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BAGIM1ENNB

Design and manufacturing of plastic injection mould

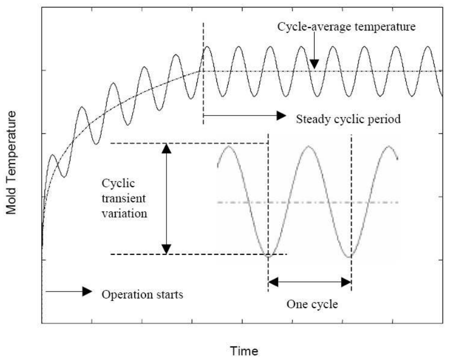
10 – Cooling system

Cooling

- Ensure the appropriate temperature of the mould
- Why?
  - Right filling up
  - Short cycling time
  - Shrinkage
  - Minimal warpage

2

Change of temperature



3

Calculation

1. Az óránként szükséges temperáló közeg meghatározása:

$$\dot{M} = \frac{m \cdot q \cdot n}{\Delta T \cdot c_{temp} \cdot 3600}$$ [kg/h]

ahol:
m - az egy ciklusban fröccsöntött anyagmennyiség, [kg]
q - az 1 kg anyagmennyiség dermedésekor és kívánt hőmérsékletre hűtésekor felszabaduló hőmennyiség, [J/kg]
n - az óránkénti fröccsöntések száma, [1/h]
c_{temp} = a temperáló közeg fajhője, [J/(kg · K)]
ΔT - a temperáló közeg megengedett felmelegedése,
$\Delta T = T_{ki} - T_{be}$ [K]

4

Temperálás számítása

2. Felszabaduló hő:

$$q = c_m \cdot \Delta T_m$$ [J/kg]

ahol:
q - az 1 kg anyagmennyiség dermedésekor és kívánt hőmérsékletre hűtésekor felszabaduló hőmennyiség, [J/kg]
ΔT_m - a műanyag fröccsöntési és szilárdulási hőmérséklete közti különbség,
c_m – a műanyag fajhője (J/kg K)

PE –	2.3 – 3.3 MJ/kg K
PS –	1.34 – 2.34 MJ/kg K
ABS –	1.25 – 1.67 MJ/kg K
PA 66 –	1.67 MJ/kg K
PC –	1.25 MJ/kg K

5

Temperálás számítása

3. A temperáló rendszerben lévő hűtőközeg tömeg árama:

$$\dot{M} = \frac{d^2 \cdot \Pi}{4} \cdot v \cdot \rho_{víz}$$ [kg / s] ⇨ d

4. A temperáló rendszer furatátmérője:

$$d = \sqrt{\frac{4 \cdot \dot{M}}{\Pi \cdot v \cdot \rho_{víz}}}$$

ahol:
v – a temperáló közeg sebessége (1-5 m/s)
ρ – a temperáló közeg sűrűsége [kg / m³]

6

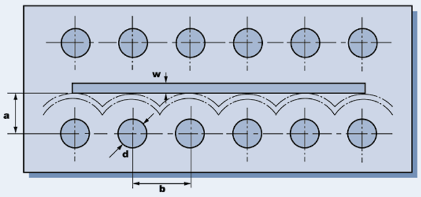
Temperálás számítása

5. A temperáló rendszer teljes hossza:

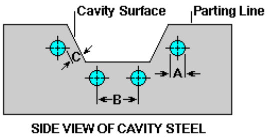
$$L = \frac{310 \cdot d \cdot \Delta T}{\left[T_{sz} - \left(T_{be} + \frac{\Delta T}{2}\right)\right] \cdot \left[1 + 0{,}014 \cdot \left(T_{be} + \frac{\Delta T}{2}\right)\right]}$$

Size and location of the cooling channel

"w"	"d"	"a"	"b"
wall thickness of the product mm (in)	diameter of the cooling channels mm (in)	center distance with respect to mold cavity	center distances between cooling channels
2 (0.08)	8-10 (0.31-0.40)		
2-4 (0.08-0.16)	10-12 (0.40-0.47)	1.5-2d	2-3d
4-6 (0.16-0.24)	12-14 (0.47-0.55)		



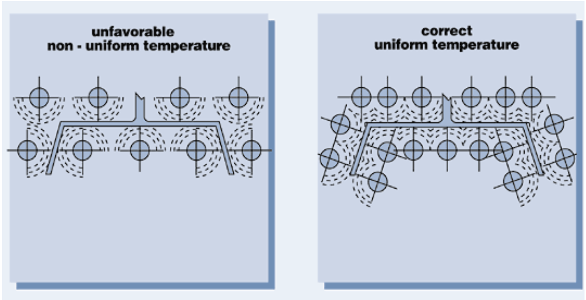
Location of the cooling channels



- Close to the surface
- Uniformly (same distance between holes
- Proportionally with the mass of the plastic

B = 2,5 – 5 A
C = 1 – 2 A (min. 10 mm)

Location of the cooling channels



Heat distribution in the insert

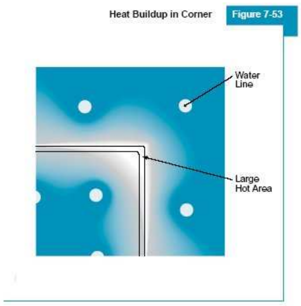


Illustration of heat distribution through the cross section of a corner showing heat buildup in the corner of the core.

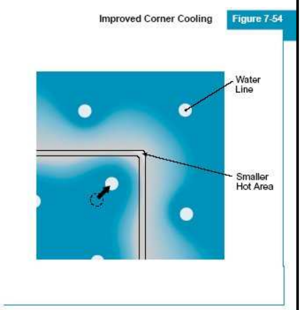
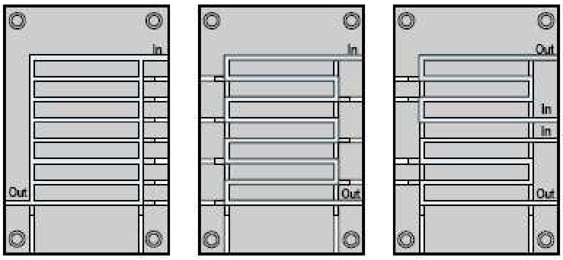


Illustration of heat distribution through a corner cross section showing improved cooling with cooling line moved closer to the inside corner.

Cooling material

- To 80℃ water
- To 120℃ water + ethylene-glycol
- From 120 ℃ silicon oil

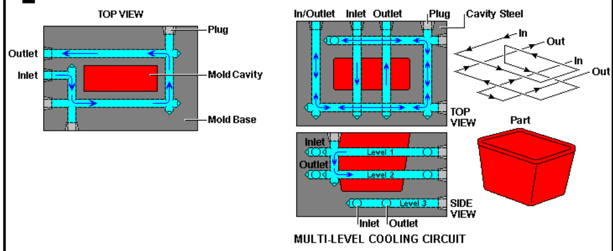
Cooling channel layout



Parallel | Serial | Multiple

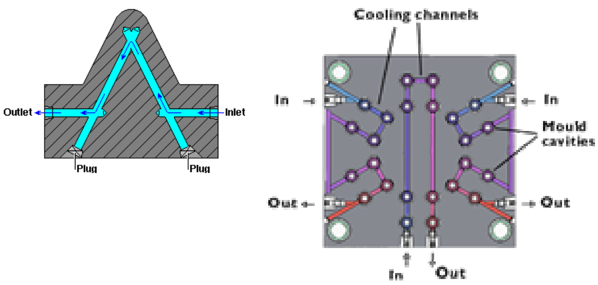
13

2D and 3D cooling web



14

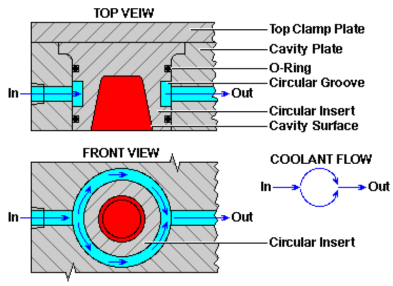
Angular cooling channel



15

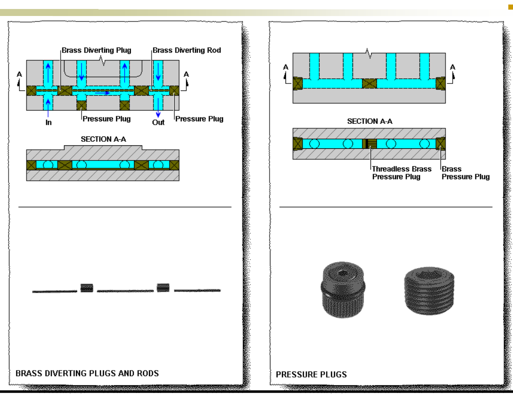
Round / circular cooling

- Easy-to-use
- Assembling means problems



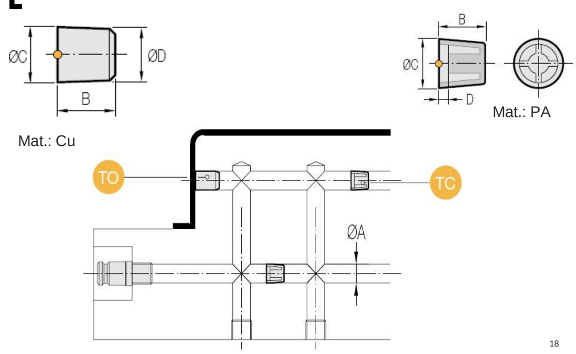
16

Drive of the water



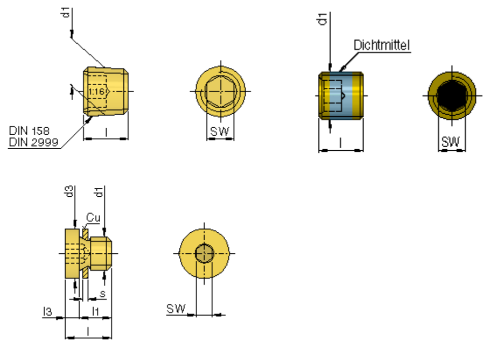
17

Sealing plugs

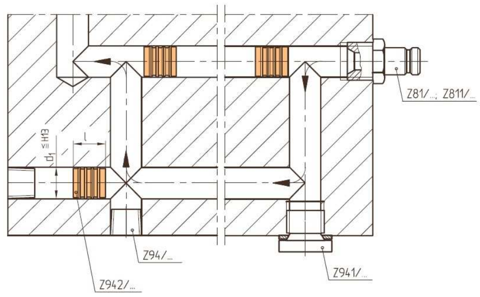


18

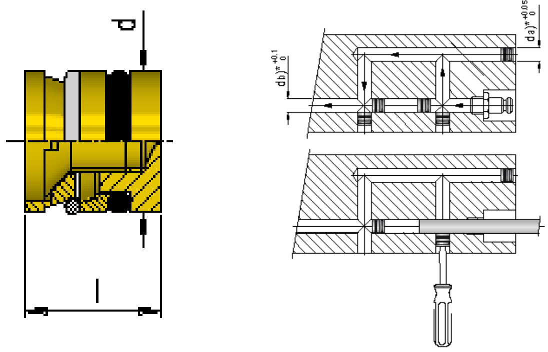
Shut-off and sealing plugs



Application of sealing plugs

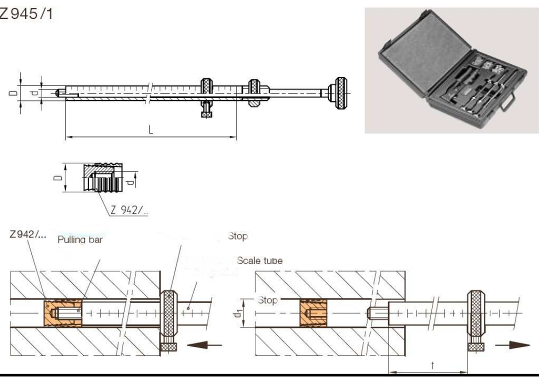


Shut-off and sealing plug

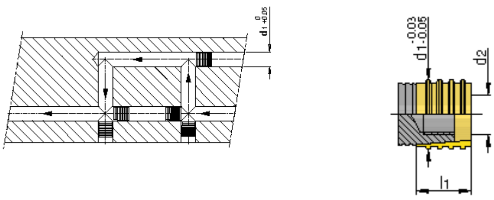


Sealing plug

Z945/1



Sealing plug



Zangenset E 2077 / pliers set E 2077
ensemble pince E 2077 / set tenaglia E 2077

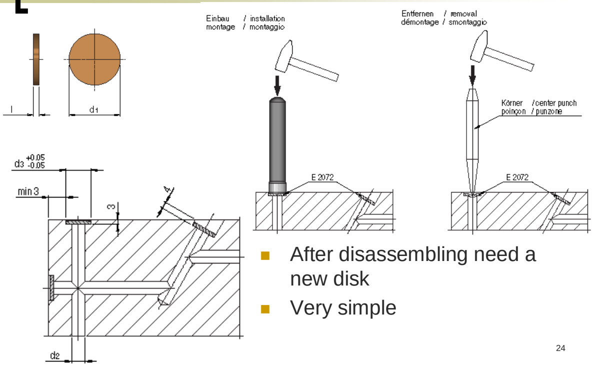
- für Verschlussstopfen E 2078
- Preis auf Anfrage

- for sealing plug E 2078
- price on request

- pour bouchon E 2078
- prix sur demande

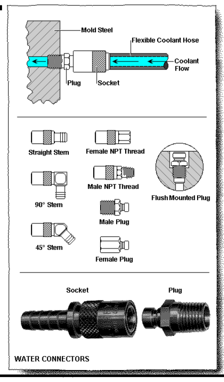
- per tappo di chiusura E 2078
- prezzo su richiesta

Cupper blank



- After disassembling need a new disk
- Very simple

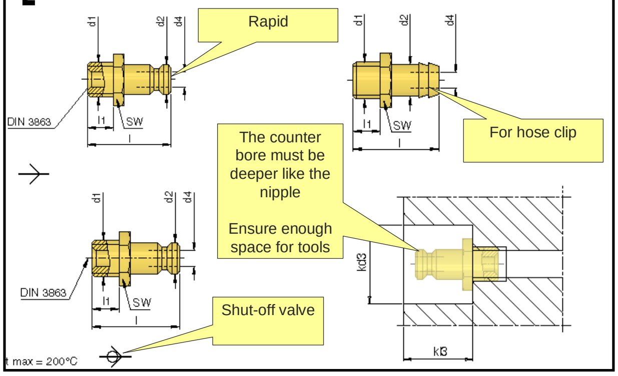
Hose nipples



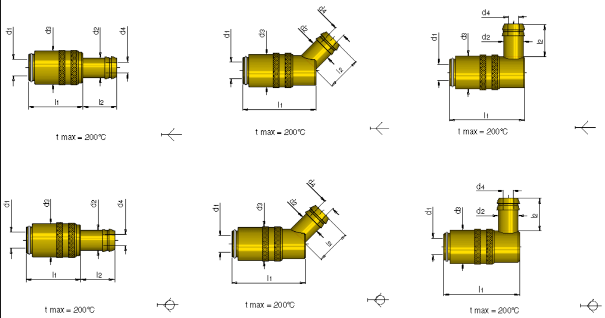
- Fast coupling:
  - rapid
  - *Not standard !!!*
  - Can be shut-off version
  - Expensive (6 – 10 €)
- Hose clip:
  - Need mode time
  - Universal
  - Cheap

25

Hose nipples

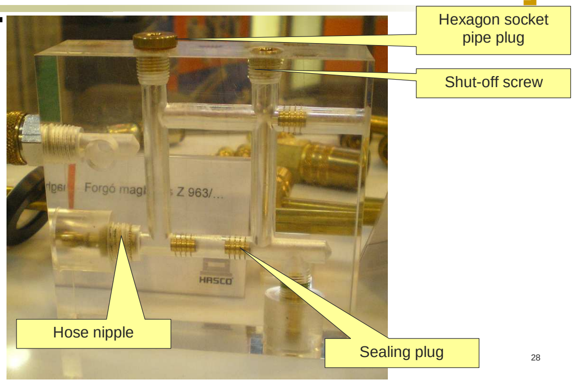


Rapid couplings



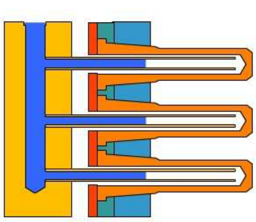
Shut-off couplings

27

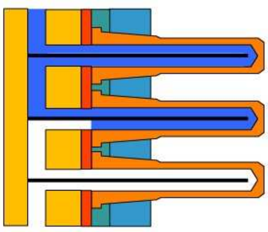


28

Core cooling / fountains



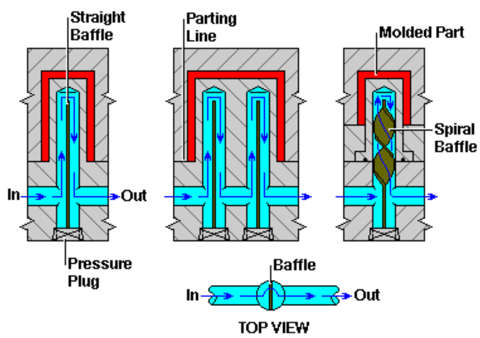
Concentric



With baffle

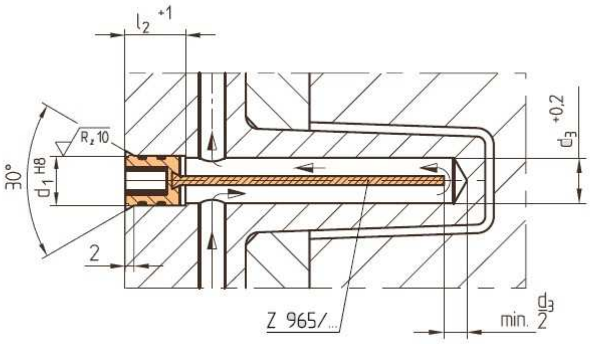
29

Use of flat baffle cooling

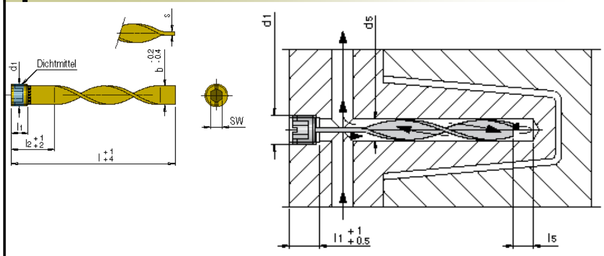


30

Flat baffle

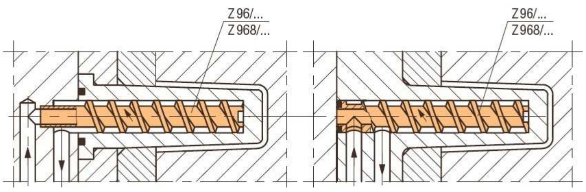


Spiral baffle



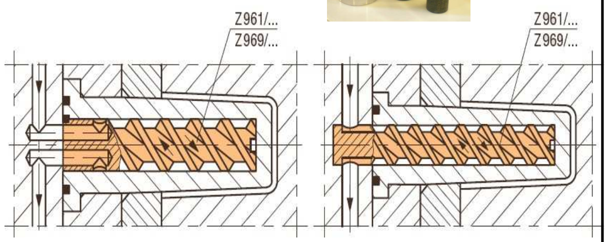
32

Spiral core



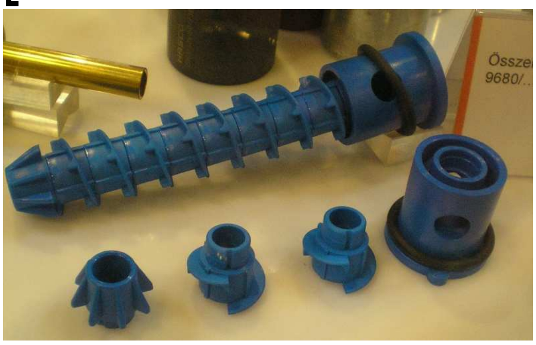
33

2 way spiral core



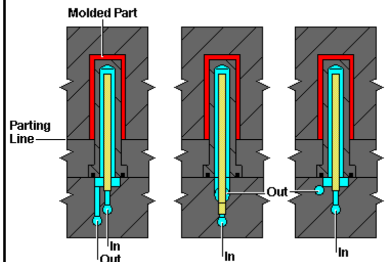
34

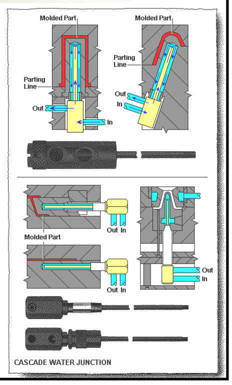
Modular spiral core



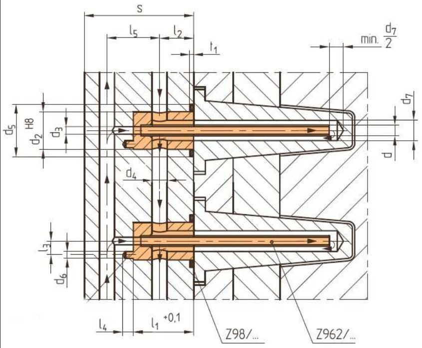
35

Parallel-flow fountain

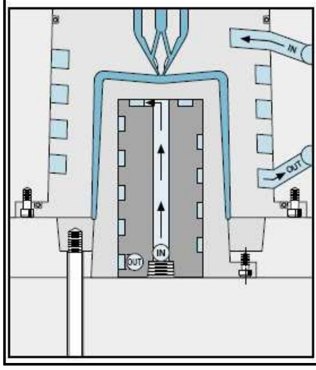




Parallel-flow fountain

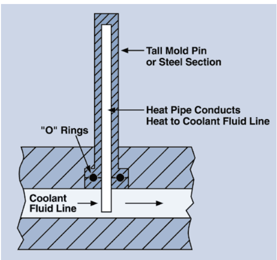


Spiral cooling



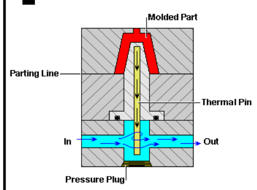
- Intensive cooling
- In case of large core and cavity
- Need a large size
- Sealing

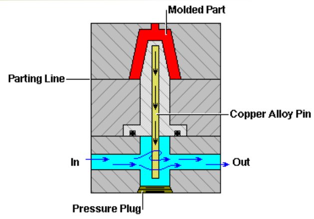
Heat pipe

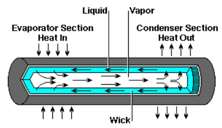


- Core with good thermal conductivity
- Core is cooled
- In case of small inserts
- Fitting and assembling can be problematic

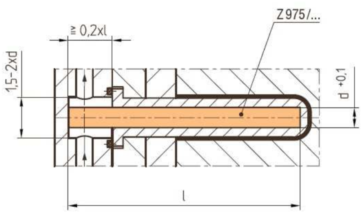
Thermal pin / Copper pin

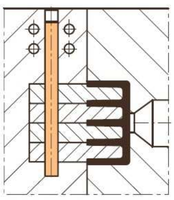




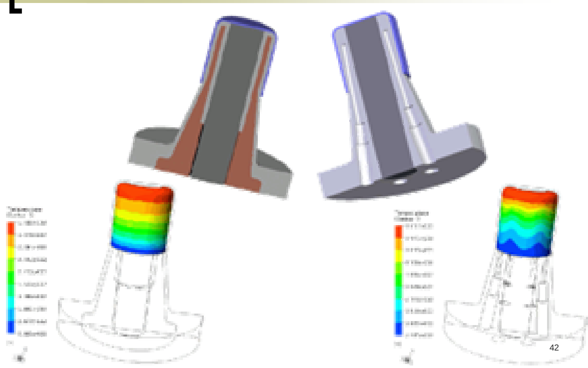


Application of the copper pin

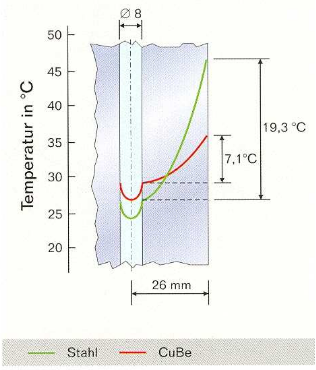




Cupper insert vs. Cooling channel



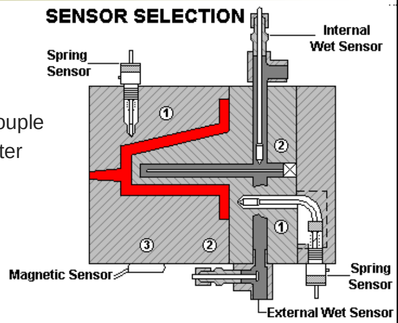
Temperature in the mould



43

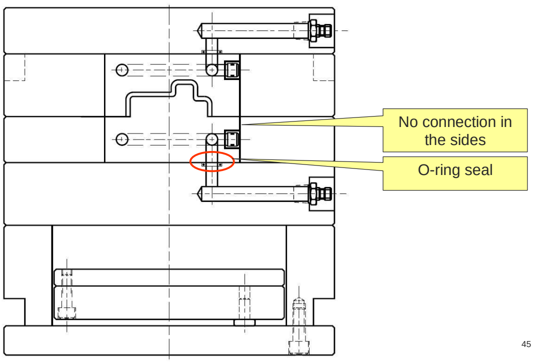
Temperature sensors

1. Bimetal thermocouple
2. Water thermometer
3. Magnetic sensor



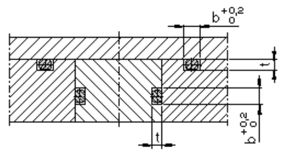
44

Cooling of the inserts

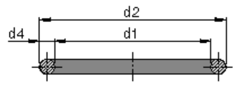


45

O-ring seal

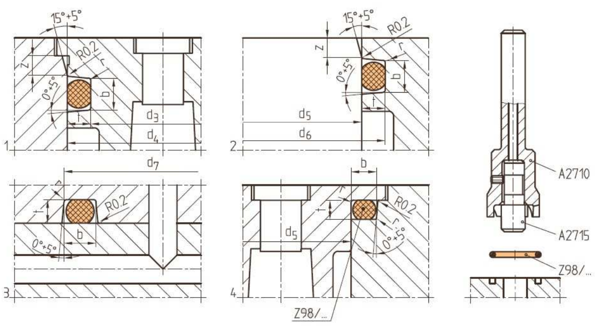


d4	b	t
1.5	1.9	1.1
2.0	2.6	1.5
2.4	3.1	1.8
2.5	3.2	1.9
3.0	3.9	2.3
4.0	5.2	3.2

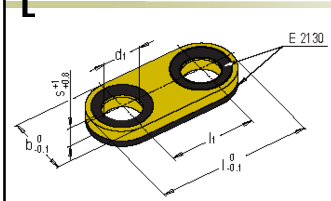


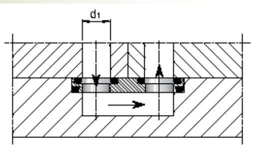
Mat.: Viton t max = 200°C

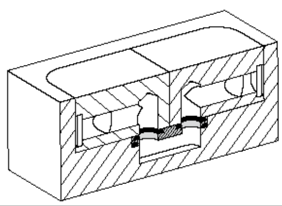
O-ring seal



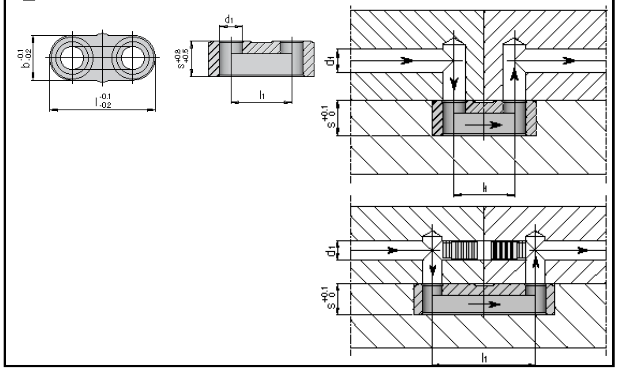
Cooling of an insert - deflection



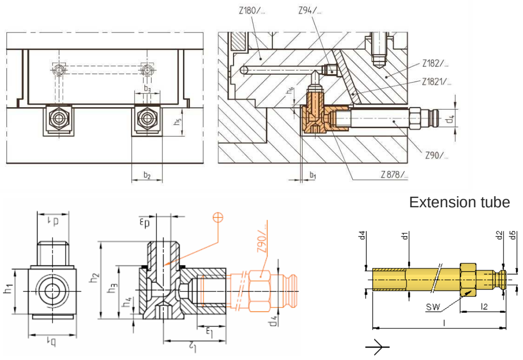




Cooling of an insert - deflection



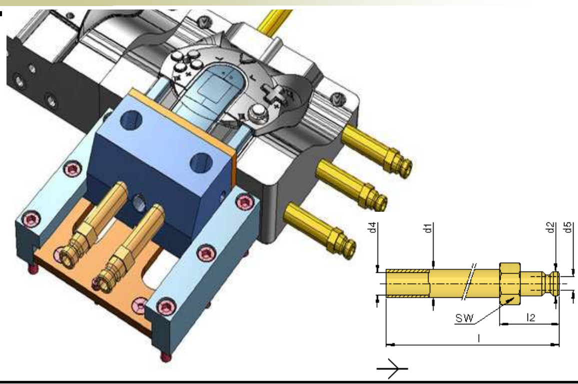
Cooling of a slider



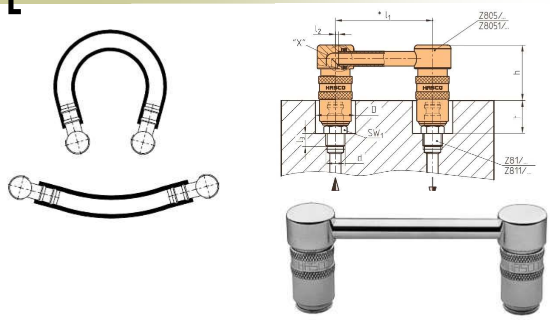
Extension tube

50

Cooling of a slider



Deflection



Aim: 1. Connect cooling channels
2. Eliminate cross holes

Diverting coupling unit

52