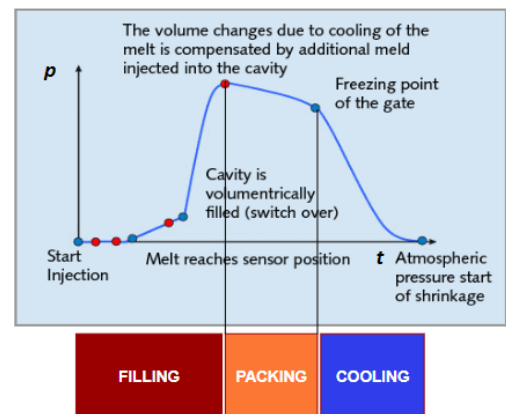


Digital Manufacturing – Industry 4.0

Module 06 – Injection Moulding Simulation & Digital Twin GUTO

- Injection moulding process
 - Step 0 – Injection Starts
 - Mold closes
 - Screw begins moving forward for injection.
 - Step 1 – Filling phase
 - Filling completes.
 - Screw continues moving forward for packing.
 - Step 2 – Packing Phase
 - Screw in full forward position
 - Packing completes when gate freezes off.
 - Step 3 – Cooling phase
 - Cooling continues.
 - Screw back begins to accumulate melt ahead of screw tip for next shot.
 - Step 4 – Ejection & End of cycle
 - Cooling complete
 - Mold opens for ejection.
- Injection moulding cycle
 - Three different cycles
 - Filling
 - Packing
 - Cooling
- Minimum cooling time for an injection moulded plate



$$t_k = \frac{s^2}{\pi^2 * a_{eff}} \ln \left(\frac{8}{\pi^2} * \frac{T_m - T_w}{T_E - T_w} \right)$$

- Where:
 - t_k = cooling time [s] RESPONSE
 - s = plate thickness [mm] FACTOR
 - a_{eff} = effective thermal diffusivity [m^2/s] CONSTANT – MATERIAL
 - T_m = melt temperature [$^{\circ}C$] FACTOR
 - T_w = mean cavity wall temperature [$^{\circ}C$] FACTOR
 - T_E = ejection/demoulding temperature [$^{\circ}C$] CONSTANT – MATERIAL

- Simulation in Injection Moulding – Why?
 - Assist and optimize design.
 - PART DESIGN

- TOOL DESIGN
 - PROCESS DESIGN
 - Avoid costly design errors and re-engineering.
 - Reduce time-to-market.
 - Reduce prototyping and experiments.
 - Predict process behaviour and settings.
 - Increase knowledge.
- Simulations in injection moulding
 - Part design
 - Analyse the behaviour of the plastic front.
 - Does the part fill homogenously?-> FLOW BALANCE
 - Is premature freezing of the plastic a problem?-> SHORT SHOT DETECTION.
 - Investigate part defects and weld lines.
 - Where do weld lines weaken the part?
 - Where do void or sink marks occur?
 - Mold design
 - Find out the best gate location.
 - Where is homogenous filling achieved?
 - Where does the gate give easiest filling?
 - Investigate gate behaviour.
 - When does the gate freeze and packing stop?
 - How is the shear rate at the gate?
 - Design and optimize cooling structures.
 - How should my cooling structure look like?
 - How does the coolant warm up?
 - Process Design
 - Find the moulding window and parameters.
 - Which temperatures gives complete filling?
 - How fast should the injection be?
 - Look at injection pressure and time.
 - Can the machine provide enough pressure?
 - How long does the injection take?
 - Analyse the temperature inside the material.
 - When does the material freeze?
 - When can the part be ejected?
 - Examine the shrinkage and warpage.
 - How does the final part bend and warp?
 - How much does it shrink in size?
- Procedure
 - Create CAD model of part.
 - Mesh the model.
 - Set analysis type.
 - Assign materials and process settings.

- Run simulation.
- Evaluate the simulation results.