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
    - A diagram of a temperature measurement

      Description automatically generated with medium confidenceScrew 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
  + Where:
    - RESPONSE
    - FACTOR
    - CONSTANT – MATERIAL
    - FACTOR
    - FACTOR
    - 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.