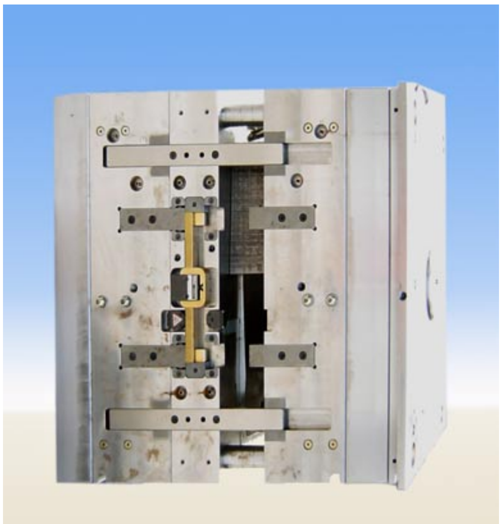
Fachhochschule Bielefeld
University of Applied Sciences

Double the Output

Tandem Moulds for Standard Machines



Overall cost pressure in modern plastics processing makes constant innovation essential. Two directions of development are possible. Either you develop new products with clever technical features to secure competitive advantage (such as the multi-component technique) or you succeed in lowering production costs. This article describes a way of increasing the production output of a machine by up to 100 %, cutting production costs by as much as 40 %.

The cost of producing a technical part by injection moulding is made up of the cost of the material (approx. 50 %) and the costs of the machine, mould and labour. If we relate this to a single part, only the material costs are fixed, all the other factors can be influenced via the cycle time. With a high production output or shorter cycles, the costs per part decline.

Lowering Production Costs with Faster Cycles

Until now, two methods have been used to increase volume output. In the case of parts with a short cycle time (e. g. packaging components) it is worthwhile shortening the mould movement time. In the case of thicker-sectioned parts with longer cooling times, the operator will endeavor to cut the cooling time with the aid of optimized cooling systems. Here, however, the physical limits are soon reached.

Another possibility is to use stack moulds, which, in the same process time (mould movement, injection, holding, plasticating) can double or even quadruple the number of parts per cycle with the number of parting lines. However, there are two main reasons why it is often not possible to use stack moulds for technical parts:

- The metering volume is inadequate for double the number of parts.
- The opening stroke of the machine does not allow the opening of two parting lines.

Use Stack Moulds also for Technical Parts

Back in 1982,1. Sorensen [1] introduced a process in which the parting lines of a stack mould opened alternately in cycles. This technique was successfully implemented in a machine concept by Husky [2]. The big advantage of this method is that use is made of the machine's non-productive time, which is the time during which the machine does not do any work but merely cools down.

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Special tandem machines are not very common at present. This is possibly due to the higher price connected with a locking mechanism on the machine for an additional parting line. Apart from this, tandem machines have a complicated melt passage via a hot runner system through a second, additionally moving platen (Fig. 1).

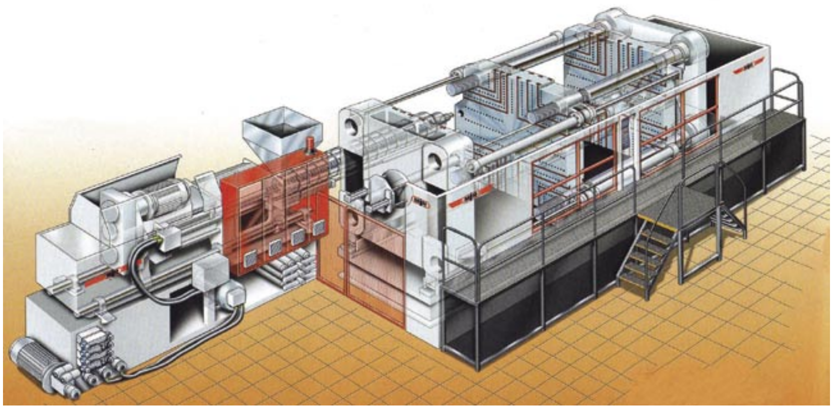

Fig. 1. Structure of a modern tandem machine (picture: Mir)

Tandem Moulds on Standard Machines

The aim of a recent development at the Bielefeld University of Applied Sciences, Germany, was to integrate the tandem technique in a mould and thus make it available for normal injection moulding machines [3]. To do this, the following basic conditions had to be met:

- The locking mechanism of the first parting line had to be such that, when activated, the second parting line was automatically unlocked to avoid defects and damage to the mould.
- The locking mechanism had to keep the parting line closed even at a residual clamping force of 20 °/ so that melts containing a blowing agent could also be used.
- It had to be possible to gate the mould conventionally. It should also be possible to get by without a hot runner system.

The locking mechanism consists of a mechanical lock similar as it is used for three platen moulds. it moves to the other position after each cycle and opens/closes both parting lines alternatingly (Fig. 2).

Every end position is monitored by a limit switch. Only when a limit switch is

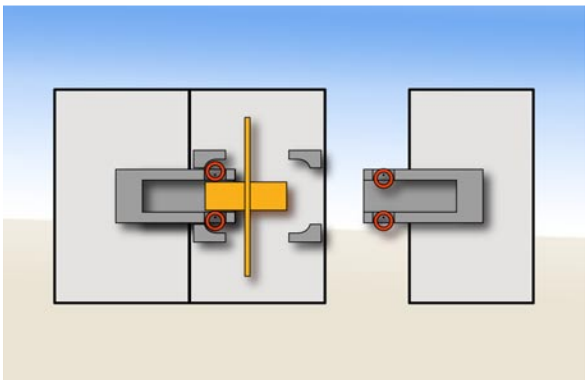

Fig. 2. Arrangement of external locking bolts for the alternate locking of the parting lines

giving a signal should the relevant core pull be released for the ejection process. For the parting line on the ejector side of the mould, the machine ejector itself must be programmable from the core pull, and only become active when the relevant core pull is activated. On modern machines this necessitates only minimal programming.

A cold runner is used for conveying the melt. The special know how about this method is that the demoulding is always done only from one parting line. Only

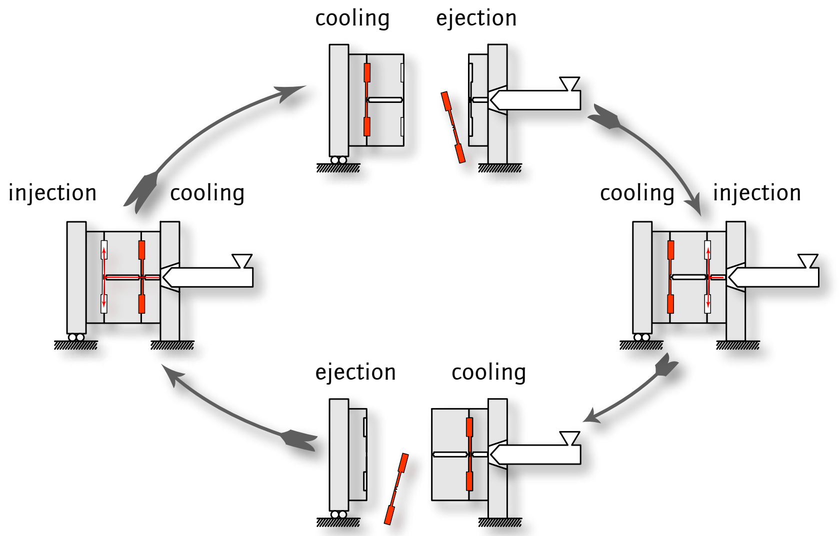

Fig. 3. Mode of operation of a tandem mould

the cold runner that leads to these cavities and the cavities themselves can be filled in the following cycle (Fig. 3).

Possible Applications

With the aid of a feasibility study, it was calculated that 30 % of the production costs could be saved in this way (Fig. 4). The saving becomes greater with increasing cooling time. The striking point is that the production costs are independent of the cooling time up until the cooling time accounts for about half the cycle time. This observation can be explained with the aid of an example (Fig. 5). A complete tandem cycle consists of two injection cycles in which the cavities of both parting lines are filled one after the other. After each injection process, the cavity filled in the preceding cycle is demoulded. The duration of one tandem cycle is therefore

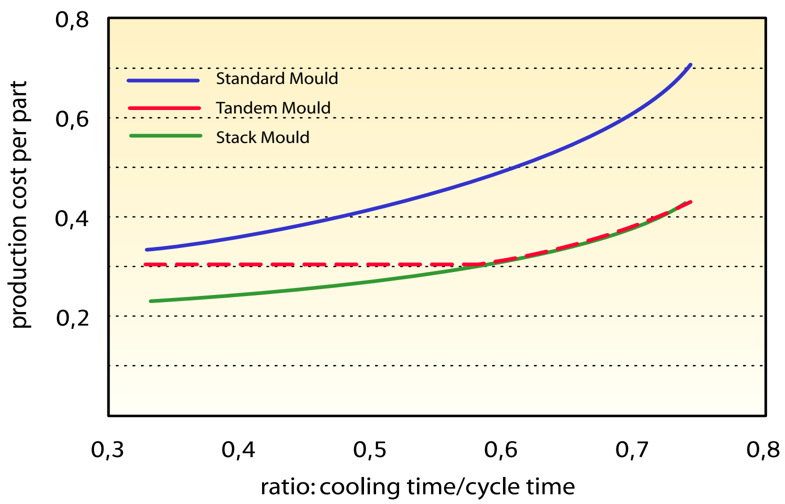

Fig. 4. Comparative calculation of the production costs for standard, tandem and stack moulds

made up of the process times of both part steps. The surprising aspect here is that the cooling time is longer than in the standard cycle, lasting until the end of the second plasticating phase. Nevertheless, the cooling time does not delay the cycle because the process continues in the second half of the mould during cooling. In a standard injection moulding pro cess, the cycle could not start until the cooling process had finished.

With long cooling times, there is a longer non-productive time (time difference between cooling time and metering time), and this is used in the

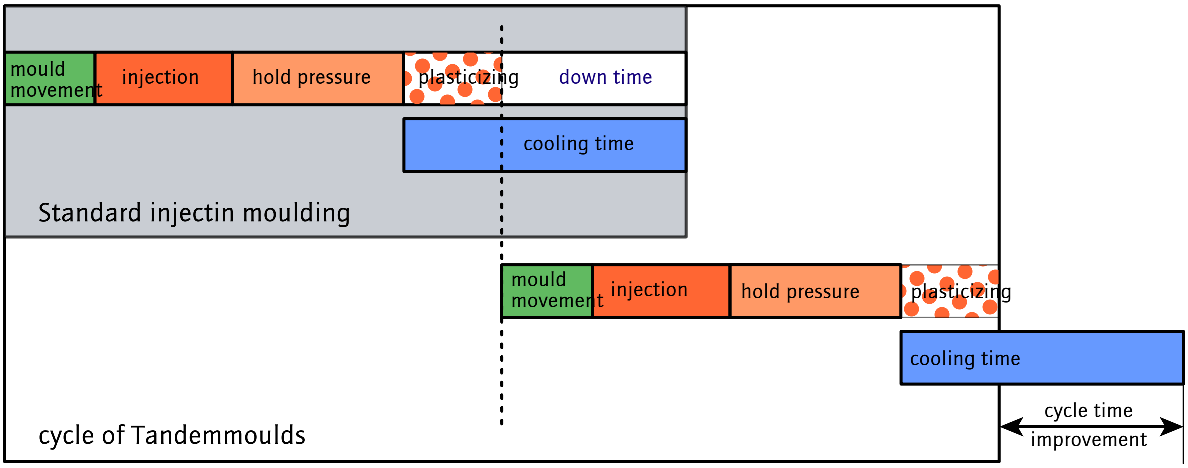

Fig. 5. Cycle and time saving with the tandem technique

tandem system. As long as the non-productive time is not shorter than the process time (see above), the cooling time exerts no further influence on the cycle time, because the phase is determined by the injection and holding time of the other parting line. For this reason, longer cooling times are not reflected in an increase in production costs; in fact, with longer cooling times, the cost savings over the standard technique become larger and larger. With a further increase in the cooling time, the costs of production with a tandem mould gradually become the same as the costs of production with stack moulds.

For this reason, the tandem technique is of interest first and foremost for mouldings with large wall thicknesses/cycle times. This includes all GIT applications and applications with melts containing a blowing agent.

Other applications include components from family moulds (e. g. toilet seat and lid). Such moulds are often very large and difficult to run. It would often be useful to have different settings for the individual components, but this is not possible in the case of a family mould.

The tandem technique offers several advantages here:

- Production can take place on a smaller machine.
- Only a relatively small metering volume is needed (sufficient for one parting line), which means that the homogeneity improves with large-volume parts.
- With longer cooling and plasticating times, use is actually made of the nonproductive time, reducing costs even further.
- With machines having a “special tandem program”, an individual metering volume and injection profile can be set for each of the two part cycles, so that single part groups of the family can be optimized separately.

Thanks

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