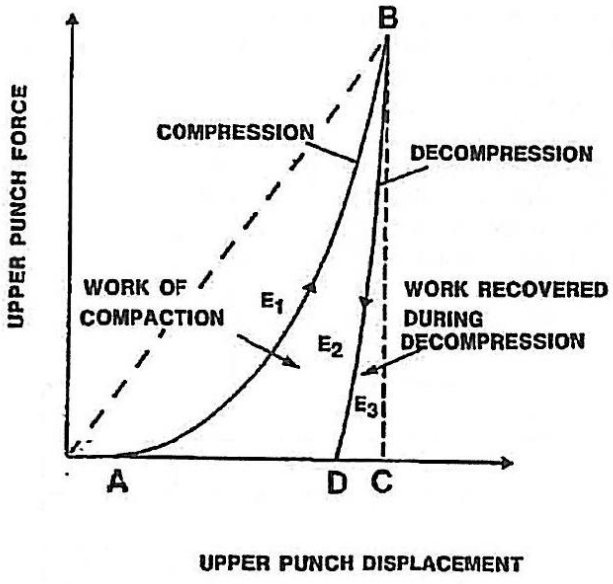
Energy profile of compression process

Energy profiles can be useful as compression characteristics in preformulation studies of compression of various substances. Their contribution primarily lies in a possibility to subsequently correlate the energy inputs or work of compression with deformation and tablet-forming properties of various materials. Formulation of solid compacts requires sufficient energy the parameters of which can be evaluated by means of the "strength-track" record, which is the graphic record of the strength and the track of the upper punch of the tableting press acting on the tableting material in the matrix.

The compression cycle can be divided into three stages. A schematic record of the strength of the upper punch versus its track during compression and decompression is shown in the following graph:



The teoretical course of compression is given by the curve connecting the points ABC, the energy of compression is represented by this whole area. When the upper punch enters the matrix, the pressure gradually increases; achieving the maximum, after the formation of the compact, it quickly decreases to the initial value. The actual experimentally determined course is different and is expressed by the curve ABD. The ABD area represents the apparent work used to form the compact and the deviation originates due to returning the part of the work expended on compression to the punch, and friction of the wall of the matrix also plays a role. The part of the work which returns to the upper punch during decompression depends

on the expansion of the compact determined by the properties of the compressed material. It is represented as the area DBC.

The total energy of compression (Emax) includes the following individual types of energy:

- E1 – energy of precompression, expended primarily on friction between the particles and between the particles and the surface of the matrix
- E2 – energy of plastic deformation – it remains in the tablet, it is important for the formation of bonds
- E3 – energy of elastic deformation, it is the energy of decompression which is released from the tablet after compression

Value E1 should be as small as possible and the ratios (E2+E3)/E1 and E2/E3 as great as possible.

E2 + E3 = E com– energy of compression

E1 + E2 + E3 = Emax – total energy of compression process

These energies can be employed for the calculation of the value of plasticity as the ratio of the energy of plastic deformation and the energy of compression:

Pl = 100. E2/ (E2+E3)

A high Pl value means that a large part of the employed energy was used for irreversible deformation of the material. A high degree of plasticity increases tablet strength.

References:

1) RAGNARSSON, G.: *Force-displacement and network measurements*. In: Alderborn, G., Nyström, C., eds., Pharmaceutical powder compaction technology, New York, Basel and Honkong, Marcel Decker, Inc., 1st ed., 1996, 4, 77-97, ISBN 0-8247-9376-5.
2) Mužíková J.: přednáška Tablety