnosi se na fizikalnu stranu, hranidbenu vrijednost, čisto bakteriološko stanje, te odgovaranje svojoj namjeni. U ovom će se radu, stoga, uglavnom usredotočiti na neka nova, zaista zanimljiva i korisna, tehnička i tehnološka rješenja, što udovoljavaju ovim glavnim zahtjevima.

Zanimljivi su osobito:

- novi sustavi mljevenja,
- nove tehnologije miješanja,
- inovacije u peletiranju u svezi s problemima,
- tehnologija ekspandiranja i ekstrudiranja.