Conditioning & pelleting

A focus on finding the right process & choosing the correct ingredients

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As a pellet mill supplier, CPM are often asked to give its opinion about the most ideal way to condition the meal before pelleting. Every pellet mill operator has the same wish; the machine just needs to run, make good quality pellets at high capacity and for every type of feed or formulation.

Our answer is always simple and revealing - unfortunately this kind of magical solution just does not exist.

Generally, it is understood that conditioning increases pellet mill capacity and pellet quality, whilst reducing energy consumption and wear costs. On top of this it can also improve the conversion rate for the animal, provide a hygienic treatment of the feed and may allow the use of lower cost ingredients.

However, the selection of the conditioning method is dependent on a wide range of process parameters. In order to make the right selection, you have to look to the input (what formulation) and the output parameters (required pellet quality). Failing to do so can result in a very costly machine with a negative impact on the production process.

Looking into more detail of the conditioning process (Preparation of the meal before pelleting) we can recognise three different treatments. It all starts in the grinding-mixing line where we produce a mix with a specific particle size. This particular aspect has a great influence on the pelleting process and the animal nutrition, however we will not elaborate on this subject in this article.

Here we will focus on the thermal treatment (adding energy by steam) and the mechanical treatment (adding electrical energy by kneading shearing and compressing).

Selecting thermal or mechanical energy

Depending on the characteristics of the material mix the emphasis is more to the thermal side, mechanical side or combination of both in the conditioning process. In our experience, starch, fibre and fat content are parameters which greatly influence the outcome of this selection.

All pellet-conditioning systems make use of the parameters temperature, moisture and time. Pressure is applied in the pellet mill die. While at high starch formulations the time is usually less than two minutes, we recognise for high fibre formulations a retention time longer than six minutes to soften the fibres and to absorb the liquids.

High fat formulations are the most complex to transfer to good quality pellets and there we see systems which also use pressure and shear to condition the material before it is shaped in the pellet mill die. Figure 1 shows the relation of all parameters to the process in the most simple terms in one graph.

Conditioning for a relatively short time

Formulations with a good combination of maize and wheat (typical poultry) are relatively easy to pelletise. They can be conditioned with the addition of steam for a relatively short time.

If the wheat content is minimalised and more maize is used the retention time requirement is increased and more mechanical energy is used in the pelleting process.

Through the years we have seen conditioners of different sizes entering the market. But all conditioners have basically the same requirements. First of all, they need to be (steam) efficient as with the increasing price of energy, it is essential to select a conditioner where special precautions are made to keep the total cost of ownership as low as possible.

Beneficial auxiliary systems are systems preventing steam escaping from the inlet of the conditioner and systems which inject the steam in or under the product so that steam consumption efficiency is optimised. A "spider" at the outlet will equalise the material flow to the pellet mill.

To minimise maintenance costs, bearings should not be mounted directly on the conditioner shell but with some distance and they should also be sealed so they are protected from the hot and dusty environment inside the conditioner.

The mixing of liquids traditionally requires a high speed but short mixing time whilst steam conditioning requires more retention time and a longer conditioning time at low speed.

This resulted in stacked conditioning systems with a combination of both, offering optimal liquids mixing and improved retention time for steam absorption.

A new conditioning technology

California Pellet Mill (CPM) brought a new conditioning technology to the market. This makes it possible to fill the conditioner up to 70 percent and it provides extensive mixing of product particles with liquids and steam.

Figure 1

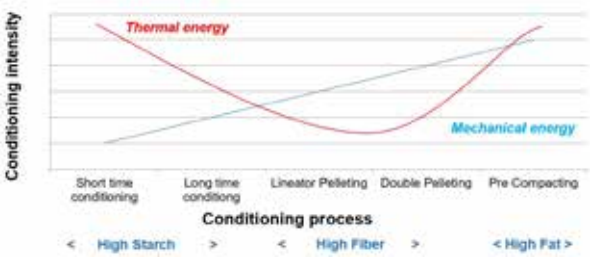


Figure 2

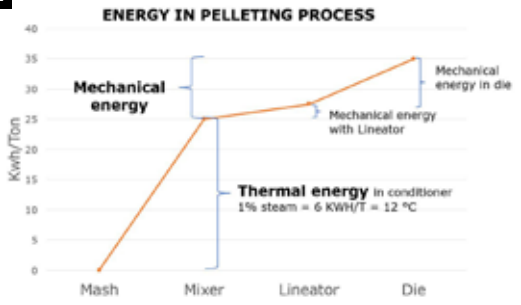
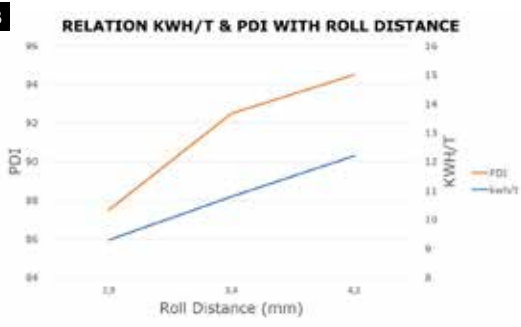


Figure 3



The improved conditioning machine provides higher possible temperatures, achieving better quality pellets and lower energy and operational costs, whilst also providing a high standard of blending for molasses and other liquids.

The design principle is based on the premise that the material is moving forwards and backwards through the conditioner and is rubbing against itself, with this then increasing liquid and steam absorption.

On top of this it has excellent product clean out characteristics after each run, a factor which improves the level hygiene and reduces cross contamination.

Hygiene is a key subject in conditioning

Whilst we are on the subject of hygiene, this became a key subject in conditioning. Breeder feeds are nowadays processed under strict conditions and this have resulted in a whole range of hygienic conditioning equipment with very specific demands.

A hygienic conditioner must be easy to clean, so it has to be easily accessible with a large 'cleaning out' door. Under no circumstance product should escape which has not reached the required temperature. In combination with an improved temperature control the 'hot-start' function provides this feature even for the first product coming out of the conditioner.

An additional benefit of the hot-start function is that the pellet mill reacts much more forgiving on the warm meal, which results that the nominal capacity can be reached within minutes from start. This improves the pelleting line efficiency importantly especially when frequent product change overs are required.

After the product is heated it needs to be kept for a certain set time at the required temperature. A hygieniser is used to keep the product (first in first out) usually between two-to-six minutes. Special precautions are made to prevent heat losses and excellent self-cleaning characteristics.

For high fibre formulations more retention time (>6 minutes) is required for the material to absorb added liquids.

Liquids and some steam is added in the first mixer. After that the material is kept for a long time (>6 minutes) in a retention bin so that liquids can be absorbed.

Before pelleting additional steam is added in a second mixer. Adding too much steam in the first conditioner will result in large amount of un-processable material in the retention bin.

Pellet mill requirements

Generally speaking, a pellet mill is selected based upon its perceived ability to reliably produce pellets of a certain quality at a certain capacity. But there is more; in a sustainable environment energy efficiency is becoming more and more essential, which is also true for the pellet mill selection.

Using gear drive machines driven by a highly efficient motor is a step towards reducing the carbon footprint and reducing operational costs on top of that. Figure 2 relates to the use of energy in the pelleting process.

Thermal energy is added in the form of steam in the conditioner, whilst mechanical energy is added in the pellet mill die. However, the optimal amount of mechanical energy varies with the processed formulation.

It is therefore required to be able to adjust the amount of mechanical energy. This can be done with the CPM Lineator remote roll gap adjustment. With increasing distance between the die and rolls more electrical energy is consumed by the pellet mill and pellet quality is increased.

If pellet quality allows it, then the roll gap can be decreased leading to saved energy (see Figure 3). The remote control of the roll gap provides an increased safety level, which also reduces downtime.

Figure 4

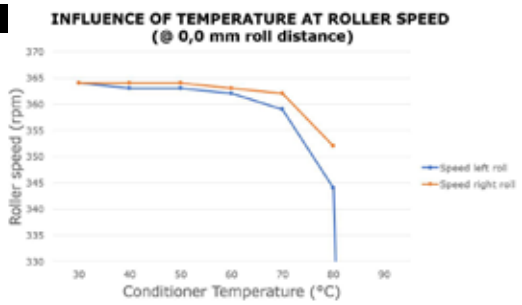


Figure 5

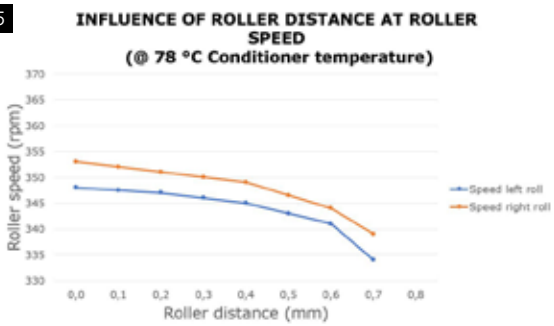


Figure 6

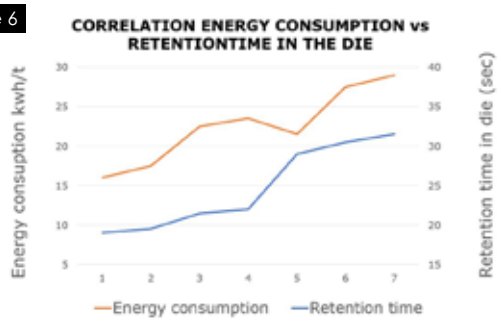
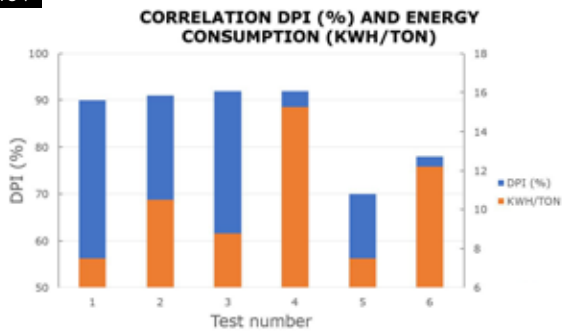


Figure 7



What is also important to realise is that during the starting up of the pellet mill, roll distance can only be limited to prevent roll slippage but once running the gap can then be increased. This reduces steel to steel contact between die and roll and saves importantly on die life. And since the die stays longer in shape it also saves energy and gains capacity.

To find the find the maximum allowable roll gap is always a challenge. The roll slip will increase with the distance until a pellet mill choke occurs. In an effort to remedy this issue, CPM have introduced a roll slip measurement system.

Figure 4 illustrates that with increasing temperature of the product coming into the pellet mill, the roll slip is increasing till a choke occurs at in this case 80°C, whilst Figure 5 shows that the slip can be controlled by varying the roll distance.

In this way the pellet mill is operating exactly on its optimal

working point. But that is not all the system prevents pellet mill chokes, reduces downtime which increases effective production capacity. It can also determine the exact zero position of the rollers and with that prevent steel to steel contact with the die, which will result in reduced wear costs.

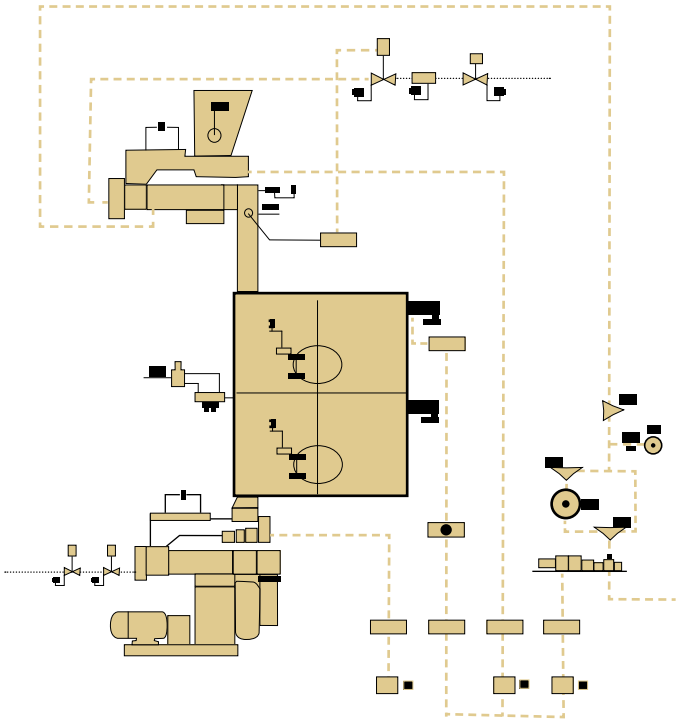
Reducing mechanical energy

In the case that even with an optimal thermal conditioning system and large roll gap you can't get enough mechanical energy into the pelleting process the retention time of the die can play an additional role.

Figure six shows that a higher retention time of the product in the die increases the energy consumption and with that increases the pellet quality. Basically, it means that for ensuring both pellet quality and pellet mill capacity the most flexible choice is selecting a larger pellet mill with a relatively thin die and adjusting the energy input by varying the distance between the rollers and the die.

If pellet quality still is a challenge while using relative thick dies (ratio 1:20). What means, less steam addition (lower pelleting temperature), reduced pelleting capacity, higher wear and energy costs and increased production costs.

Apart from that, thick dies are sensitive for surface wear and many other curses. In this instance, a next step can be considered.



If at first you don't succeed…

Something that we consider to be a quite simple solution is double pelleting. If it is hard to do it in one big step, then do it in two smaller steps! Back to thinner dies, increased flexibility, low cost raw materials and lower production costs.

This pelleting principle is extremely successful on high fibre (ruminant) formulations, in areas where low cost raw materials have replaced grains and soya.

When compared to the energy input by the use of the lineator roll adjustment, the mechanical energy input is increased further by the use of the additional pellet mill, or alternatively other pre-compactors.

With the increasing amount of fat, a higher amount of thermal and mechanical energy is required to still get a good quality pellet. That said, you should always be very mindful that the first step to quality improvement of high fat formulations is post pelleting fat coating.

Expander pelleting

An expander is a tube with cantilevered shaft fitted with proportioning, mixing and kneading elements. The hydraulically adjustable cone at the outlet together with the outlet ring forms the annular gap. By means of adjusting the cone, the pressure, the intensity of kneading, the product heating, and the energy consumption can be controlled.

Figure 7 shows three different formulations that have been produced. The odd tests are single pelleting tests and the even test numbers are produced on an expander pelleting set up.

At high fat and liquid formulations, where it is hard to get energy in, the expander improves pellet quality. But running the expander on lower fat and liquid formulations results in higher energy and wear costs, as well as a less user friendly and controllable process.

There is no 'one size fits all' solution

Going over the characteristics of the different conditioning systems we can conclude that there is no one size fits all solution. The selection is depending on process parameters like the binding properties of raw material, and desired pellet quality. What works for him doesn't necessarily work for her and an incorrect selection may result is a very costly machine which have a negative impact on the production process.

What may be the safest conclusion to arrive at is that the key to the art of conditioning is to fully understand the science.

About the author:

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Arthur vom Hofe is working as Segment Manager - Feed & Oilseed at CPM Europe BV, a California Pellet Mill subsidiary in Zaandam - the Netherlands, where he has worked for more than 30 years.

Mr vom Hofe has been involved in the front line since the early nineties, when representing the company for pelleting and particle size reduction equipment. Throughout this time, he has gained valuable experience of feed production processes across the world.