INTRODUCTION

The Stylcam 200 R (Fig. 1) is a single punch press, simulating speed profiles of various rotary tablet presses by controlling the speed of two cams electronically. This press can be used for trouble shooting in production and R&D efficiently by using just the standard force measurement instrumentation of upper and lower punch.

For characterising the compaction behaviour of powders as to their deformation properties, also a high precision in-die tablet height measurement system is required, which will be addressed first in our investigations. Assuming that a precision of ± 2 MPa for compaction pressures is a reasonable requirement, the corresponding maximally allowable deviation from linearity of about 0.1 to 0.5% of the rated force-displacement curve, is estimated to be at most ± 20 µm for the densification and ± 4 µm for the expansion process.

Usually, displacement transducers have a deviation from linearity of about 0.1 to 0.5% of the rated stroke. For a stroke of 40 mm, this corresponds to ±2 µm, and secondly because an increase has only little influence on the deviation of the residuals.

The importance of preventing the plunger from rotating is illustrated in Fig. 6. For measurement one and two, the polynomial fit was performed. Before the third measurement the plunger was rotated randomly. Due to this rotation, this calibration curve differs systematically from the two previous measurements, and so, if unrecognised, might result in an uncertainly larger error of up to 30 µm.

The finally achieved results are summarised in Tab. 1.

RESULTS

By plotting voltage versus displacement, a nearly linear correlation is obtained for both displacement transducers. To visualise the deviation of the data points from linearity, the residuals of the linear fit for the SM210 are shown in Fig. 3. As obvious from the deviation from linearity, reproducibility is excellent. The few outliers (blue circles) were likely due to manual documentation errors. Therefore, they were neglected and not included in the evaluation of the measured data. According to the residuals, the deviation from the linearity is about ± 0.025 mm (0.25%) as specified.

For achieving a better accuracy, a polynomial regression analysis was performed. In doing so the polynomial degree is enlarged until the residuals of the regression vary around zero more or less randomly. Fig. 4 and 5 show the residuals of a polynomial fit for the displacement transducer SM210 and SM260, respectively. Now the residuals vary about ± 2 µm for SM210 and ± 9 µm for SM260. The degree of the fitting polynomial is not increased further, firstly because the residuals are equal to the precision of the micrometer screw, which is about ± 2 µm, and secondly because an increase has only little influence on the deviation of the residuals.

The importance of preventing the plunger from rotating is illustrated in Fig. 6. For measurement one and two, the polynomial fit was performed. Before the third measurement the plunger was rotated randomly. Due to this rotation, this calibration curve differs systematically from the two previous measurements, and so, if unrecognised, might result in an uncertainly larger error of up to 30 µm.

The finally achieved results are summarised in Tab. 1.

CONCLUSION

It is possible to measure the densification part of “force-displacement” curves with sufficient accuracy, because the relation between core position and output signal of the displacement measurement system being used is far more better than their specified precision. Due to the excellent reproducible deviation from linearity, a polynomial regression may be used for describing this relation. For the examined displacement transducers, it is necessary to prevent the plunger from rotation.

REFERENCES


ACKNOWLEDGEMENTS

We kindly thank Medelpharm to allocate an instrumented Stylcam at the University of Bonn.

Table 1: Summary improved accuracy

<table>
<thead>
<tr>
<th>transducer</th>
<th>stroke</th>
<th>deviation from linearity</th>
<th>deviation from poly., regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM210</td>
<td>10 mm</td>
<td>± 25 µm</td>
<td>± 2 µm</td>
</tr>
<tr>
<td>SM260</td>
<td>40 mm</td>
<td>± 100 µm</td>
<td>± 9 µm</td>
</tr>
</tbody>
</table>