Influence of extended dwell time tooling on tablet performance.

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Introduction

During scale-up the tensile strength of tablets can decrease due to dwell time sensitivity and elastic recovery, and it can cause problems if strength falls below the target level. In production, there are limited options to improve strength without slowing output.

I Holland Ltd (Nottingham, UK) have introduced a new type of punch called the XDF (eXtended Dwell Flat) with a patented elliptical head form, designed to increase dwell time on a press without the need for time consuming and expensive modifications (Fig.1).

The aim of this investigation was to create a press simulation for the Compaction Simulator (Fig. 2) to predict the change in compact properties using standard head dimension compared to XDF tooling. The effect in compact properties of Formulation X was determined.

Fig. 1: Image of an EXF punch head.

Fig. 2: Compaction Simulator.

Press profile

Two profiles designed to simulate a Fette P1090i press at 60 rpm were created for the investigation. The Press Profile software was updated to include the XDF parameters. Press simulations were created using both standard B and the XDF tooling head dimensions. Fig.3 Shows the movement of the upper punch over time.

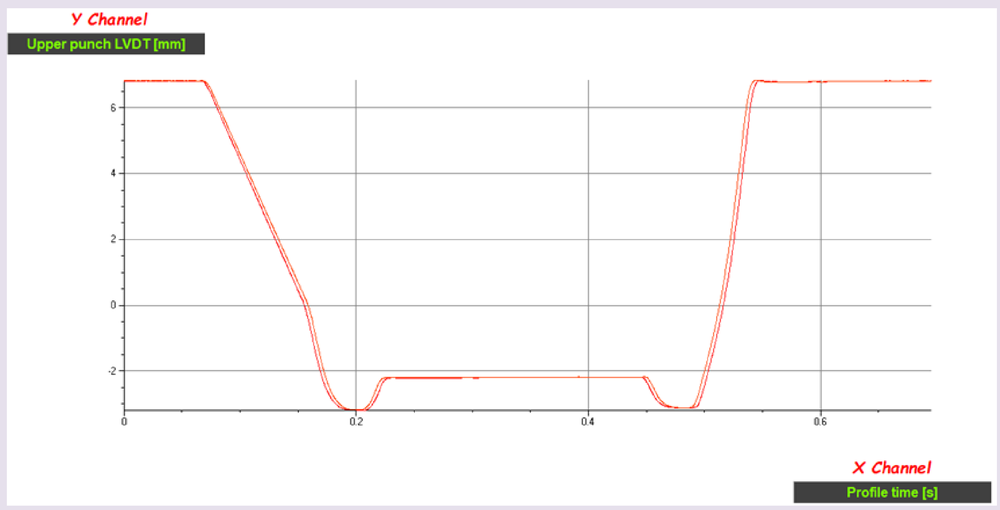

Fig. 3: Profile time (s) vs Upper punch LVDT (mm) for the standard B tooling and XDF tooling

Standard: 10 mm flat faced B standard tooling dimensions was used with a head flat diameter of 9 mm.

XDF: an effective head flat of 15 mm was used for the simulation.

Fig. 4 shows the close-up view of the upper punch movement at main compression. Formulation X was characterised using a Phoenix Compaction Simulator (Brierley Hill, UK)

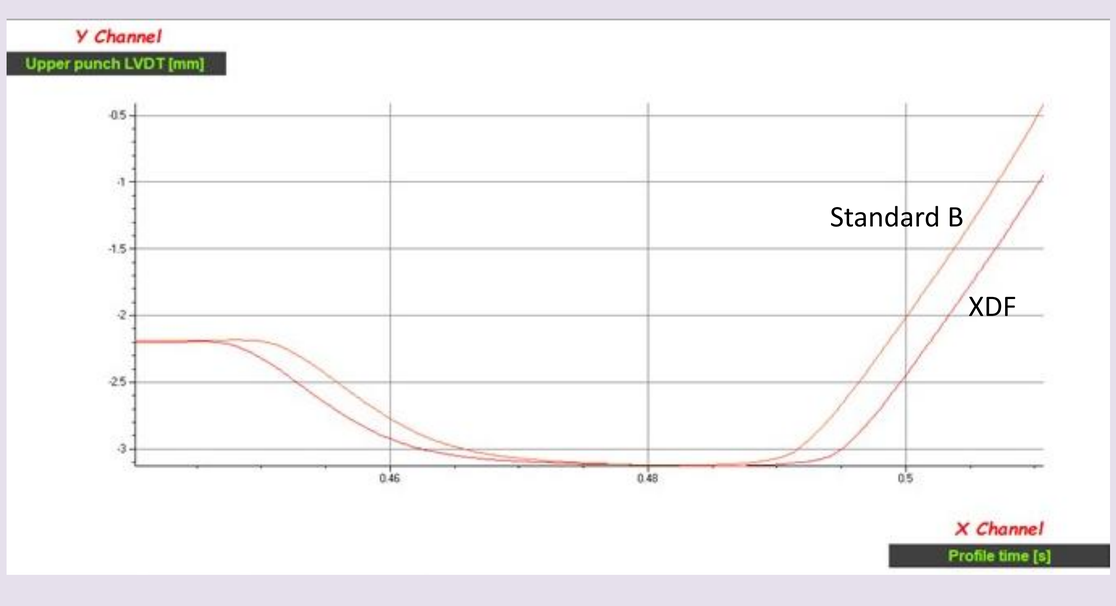

Fig. 4: Profile time (s) vs Upper punch LVDT (mm) at main compression for standard B tooling and XDF tooling

Formulation Tabletability

Formulation X is currently in development as a pharmaceutical tablet. In earlier investigations it has been shown to be strain rate sensitive. Tablets were made at a range of forces and the diametrical crushing strength determined. The compaction simulator was used to accurately record the compression force/punch pressure. Tensile strength was calculated using the out of die measurements of the compacts. The tabletability of formulation X was determined for the standard tooling and the XDF tooling and tabletability was plotted (Fig. 5).

Results

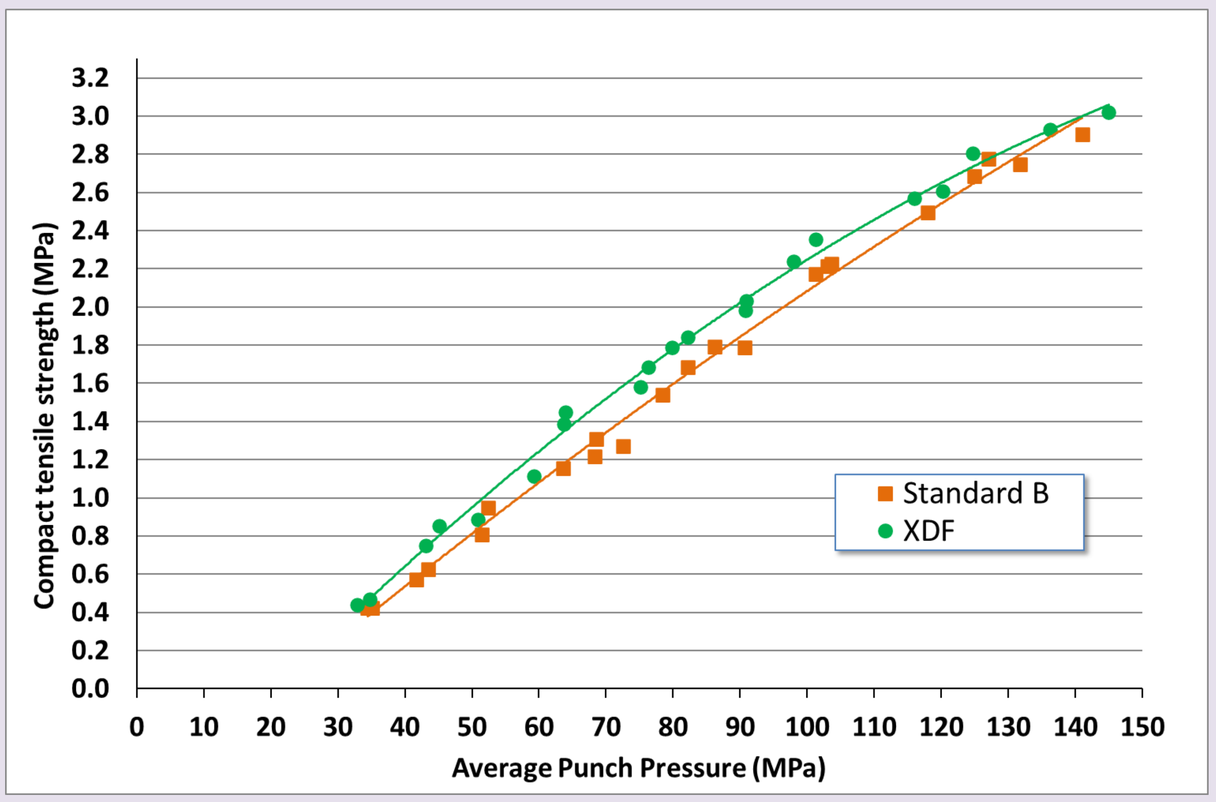

Fig. 5 Tabletability of Formulation X

The tabletability results show an increase in tensile strength of up to 0.2 MPa with the XDF press simulation compared with the standard B press simulation.

The dwell time was calculated by the software as the time the punch force was between 90-100% of maximum force. The dwell time goes from 0.013 seconds using standard B tooling to 0.018 seconds using XDF B tooling This shows an increase in dwell time of ~38.5%.

Table 1: The average dwell times for a Fette P1090i press simulation at 60 rpm per tooling type.

Tooling Type	Average Dwell Time
Standard B	0.013 s
XDF	0.018 s

In tableting, dwell time is defined as the amount of time that the surface of a punch head stays in contact with the compression roller in a standard tableting press. It can be shown in [Eqn 1].

$$dt = \frac{Dhf}{Dpc \times \pi \times rpm}(60)(1000) \quad \text{[Eqn.1]}$$

Where:
dt = dwell time (ms)
Dhf = head flat diameter (mm)
Dpc = pitch circle diameter of turret (mm)
rpm = revolutions per minute (turret speed)

Conclusions

A press profile was able to be created which simulates the punch movement changes with XDF tooling.

The tabletability of Formulation X showed an improvement in tablet strength properties following the XDF simulated profile.

This offers the potential of a laboratory based assessment which could predict the benefits of tooling solutions on a small scale.

The next steps would be to confirm the prediction with production scale data.

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