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Fundamental principles

# of injection moulding

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Content

Lengths and strokes

d	Wall thickness of the moulded part
D	Screw diameter
R_A	Sprue bush radius
$R_{DÜ}$	Injection nozzle radius
s_A	Ejector stroke length
s_D	Metering stroke
s_{DK}	Dekompressionshub
$s_{DÜ}$	Decompression stroke
sDÜ	Nozzle retraction stroke
s_E	Demoulding stroke
s_F	Mould safety device stroke
s_{FL}	Maximum flow path length
s_K	Core height
s_S	Screw stroke
s_{SI}	Safety
$s_{SÖ}$	Closing and opening stroke
s_{UP}	Changeover point

Times

t_D	Metering time
t_{DV}	Metering time delay
$t_{EÜ}$	Injection time monitoring
t_F	Mould filling time
t_{FS}	Mould safety time
t_K	Cooling time
t_N	non-productive time
t_{ND}	Holding pressure time
t_P	Mould pause time
t_{RK}	Residual cooling time
t_Z	Cycle time

Speeds

v_A	Ejector speed
v_E	Injection speed
v_F	Flow front speed
v_S	Closing and opening speed
v_{SR}	Screw retraction speed
v_U	Peripheral speed

Volumes

V_D	Metering volume
V_{DK}	Decompression volume
V_F	Part volume
V_R	Residual melt cushion
V_{UP}	Changeover volume
V_Z	Additional volume

Volumetric flow rates

$\dot{V}_E$	Volumetric injection flow rate

Speed data

n_S	Screw speed

Temperatures

T_{1-n}	Barrel temperatures
$T_{DÜ}$	Nozzle temperature
T_F	Flange temperature
T_M	Melt temperature
T_W	Mould wall temperature

Forces

$F_{DÜ}$	Nozzle contact force
F_S	Clamping force

Pressures

p_A	Ejector pressure
p_{EB}	Injection pressure limitation
p_{ES}	Specific injection pressure
p_F	Mould safety pressure
p_{NDS}	Specific holding pressure
p_{STS}	Specific back pressure

Other parameters

m	Mass of the moulded part
n_A	Number of ejector strokes
ρ	Density of the plastic material

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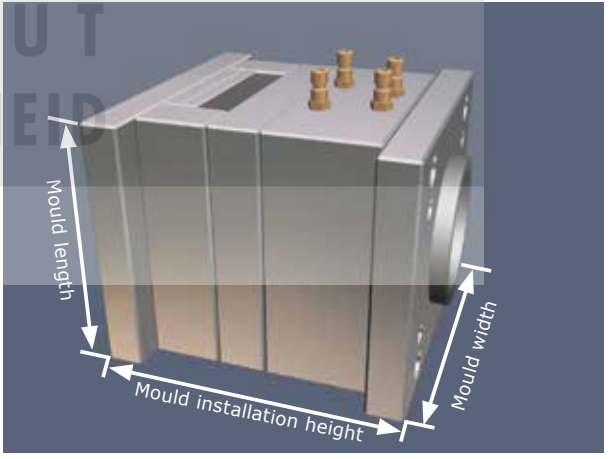
KAPITEL 4

Mould installation
and inspection

- Check the mould installation height, length and width against the corresponding dimensions of the machine (see Fig. 4.1.1).
- Check the necessary mould opening stroke against the opening stroke of the machine (see Fig. 4.1.2).
- Check the ejector stroke necessary for demoulding against the maximum ejector stroke of the machine.
- Check the number of necessary hydraulic or pneumatic valves (core pullers, needle valves, air valves, etc.) against the number of valves installed in the machine.
- Check the number of necessary control points for a hot-runner system against the number of control points of the machine.
- Check the necessary clamping force against the maximum clamping force of the machine.
- Check the necessary shot volume (part volume + sprue volume) against the maximum metering volume of the plasticising unit.
- Check the machine-adapted central alignment, sprue bush (see chapter 8) and ejector adaptation.



4.1.1
Names of the mould dimensions

Note:

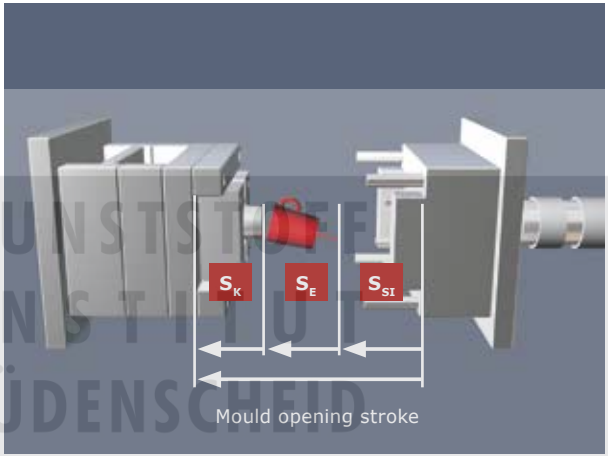
W_O = mould opening stroke

s_K = core height

s_E = demoulding stroke
(height of the moulded part + sprue)

s_{SI} = safety
Set the following as an initial value for the mould opening stroke:

$W_O = s_{SI} + (2 * s_E) + s_K$



4.1.2
Mould opening stroke

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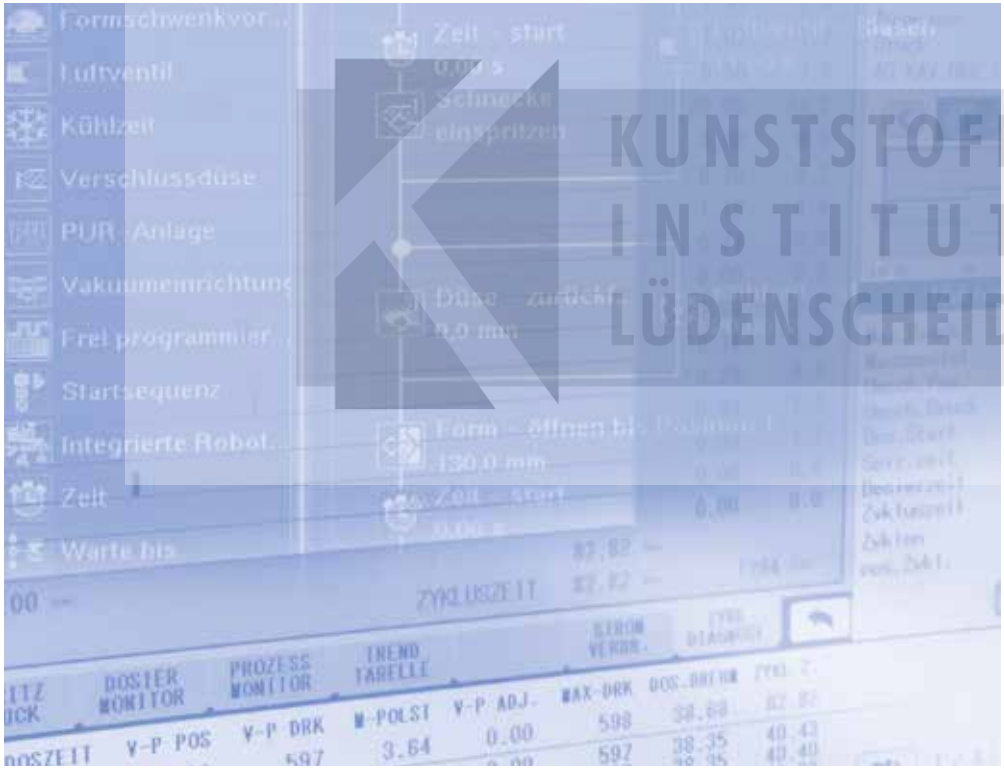


CHAPTER 9

Basic settings of the plasticising unit up to the first shot

9.1 Peripheral screw speed

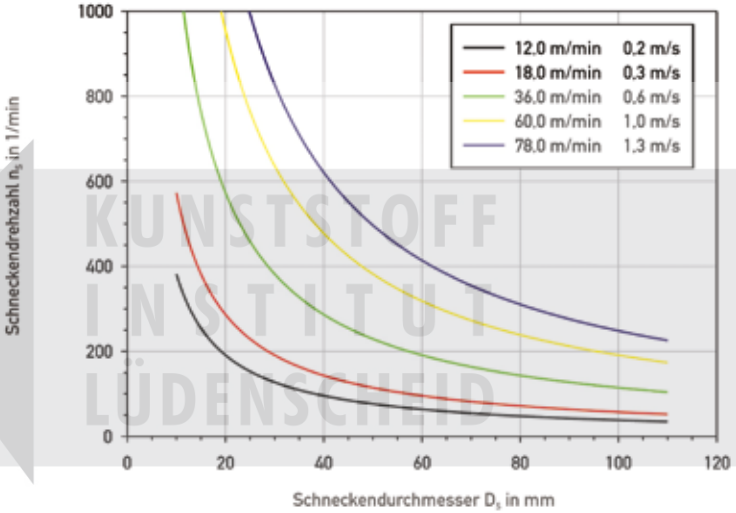
First, adjust the maximum possible peripheral screw speed in line with the material being used so that proper metering can be ensured during the residual cooling time.

Note:

- Contrary to this method, a lower peripheral screw speed must be adjusted if shear-sensitive plastic materials are used. Shear-sensitive materials are, for example, ABS, PC, PMMA, PBT, PET and PVC-U as well as all long-fibre-reinforced materials. Follow the instructions provided by the raw material suppliers.
- The peripheral screw speed has a strong influence on the melt homogeneity.

The information provided hereinbelow can be used for general guidance in terms of the maximum peripheral speed.

Screw speed diagram



9.1.1
Screw speed [ns] as a function of the peripheral speed [vu] and screw diameter [D]

Max. peripheral speed (m/s)	
PS	1
ABS	0,3
PMMA	0,3
PC	0,3
PA	0,6
PE-LD	1
PE-HD	1
PP	1
POM	0,6
SB	0,6
SAN	0,3
PETP	0,2
PBTP	0,2

Measure: increasing the peripheral screw speed

Einfluss auf den Prozess	
Melt homogeneity *1	▼
Melt temperature *2	▲
Flowability *3	▲
Thermal material stress *4	▲
Glass fibre length *7	▼
Uneven mould filling *5	▼
Metering time *1	▼

Einfluss auf das Formteil	
Coloured streaks *6	▲
Stability *7	▼

*1 Higher peripheral screw speeds reduce the metering time. Very short metering times lead to thermal and mechanical inhomogeneities of the melt.

*2 See the chapter „Melt temperature".

*3 Higher screw speeds lead to a high level of friction (frictional heat) in the melt. The frictional heat reduces the viscosity of the melt and improves its flowability.

*4 High melt temperatures - caused by frictional heat - can lead to thermal material damage.

*5 Short metering times in combination with high metering volumes lead to high axial temperature differences in the space in front of the screw.

*6 If dyeing is performed by way of a master batch, high screw speeds can lead to an uneven mixture of the melt and dye.

*7 Mechanical melt inhomogeneities, e.g. agglomeration, can reduce the mechanical strength of a part. In the case of long-fibre-reinforced plastic materials, an excessive screw speed leads to strong damage to the glass fibres and, thereby, to a reduction of the mechanical characteristics of the part.

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