Making feed for purpose – Feed milling technology

The cornerstone of the feed and livestock industry, feed milling technology continues to increase productivity, and is shaping the evolution from simple to complex.

by Ngai Meng CHAN

Specific industry terms like premix, concentrate and compound feed are now common knowledge to the modern-day feed miller, and they indicate how feed milling technology has evolved to meet growing demands of the industry.

For example, when a uniform dispersion of micro-ingredients in a larger mixture is required by the feed miller, a premix, which is a uniform mixture of one or more micro-ingredients with diluent and/or carrier is used.

Sometimes when the nutritive balance of a feed is required to be improved, another feed which is intended to be further diluted and mixed, is added. Such a feed is known as a concentrate.

And more generally speaking, a feed composed of a mixture of products, whether or not containing additives, is termed a compound feed.

According to Alltech’s 2015 Global Feed Survey, worldwide compound feed production increased 2% from 960 million tonnes in 2013 to 980 million tonnes last year. This was higher than the 1% year-on-year rise in 2013.

Similarly for the global premix market, Research and Markets projects a compound annual growth rate of 3% in dollar terms, as studied from 2014, reaching US$9.94 billion by 2019.

With such indicators pointing towards continuing growth in the feed industry, demand for products and services along the whole feed milling process line rises concomitantly.

Even before raw feed enters the feed milling process line, increasingly companies are providing customised feed formulation services for their customers.

Recently Cargill Animal Nutrition launched its proprietary nutrient formulating platform, Cargill Nutrition System (CNS). CNS delivers precise real-time feed formulations to producers based on a host of variables often unique to each individual customer: species, climate, location, business goals, nutrient-content requirements and cost considerations of available ingredients. The database behind CNS is comprised of over two million nutrient samples, covering more than 200 ingredients, ten million annual nutrient predictions, and is constantly being refreshed.

Another database technology for feed formulation is AB Vista’s services for corn and sorghum quality. The services are website-based tools which use Near Infra-Red (NIR) spectroscopy to analyse the nutritional components required to predict the energy value of corn or sorghum. The service can be accessed worldwide and provides a fast solution to analysing corn or sorghum quality.

Following feed formulation, a typical feed milling process is illustrated in Figures 1a and b.
Figure 1: Typical feed milling process

Referring to Figure 1a, a grinder or crusher (5) is typically the first stage of a feed milling process.

The grinding of ingredients generally improves feed digestibility, palatability, mixing properties, pelletability, and makes some ingredients more compact.

There are several other reasons for grinding, particularly for aquaculture. Small fish and fry require plankton-size feeds. Large particle sizes are often dangerous. Fry have been known to be killed by large pieces of connective tissue and bone present in animal by-products, or hull fragments found in grain, because of their inability to pass through the digestive system. On the other hand, dust or ‘fines’ may become dilute colloidal suspensions in water with little nutritive value.

Grinding is accomplished by mechanical operations involving impact, attrition, and/or cutting, in different types of grinders.

A common type of impact grinder is the hammer mill, with swinging or stationary steel bars forcing ingredients against a circular screen or solid serrated section.
Figure 2: Hammer mill with horizontal drive shaft, the most common configuration

For roller mills, a combination of impact, attrition, and cutting occurs. In these grinders, smooth or corrugated rolls rotate with feed material passing in between.

Referring back to Figure 1a, an expander (4) and a mixer (3) located in-line before the grinder are worth mentioning.

For the expander, in some configurations, it may be optional, used in place of the pellet mill (6), or located off-line.

The expander creates high shear and pressure, and aided by addition of steam, heat is produced. The expander can be seen as a pressure cooker in which the feed material is cooked at about 120°C at up to 20 times atmospheric pressure. After the feed material passes the resistor in the outlet gate, the pressure immediately drops to atmospheric. The release of pressure and spontaneous evaporation of water makes the feed material expand in volume and the temperature to drop rapidly.

Some expanders for industrial use include: the annular gap (ring-spalt) expander, or Kahl expander; Boa Compactor; Almex Contivar; and, Matador Food Processor.

Figure 3: The Kahl expander

As for the mixer (3), in some configurations, it may be located off-line.

Most mixers come in horizontal or vertical configurations. The commonly available continuous or twin-spiral mixer consists of a horizontal, stationary, half-cylinder with revolving helical ribbons placed on a central shaft so as to move feed materials from one end to the other as the shaft and ribbon rotate inside.
Referring back to Figure 1a, the pellet mill (6) (item 2, Figure 1b) lies at the heart of the entire feed milling process.

Pelletizing is accomplished by the mechanical operations of compression, extrusion, and adhesion. The general process involves passing the feed material through a conditioning chamber where 4-6% water (usually as steam) may be added. Moisture provides lubrication for compression and extrusion. In the presence of heat it also causes some gelatinisation of raw starch present on the surface of vegetative ingredients, resulting in adhesion. Therefore, one important advantage of pelleted feeds versus mash feeds (unpelleted) is the ability for the feed miller to incorporate a higher level of otherwise incompatible ingredients in the formulation.

The pelleted feed material then enters into a vertical or horizontal cooler-dryer (item 3, Figure 1b).

From the cooler-dryer, the pelleted feed is passed through or around a pair of crumble rolls (item 4, Figure 1b). If a relatively fine product is desired, then the pellets are passed between the crumble rolls to be crushed to a smaller size. If the full pellet size is desired, then the pelleted feed is passed around the crumble rolls.

In the final stages of the feed milling process, the pelleted feed or crumbles are sifted and screened according to particle size, before being distributed and packed.

An additional note is that similar to the expander, which operates at high temperature and pressure, an extruder is sometimes used in place of the pellet mill. Owing to the high temperature and pressure operating conditions, reported advantages of extrusion include: higher starch gelatinisation, less dusty feed, increased water stability and higher pathogen kill. The availability of a variety of extruder screws with different physical dimensions further imparts flexibility in determining the final product size and density (of the extruded feed).

References:
1 http://www.fao.org/docrep/005/y1453e/y1453e06.htm (accessed Feb 2, 15)
2 Norwegian University of Life Sciences. HFE 305 Feed Manufacturing Technology. Expander Treatment.
4 http://www.fao.org/docrep/x5738e/x5738e0i.htm (accessed Feb 2, 15)