International Journal of Science, Environment and Technology, Vol. 7, No 4, 2018, 1361 – 1365

ISSN 2278-3687 (O)
2277-663X (P)

Review Article

FACTORS AFFECTING PELLET QUALITY

R. Yasothai
Veterinary University Training and Research Centre,
Tamilnadu Veterinary and Animal Sciences University,
Erode – 638004, Tamilnadu, India

Introduction

The pelleting process is widely used because of its physical and nutritional benefits. The physical benefits are improved easy handling, reduced ingredient segregation, less feed wastage in the form of dust, etc., and increased bulk density. The nutritional benefits of the pellet feed improve animal performance and efficiency of feed utilization compared with mash feed.

Factors affecting pellet quality

The pelleting of animal feed is more art than science. There are many variables which affect the pelleting process, *viz*. machinery used, feed materials processed and the conditioning of the feed. Mean particle size, inherent binding capacity and fat content of the feed mixture plays major role in pellet durability. Hence for many years pelleting was considered as a luxury added for commercial feeds. However, with rising ingredient and energy costs and taking into consideration improvements in animal feed efficiency, pelleting has become more economically feasible and necessary.

Commercial feed manufacturing companies and farmers emphasis on pellet quality. With increasing costs of production, the margins are shrinking, and thus pellet feed producers must find ways to preserve high quality while lowering the cost of operation. Therefore the study was chosen to evaluate the factors influence for efficient and effective pelleting process and pellet quality and analyse the energy consumption in pellet mill.

The primary factors controlling pellet quality are formulation (40%), fineness of grind (20%), steam conditioning (20%), die selection (15%) and cooling/drying (5%) (Reimer, 1992).

Particle size

Particle size also has a direct effect on how well the mash is preconditioned. Larger particles (> 400 microns) require twice as much hydration time than smaller particles (< 200 microns) (Bouvier, 1996). Particle size is the second factor influence about 20% of pellet quality

*Received July 12, 2018 * Published Aug 2, 2018 * www.ijset.net*

(Reimer, 1992). Decreasing particle size from a coarse to a fine grind exposes more surface area per unit volume for absorption of condensing steam and increases the surface area available for bonding. Variation in particle size produces a better pellet than a homogeneous particle size (MacBain, 1966). When pelleting corn or wheat based diets, the particle size had no effect on pellet durability index (PDI) as determined by the tumbling can method (Stevens, 1987).

A larger particle size led to a higher pellet durability. As the particle size increased from 670 microns to 1,289 microns, the pellet durability index (PDI) value increased from 91.0 to 92.5 respectively (Reece *et al.*, 1985). An increase in pellet mill throughput (545 kg/h to 1646 kg/h) led to a linear increase in pellet mill efficiency (73.3 to 112.4 kg/hph) and linear reduction in pellet durability (55.4 to 30.2 PDI) (Stark, 2009). It suggest that pellet mill throughput is an important factor affecting pellet durability and energy consumption.

Nature of ingredient

Ingredients such as starch, protein and fibre change physical or chemical structure during processing and can affect the final pellet quality. Hence pelleting of feed classified as heat sensitive feeds, urea feeds, molasses feeds, high natural protein feeds, high starch feeds and complete dairy feeds. Addition of fat makes a pellet less durable. The fat content of the formula to be pelleted down around 1 to 2%. The remaining fat necessary for the total formula can be sprayed on the pellet after they are made while they are hot. However, it is difficult to cool and dry the pellet (Reddy, 2011).

The addition of fat to the mash pre-pellet usually results in decreased pellet quality (Richardson and Day, 1976). However, the addition of protein and fibrous materials increase pellet quality. Fahrenholz (1989) reported an increase in the pellet durability of swine diet pellets and the level of wheat middlings increased from 0 to 45%.

Preconditioning

The most critical step in the process of pelleting is preconditioning. The quality of preconditioning process will depend on particle size of the mix, the steam quality, initial moisture content of the mix, meal initial temperature as it enters the preconditioner and the residence time in the preconditioner.

Die and rolls

The most important factors that affect the performance of pelleting operation are the physical and geometric characteristics of the die and rolls, adjustment of the roll to die clearances, proper speeds of rotation, and maintenance of the rolls and die. The character that has largest effect is the thickness of the die (L) in relation to the hole diameter (D) known as the die L:D ratio. A larger L:D ratio means that the die is thicker, which will typically increase pellet durability due to friction and possibly die retention time, but is negatively related to throughput and energy consumption (Fahrenholz, 2012).

Steam conditioning

In pelleting system, conditioning is the most important factor that influences pellet quality. Proper conditioning allows the use of the thinnest possible die and therefore, the greatest potential throughput. Hence conditioning is more important than die or roll selection. In the pellet mill when heat is added to the system, the pressure rises directly with the temperature. At 0 KPa (0 psi) gauge pressure, 0.5 kg steam occupies 0.84 m^3, but at 552 KPa (80 psi), that same 0.5 kg of steam occupies only 0.15 m^3 (Behnke and Gilpin, 2014). High quality steam is recommended for efficiently producing a durable pellet (Stark, 1990).

Conditioning time

Longer residence time in the conditioner permits more penetration of the moisture and better distribution of heat, which results in better binding of feed particles, hence increasing the pellet hardness that can result in a reduction of fines produced (Bortone, 2014). An adequate supply of high quality steam is necessary to have an efficient pelleting operation. A properly sized steam supply accounts for steam quantity, pressure and quality. The optimum conditions for pelleting are 13-17% moisture and 170-190°F (77-88°C) temperature as the feed enters the die (Reddy, 2011).

Steam pressure

Steam pressure also influencing pellet durability and energy consumption. Increasing the pressure of the steam used for conditioning improved pellet durability (Cutlip *et al*., 2008). Low pressure steam produced a higher quality pellet with greater throughput on high strach feed compared with high pressure steam (MacBain, 1966). Steam quality directly affects the maximum obtainable feed temperature because of moisture limits (Reimer and Beggs, 1993).

Major factors affecting electricity consumption during pelleting are the type of ingredients in the formula and degree of steam conditioning and compression in the die. Feed with low cereal content, and high molasses and fibre levels (eg. feeds for cattle and rabbits) receive lower levels of steam energy input but require higher levels of electric energy at the pellet die to generate friction and compression for pelleting (Reddy, 2011). During pelleting, damage is mainly caused by friction as the mash is compressed and extruded through the working area of the die (Stevens, 1987).

In feed mill design and equipment, there has been much greater attention on energy management. Steam is usually generated in the mill from fossil, such as oil and gas. It is reported that a Kilowatt of steam energy is less costlier than a Kilowatt of electric energy. During mash feed preparation the energy consumption varies with the type of feed ingredients used in the formula. Grinding of oil seed meals required 3.5 to 7.0 kwh per ton and cereals required 7.0 to 15.0 kwh/ton. Energy consumption for pre-pelleting is 13 kwh/ton (28%), pelleting is 26.8 kwh/ton (60%), post pelleting is 5.7 kwh/ton (12%). Total energy consumption for pellet feed preparation is 45.5 kwh/ton (100%). During pelleting steam generation required 26.1 kwh/ton (83%) and post-pelleting required 5.4 kwh/ton (17%). Total steam generation required 31.5 kwh/ton (100%) (Reddy, 2011).

Conclusion

Energy consumption is minimized by operating at the maximum possible production rate based on diet characteristics, die volume or motor load. The highest possible conditioning temperature improved both pellet durability and reduced pellet mill energy consumption in fat free or low fat diets, and improved pellet durability in high fat diets (Pfost *et al*., 1962). Increased steam conditioning led to a decrease in mechanical friction during pelleting, as determined by lower temperature rise across the pellet die, decreased electrical energy consumption and improves pellet durability (Skoch *et al*., 1981).

References

[1] Behnke, K.C. and A. Gilpin, 2014. Priciples of mash conditioning. In: Feed Pelleting Reference Guide. Kansas State University, Manhattan, Kansas, USA.

[2] Bortone, E., 2014. Critical Steps in Mash Conditioning. In: Feed Pelleting Reference Guide. Kansas State University, Manhattan, Kansas, USA.

[3] Bouvier, J.M., 1996. Engineering analysis of preconditioning in the extrusion cooking process. Cereal Foods World, 41: 738-740.

[4] Cutlip, S.E., J.M. Hott, N.P. Buchanan, A.L.Rack, J.D. Latshaw and J.S. Moritz, 2008. The effect of steam conditioning practices on pellet quality and growing broiler nutritional value. J. Appl. Poult. Res., 17: 249-261.

[5] Fahrenholz, A.C., 2012. Evaluating factors affecting pellet durability and energy consumption in a pilot feed mill and comparing methods for evaluating pellet durability. PhD. Dissertation, Kansas State University, Manhattan.

[6] Fahrenholz, C.F., 1989. Utilization of wheat milling by-products. I. Effect of wheat mill run on finishing pig performance. II. Effect of processing on the physical characteristics,

handling properties and utilization of wheat middlings. PhD. Dissertation, Kansas State University, Manhattan.

[7] MacBain, R., 1966. Pelleting animal feed. Regional Feed School Presentation. American Feed Manufacturers Association, Arlington, Virginia, USA, 1-28.

[8] Pfost, H.B., R.M. Allen, G. Gutekunst, W. Monti and R.L. Stroup, 1962. Chapter 4: A standard method of measuring pellet quality. Proceedings of the 1962 Feed Production School sponsored by the Midwest Feed Manufacturers Association.

[9] Reddy, D.V., 2011. Feed pelleting technology including newer developments. In: Advanced Animal Nutrition. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp.291-309.

[10] Reece, F.N., B.D. Lott and J.W. Deaton, 1985. The effects of hammer mill screen size on ground corn particle size, pellet durability and broiler performance. Poult. Sci., 65: 1257-1261.

[11] Reimer, L.L. and Beggs, W.A, 1993. Making better pellets: Harnessing steam quality. Feed Management, 44: 22.

[12] Reimer, L.L., 1992. Conditioning. Northern Crops Institute Feed Mill Management and Feed Manufacturing Technology Short Course. Northern Crops Institute, Fargo, North Dakota, USA, 7.

[13] Richardson, W. and E.J. Day. 1976. Effect of varying levels of added fat in broiler diets on pellet quality. Feedstuffs 48: 24.

[14] Skoch, E.R., Behnke, K.C., Deyoe, C.W. and Binder, S.F., 1981. The effect of steam conditioning rate on the pelleting process. Anim. Feed Sci. Tech., 6: 83-90.

[15] Stark, C.R., 1990. Evaluation of pelleted soybean meal for domestic and international markets. Master's thesis. Kansas State University, Manhattan, Kansas, USA.

[16] Stark, C.R., 2009. Effect of die thickness and pellet mill throughput on pellet quality. Abstr. T89. Southern Poultry Science Society Meeting.

[17] Stevens, C.A., 1987. Starch gelatinization and the influence of particle size, steam pressure and die speed on the pelleting process. PhD dissertation, Kansas State University, Manhattan, Kansas, USA.