Polymer processing and rheology

Injection Moulding
Extruders
Mixers and compounders
Thermoforming
MKH hydraulic press
SOMOS Dry Air Dryer
Rheology
3-component injection moulding
Krauss-Maffei 80-220/60/90 CZL

Technical details:
- Unit A (the main unit) for thermoplastics
- Vertical B unit for thermosets or thermoplastics
- C unit L-unit for rubbers or liquid silicone rubbers
- 180° rotating table
- The maximum temperature for tempering: 150°C

<table>
<thead>
<tr>
<th>Unit</th>
<th>Screw diameter</th>
<th>Vmax</th>
<th>pmax</th>
<th>vmax</th>
<th>tmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>30 mm</td>
<td>85 cm</td>
<td>2500 bar</td>
<td>212 cm³</td>
<td>375 °C</td>
</tr>
<tr>
<td>B</td>
<td>18 mm</td>
<td>23 cm</td>
<td>2400 bar</td>
<td>76 cm³</td>
<td>375 °C</td>
</tr>
<tr>
<td>C</td>
<td>25 mm</td>
<td>52 cm</td>
<td>1750 bar</td>
<td>147 cm³</td>
<td>95 °C</td>
</tr>
</tbody>
</table>
Fanuc Injection Moulding Machine Roboshot α-C30

Fanuc Injection Moulding Machine Roboshot αC30 is precise and fast all-electric injection molding machine. It is suitable for small and thin-walled samples.

Technical details:

- Mould height 150-300 mm
- Maximum stroke 530 mm
- Locating ring diameter 100 mm
- Tie bar spacing 280x280 mm
- Screw diameter 20 mm
- Maximum injection volume 19 cm³
- Maximum injection pressure 2000 bar
- Clamping force 300 kN
- Maximum injection speed 300 mm/s
- Nozzle radius 10 mm
- Standard or Barrier screw
- Possibility to collect mould pressure and temperature data
DSM Xplore TM twin screw micro-compounder and micro injection moulder

DSM Xplore TM 5 cm³ twin screw micro-compounder is suitable to compound and extrude small patches.

**Technical details:**
- Capacity 5 cm³
- Two co-rotating screws
- The length of the conical screw 90 mm
- Rotation speed 5-400 rpm
- N₂ feed
- Maximum process temperature 400°C
- Water and air cooling

DSM Xplore TM 4 cm³ micro injection moulder is fast and suitable for small sample volumes.

**Technical details:**
- Maximum injection volume 5 cm³
- Injection pressure 400 - 1300 bar
- Maximum temperature of the cylinder 400°C
- Maximum temperature of the mould 200°C

The following moulds are available:
- Impact test specimen (Charpy / IZOD ISO 179 / 180)
- Tensile test specimen (ISO 527-2-1BA)
- Coin (diameter 25 mm, thickness 1.5 mm)
The Brabender Twin Screw Extruder DSE 25 is suitable to process plastics and elastomers. In addition to compounding, the equipment can be used to reactive extrusion and recipe development.

Technical details:
• Gravimetric, volumetric or forced feed
• Screw diameter 25 mm
• Screw length 16 - 44 L : D
• Modular screw
• The screw geometry can be altered
Single screw extruders

**Extrudex ED-N 30**
Extrudex ED-N 30 is a single screw extruder to manufacture different kind of profiles, such as film. It can also be used to compound different additives to plastics.

Technical details:
- Screw diameter 30 mm
- Screw length 20-30 L : D
- Rotation speed 0-150 rpm
- Temperature 0-400 °C (3 cylinders)

**Brabender Plasti-corder**
- Batch or continuous process
- Material compounding or sample manufacturing
- Recommended sample size 100-1000g
Batch mixers

Rubber mixer
Krupp Elastomertechnik GK 1,5 E laboratory mixer

Technical details:
• Capacity: 1.5 l
• Intermeshing rotors
• Rotor speed 10-100 rpm
• Automatic process control and data collection

Batch mixers
Brabender W 50 E
• Capacity 55 cm³
• $T_{\text{max}}$ 500°C

Brabender N 350 E
• Capacity 370 or 440 cm³
• $T_{\text{max}}$ 300°C
Dispermat CA-40 is a high-shear mixer with computer control. Mixing can be done at certain temperature (heating/cooling unit) and in vacuum or atmospheric pressure. Graphic display with indications of speed, torque, power, product temperature, timer, peripheral speed and height of the dispersing tool. The control is able to record the process parameters with graphical indication, switch–off function for temperature, speed, torque and power.

Technical details:
Power: 1.5 kW
Speed: 0 - 20 000 rpm
Torque: 1.5 Nm
Product volume: ~ 20ml – 6l (high volumes only for materials with medium viscosity)
High definition vacuum forming machine
Formech 300x

Thermoforming machine is used to reshape a heated plastic sheet with a mould using pressure and vacuum. Materials suitable for thermoforming are for example PVC, PS, ABS, PMMA, PC, PE-HD and PP.

Technical details:
• Plastic sheet 450 mm x 300 mm
• Minimum thickness 6 mm
MKH hydraulic press MPDE 40

Hydraulic press is used in compression moulding of polymeric materials.

Technical details:
• Temperature: RT- 400°C
• Press: 0-400 kN
• Maximum sample size 350x350 mm
• Water cooling
SOMOS Dry Air Dryer TF 10 HT is designed for drying of hygroscopic plastic pellets or regrinded material. It is equipped with an integrated conveying system for automatic feeding of the processing machine.

Technical details:
• Dry air temperature: +60 - +200°C
• Mass: 140 kg
• Volume: 30 l
• Dry air volume 20 m³/h
Rotational rheometer is a technique for the measurement of material deformations and rheological properties, such as melt viscosity. During the measurement, the sample is subjected to shear deformation by constantly rotating or oscillating measuring system.

Measuring systems:
- Plate/plate and cone/plate geometries for polymer melts
- Concentric cylindrical geometry for liquids, suspensions and solutions
- SER-extensional rheology system for polymer films
- Sample holders for solid polymeric materials
- Magneto-Rheological device for magnetorheological fluids

Technical details:
- Maximum temperature depends on the measuring system
  - Plate/plate, cone/plate, SER and solid samples RT-600°C
  - Concentric cylindrical -20 to +200 °C
- Maximum torsional moment 200 mNm
- Frequency $10^5$-628 Hz
Capillary rheometry can be used to study the rheological properties of molten plastics and elastomers at different temperatures. Rheological properties are needed in mould and tool simulation of injection moulding and extrusion processes. Capillary rheometer is used to measure viscosity and shear stress at high shear rates, which provides valuable information about the material’s behaviour in actual process environments that can be used to solve material based problems in processing.
Melt flow index tester

The melt flow is measured according to the ISO 1133 standard. In this method, the ease of flow of the melt (g/10min) is measured at a certain temperature at a certain loading. The test equipment includes a vertical heated cylinder, in which the sample is placed, a die in the bottom of the cylinder and a piston and weight above the sample. The sample is let to flow through the die with certain diameter and the mass of the flown polymer is measured.
The Advanced Polymer Analyzer (APA2000) is used to study the dynamic mechanical rheological properties of rubbers and other polymers (before, during and after curing or melt solidification). Tests possibilities include cure tests, sweep tests and stress relaxation tests.

Technical details:
- Torque 0-22.6 Nm
- Frequency 0.0015-33.33 Hz
- Strain 0.28-1256%
- Temperature 30-230°C
- Time 0.01-9999.99 min
The MV2000, Mooney Viscometer is used to measure viscosity and scorch of elastomers and mixed rubbers.

Technical details:
- Testing standards: ASTM D1646 and D3346
- Temperature: Ambient to 200°C
- Rotation: 2 rpm standard, 0.1 to 20 rpm optional
Contacts

Dr Minna Poikelispää
minna.poikelispaa@tuni.fi
+358408490121

Assistant Professor Essi Sarlin
essi.sarlin@tuni.fi