INTERNET EDUCATION

Presented by The Center of Feed Technology Ltd.
Instructor - Edward Perez

Module - Pellet press components (rolls, dies, knives,feeder)

Introduction

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Pelleting

The basic function of a pellet mill is to form pellets. This actually occurs at the nip between the die and the rolls. All other portions of the process are important support activities to the actions occurring at this critical area. This action must be understood to appreciate the reasons for proper steam conditioning and die and roll management.

Figure 1 shows the pelleting chamber.
Figure 2 shows a close-up of one roll assembly and its relationship to the die.

Theory of Operation

Definitions

a. Roller Assembly - This is simply a cylinder idling on bearings. The only driving force on the roller assembly is the frictional force from contact with a very thin mat of feed between the die and roll.

b. The die is the driven component, getting its power from the main driver motor in the pellet mill. The die is perforated with holes through which the material flows. The die holes and thickness determine the final pellet size and characteristics.

c. Feed - This is the product to be pelleted as it is received into the pellet mill.

d. Work Area - Area where feed is received compressed and forced into the die holes.

e. Compression Area - Area where the feed is compressed.

f. Extrusion Area - Area where the feed begins to flow through the die.

b. Pellet Mill Forces

Three main forces act on the wedge of feed at the nip in the pellet mill. Refer to Figure 3. These forces include:

a. Roll Force - The force from the roll acting on the material. This force acts on the material relative to the contact point with the die. It is a force that acts to compress and extrude the material.
b. Radial Force - The force from the die that resists the flow of material through the die holes.
c. Tangential Force - The force along the face of the die that keeps the material from sliding along the face of the die in front of the roll. This force is related to the pressure exerted by the roll and the frictional characteristics of the feed.

c. External Factors

a. Feed Rate - Figure 4 shows the changes in roll forces when the feed rate is doubled. The mat thickness in front of the roll doubles. Thus, there is a greater portion of the roll force tending to push the feed ahead instead of down through the die holes.

   This roll force, which tends to skid the feed along the die face, is the factor that causes the plug in a pellet mill. The mat of feed can build up in front of the roll to a point where the roll cannot grab it. Thus, the roll begins to push the feed forward along the face of the die rather than down through the holes. A plug-up results. The pelleting cavity then fills with feed until the feed flow is stopped.

   An even feed rate to the pellet die cavity must be maintained. Die plug-ups will be minimized and constant motor loadings will be maintained. When a surging feed rate to the die cavity is allowed, the following occurs:

   i. A very thin mat of feed is present ahead of the roll, which the roll can easily grab,
   ii. Suddenly an increased mat thickness is present ahead of the roll which the roll cannot grab, thus the mat and roll begin to slide,
   iii. Fluctuations in motor load (i.e., ammeter reading) result,
   iv. The mill may plug.

b. Feed Distribution - Equal feed distribution to each roll and across the face of the die must be maintained. Production rate will be decreased if the distribution becomes unequal. The density of the meal being pelleted and the feed rate affects this distribution.

c. Roll Setting - The roll must be adjusted down to a proper relationship with the die or the roll will not turn. The roll is always turning about its contact point with the die. Any time this is disturbed, the roll wants to act as a plough forcing the material along the face of the die rather than down through the die holes. The "touch and skip" method can be used to properly set the rolls. The rolls must be set on a regular basis as the die wears away from the roll. Rolls set in direct contact with die will cause die damage. Refer to the die and roll management section for additional information on roller adjustment.

d. Frictional Characteristics of the Feed - The frictional characteristics of the feed ingredients influence the action at the nip between the roll and die. If excessive moisture is added through conditioning, the meal tends to become slippery beneath the roll assembly. This alters the driving force that turns the roll. The roll will begin to plough the material ahead of itself. The feed has lost its ability to turn the roll. It is very important to evenly blend the proper amount of steam into the meal at the conditioner. Moisture fluctuation in the conditioned meal will vary the frictional characteristics and the operation of the pellet mill.

Lack of proper moisture content in the conditioned meal will decrease the tendency of the material to slide through the holes. The resistance from the die holes can become greater than the roll force, which attempts to extrude the meal. A plugged condition will result.

If segregation or inadequate mixing occurs, there can be continuous and rapid changes in the frictional characteristics. This will result in uneven motor loading or pellet mill plugging.

e. The Die- There will be changes in the die itself. As the die wears properly, the face of the die will become evenly recessed. The pellet die is an excellent indicator of problems at or before the pellet mill. Careful examination of each worn die should be made. Causes for early or incorrect die wear must be determined and corrected. Correct die wear will result in improved production rate and pellet quality through the life of the die. Die and roll management is discussed in a later section.

f. The Roll - The face of the roll can change which reduces the frictional characteristics at the nip point. The rolls must wear evenly to maintain the proper relationship with the die. Rolls also indicate problems at the pellet mill. Refer to the die and roll management section.

Reference: The Pelleting Process, Sprout-Waldron/Koppers, Muncy, PA

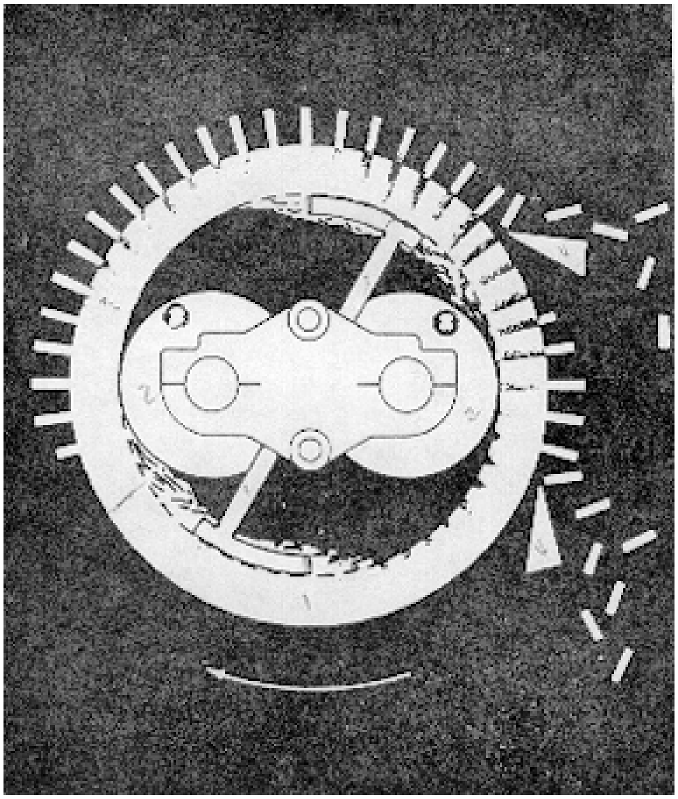
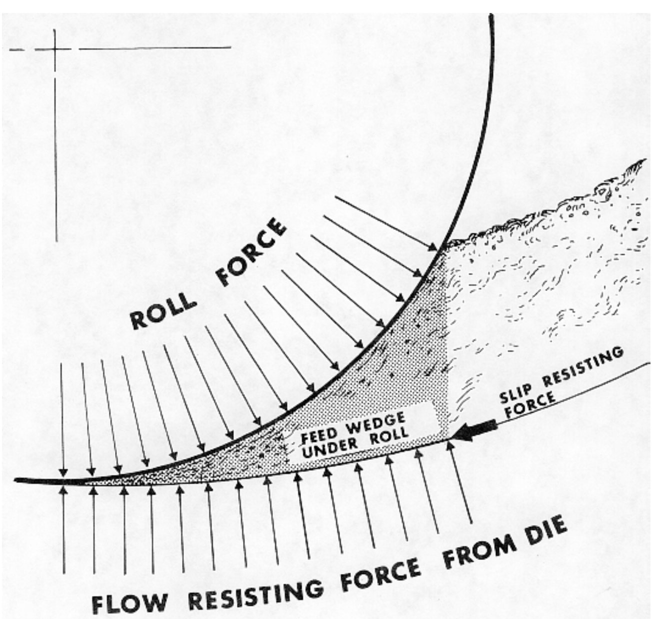


Figure 1

- Incoming feed flows into the feeder and is delivered uniformly into the conditioner for the controlled addition of steam and/or molasses.
- From the conditioner. The feed is discharged over a permanent magnet and into a feed spout leading to the pelleting die.
- Inter-elevator flights in the die cover feed the mash evenly to each of the two rolls.
- Feed distributor flights distribute the material across the face of the die.
- Friction driven rolls force the feed through holes in the die as the die revolves.
- Cut-off knives mounted on the swing cover cut the pellets as they ore extruded from the die.
- The pellets fall through the discharge opening in the swing door.



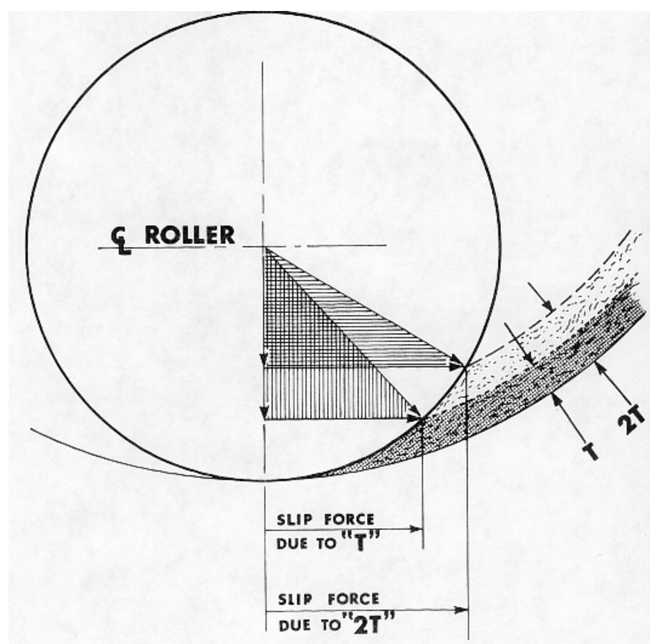


Figure 2

Pellet mill (Pellet Press)

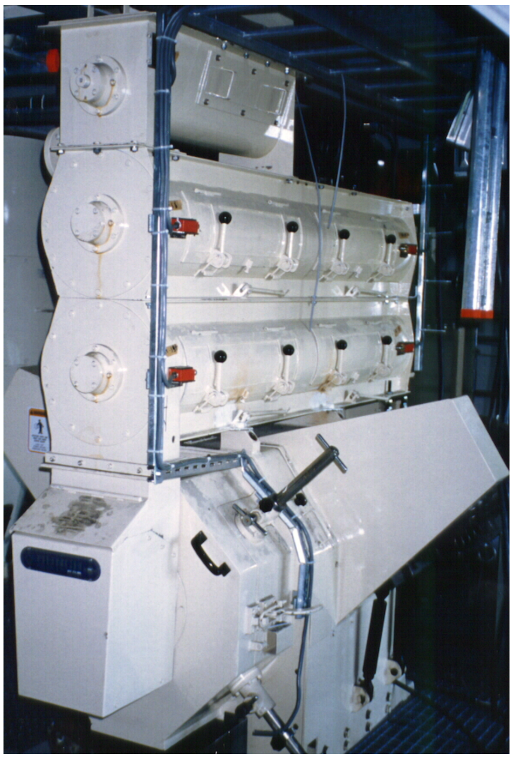
The pellet press is described as a machine which compresses meal material into pellets.

Meal Hopper or Supply Bin

A container designed to receive meal from the mixer and to serve as a reservoir that will keep the pellet press with the necessary flow throughout its operation.

The meal hopper must be designed to store at least enough material to run two times the capacity of the mixer.

The Feeder Screw



Courtesy of Muench

The feeder screw allows the meal to go from the "meal hopper" into the "conditioner" with a given speed and volume. It can be said that it is a throttle for the pellet press.

The screw should have variable speed and have a ½ pitch under the meal hopper in order to let the feed flow uniformly from the hopper into the conditioner. The feeder screw also prevents steam from the conditioner to go back into the meal hopper.

The Conditioner

The conditioner can be described as a blender where additives such as steam, molasses and other liquids can be introduced to a mixture prior to entering the pellet press.

Conditioning takes place for the following reasons:

- To lubricate the meal for faster production rates
- To lubricate the meal to reduce energy costs.
- To extend die life by avoiding extra friction.
- To rupture starch granules to increase nutritional value.
- To improve pellet quality.

Feed Chute

The feed chute, also known as “by-pass and/or dump valve” is a duct or piece of pipe that directs the flow of the conditioned meal into the die.

Meal Deflectors

Meal deflector, sometime called “feed plows” are a set of blades positioned inside the die for the purpose of having uniform meal distribution.

Uneven meal distribution inside the die will result in decreased production rate and for rollers to slip and cause uneven die wear.

Dies

A simple definition of a die is that of a metal cylindrical shape unit with holes through which feed is forced to produce pellets.

See enclosed sheet on types of dies and parameters to consider for correct selection of dies.

Rolls

Figure 10-8. Tungsten carbide roll shell.

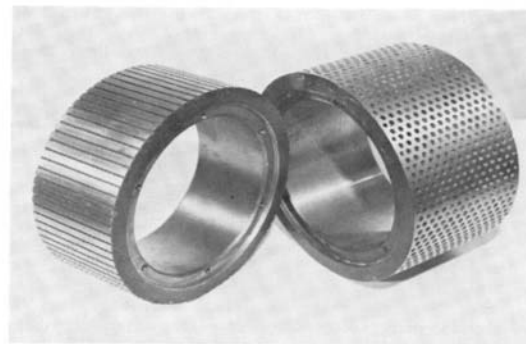


Figure 10-9. Corrugated and indented roll shells.

Rolls, like dies, are also a cylindrical shaped equipment that it is normally made of tungsten carbide particles or corrugated shells.

The main purpose of the roll is to help meal get into the die hole, thus the shape and construction of the roll is designed for preventing slippage of meal and to give a rough surface for better traction.

A pellet press normally has two or three rolls operating inside the die.

Knives

A blade that is installed outside the die area for the purpose of cutting the pellet to a given size. Knives also help in avoiding excessive fines by limiting the size of a pellet before it gets to long and it brakes against the side of the pellet press door.

Die and Roll Management

Die Design

Figure 12 illustrates the significant parts of a pellet die:

d = pellet diameter

L = effective thickness.

This is the actual thickness of the die, which promotes pellet compression, thus, the working thickness of the die. The effective thickness of a straight hole (die without relief) is the overall thickness. Effective thickness of a relieved die is the overall thickness minus the relief. As an example, a 2" overall thick die has a "working hole" of 2", whereas, the same 2" die with 1 /2" relief has an effective thickness of 11/2'.

T = total thickness.

This is the overall thickness of the die. There are many instances where the overall thickness of the die is made larger than the effective thickness because of stress within the die during the pelleting operation. The thicker the die, the stronger the die. Normal die thickness increments vary by 1/4" between 11/4" and 5" thick.

X = relief depth.

This is the difference between total and effective thickness of the die. A die is relieved by drilling in from the outside of the die with a larger bit. Relief accomplishes two purposes:
To promote strength through the use of thicker die blanks and yet obtain the desired effective thickness.
To improve material flow through the holes across the die face.

D = inlet diameter (countersink).

Most dies have a tapered inlet to start the flow of material into the hole. This taper also begins to compress the material as it enters the hole, thus doing work on the material.

Ø = inlet angle. This is normally 30° to 40° on small hole dies.

Die Terminology

Hole Count.

This is the total number of holes in a specific die. For a die to produce at maximum capacity land area between holes must be minimized, that is, a maximum number of holes are needed. However, if the holes are too close, the die may be weak. The hole count on any size die may vary depending on die design. For small pellets

(5 mm **diameter), three hole counts are available:**

"Close" hole count - This type of die is suitable for "easy to pellet feeds" or ingredients where maximum die strength is not a factor. Broiler feeds are in this category. "Standard" hole count - This type of die is normally used in a general purpose pelleting operation and will accept a rather broad range of formulas and materials.

"Heavy Duty" hole count - This die is specially designed for a specific pelleting application where extreme pressures and stresses may be encountered. High mineral, high urea supplements may require such a die.

Tapered entry die - A type of ho1e entry in large hole dies (usually:> 10 mm). The taper consists of reamer angle and reamer depth. The reamer angle is measured in inches of taper per foot. Taper depth is the depth of the reamer into the hole. Reamer angles vary from 20 mm to 75 mm to the foot and taper depth is usually from 20 mm to 50 mm. Generally tapers are
not severe angles. Tapers are to increase compression moderately. Well dies are used for greater compression as required.

Well die - A type of hole entry in large hole dies (::> 12 mm hole diameter). The hole entry is substantially larger than the actual hole size. Hole depth is predetermined based on hole diameter. Well dies offer greater versatility to handle variations in ingredients and formulas and to obtain desired cube quality.

Well die-tapered bottom – The well has a slight taper at bottom into the true hole (cube) size. The taper is a transition between the well and hole.
Well die-flat bottom - The well in this die has a flat bottom and there is no taper transition. Maximum compression is obtained with this die.

Alloy Steel - Alloy steel is a type of steel to which one or more alloy elements have been added to provide improved strength and toughness over plain carbon steel.

Standard stainless steel - Stainless steel is an iron carbon alloy to which chromium has been added in order to provide superior corrosion resistance.

"Chrome-plus" stainless steel - A higher quality stainless steel with higher percentages of chromium and nickel to improve the corrosion resistance over stainless steel.

Die specification - The die(s) design selected for any specific application (i.e., hole diameter, overall die thickness and depth of relief).

Die and Roll Management - Die Selection

Introduction

Die selection is important to achieve:

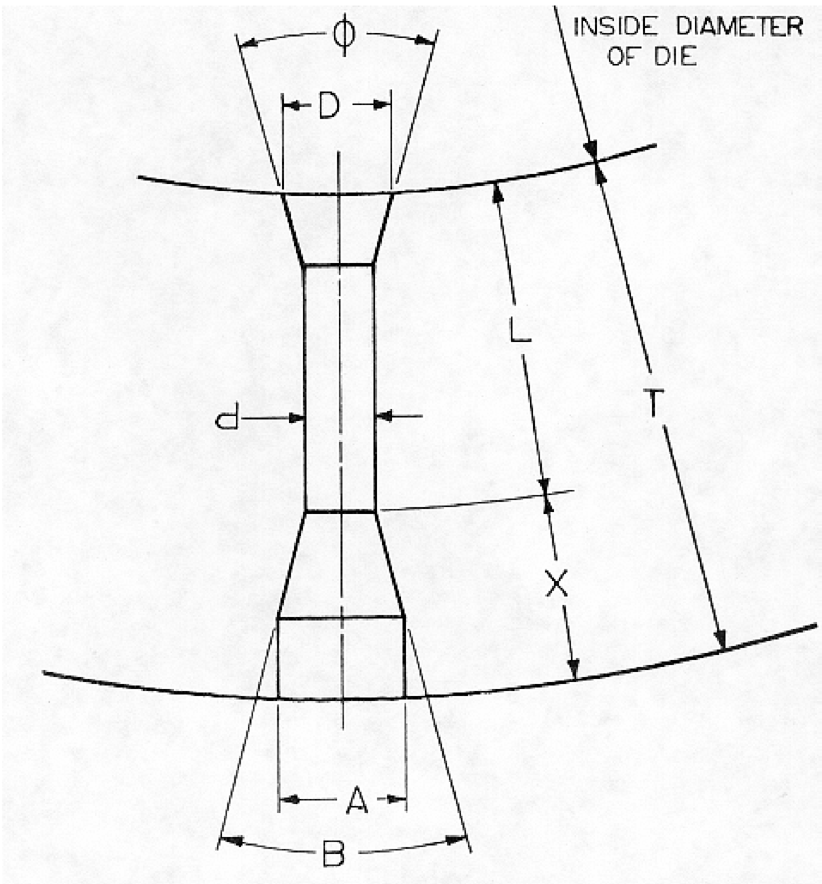


Figure 12 (Courtesy of CPM)

- Highest pellet quality
- Optimum capacities
- Operational ease
- Smooth start-up
- Reduced plugging
- Longest die life

Die Selection Criteria

Type of Metal

a. Alloy - This metal is satisfactory for pelleting most complete feeds. If corrosive problems occur, stainless steel dies may need to be used.

b. Stainless steel - This alloy contains chromium, which provides resistance to pitting, scoring and corrosion.

c. With stainless steel, less enlargement of the die hole occurs compared to alloy dies. Stainless steel dies should be used when corrosion, pitting and/or scoring result in short die life of an alloy die.

d. "Chrome-Plus" stainless steel - This higher quality stainless steel die may be needed for pelleting very abrasive or corrosive ingredients (i.e., high urea/mineral formulations).

Die Design Factors - The following factors are dependent on the type of formula to be pelleted.

a. Thickness-Refer to the manufacturer for recommendations

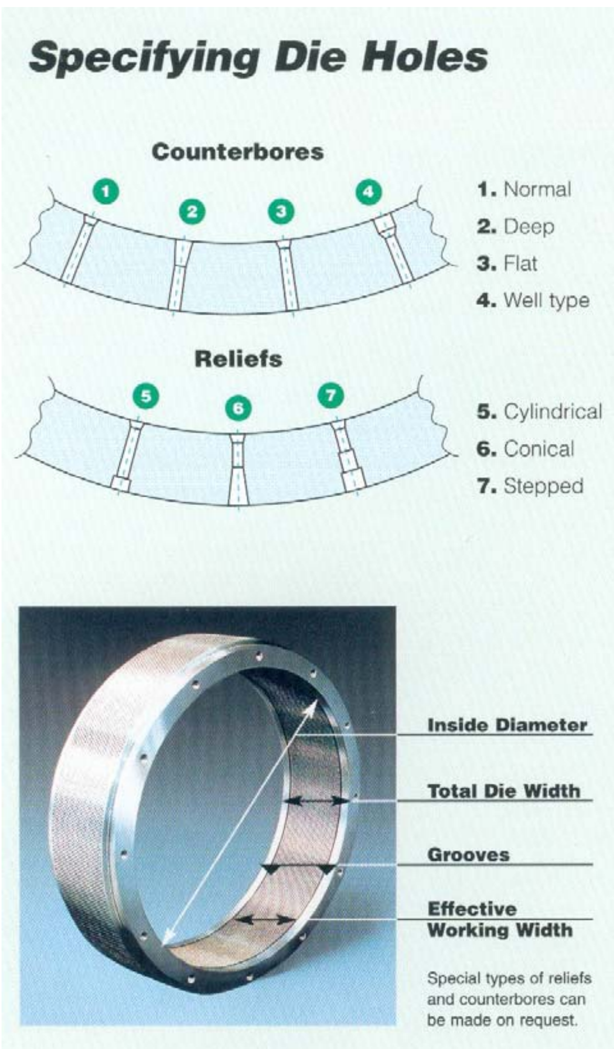
b. Drill pattern 1. Close-use with high grain formulas 2. Standard-general range of formulas 3. Heavy duty-use with high mineral, high urea supplements

c. Relief Consult with pellet die supplier for recommended type of relief for specific uses.

d. Die Type (Figure 1) - Three types of dies are available for CPM Century or Dual Speed pellet mills (929 dies). The designs of the cone flanges differ.

- Type 16 - for use with general range of formulas
- Type 23 - for use with highly abrasive or high fibre formulas.
- Type 25 - for use with highly abrasive or high fibre formulas.

Pellet Mill Die



Courtesy of: Sprout Matador

A die is a metal cylindrical shaped unit with holes through which meal is forced in order to produce pellets.

When selecting a die one must consider the following criteria:-

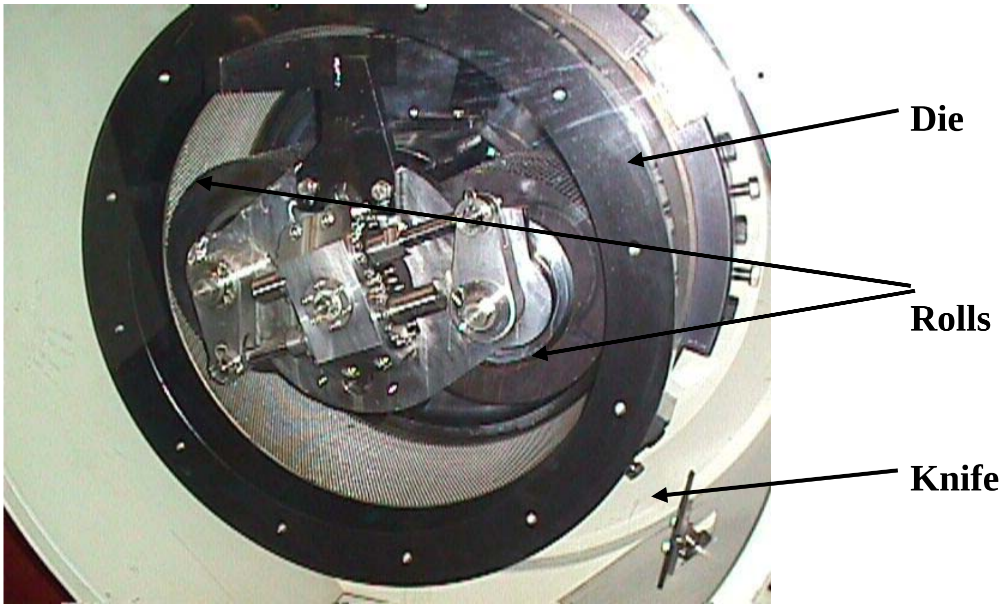
- Best pellet quality (pellet hardness).
- Highest capacity (hole count and shape).
- Operational ease (can be handled easily).
- Reduced plugging.
- Longest die life – Total tons produced.

Die manufacturers have, for the most part, recommend die characteristics and feed manufacturers have purchased the dies on basis of price vs tonnage.

With the increase of quality requirements on feed producers and the economic demands of the feed industry we are experiencing more and more research being done into the areas of:-

- Die compression (Thickness of the die divided by the hole diameter)
- Hole characteristics (counterbores and reliefs – see picture left)
- The total number of holes in a die
- The number of rows of holes.

Inside The Pellet Press



Courtesy of Muench

More Die Terminology

Straight Relief. The relief is uniform across the die to obtain the desired effective thickness (See Exhibit 1)

Variable relief (CPM Patent) - The outside two or three rows are relieved 1/4", thus reducing the effective thickness of these holes. The purpose is to improve material flow through these holes. (See Exhibit II.)

Staggered variable relief (CPM patent) - A predetermined number of holes are relieved in "step fashion" across the die face. Usually one third of the die holes are the true effective thickness, one third of the die 1/4" less and one third of the die 1/2" less than the true effective thickness. The centre third of the die would be the full effective thickness, one sixth of the holes on each side would be relieved 8 mm and the remaining one sixth on each side would be relieved 12 mm.
Taper relief - A relief occasionally used for special applications.

Straight hole die (No relief) - Die with common hole size the full thickness of the die.