

# Best Wax Injection & Assembly Practice

# Key Points for Wax Injection and Assembly

- Injection Parameters
- Wax melting
- Wax Transportation & Handling
- Control on Injection equipment
  - Temperature/Pressure/Flow Rate/Time
- Die
  - design and preparation
- Common Problems
  - Injection
  - assembly
- Assembly
  - techniques
  - runners, gates and feeders
  - equipment and methods
- Pattern/assembly cleaning

# Wax Pattern Production

- The importance of consistently producing good quality wax patterns cannot be overstated – a bad pattern leads inevitably to a bad casting.
- Failure to exercise good process control will result in a variety of pattern faults
- Wax compounds are complex
  - correct wax choice important
- Process control essential to produce good patterns
- Basically the same for all wax types and product forms
  - filled/straight/emulsified
  - pellets/pastilles, slabs

# Injection Parameters

Essentially 2 controllable parameters :

## 1. Temperature

- Wax slow to react to temperature adjustments
- Temperature should be last variable to adjust
- Use lowest temperature possible

## 2. Pressure/Flow/Time

- Primary adjustment should be to pressure, flow rate and hold time

# Melting Equipment and Techniques

- 2 types :
  - Fixed, wax transported in containers
  - Mobile, delivers wax through heated hose
- Use electric or fluid (oil or water) heating (80/85°C)
- Capacity should easily handle maximum demand
  - Avoids need to overheat wax to speed melting
  - Fast melters preferred, melts wax before entering tank
  - Agitation prevents settling, maintains uniform temperature
- Good temperature control essential
- Good discharge method needed
  - Heated valve into suitable container
  - Heated hose into machine

# Wax Transportation & Handling

- H&S implications, care needed :
  - hot liquid in a container
  - may be necessary to climb steps
- Filling of containers and pouring into injection machine holding tanks can entrap air
  - wax needs to be poured carefully
  - where possible top up/fill tanks at end of day to allow air to dissipate
- Agitation essential
  - uniform temperature distribution
  - prevent filler settlement
  - tank shape/design influential
  - agitator design & speed important to avoid problems
  - agitator speed 10 – 15 rpm maximum
  - wax level should always be above agitator blades

# Temperature Control on Injection Equipment

- Critical point – Never trust gauges
  - Regular checks with digital thermometer
- Hold wax as close to injection temp as possible
- Equipment temperature profile must be balanced
  - Same temp from holding tank to point of injection
  - Typically 57°C paste to 72°C liquid
- Wax a poor heat conductor, takes time for temperature to change
  - if holding tank maintains wax at too high temp, wax will be injected above correct temp
  - Adjust in 1° increments
  - Allow 24 hours to stabilise after temperature changes
- Temperature last resort !
  - Before producing patterns set to lowest temp
  - Adjust flow and pressure to improve quality in first place

# Pressure/Flow Rate/Time

- Injection pressure
  - Maximise pressure, minimise temperature
- Flow rate
  - Too fast will cause turbulence and trap air
  - Especially with tight new tool and/or where venting poor
  - Not all machines allow flow rate adjustment
- Hold time
  - Increasing will maintain mould filling, reduce contraction/cavitation
  - Ingate freezing - once wax sets pressure and time irrelevant
- Excess pressure or flow rate can cause core breakage

# Die Design

- Sprue geometry
  - Maximise diameter, 8mm minimum recommended
  - Minimise sprue length
  - Position carefully to ensure speedy mould filling and best flow pattern
  - Restrictive 'necks' should be avoided
- Gating/running system
  - Design, size and positioning critical
- Venting – needed to let air out
  - Scratch or pin vents
  - Overflows can be used on difficult jobs
  - Can create extra cavity and vent through it
  - NB silicone spray can seal die and prevent breathing
- Important for toolmaker to understand parameters
  - List tooling requirements, nozzle location/size, feeds, vents, sprue

# Preparation of Dies

- Surface must be clean
- Only lubricate if patterns difficult to remove
- Silicone & non-silicone sprays available
  - Silicone increases ash levels
- Basic rule : If you can see the spray on the die application is too heavy
  - Over-application can cause joint/knit lines/orange peel
  - Block die vents

# Common Problems - Flow Lines

- Lines/circles/marks, several possible causes
  - Wax temp too high
    - Lines tend to be glossy
  - Wax temp too low
    - Lines tend to be matt
  - Insufficient flow rate/pressure
    - Sprue/runner size too small
    - Sprue/runner in wrong position
  - Die temperature too cold
  - Poor venting
  - Incorrect wax properties

# Common Problems - Short shot/Misrun/Non-fill

- Failure to fill the pattern cavity
  - Lack of wax feed
    - Wax too cold
    - Injection pressure too low
  - Air entrapment in cavity
  - Cold die
  - Injection runner/sprue size and location

# Common Problems - Sinkage/Cavitation

- Depression on thicker section of pattern caused by excessive contraction
  - Lack of chills
  - Use of unfilled wax
  - Lack of wax feed
    - Low injection pressure/flow rate
    - Hold time too short
    - Sprue/runner size and location
  - Wax temperature too high
  - Die too cold

# Common Problems - Knit Lines

- Often occur at fine edges
  - Wax fails to fuse together
  - Usually temperature related – too low
  - Can be sprue size or location wrong
  - Over lubrication of die

# Common Problems - Orange Peel

- Poor surface finish
  - Excessive die lubrication
    - over application of silicone spray
    - spray nozzle too coarse
  - With soluble cores when die too cold
  - Incorrect particle size of filler in filled wax
  - Die too cold
  - Wax too cold
  - Low injection pressure

# Common Problems - Sticking/Cracking

- Lack of lubrication/dirty die
- Wax temperature too high
- Injection pressure too high
- Excessive hold time
  - wax contracting onto die during hold cycle
- Consider using mechanical, air ejectors
- Die design
  - sharp inside corners

# Common Problems - Flash/Finning

- Fin like projection associated with a die joint line
  - Wax temperature too high
  - Excessive die wear
  - Injection pressure too high
  - Flow rate too high
  - Poor die clamping
  - Damaged die

# Common Problems - Distortion

- Patterns not conforming to the intended shape/geometry
  - Mishandling/excessive force on die removal
  - Incorrect opening of die
  - Lack of lubrication
  - Injection/hold cycle incorrect
  - Wax too hot
  - Inconsistent wax room temperatures

# Common Problems - Air Entrapment

- Surface defects, blistering of the pattern surface, cracking
  - Due to air in wax before injection
    - incorrect pouring/transportation/agitation
  - Poor wax tank top up procedures
  - Due to turbulent filling
    - Wax too hot
    - Too high flow rate
  - Air trapped in die/poor venting
  - Air entrained at injection nozzle

# Wax Assembly Practice and Equipment

# Wax Assemblies

## Definition

- The building of one or more wax patterns, ingates and runner bars into a wax pattern assembly prior to the shell building/block moulding process
- Most important process
- Assembly technique and taking care critical

# Wax Pattern Preparation

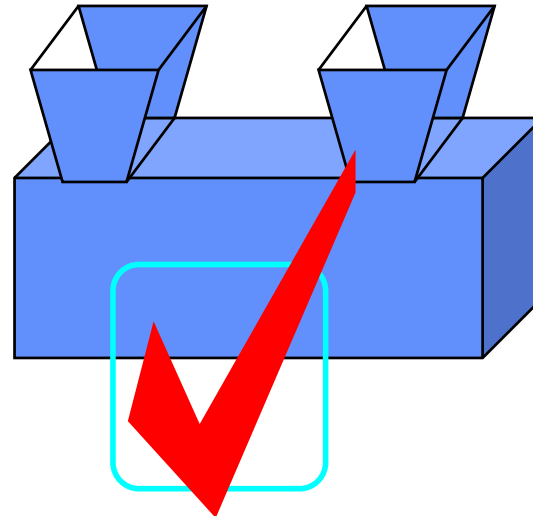
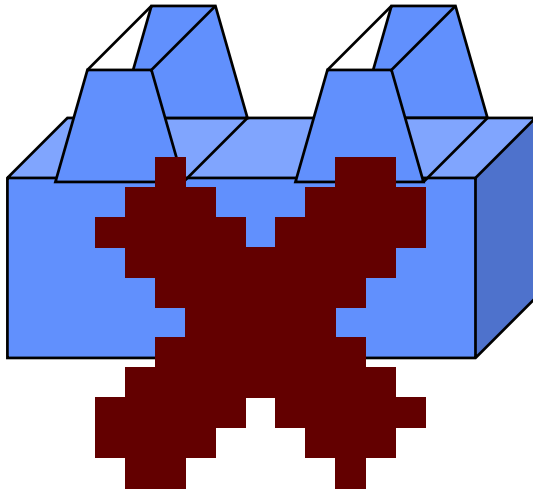
- Inspection - for cracks, distortion, imperfections
  - Visual/fixtures/gauges
  - Patterns require 24 hours to stabilise following injection
- Repair
  - Soft or hard repair wax, pencils (low ash)
- Checking
  - Dimensions/SPC/fixtures/gauges/micrometers/verniers
- Trimming
  - Remove flash, beware over trimming/undercuts

# Runners

- A fabricated or pre-injected wax system of runner bars and pouring bush (wax or ceramic) to support one or more patterns
- Bars/grids may be poured/injected/extruded
- Inserts
  - for robot/hand dipping
  - for strength
  - ‘single pole’ system (metal insert with dip wax coat)
- The runner system forms the metal feed path
- Quality of the runners and joints is critical
  - Surfaces and joints should be smooth to avoid turbulence in poured metal

# Gates and Feeders

- Located between the pattern and runners to feed metal from the runner system into the pattern cavity
  - may be straight sided or tapered pattern
  - should always have a small fillet radius where the feeder joins the pattern
  - should not overhang or have uneven joints



# Assembly Equipment

- Band saw
- Hot blades
  - gas/electric
- Blades/Sidecut pliers
  - to cut sprues from patterns
- Hot knives/Gas torch for assembly
- Hot tables
  - for even assemblies
- H&S recommendations
  - max temperature should not exceed 120 °C
  - good air extraction

# Assembly - Method 1

- Good practice to degrease runner bars before assembly to remove silicone
- A hot knife is used to melt the mating surfaces of the gates, runner and pattern which are then joined together by gentle hand pressure to avoid distortion
- All joints should be smooth and have a small fillet radius without pinholes or undercuts

## Assembly – Method 2

- Patterns are assembled to runner system using a hot wax adhesive
  - normally restricted to small patterns in volume situations
  - wax melted at recommended temperature
  - applied sparingly to mating surfaces
  - parts joined with careful hand pressure to avoid distortion

# Assembly – Method 3

- Auto assembly
  - machine dependent
  - suitable for high volume parts

# Pattern Cleaning

- Required to degrease assembly prior to prime coat dip
- A good pattern cleaner removes silicone
  - gives a 'key' to aid prime coat adhesion
- H&S dictates safe systems
  - water wash systems recommended
  - some pattern cleaners contain flammable constituents and are irritant/skin sensitisers
- Some pattern cleaners can soften wax patterns
- Detergents sometimes used
  - remove dirt, do not remove silicone

# Pattern cleaning

1. Immerse pattern/assembly in Trisol 60 Plus for 3-5 secs.
2. Agitate in first rinse
3. Agitate in second rinse
4. Allow excess water to drain off
5. Proceed to prime coat



# Summary

- Process control is everything
- Operative training essential for optimum results

## Injection

- Minimise temperature, maximise pressure
- Avoid air by careful handling
- When successful injection settings are found record them

## Assembly

- Careful inspection and preparation of components is required
- Correct choice of materials/process/equipment to suit assembly
- Degrease thoroughly prior to shell build