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Tablet compaction to a constant load

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In studies of tablet compaction, it is usual to work at constant tabletting force (or pressure) or to correlate the tablet properties with the force. Owing to the friction between the tablet and the die wall, different forces are obtained on the upper and lower punch and it is not obvious which of the values is the most relevant one to use.

In most studies on instrumented reciprocating tablet presses, the maximum upper punch force (UPF) is regarded as the tabletting force but the mean of the UPF and the maximum lower punch force, (LPF), has also been used (e.g. by Hersey et al., 1967). The lower punch force has been claimed to be independent of the die wall friction (Lammens et al., 1980, 1981) and would be a useful measure of the tabletting force. There seem, however, to be few experimental data supporting the choice of the different force measures or their importance in compaction studies.

In a recent study (Ragnarsson and Sjögren, 1983) we compressed a number of tablets of sodium chloride, anhydrous lactose and saccharose in a die which was lubricated at the beginning of each series. No lubricant was added during the series and the die wall friction consequently increased while all other factors were kept constant. As illustrated in Fig. 1, both the UPF and the LPF were affected by the

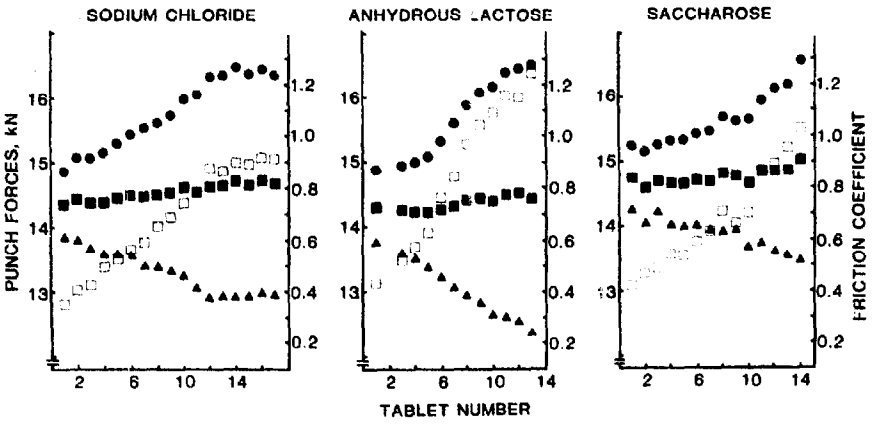

Fig. 1. Punch forces and friction coefficients of consecutive tablets. ●, UPF; ■, MPF; ▲, LPF; □, friction coefficient.

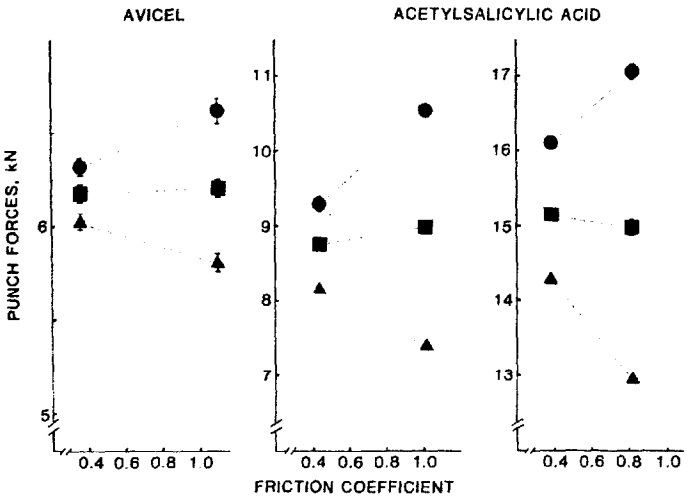

Fig. 2. Punch forces and friction coefficients (mean of 10 tablets and 95% confidence limits) of microcrystalline cellulose (Avicel) and acetylsalicylic acid compressed with and without die wall lubrication. ●, UPF; ■, MPF; ▲, LPF.

friction. The mean force (MPF) remained constant, however, and probably corresponds to the value of UPF and LPF when no friction is present. The tablet strength was practically constant in spite of differences in die wall friction, UPF and LPF (Ragnarsson and Sjögren, 1983) indicating that the MPF gives a good estimate of the force applied to the compact.

To study the effect of the die wall friction on the punch forces further, we have compressed dry-granulated microcrystalline cellulose (prepared from Avicel PH 101, FMC, U.S.A.) and granulated acetylsalicylic acid (Asagran 7017, Monsanto, U.K.), at two pressure levels, in a prelubricated and an unlubricated die. The prelubrication was carried out as before by compressing a mixture of the material and 25% magnesium stearate, but was repeated for each tablet in the series. As can be seen in Fig. 2, both the UPF and the LPF were affected by the change in die wall friction also for these two materials. Since the MPF appears to be practically unaffected, it is reasonable to assume that it corresponds to the part of the force input which is actually used to reduce the volume of the material and to form a compact. The MPF, or mean pressure, should therefore be the most relevant measure of the compaction load.

If the UPF or the LPF is kept constant, the MPF will decrease or increase respectively with an increase in die wall friction. Such changes in the compaction load might affect the results of a compaction study, especially at high friction levels. To investigate the effect of such changes on the tablet strength, we compressed sodium chloride, granulated Avicel and granulated acetylsalicylic acid in an unlubricated die. Thereafter tablets were compressed in a lubricated die to the same UPF, MPF or LPF as in the unlubricated die. The tablets were stored for at least 3 days before the diametral crushing strength was measured.

The tablet strength was unaffected by the die wall friction when sodium chloride and Avicel granules were compressed with the same MPF in the unlubricated as in

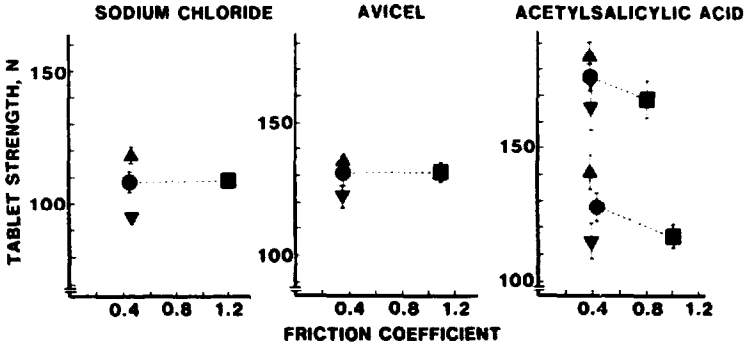

Fig. 3. Crushing strength and friction coefficients of tablets compressed in a lubricated die (low friction coefficients) to the same UPF, MPF or LPF as tablets in an unlubricated die (high friction coefficients). Each symbol represents the mean and 95% confidence interval of 10 tablets. ■, unlubricated die; ▼, lubricated die, same LPF; ●, lubricated die, same MPF; ▲, lubricated die, same UPF.

the lubricated die (Fig. 3). The strength of acetylsalicylic acid tablets increased when the die wall friction was reduced. This result, which was verified at two different pressure levels, is probably caused by the disruptive effect of the frictional force during the ejection. The effect of the die wall friction on the tablet strength appeared in general to be significantly different if the tablets were compressed to a constant UPF or a constant LPF (Fig. 3). The results obtained when compressing sodium chloride to a constant LPF may, for example, give the erroneous impression that an increase in die wall friction will promote good bonding while the use of a constant UPF will give the opposite impression. We conclude that the mean force or the mean pressure offers a simple and practically friction-independent measure of the compaction load which in general is more relevant than the commonly used UPF.

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