PHILIPPINE NATIONAL STANDARD

PNS/BAFS PABES____:2019
ICS 65.060.99

Production Machinery – Feed Pellet Mill – Specifications

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Foreword

The formulation of this national standard was initiated by University of the Philippines Los Baños – Agricultural Machinery Testing and Evaluation Center (UPLB – AMTEC) through the project “Testing and Evaluation of Machinery Generated from PCAARRD-funded Projects” funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development – Department of Science and Technology (PCAARRD – DOST). This is in collaboration with the Bureau of Agriculture and Fisheries Standards (BAFS). This covers the development of PNS for Feed Pellet Mill.

This Standard has been technically prepared in accordance with International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Directives Part 2, 8th Edition - Principles and rules for the structure and drafting of ISO and IEC documents.

The word “shall” is used to indicate mandatory requirements to conform to the standard.

The word “should” is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

1 Scope

This standard specifies the fabrication and performance requirements for a pellet mill that can be used to produce feed pellets for livestock, poultry, and aquaculture.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

PAES 101:2000, *Agricultural Machinery – Technical Means for Ensuring Safety – General*

PAES 102:2000, *Agricultural Machinery – Operator's Manual – Content and Presentation*

PAES 103:2000, *Agricultural Machinery – Method of Sampling*

PNS/BAFS/PAES 192:2016, *Agricultural Machinery – Guidelines on After-Sales Service*

PNS/BAFS PABES ---:2019, *Production Machinery – Feed Pellet Mill – Methods of Test*

3 Terms and Definitions

For the purpose of this Standard, the following terms and definitions shall apply.

3.1
barrel
houses the screw conveyor in a feed extruder

3.2
conditioner
machine component that initiates heating process by blending the dry feed mix with additives such as steam, molasses, and other liquids; and plasticizes the raw material particles before entering the pellet mill or extruder to reduce wear on the equipment caused by the abrasive raw materials.

3.3
coefficient of variation of pellet diameter
statistical representation of the precision of the diameter of the pellets produced

3.4
discharge chute
part of the machine where the pellets are collected

3.5
feed formula
feed mix
two or more ingredients proportioned, mixed, and processed according to specifications

3.6
hopper
part of the machine through which the feed formula is fed into the machine

3.7
feed pellet mill
machine used to densify bulk feed formula into pellets

3.8
feeds
substance or product, including additives, intended to be used for oral feeding to animals

3.9
pellet die
part of the machine which can either be a ring die or flat die through which the feed formula is forced to pass through by roller pressure or rotating screw conveyor making it into pellets

3.9.1
countersink, CS
conical or tapered hole placed on the inlets of die holes to aid the feed formula flow into the holes (see Figure 1)

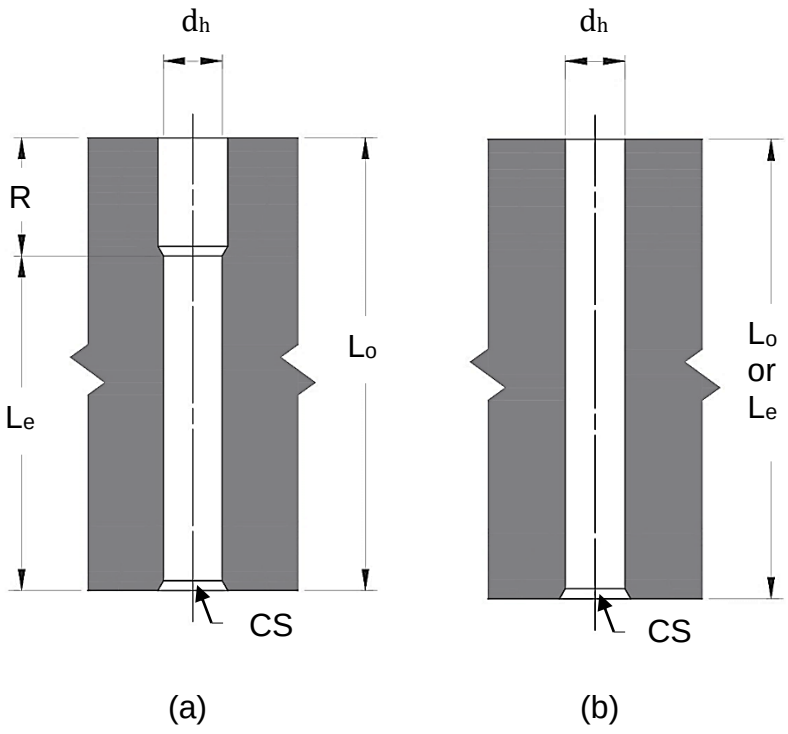

Figure 1 – Dimensions of (a) relieved and (b) straight die holes

3.9.2
die hole diameter, d_h
hole size
diameter of the holes in the die through which the feed formula is extruded (see Figure 1)

3.9.3
effective die hole length, L_e
effective thickness
working thickness of the die where the pellets are formed which is equal to the overall die hole length (L_o) for straight hole, or overall die hole length minus the relief depth for relieved die hole (see Figure 1)

3.9.4
hole count
total number of holes in a specific die

3.9.5
relief depth, R
difference between the overall and effective thickness of the die (see Figure 1)

3.10
pelleted feeds
pellets
agglomerated feeds formed through extrusion or compaction forcing individual ingredients or feed formula through the die

3.11
pelleting capacity
weight of pellets produced per unit time of operation, expressed in kilograms per hour (kg/h)

3.12
pelleting efficiency
ratio of the weight of whole pelleted feeds to the weight of output collected in the discharge chute, expressed in percent (%)

3.13
pelleting recovery
ratio of the weight of pellets collected at the discharge chute to the total weight of feed mix input, expressed in percent (%)

3.14
pellet roller
part of a flat die or ring die pellet mill that compresses the feed formula through the die

3.15
screw
screw conveyor
part of a feed extruder that conveys the feed mix through the die which in the process mixes and heats up the feed mix

4 Classification

The classification of corn mill should be based but not limited to type of pelleting mechanism.

4.1 Flat die pellet mill

In a flat die pellet mill as shown in Figure 2, feed formula is introduced into the top of the die. The mixture is then pressed down through the holes with the interaction of the rollers and the die, then cut by the knife to produce the pellets (see Figure 3).

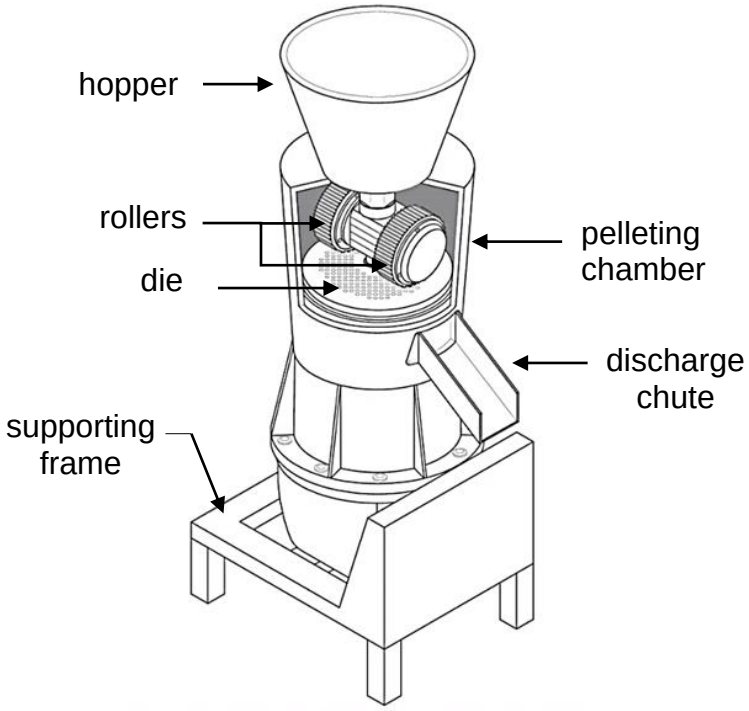

Figure 2 – Flat die pellet mill

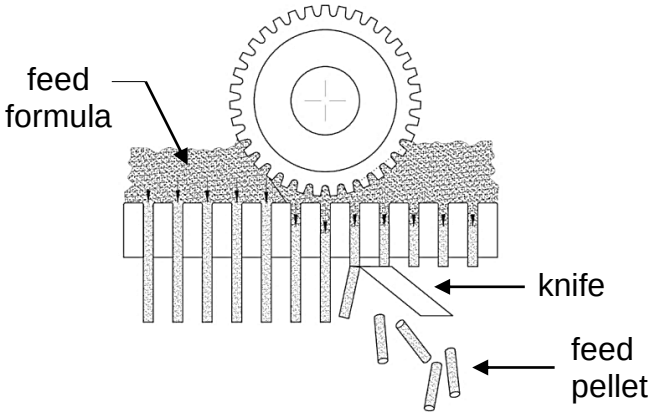

Figure 3 – Pelleting mechanism of a flat die pellet mill

Flat die pellet mill can be further classified according to the driving component of the pelleting chamber:

4.1.1 Roller-driving flat die pellet mill

Roller-driving type or R-type is characterized by its stationary die and rotating rollers as shown in Figure 4.

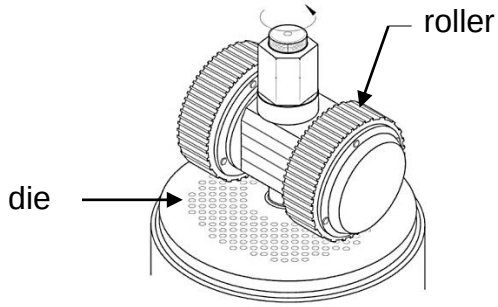

Figure 4 – R-type flat die pellet mill

4.1.2 Die-rotating flat die pellet mill

In a die-rotating type or D-type, the rollers are stationary and the flat die is rotating as shown in Figure 5.

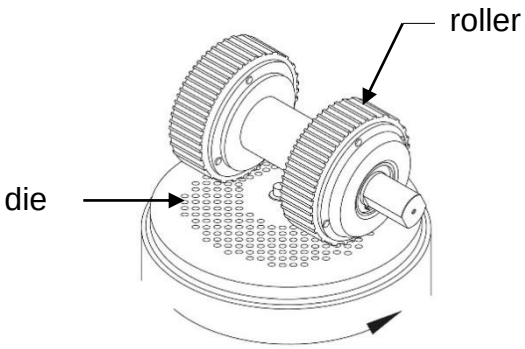

Figure 5 – D-type flat die pellet mill

4.2 Ring die pellet mill

In a ring die pellet mill as shown in Figure 6, feed formula is fed and distributed over the inner surface of the die. Rollers then compress the mixture through the radial slots or holes throughout the die (see Figure 7). The compressed feed mix is cut by a knife forming the pellets.

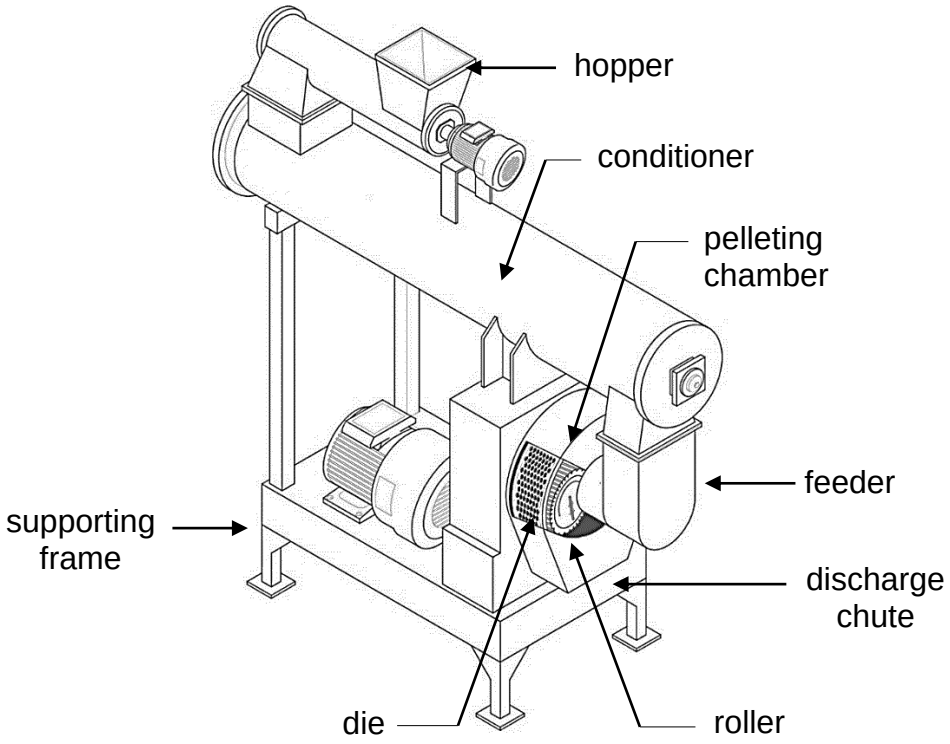

Figure 6 – Ring die pellet mill

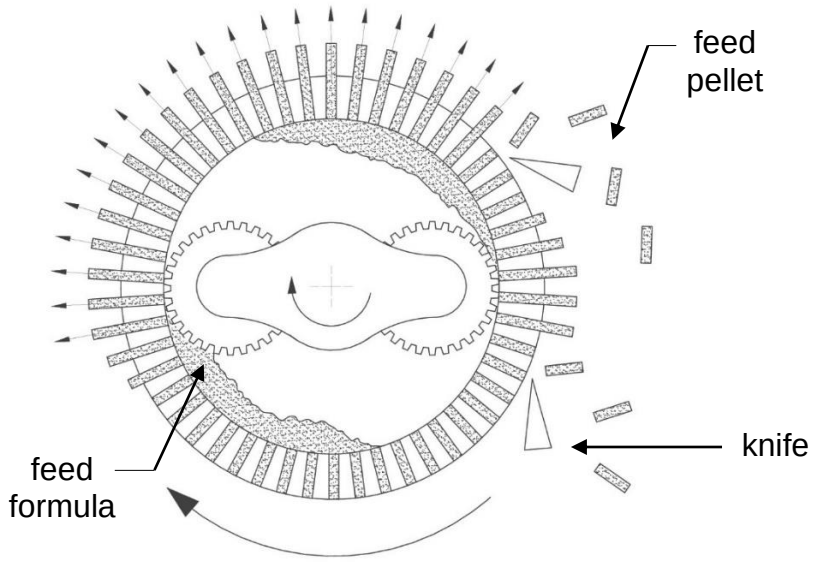

Figure 7 – Pelleting mechanism of a ring die pellet mill

4.3 Feed extruder

Feed extruder is basically a stationary long barrel with rotating screw inside, and a die at the end as shown in Figure 8. In a feed extruder, feed mix is subjected to high heat and steam pressure, forced through the die, and then cut to a specific size.

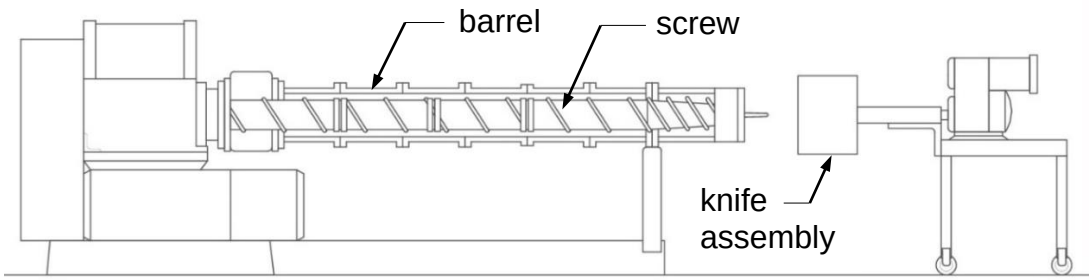

Figure 8 - Barrel and screw assembly of a feed extruder

Feed extruder can be classified according to the number of screws:

4.3.1 Single-screw extruder

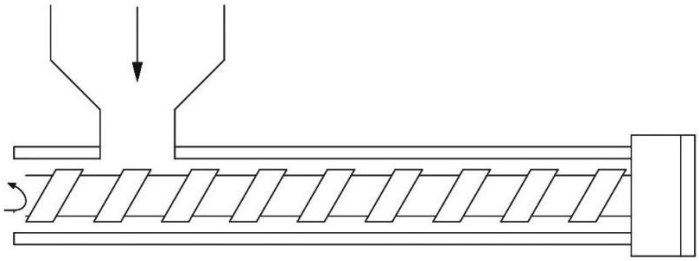

Figure 9 – Single-screw extruder

4.3.2 Twin-screw extruder

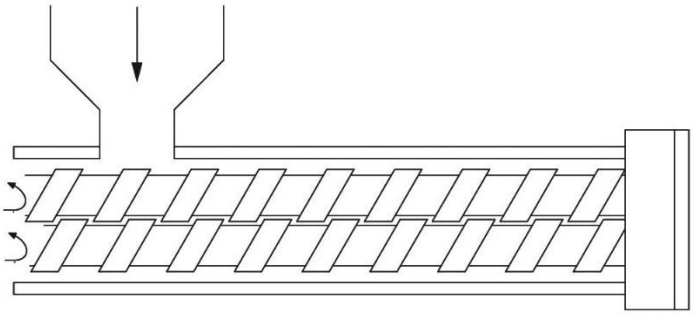

Figure 10 – Twin-screw extruder

5 Fabrication Requirements

5.1 The hopper shall be made from any corrosion-resistant and smooth material to reduce feed mix from sticking to the inside surface of the hopper and for ease in cleaning. Auxiliary devices should be provided to reduce sticking or bridging of feed mix to the surface of the hopper.

5.2 Pelletizing components of the machine such as conditioner, pelleting chamber, roller, barrel and screw, and die shall be made from corrosion and wear-resistant materials.

5.3 The pelleting chamber shall be able to withstand the force developed by the rotating die and/or rollers during operation.

5.4 Die and roller should be heat treated to prevent premature breakage.

5.5 Steel bars (angle bars and flat bars), metal sheet or plate, mild steel, stainless steel, and other steel materials shall be generally used in fabricating the other components of the pellet mill.

5.6 Bolts and nuts, screws, bearings, bushing and seals to be used shall conform to PAES or other international standards.

6 Performance Requirements

6.1 The pelleting capacity shall meet the manufacturer's specification.

6.2 The performance criteria for feed pellet mill shall be as specified in Table 1.

Table 1 – Performance Criteria for Feed Pellet Mill

CRITERION	PERFORMANCE DATA
Pelleting efficiency, percent, minimum	92
Pelleting recovery, percent, minimum	95
Pellet diameter's coefficient of variation, percent, maximum	7

7 Safety, Workmanship, and Finish

7.1 The noise level should conform with the provisions given in Annex B.

7.2 The feed pellet mill shall be free from any manufacturing defects that may be detrimental to its operation.

7.2 The base or frame assembly of the feed pellet mill shall be rigid and durable without any noticeable cracks and weak joints.

7.3 The rotating components of the feed pellet mill shall be statically and dynamically balanced for stable running.

7.4 The pelleting mechanism shall be adjustable and replaceable when needed.

7.5 There shall be provision for adjusting the clearance between the die and the rollers.

7.6 All metal surfaces shall be free from rust.

7.8 Mechanism for emergency stop shall be provided.

7.9 All moving parts, sharp edges and rough surfaces shall be provided with safety features. Warning notices shall be provided in accordance with PAES 101:2000.

7.10 There shall be provision for access to parts during repair, maintenance, and operation.

7.11 There shall be provision for belt tightening and adjustments.

8 Warranty for Fabrication and Services

Warranty shall be provided for parts and services except for normal wear and tear of expendable or consumable maintenance parts for at least one (1) year upon the acceptance of procuring entity of the feed pellet mill. General requirements of the warranty shall conform to PNS/BAFS/PAES 192:2016.

9 Maintenance and Operation

9.1 Each unit of feed pellet mill shall be provided with a set of manufacturer's standard tools required for maintenance.

9.2 Operator's manual based on PAES 102:2000, maintenance schedule, and list of the warrantable parts of the feed pellet mill shall be provided.

9.3 The aquaculture feeder shall be easy to operate, maintain and repair.

10 Sampling

Feed pellet mill shall be sampled for testing in accordance with PAES 103:2000 or any other suitable method of selection.

11 Testing

The sampled feed pellet mill shall be tested in accordance with PNS/BAFS/PABES ---:2019.

12 Marking and Labeling

12.1 Each unit of feed pellet mill shall be marked at the most visible place with the following information.

12.1.1 Registered trademark of the manufacturer

12.1.2 Brand

12.1.3 Model

12.1.4 Year of Manufacture

12.1.5 Serial number

12.1.6 Name, address, and contact details of the manufacturer/importer/distributor

12.1.7 Country of manufacture/origin (if imported)/ “Made in the Philippines” (if manufactured in the country)

12.1.8 Pelleting capacity, kg/h

12.1.9 Power requirement, kW

12.2 Safety/Precautionary markings shall be provided. It shall be stated in English and Filipino and printed in red color with a white background.

12.3 The markings shall be durably bonded to the base surface material. It shall be all weather resistant and under normal cleaning procedures. It shall not fade, discolor, peel, crack, or blister and shall remain legible.

Annex A
(informative)

Designs and Configurations of the Different Parts of Feed Pellet Mill

A.1 Type of die

The pellet die may vary according, but not limited, to the following:

A.1.1 Design of die

A.1.1.1 Flat die

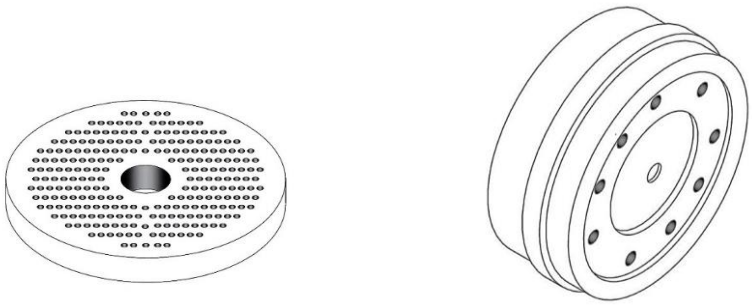

Figure 11 – Examples of flat dies

A.1.1.2 Ring die

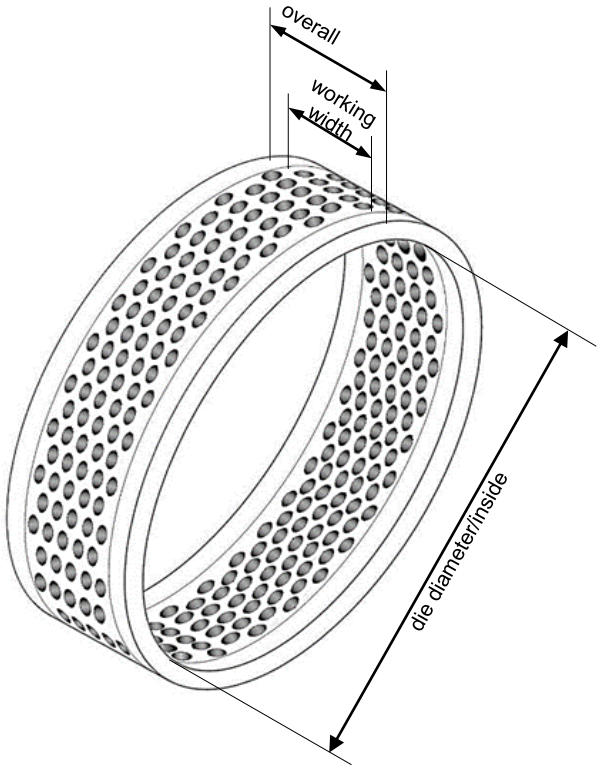

Figure 12 – Ring die

A.1.2 Type of die hole pattern

A.1.2.1 Standard hole pattern die

Dies with standard hole pattern are for pelleting different formulas on the same machine through the same die. They are suitable for general purpose pelleting operation.

A.1.2.2 Heavy-duty hole pattern

Dies with heavy-duty hole pattern have fewer number of holes than normal in order to increase the ligament thickness between the holes, thereby strengthening the die. The increased hole spacing result to about 32 % open die area. They are used in all heavy-duty applications such as pelleting high mineral and high urea supplements.

A.1.2.3 Close-hole pattern die

Dies with close-hole pattern have increased number of holes over that of the standard hole count, sometimes by as much as 25% or more. They are characterized by their open die area of about 43 % which are suitable for easy-running applications with high grain formulas.

A.1.3 Type of die hole relief

A.1.3.1 Non-variable relief die

Equal effective thickness is maintained across the die working surface so the relief has the same depth in all the holes as shown in Figure 13.

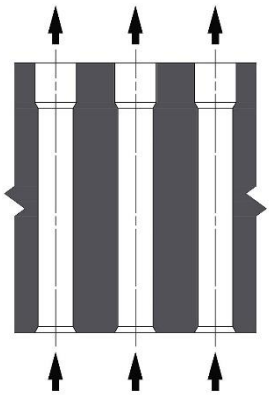

Figure 13 – Non-variable relief die

A.1.3.2 Variable relief die

The outer rows of holes are relieved deeper than the middle rows of holes in the die as shown in Figure 14.

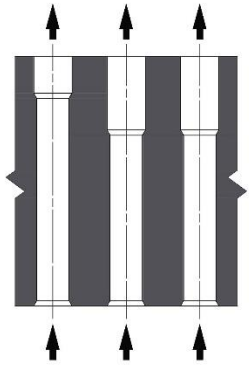

Figure 14 – Variable relief die

A.1.3.3 Staggered variable relief die

A variation of the variable relief die in which some of the rows of holes are drilled deeper than the others (see Figure 15), instead of just the outer rows having deeper relief than the middle rows.

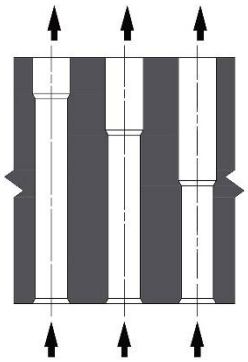

Figure 15 – Staggered variable relief die

A.1.3.4 Step relief die

The die has different hole sizes in the relief as shown in Figure 16.

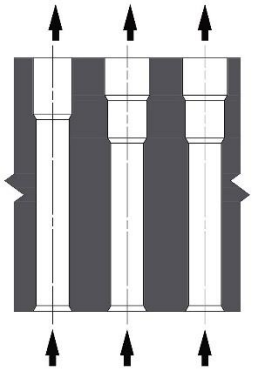

Figure 16 – Step relief die

A.1.3.5 Taper relief die

A variation of the step relief die as shown in Figure 17, which allows the pelleted feeds to expand in the relief without dragging on the side of the relief.

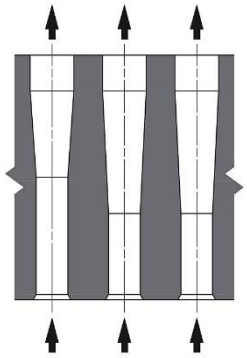

Figure 17 – Taper relief die

A.2 Roller

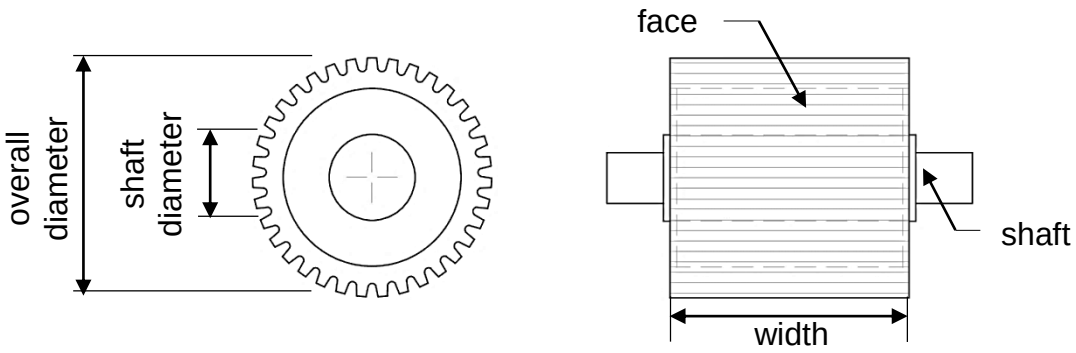

Figure 18 – Parts and specifications of a pellet roller

Rollers may vary according, but not limited, to the configuration and design of their face:

A.2.1 Straight open-end corrugated roller

Roller face consists of narrow corrugations running horizontally across it as shown in Figure 19, and is suitable for high-fiber materials.

Figure 19 – Straight open-end corrugated roller

A.2.2 Straight closed-end corrugated roller

Rollers characterized by its face with gently sloping corrugations that close off at the shell edges and run horizontally across it as shown in Figure 20. They are suitable for well-conditioned, high grain rations.

Figure 20 – Straight close-end corrugated roller

A.2.3 Helical closed-end corrugated roller

Rollers with face consisting of two helices which can be used either as a pair in tandem by using one of either helix to create a natural opposition as shown in Figure 21. They are suitable for well-conditioned, high grain rations.

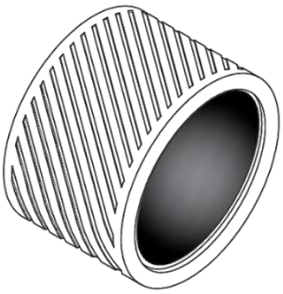

Figure 21 – Helical closed-end corrugated roller

A.2.4 Dimpled roller

Rollers with face surface machined with a series of specially-designed holes as shown in Figure 22. They are suitable for high mineral cattle feed concentrates or supplements; and high-fiber, abrasive-type materials applications.

Figure 22 – Dimpled roller

A.2.5 Tungsten carbide roller

Rollers created by using similar steel as the other shells and by depositing tungsten carbide particles into a molten bed of welding material that is being simultaneously deposited onto the roller shell surface. They are suitable for pellets composed of low ground crops which contain sand and dirt, or with high mineral cattle feeds.

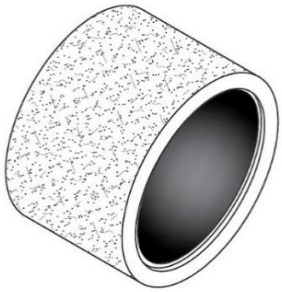

Figure 23 – Tungsten carbide roller

Annex B
(informative)

Occupational Safety and Health Standard (Rule 1074.01 – 1074.03)

B.1 Threshold Limit Values for Noise

The threshold limit values refer to sound pressure that represents conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse effect on their ability to hear and understand normal speech.

Feasible administrative or engineering controls shall be utilized when workers are exposed to sound levels exceeding those specified in Table 2 hereof when measured on a scale of a standard sound level meter at slow response. If such controls fail to reduce sound within the specified levels, ear protective devices capable of bringing the sound level to permissible noise exposure shall be provided by the employer and used by the worker.

B.2 Permissible Noise Exposure

B.2.1 The values specified in Table 2 apply to total time of exposure per working day regardless of whether this is one continuous exposure or a number of short-term exposures but does not apply to impact or impulsive type of noise.

Table 2 - Permissible Noise Exposure

Duration per day, hours	Sound Levels [dB(A)], slow response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼	115

B.2.2 If the variation in noise level involves maximum intervals of one (1) second or less, it shall be considered as continuous. If the interval is over one (1) second, it becomes impulse or impact noise.

B.2.3 When the daily noise exposure is composed of two or more periods noise exposure of different levels, their combined effect should be considered rather than the effect of each.

If the sum of Equation A exceeds one (1), then the mixed exposure should be considered to exceed the threshold limit value. However, the permissible levels found in the table shall not be exceeded for the corresponding number of hours per day allowed. Noise exposures of less than 90 dBA are not covered by Equation A.

$$X = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_3}{T_3} \qquad (Equation\ A)$$

where: X is the sum of the ratio of C and T
C is the total time of exposure at a specified noise level
T is the total time of exposure permitted at the level

B.2.4 Exposures to impulsive or impact noise shall not exceed 140 decibels peak sound pressures level (ceiling value).

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