Rhodimet®

TECHNICAL REPORT

N°6 - 09/2016

PELLET - ENERGY - SAVINGS - FEED MILL - D,L-HMTBA - D,L-MET

SAVING ENERGY WITH LIQUID METHIONINE WHEN PELLETIZING

Ivan Gaytan, Adisseo Technology Development Engineer / ivan.gaytan@adisseo.com
William Goh, Regional Engineering & Products Application Manager / william.goh@adisseo.com

In the feed mill, pellet production is one of the most energy consuming steps; therefore, any potential area of optimization is beneficial to pursue. Adisseo's recent studies have shown that the addition of a liquid source of methionine (D,L-HMTBA) may lead to power savings of up to 7% compared to the powder form (D,L-Met) when pelletizing.

Power consumption is one of the key points that must be monitored when managing a feed mill as it directly affects the feed mill's performance. The manufacturing step that contributes the most is pelletizing, as it can account for up to 60% of the electricity consumption (Tecaliman, 2016). Thus, even the smallest source of savings should be considered as it will improve the feed mill's performance. This is even truer when we deal with high production volumes.

To minimize energy consumption, one solution is to push the pellet mill to its maximum production capabilities. This is usually done by producing in maximal motor load and modifying the mechanical energy required at the die (Fahrenholz, 2012). This energy is dependent mainly on the strength of the friction between the mash particles and the die walls.

Pelletizing is a matter of friction

Pellets are formed by the extrusion of the mash through the die holes. The surface shrinkage generates a friction force that resists the flow of particles, causing compression (Thomas et al., 1997; Nathier-Dufour, 1994) and allowing the mechanisms for pellet formation (figure 1). Such mechanisms are solid bridges, capillary forces, adhesive and cohesive forces, mechanical bounds and attraction forces between solid particles (Fahrenholz, 2012; Thomas and Poel, 1996).

It is well known that increased friction has a detrimental effect on energy efficiency (Fahrenholz, 2008; Von Harald, 1985) and production rates (Behnke, 2001). This frictional force, and therefore energy consumption, is dependent on the coefficient of friction between the mash and the die walls which is in turn affected by the mash feed characteristics (added fats, mash grind size, mash physical-chemical composition, etc.). Other parameters will also have an impact on such coefficient, namely the residence time in the conditioner, moisture content, mash compressibility, also die parameters (Length (L) : Diameter (D) ratio), die temperature (Fahrenholz, 2008), roller distance to the die (Thomas et al., 1997) and die and roller wear (American Feed Industry Association, 1985).

In addition, the diet ingredient composition is considered highly influential on energy consumption. For example, moisture and fats are known to enhance pellet production. Oil or fat will act as lubricants between the particles and toward the die walls, reducing needed pressure for pellet formation, therefore, reducing energy consumption (Thomas et al., 1998).

Little is said about the effect of moisture addition. However, (Hott et al., 2008) found that relative electrical energy usage decreases with the increasing spraying of a blend of water (95%) and mold inhibitor (5%). These findings go in the same direction as those of (Moritz et al., 2003) and are attributed to the lubricant effects of added moisture.

Inversely, due to their crystalline structure, minerals may increase friction when extruding and limit the cohesion and compression capacity of the feed (Nathier-Dufour, 1994), resulting in reduced production capacity.

Methionine is an amino acid added to feed in either powder or liquid form. Recently, it has been reported that customers using liquid methionine instead of powder experience energy savings when pelletizing. Adisseo performed trials in order to analyze if the physical form of this additive may have an influence on energy consumption, similar to other ingredients.

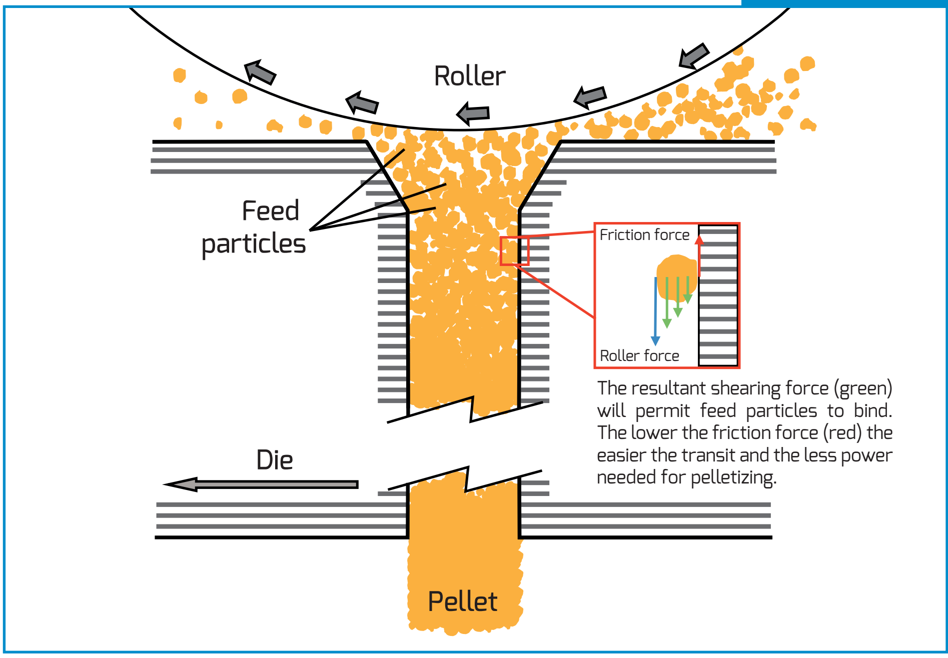


Figure 1: Schematics of pellet formation and the most basic forces taking place during mash extrusion.

Changing methionine source can bring unexpected benefits

Ingredient	Quantity (%)
Wheat	40.25
Corn	23.12
Soybean meal	30.15
Soybean	4.02
Dicalcium phosphate	1.16
Calcium carbonate	0.95
Salt	0.35
Calculated nutritional values	
Fat	2.51
Crude fiber	2.83
Crude protein	20.40
Ash	6.23
Moisture	12.92

Table I: Feed base formulation for broilers. Feed was provided by a French research center.

In order to evaluate energy consumption and the effect of methionine sources, Adisseo trials were conducted using a pilot pellet mill. Thirty two batches of 7 kg were prepared using the same diet (table I). All process variables (steam addition, throughput, die characteristics, pellet length, etc.) were at fixed values. Powder D,L-methionine (D,L-Met) and liquid DL-2-hydroxy-4- (methylthio)-butanoic acid (D,L-HMTBA) were used as methionine sources.

D,L-Met, D,L-HMTBA, oil and/or water were added at different inclusion rates. Pelletizing was done following the method described in figure 2. Feed and dry ingredients were mixed for a period of 4 minutes. Then, liquid ingredients were sprayed in the beginning of the wet mixing cycle (4 minutes).

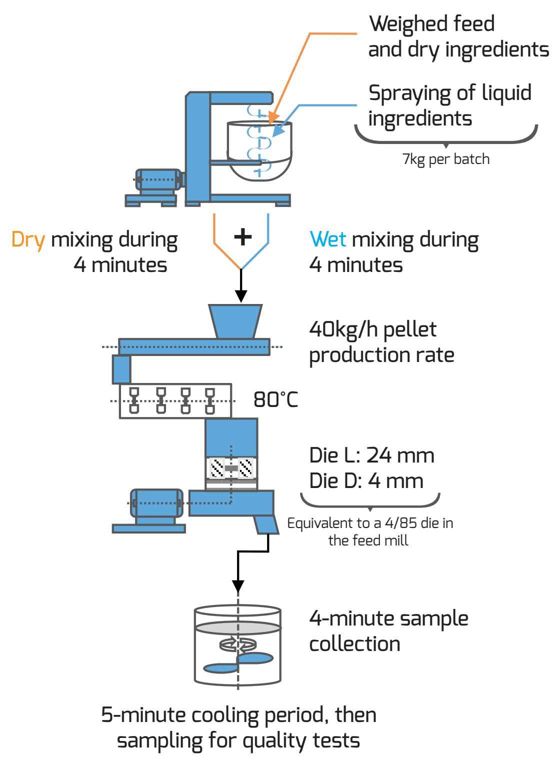


Figure 2: Schematic representation of the performed pelletizing protocol.

Pelletizing was done in a Kahl flat die pilot pellet mil in which only the rollers apply compression. The press was fed at a constant rate of 40kg/h and the vapor added was set to maintain a constant temperature of 80°C. A stabilization period of 1 hour was performed, then, each formulation was pelletized with a rinsing 5-minute period in between. Samples were taken for 4 minutes after the rinsing and cooled in a vertical pilot cooler for a minimum of 5 minutes. They were stored overnight prior to quality tests. Electricity consumption was obtained by measuring the instantaneous power absorbed (kW) by the motor of the press each second. Only the values in which pelletizing conditions (production rate and temperatures) are stable were used. This amount was then divided by the real output rate (t/h) to calculate the specific energy consumption (kWh/t).

Two series were performed. The first pointed to an effective reduction in energy consumption with D,L-HMTBA. In general, the addition of high levels of D,L-HMTBA (more than 0.23%) diminished the power consumption in all cases. When normal doses (0.23%) of liquid methionine were used, the reduction phenomenon was particularly observed when no other liquids were added to the formulation (figure 3 – Dry feed). Here, a 7% reduction was obtained. As expected, the addition of oil reduced the overall energy consumption. When 3% was added (figure 3 – Oil 3%), savings when using D,L-HMTBA instead of D,L-Met accounted for 4%.

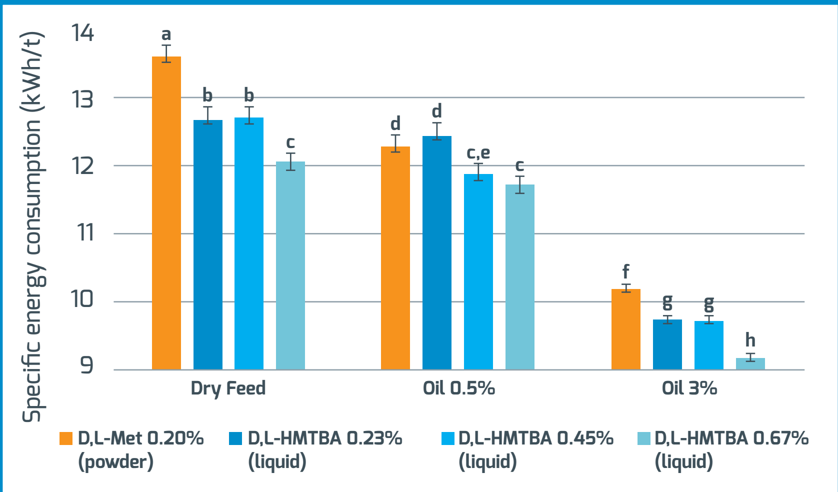
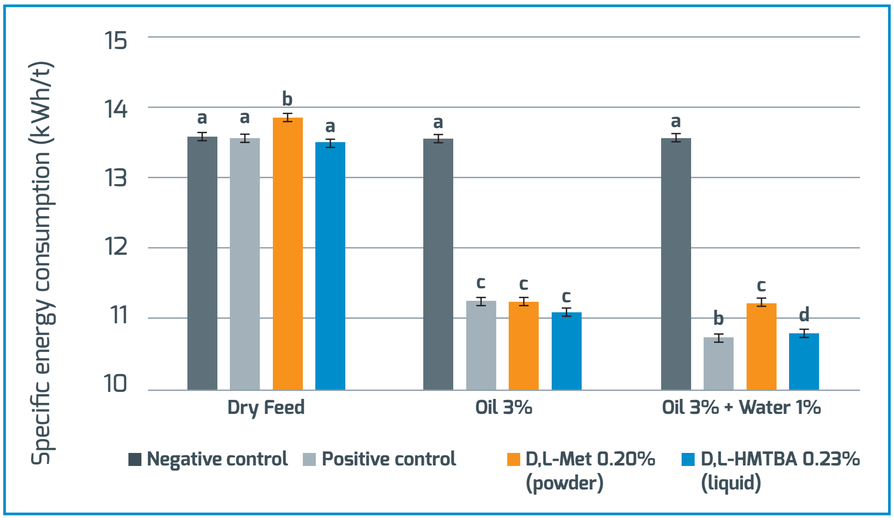


Figure 3: Specific energy consumption for different feed formulations in trial 1: comparison between the addition of D,L-HMTBA at increasing rates and D,L-Met. Mean ± standard error. [a,b,c,d,e,f,g,h] groups are significantly different ($p<0.05$).

These trials also led us to believe that a possible increase in energy consumption was caused by the addition of powder methionine.

A second trial set was performed in order to confirm these findings. The negative control was prepared without additives, oil or water. The positive control did not contained additives and was prepared with oil and/or water according to the different tested conditions. Results showed that, on one hand, there was no significant difference between the positive control and feed with D,L-HMTBA. On the other hand, a significant increase in energy consumption when D,L-Met was used instead of D,L-HMTBA was confirmed. Although the addition of oil alone showed only a tendency for lower power usage (figure 4 – Oil 3%), savings ranged from 2.8% when feed was dry (figure 4 – Dry feed) to 4.4% when feed contained additional free oil and water (figure 4 – Oil 3% + Water 1%).

Figure 4: Specific energy consumption for different feed formulations in trial 2: comparison between the addition of oil, water, D,L-HMTBA at 0.23% and D,L-Met at 0.2%. Mean ± standard error. [a,b,c,d] groups are significantly different ($p<0.05$).

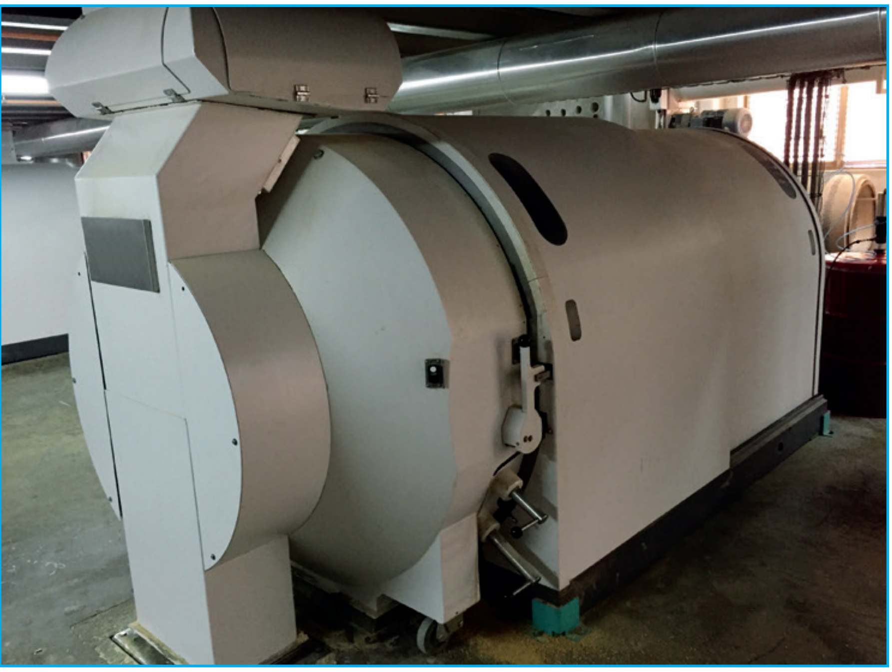


The effect of water alone was also explored and 3 levels of water were tested (0.5% – 1% – 2%). The addition of water alone did not permit to differentiate the control from D,L-Met and D,L-HMTBA (table II). Therefore, in this case, benefits for D,L-HMTBA were not clear. However, a tendency of lower power consumption was observed in each case.

		Negative control	Positive control	D,L-HMTBA 0.23 %	D,L-Met 0.2 %
Water added	0.0 %	14.25^{a}	-	-	-
	0.5 %	-	14.05^{a}	1362^{b}	13.70^{b}
	1.0 %	-	14.06^{a}	14.17^{a}	14.31^{a}
	2.0 %	-	14.42^{a}	14.31^{a}	14.46^{a}

Table II: Effect of different inclusion levels of water on specific power consumption (kWh/t) when pelletizing. ^{a,b} groups are significantly different ($p<0.05$).

The general mechanisms that cause the energy reduction observed between usage of D,L-HMTBA versus D,L-Met are still unknown. However, as the main power drain in the pellet press comes from the effort needed to overcome the friction force in between the interface feed/die, it is possible that the D,L-Met effect originates from an increase of this force. The apparent balancing effect when moisture is added leads us to believe that the phenomenon may be caused by hydrophilic particle interactions between the die walls and among themselves. Because D,L-HMTBA is a water soluble liquid, these interactions may not take place which could justify the power savings observed. These savings are a common trend overall but they are variable. Indeed, one must be aware that the coefficient of friction which affects energy usage is impacted by an important number of parameters making it difficult to obtain a precise number. Nevertheless, Adisseo's trials demonstrated that D,L-HMTBA has the capacity to reduce power consumption from 2.5% to 7% when pelletizing formulations without moisture addition.



Additionally, pellet quality is a major parameter to consider when looking at power consumption. Lower quality may imply lower compression and therefore less energy needed. Pellet hardness and durability from the different formulations were tested using a Eurotest Sabe and a Schleuniger machine respectively. Results showed that when energy differences were significant, the pellet quality was generally maintained. Values ranged at 91% ± 0.8% for durability* and at 34 N/pellet ± 3.3 N/pellet for hardness** for feed without oil. Oil addition resulted in expected lower values going from 84.5%± 0.7% and 23.5 ± 1.4 N/pellet for durability and hardness respectively.

* Mean of the durability for all formulations ± 1 Standard Deviation (SD). Durability was obtained after the difference in percentage between 500g of pellets and the fines caused by the Eurotest Sabe processing for each formulation.

** Mean of the hardness for all formulations ± 1 SD. Hardness was obtained after the median of 36 tested pellets for each formulation. Test consist on crushing a pellet until its breaking point. Force is measured in Newton.

Power saving trends showed in the field

When following the good practices for liquid methionine application recommended by Adisseo, besides obtaining the same feed quality as with the powder, the energy necessary for pelletizing may be reduced.
This was showed in the field after trials conducted by Adisseo comparing the two sources of methionine in two different Malaysian feed mills. D,L-HMTBA and D,L-Met were added in the mixer in 2 independent batches of the same formulation and tonnage. First trials demonstrated savings up to 3% in favor of D,L-HMTBA. In a second feed mill (figure 5), a formulation composed of a corn and soy bean base with 0.25% of water and water based liquids and 3% of palm oil was used. Pelletizing was conducted according to the feed mill current practices and power consumption measured with a power analyzer Lutron DW-6093. The specific energy consumption was obtained by doing the ratio between the mean power absorbed by the press (kW) during the trials and the real production rate (t/h).

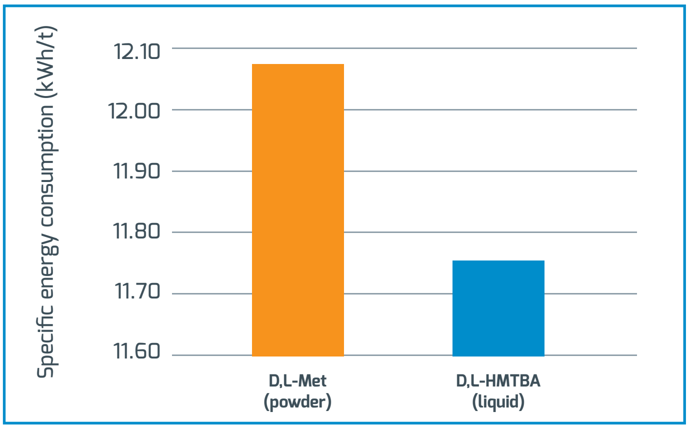


Figure 5: Specific energy consumption when pelletizing in an industrial feed mill. The effect of D,L-HMTBA and D,L-Met as sources of methionine in power consumption is observed.

The data showed power consumption when pelletizing to be 2.5% inferior when using D,L-HMTBA instead of D,L-Met. Overall, feed mill and pilot trials showed an advantage in power consumption for D,L-HMTBA with values from 2.5% to 7% less compared to D,L-Met.
For the feed miller, these potential savings will reflect on the cost of feed production. For example, a pellet press absorbing 250 kW and producing 20 t/h of acceptable pellet quality will have a specific energy consumption of 12.5 kWh/t. A reduction of 2.5 to 7% when using D,L-HMTBA will drop electricity consumption to values between 12.2 and 11.6 kWh/t (Table III). According to the International Energy Agency (Department of Energy & Climate Change, 2015), 1 kWh = 0.13 $. For a plant producing 100,000 tons, this will represent from 4,000 $ to 12,000 $ savings at the end of the year.

Table III: Example of savings at the pellet press

	Power consumption (kWh/t)
With D,L-Met	*12.5*
With D,L-HMTBA	*11.6 - 12.18**
Savings	**2.5% – 7% → 0.04 $/t – 0.12 $/t****

* Specific power consumption relative to the theoretical value for a formulation containing D,L-Met.

** Data was calculated using prices based on data collected by the International Energy Agency (IEA).

In order to correctly apply and bring forward all the benefits of D,L-HMTBA, Adisseo provides services such as DIM (Design – Implement – Monitor). With this service, all the expertise of Adisseo is at the service of clients to adjust their installations, calibrate them and ensure proper monitoring for reliable performances.

References

American Feed Industry Association, 1985. Feed Manufacturing Technology III. American Feed Industry Association, Arlington, Virginia.

Behnke, K.C., 2001. Factors Influencing Pellet Quality. Kansas State University, Manhattan, Kansas, USA.

Department of Energy & Climate Change, 2015. International industrial energy prices - Statistical data sets - GOV.UK [WWW Document]. URL https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices (accessed 5.11.16).

Fahrenholz, A.C., 2012. Evaluating Factors Affecting Pellet Durability and Energy Consumption in a Pilot Feed Mill and Comparing Methods for Evaluating Pellet Durability (An abstract of a dissertation). Kansas State University, Manhattan, Kansas, USA.

Fahrenholz, A.C., 2008. The effects of DDGS inclusion on pellet quality and pelletizing performance (Thesis). Kansas State University.

Hott, J.M., Buchanan, N.P., Cutlip, S.E., Moritz, J.S., 2008. The Effect of Moisture Addition with a Mold Inhibitor on Pellet Quality, Feed Manufacture, and Broiler Performance. J. Appl. Poult. Res. 17, 262–271. doi:10.3382/japr.2007-00083

Moritz, J.S., Cramer, K.R., Wilson, K.J., Beyer, R.S., 2003. Feed Manufacture and Feeding of Rations with Graded Levels of Added Moisture Formulated to Different Energy Densities. J. Appl. Poult. Res. 12, 371–381. doi:10.1093/japr/12.3.371

Nathier-Dufour, N., 1994. Prédiction de l'aptitude à l'agglomération des aliments composés pour animaux par des méthodes physiques (Thèse). Université de Nantes. Faculté des sciences et des techniques.

Tecaliman, 2016. Granulation [WWW Document]. Procédé Fabr. URL http://www.tecaliman.com/index.php?option=com_content&view=article&id=114&Itemid=142&lang=fr (accessed 10.11.15).

Thomas, M., Poel, A.F.B. van der, 1996. Physical quality of pelleted animal feed 1. Criteria for pellet quality. Anim. Feed Sci. Technol. 61, 89–112. doi:10.1016/0377-8401(96)00949-2

Thomas, M., Vliet, T. van, Poel, A.F.B. van der, 1998. Physical quality of pelleted animal feed 3. Contribution of feedstuff components. Anim. Feed Sci. Technol. 70, 59–78. doi:10.1016/S0377-8401(97)00072-2

Thomas, M., Zuilichem, D.J. van, Poel, A.F.B. van der, 1997. Physical quality of pelleted animal feed. 2. contribution of processes and its conditions. Anim. Feed Sci. Technol. 64, 173–192. doi:10.1016/S0377-8401(96)01058-9

Von Harald, G., 1985. Energieausnutzung bei Futtermittelpressen. Mühle U Mischfuttertechni.