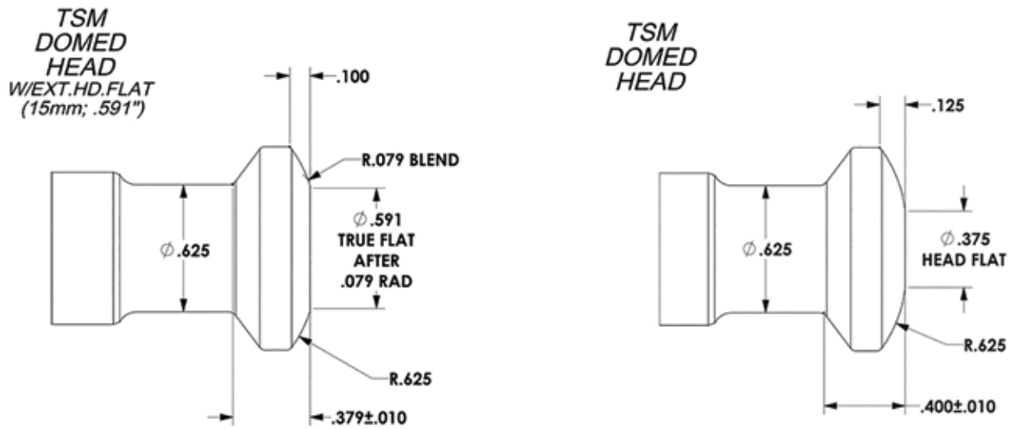

FIG. 1: **Differences in dimensions between a standard B-type, TSM domed head and a Natoli B-type, extended head flat, domed head**

TABLET TOOLING TECH

Kevin Queensen explains how extended head flats reliably increase dwell time

Many options are available for punches and dies to help compress difficult drug products. One commonly overlooked punch modification, the extended head flat, increases the diameter of the flat area atop the punch head. Typically, this option doesn't require any modifications to the press.

The extended head flat offers multiple benefits, including a longer dwell time – the time the head flat spends in contact with the pressure roll – at a given press speed to better compact poorly compressible products. The longer dwell time may even reduce the amount of force required to attain a specific tablet hardness.

$$dt = \frac{Dhf}{Dpc \times \pi \times rpm}(60)(1000)$$

Where:

dt = dwell time (ms)
Dhf = head flat diameter (mm)
Dpc = pitch circle diameter of turret (mm)
rpm = turret speed

Dwell time is dependent on press speed, the pitch circle diameter of the turret and the head flat's diameter. The formula for calculating dwell time is shown above. Increasing the diameter of the head flat is the easiest way to prolong dwell time without switching to a press with a smaller turret pitch circle (and therefore fewer stations) or decreasing the turret speed, both of which would decrease production. For example, a Fette 2090 press has a pitch-circle diameter of 410mm, and assuming an operating speed of 50 revolutions per minute, a standard B-type, TSM domed head – 0.375inch: 9.525mm flat – would have a dwell time of 8.88ms, while a B-type, extended head flat, domed head – 0.591inch: 15mm flat - would have a dwell time of 13.98ms. Fig. 1 illustrates the differences in dimensions between a standard B-type, TSM domed head and a Natoli B-type, extended head flat, domed head. The larger head flat increases dwell time by more than 50% without reducing the turret speed.

TABLET HARDNESS

The extended head flat can reduce the amount of compression force needed to form a tablet at a given breaking force, also known as hardness. Tablet hardness and density are related to compression force and dwell time. If the amount of time spent under compression increases, the amount of force necessary to maintain the same tablet hardness may decrease. The reduction in required compression force depends on the characteristics of the granulation being compressed.

As the required compression force is dependent on the product being compressed, it is impossible to accurately predict how much an increase in dwell time will decrease compression force. The effect of dwell time on compression force can be best quantified during R&D and understanding the relationship of dwell time to compression force can mitigate issues that commonly arise during scale-up to large production presses.

Geometrically, the design of the extended head flat differs only slightly from a TSM domed head or an EU head. Other than the increased head flat, one notable difference is a reduction in the head's thickness to allow the larger flat to fit through the same cam profile as a standard TSM domed or EU head. This slightly thinner head allows extended flat heads to traverse standard cams without modifications to the cam tracks or press. The head flat can even be customised to achieve a specific dwell time on a given press.

The limiting factor on the head flat's size is the punch's neck diameter. The neck transfers the force from the head to the barrel and tip and then to the granulation. If the head flat is larger than the neck's diameter, it won't have the support required to transfer the force generated when it contacts the pressure roll, which can cause the head or neck to fail (Fig. 2).

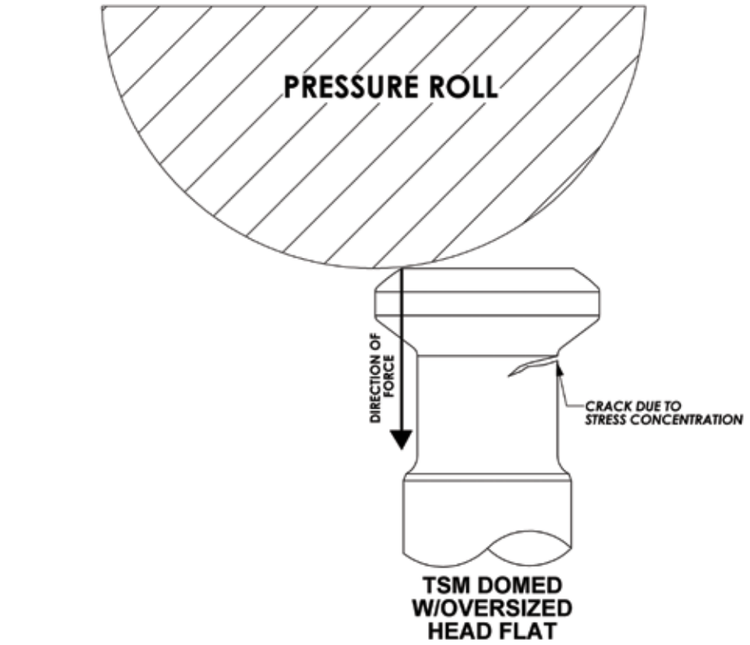

FIG. 2: **A head with a stress crack**

Extended head flats also can be an oval or elliptically shaped. Although this design extends the dwell time exactly as a round extended head flat does, it has some drawbacks. For example, the oval head flat can pass under the pressure rolls only in one direction (along the major axis of the oval/ellipse) to extend dwell time. For that reason, punches with an oval head flat must be keyed, even if round, to prevent them from rotating as they pass under or over the pressure rolls.

Additionally, if a turret doesn't have lower key slots the round tooling with an oval head can't be used because the benefit of the extended head flat will be lost if the punch rotates. Another issue: if two presses have turrets with key slots of different angles, the oval head flat punches cannot be interchanged because the different angle will alter the orientation of the head flat with respect to the pressure rolls.

Ultimately, using extended head flats can provide a quick and reliable way to increase dwell times and possibly reduce compression force without modifying the tablet press or cam tracks. Round extended head flats don't require keyed tooling as oval ones do, and that allows them to be used on multiple makes and models of tablet presses.

Head flats and the resulting dwell time play an important role in the compaction characteristics of many drug products. It's advisable to work with a knowledgeable tool vendor such as Natoli Engineering early in the development process to examine the role of dwell time. That early work can help minimise compression-related issues that could ultimately limit production.

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www.natoli.com