DIES AND DIE SELECTION

Die Metallurgy

The basic physical properties of the die materials are controlled by the heat treating process and the composition of the die's steel.

Carbon and Chromium

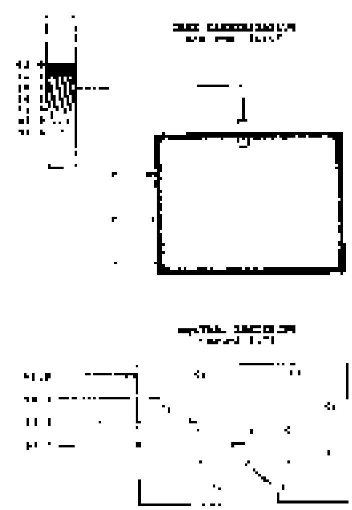
The two key elements in our dies are carbon and chromium. The carbon content of the steel affects the corrosion resistance and the wear resistance of the die. A free chromium content above 12% classifies a steel as stainless. Chromium carbides are formed during the heat treat process through a combination of chromium and carbon atoms, which increases wear resistance. There is no such thing as a rust free "stainless steel".

Heat Treating: carburizing vs. neutral hardening

We heat treat our dies two different ways, either carburizing the die or neutral hardening the die. Case carburizing dies can be done in a pit furnace or in a vacuum furnace by the addition of a carbon rich gas, such as propane. The CPM Alloy Die is processed in the pit furnace. The CPM Mor-Ton Die is vacuum carburized. When carbon is added into the atmosphere of either of these furnaces, it soaks into the steel to form a hard case. Case carburized dies tend to create more friction in the pelleting chamber, meaning they will usually provide better quality pellets.

Neutral hardening is a process that gives the same relative hardness throughout the thickness of the die. One of these steels is CPM's Chrome Plus. Due to its homogeneous hardness throughout, Chrome Plus offers excellent die life. Neutral hardened dies tend to be easier to start.

CPM offers three types of materials. **Alloy** is a medium-grade carbon steel which is case carburized for a hard outer case 57 HRC and a soft core. **Mor-Ton** is a stainless steel which is carburized in a vacuum for a hard case 61 HRC and a soft core. **Chrome Plus** is neutral hardened 52 HRC through the thickness of the die.



Die Material Application

Each material has characteristics that may make it more desirable than another for an application. **Alloy** is the most breakage resistant die material currently offered, which means that it is best suited for heavy tramp metal situations. Alloy has been used in heavily abrasive situations where die life with other die materials is not significantly longer in order to keep cost/ton ratios low. Alloy is also used extensively with high mineral content applications. Alloy is the lowest price die.

Mor-Ton dies can be used in mildly corrosive applications. Because of its case carburization and hole erosion characteristics, Mor-Ton should only be used with customers whose primary concern is pellet quality. It works well with moderately to highly abrasive materials which tend to keep the pellet hole inlets open. The best wear characteristics and throughput seem to be achieved with closer hole patterns, especially with smaller hole diameters of 5/32 and below. Reducing ligament thickness lessens the occurrence and severity of rollover. Rotating the pattern had much the same effect. In this case, thicker die blanks should be used. Even though Mor-Ton is a stainless steel, it will rust or corrode.

Chrome Plus allows high throughput and die life at the expense of pellet quality. It should be used in extremely high corrosion applications, high throughput applications and extended die life applications. Pellet quality may be significantly lower than carburized dies in the first half of a die's life. It performs well with abrasive applications where pellet quality is not an important issue. Chrome Plus needs more effective thickness to achieve quality similar to carburized dies. When changing from a carburized die to Chrome Plus always increase the blank thickness 1/4" to 1/2".

Die Design Features

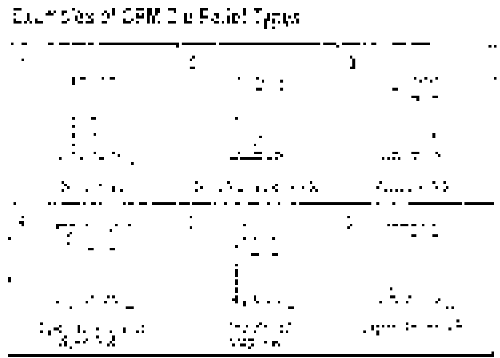
The physical characteristics of a die can determine its performance through the blank and effective thickness, the reliefs and the hole pattern. Perhaps the most important physical characteristics of a die are the blank thickness and the effective thickness. The blank thickness determines the overall strength of the die. The thicker the blank, the more it resists deflection caused by the rollers. Blank thickness should be increased instead of ligament thickness, especially in cases of repeated circumferential breakage.

DIE CROSS SECTION VIEW

Effective thickness is the length of the pellet chamber that will perform the pelleting. Effective thickness governs the amount of work the die will perform on a material, increasing pellet quality. It also controls the amount of stress added to a die - more thickness = more stress. Changes in material necessitate changes in effective thickness due to changes in the materials coefficient of friction.

Reliefs were developed so that increased blank thickness could be used with applications that needed thinner effective thicknesses. Currently, there are two major types of reliefs: straight hole and tapered. Straight holes can be oversized, while tapered holes can be at different angles. Tapered reliefs over 1.000" are extended by adding a straight relief to it. These two reliefs can be drilled in three methods: variable, non-variable, and special variable.

The hole pattern is the major factor in determining a die's wear pattern. Each of the above types of pattern can have one of the three types of ligaments. This is determined by the ECJK value. **Close** is used for easy running, high throughput feeds. Benefits of the close pattern include increased throughput, better die face wear (especially with Mor-Ton), and easier startup (especially Mor-Ton). Spreading the feed over more holes in the close pattern also retains pellet quality over life of the die. Increased amounts of steam to feed means more heat and moisture. Conditioning is improved, pellet quality increases, die life increases and operating costs decrease (lower operating amperages, power savings). **Standard** is the normal pattern and **Heavy** is used in high pressure, hard running feeds. These patterns, when applied to various materials, will give you different results. Every opportunity should be taken to get maximum hole count in a die as it increases throughput and die life.



Die Inspection

Keeping accurate and complete tonnage reports allows the study of individual dies and the compilation of this information enhances the proper review of specifications.

Review of the various die categories.

The most important result is tonnage. Tonnage is the basis for evaluating your costs and productivity.

Hours run is an equally important statistic because it details the rate at which the product flowed through the die.

Tramp metal is a source of potential damage to a die.

Depth of wear has significant impact on both quality and throughput of pellets.

Honeycombing is indicative of a section of the die that has worn well, maintaining a steady throughput.

Rollover is a peening action that closes the hole entrance, decreasing throughput and increasing the stress on the die.

Pitting is a common result in dies which are not corrosive resistant. Corrosion occurs in the pelleting chamber, slowing the production.

Scoring is caused by highly abrasive material eroding a groove in the pelleting chamber.

Clamping surfaces show the state of the mating surfaces with the die.

Breakages occur in three major categories. Circumferential is related to the strength of the die blank. Blowouts are when part of the pattern releases from the die face, More often than not, a circumferential break is present. Flange failures are the result of a snapping or stretching motion.

Depth of Wear

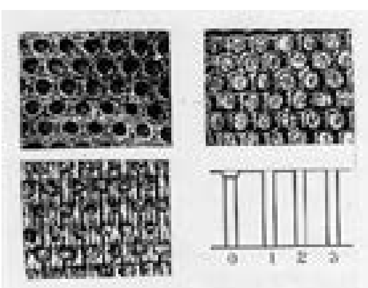
The most noticeable and important trait of any worn die is the depth of the surface wear experienced by the die face. The depth of surface wear is defined as the perpendicular distance to the die face from the horizontal plane that marked the original die face surface. This information is recorded in three sections: the cone, the center, and the quill.

Cone readings are taken in the front third of the die face, while center and quill readings are taken in the thirds of the die face bounding their respective areas. A good standard practice is to take these measurements in the exact center of the die and three rows in from each flange. This helps bring consistency to the measurements. The only exception to these locations would be if there was an exceedingly deep band of wear in an area, then the measurement should be taken in the deepest spot.

To take readings, simply remove the pellets from the respective holes. Make sure the outer surface is clean by scraping away excess fat, sediment, and other pellets that may hinder a proper measurement. Using micrometers or a small diameter rod, insert from the O.D. of the die the depth gauge of the micrometer or the rod until it appears on the I.D. of the die face. Mark the rod on the IO.D. or check the measurement of the dial micrometers. You have just measured the remaining blank thickness. This measurement can be subtracted from the original blank thickness to arrive at the depth of wear. These measurements should be given in thousandths of an inch.

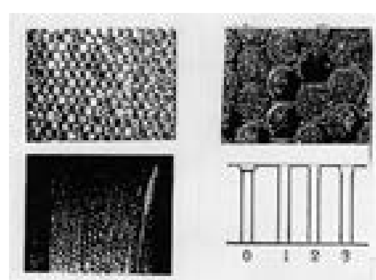
The depth of wear measurement gives important information concerning feed distribution by evaluating which portion of the die is worn the deepest. This measurement identifies worn wipers and deflectors as well as unevenly worn roller shells.

Rollover



Rollover is the condition of the die face when the hole inlets start to peen closed. This peening action will have dramatic effects on both the pellet quality and the throughput of the die, usually lowering both. Rollover is caused when the force exerted on the face of the die exceeds the toughness of the die material. Roller adjustment and certain types of feed exert excessive stresses on the die face, initiating rollover. In the case of Mor-Ton and Alloy dies, the likelihood of rollover occurring increases as the depth of wear increases, exposing greater amounts of softer ligament material. The illustrations show cross sectional appearances and die face appearances of common rollover.

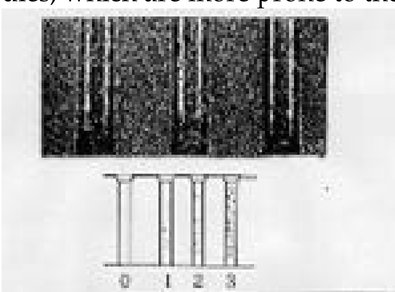
Honeycombing



Honeycombing is the result of the abrasive wear of the pelleted material enlarging the hole entrance on the die face. This action at its most severe may result in a serious reduction of the ligament thicknesses between holes. It is characteristic of a honeycombing condition for the ligaments to round at the tops, allowing material to flow into the holes. Honeycombing in its mild state is an indication of a good producing die and is characteristic of Chrome Plus material. The illustrations show cross sectional appearance and die face appearances of common honeycombing.

Pitting

Pitting is a condition caused by corrosion, which is the result of the effects of moisture and heat combining with the feed in a die. Pits appear as small places of micro corrosion that grow as the die continues to wear. Pitting slows down a die by reducing the throughput and often can reduce pellet quality due to the rough surface created inside the hole. This is especially true for cube dies, which are more prone to the effects of pitting.

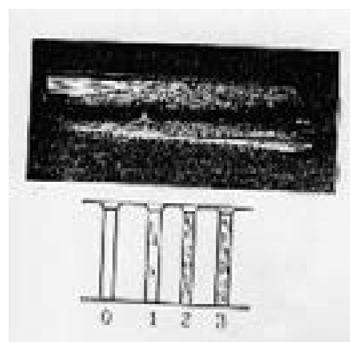


The condition can be observed by removing feed from a hole and shining a light from the die I.D. so that a hole is illuminated. When looking down the hole from the outside, a contrast can be caused on the hole walls so that early pitting will appear as little pin pricks in the sides of the hole wall. More severe pitting will appear as larger blotches. WARNING: Make sure that all the sediment has been removed from the sides of the holes with either a test tube cleaner or a pipe cleaner.

Scoring

Scoring is the appearance of longitudinal lines down the hole wall. These marks are caused by severely abrasive pelleting materials scratching the hole wall as they pass through. Very commonly, scoring will occur as the result of earlier pitting in the shape of a comet. The origin is the pitting and the tail is caused by scoring being passed through the pitted area. Severe scoring will slow die throughput and disrupt pellet quality.

The condition can be observed by removing feed from a hole and shining a light from the die I.D. so that a hole is illuminated. When looking down the hole from the outside, a contrast can be caused on the hole walls so that early scoring will appear as little scratch marks in the sides of the hole wall. More severe scoring will appear as larger grooves. WARNING: Make sure that all the sediment has been removed from the sides of the holes with either a test tube cleaner or a pipe cleaner.



Clamping Surfaces

An important part of any die inspection is the inspection of the quill flange clamping surfaces. These areas can commonly be cause of a broken die if the proper maintenance has not been performed on the adjacent wear parts, such as clamps and wear inserts. Thus, the overall goal of examining the clamping surfaces is to gauge damage to other parts of the machine. There are four surfaces that are inspected: the loose clamp surface, the clamp bottoming surface, the wear ring surface and the keyway.

Loose Clamp Surface

The loose clamp surface is the front of the die quill flange that mates against the clamping surfaces. This surface can suffer wear for various reasons. Items that can affect the wear include undersized quill flanges, worn pellet mill quills, worn die clamps, worn wear rings, and worn keyways. Finding the cause of the wear will necessitate gauging the rest of the surfaces.

A worn quill can cause wear on the loose clamp surface and the butt surface that mates against the quill directly opposite the loose clamp surface. Wear on both of these surfaces could indicate a quill rebuild is needed. Certainly the quill should be inspected carefully and the next opportunity.

Usual wear on the loose clamp surface is the result of worn die clamps. The clamps should be checked with the appropriate wear gauge provided for that die.

The condition can be observed by cleaning off any anti-seize material or rust from the surface. Wear will appear as polished metal. A good item to determine is whether the surface was ground or hard turned during manufacture. By determining the type of finish, the wear can be gauged.

Clamp Bottoming Surface

Clamp bottoming occurs when wear to the die, quill, clamps, or any combination of the three becomes so severe that the inside of the clamp rubs against the top of the quill and the top of the die quill flange (the clamp bottoming surface).

The condition can be observed by cleaning off any anti-seize material or rust from the surface. Wear will appear as polished metal. A good item to determine is whether the surface was ground or hard turned during manufacture. By determining the type of finish, the wear can be gauged.

Wear Ring Surface

The wear ring surface is commonly called the die pilot surface. This surface mates up against the wear ring insert in the quill. Again, the types of grinding and turning are similar to those previously mentioned, depending on the place of manufacture. Wear on this surface can be caused by installation with an already worn wear ring or an undersized pilot diameter. Undersized pilots are an uncommon occurrence. Most wear on these surfaces is caused by installation of the new die with an old wear insert. Wear on this surface indicates that wear ring inserts should be changed immediately. Wear can also indicate that a die is loose and may often be the cause of wear on other surfaces within the mill.

The condition can be observed by cleaning off any anti-seize material or rust from the surface. Wear will appear as polished metal.

Keyway

The keyway is the area recessed into the die pilot that fits the key and provides the drive for turning the die. This surface will tend to experience wear only if the die is loose or the key was undersize and worn to begin with at installation. The battering or "wallering" effect experienced by the keyway is caused by the loose key. As the key pivots in the keyway, it causes a doming effect on the sides of the keyway.

Common Problem Solving

Die throughput loss has several causes: conditioning, grind, die face rollover, and die hole condition (pitting and scoring).

Pellet quality losses are the other common complaint. Conditioning, grind, uneven die face wear, excessive honeycombing, die hole condition (pitting and scoring), relief pelleting and insufficient effective thickness are all culprits of pellet quality loss.

Good Die and Roller Maintenance Procedures

Inspect dies carefully when they are on and off the mill, looking for key items.

1. Rollover and pitting/scoring - the most common cause for a slowdown in production.
2. Inspecting clamping surfaces for wear when removing old dies can prevent breakage.
3. Check the face wear pattern for indications of poor feed pad distribution.
4. Inspect your wipers and deflectors.

Roller maintenance is the key to getting maximum life out of your die.

1. Check your rollers routinely for unusual wear, chipping and/or sluffing.
2. Probably the most important factor in die life is the setting and adjusting of the rollers.
3. Roller lubrication is an important factor.
4. Depending on the amount and frequency of your die changes, always try to start new rollers with new dies.
5. Try to even out the wear on the roller shells by rotating them frequently.

What you need to know about rollers and how to adjust them.

Rollers

Two or three rollers are mounted inside of the die cavity on eccentric shafts so their outer faces can be adjusted to contact the inner surface of the die. **This is the most important adjustment on your pellet mill**. Correct adjustment will result in maximum capacity, minimum wear on both rollers and die, and eliminate undue stresses in the pellet mill. When properly adjusted, the rollers will contact the die just enough to cause them to rotate.

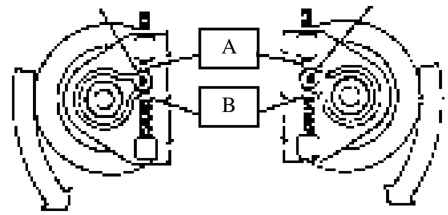
Damage can be done by excessively tightening the rolls.

WARNING

1. Do not adjust rollers while die is turning.
2. Pellet mill start switch should be locked out before adjusting rollers.
3. Adjusting any machine while parts are in motion is extremely hazardous and failure to comply with this warning may result in injury.

Roller adjustment should be made whenever required. The die should not be run without feed any more than is absolutely necessary. Operating the pellet mill with rolls too tight will result in peening closed the entrances to the holes in the die and excessive wear of the die and rolls. See below for proper roller adjustment procedures. Instructions for changing die and roller assemblies are in the manual.

Clockwise Roller Adjustment | Counterclockwise Roller Adjustment



Counterclockwise Die Rotation | Clockwise Die Rotation

Different types of roller shell surfaces are available to meet varied conditions experienced in pelleting different material. Before ordering other configurations, discuss with your CPM Representative.

Procedure

A. Clean off die and rollers.

B. Loosen adjusting screws ‘B’ away from adjusting gear.

C. To adjust roller closer to die, turn adjusting screws ‘A’ so they move the adjusting gear in the direction of the arrows. If this adjustment can not be made in the direction indicated, then the rollers have been incorrectly installed and must be properly reinstalled.

D. Properly adjusted rollers just clear the die surface.

E. If the end of the adjusting gear adjustment is reached, back off screw ‘A’ all the way, remove the adjusting gear, and reinstall it in the position shown above.

F. After adjusting roller position with screw ‘A’, lock adjusting gear in place by tightening screw ‘B’ against adjusting gear.

Comments

1. Rollers must be moved away from the die surface before changing dies. Use special roller wrench, if available, to rapidly rotate the rollers to their full back position.

2. Wear occurs on the surface of die and rollers as the pellets are produced. Check these surfaces periodically for wear and adjust rollers according to the above instructions when necessary.

Die Maintenance Tips

Loss of Production Rate

- Die face rollover
- Pellet chamber pitting/scoring
- Pelleting in reliefs

- Rollers need adjustment

Loss of Pellet Quality
- Die face rollover
- Loss of effective thickness
- Excessive honeycombing

Poor Die Face Wear
- Badly worn rollers
- Worn wipers and deflectors
- Die face rollover

Roller Maintenance
- Follow proper lubrication procedures
- Proper roller adjustment, avoid hitting the die face
- Look for unusual wear, especially chipping or sluffing
- Start new dies with new rollers
- Rotate rollers to evenly disperse wear