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WAX PATTERN DEFECTS

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Abstract:

It is common knowledge that the investment casting process or "lost wax process" starts with a wax pattern. It is created by injecting wax into a mould cavity, where the pattern is an exact copy of the cast part with strict dimensional tolerances. It also has to allow for shrinkage of the material to be cast. This pattern is then dipped into a silica slurry bath. For a good surface finish, finer slurry and zircon sand is often used. The shell is then heated to dewax the mould, followed by firing and preheating before the molten metal is poured into the dewaxed cavity. A good understanding of the wax injection process is essential for good quality parts to be created.

Keywords : *investment casting, modeling methodology, cost reduction, concurrent engineering.*

1.INTRODUCTION

The investment casting (lost wax) process has start his commercial life during the WW II (November 1943) to consistently manufacture precision engineered components.

Nowadays, investment casters need to stay on the cutting edge of new technologies to remain competitive in the marketplace.

Investment casting wax materials are blend of numerous complex compounds [1]. Each compound has been included to influence the final properties of the wax in some way.

2.TECHNICAL CAUSES OF DEFECTS

Trapped air, shrinkage, weld lines, and flow lies contribute to the majority of investment casting defects and rejections having high cost implications. The placement and design of gates and feeders are a critical step in controlling the last areas to fill and reducing part defects.

To date investment casting technology has been based on hands-on training and experience technical literature is limited to experimental, phenomenological studies aiment at obtaining empirical correlations for quick and easy application in industry.[2] Pattern development is the main bottleneck. The pattern die is often reworked several times to produce casting whose dimensions are whit in acceptable tolerances.

Improvements in industrial dimensional practices are hindered by:

a) The complexity of physical phenomenon that determine casting dimensions.
b) The lack of thermo-physical property data for the wax, shell and alloy.
c) The lack of well-established validated thermo-mechanical models that describe the deformation of the wax shell, and alloy.

2. INJECTION MOULDING DEFECTS

The injection moulding stage of the lost wax investment casting process is a crucial stage in determining the final dimensions of the cast metallic component. At this stage, molten (or semi-solid) wax is injected into a relatively cool die cavity and held under pressure as it solidifies (Fig. 1).

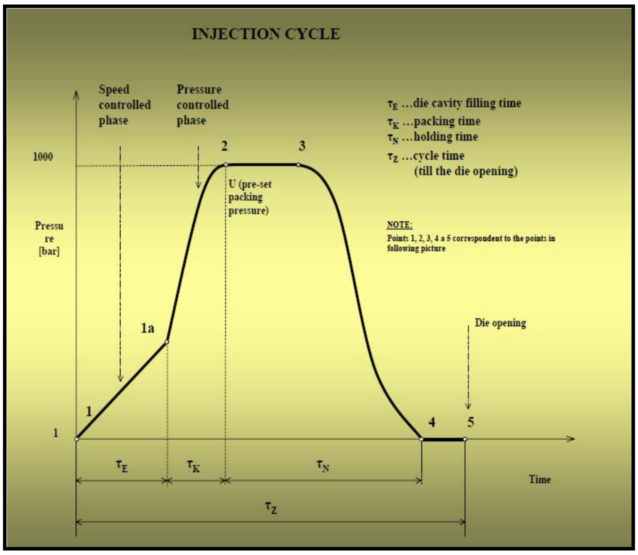

Fig.1 Injection wax cycle[3]

During this stage,[3] the principal factors that contribute to the appearance of defects are:

1. As the wax enters the die, the speed of the flow front relative to the die surface is too fast leading to air bubble entrapment.
2. The speed of the flow front relative to the die is too slow leading to the appearance of flow lines.
3. Two or more cooling fronts meet within the die leading to the appearance of flow or weld lines.
4. The flow front stops and then starts again leads to the appearance of a mis-run.
5. As the wax cools within the die, sink marks may occur at areas of thick cross section,where the wax cooling rate may be slower.
6. As the wax cools, density changes can cause the material to contract causing undesirable variations in the wax pattern dimensions.
7. Unsuitable injection parameters which affect the wax properties e.g. high wax viscosity, and/or wax shrinkage can lead to breakage of the ceramic core held within the die.
8. The wax is held under pressure in the die.

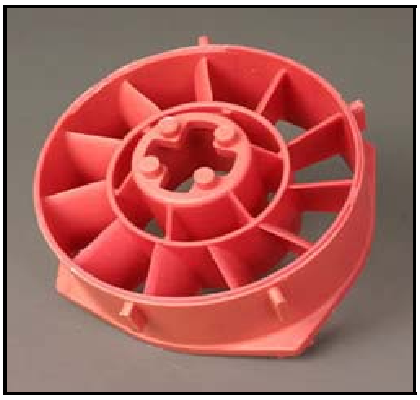
Fig.2 Wax pattern part.

At the wax pattern production stage, (figure 2) a chosen optimum manufacturing procedure might therefore contain inherent limitations. Wax patterns produced might still contain certain defects, whether by deliberate design (i.e. the same known type of defect in the same position), or accidentally (random defects occurring in different positions) All of the surface defects must be addressed and removed prior to casting, as otherwise similar manifestations of the defects may appear on the surface of the cast metallic components. (figure3).

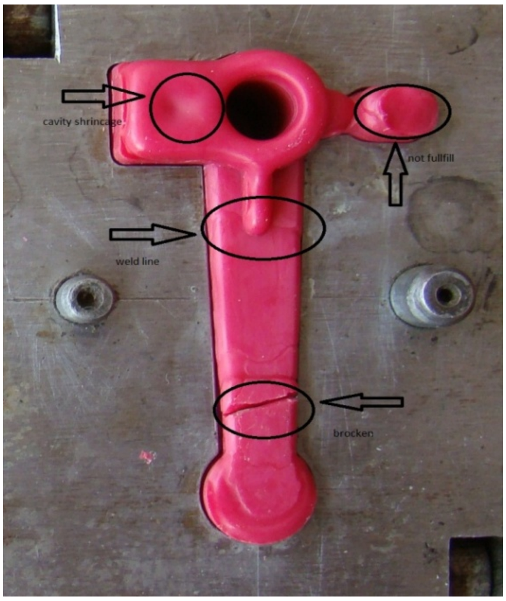

Fig. 3 Scrap wax piece

Injection Wax Trouble Guide [4] *Tab.1*

Problem	Remedies
Wax Pattern Sticky-Pattern Distortion	• Reduce Wax Temperature • Increase Pattern Dwell Time
Pattern Flashing/Fins Mild Overfills	• Reduce Wax Temperature • Clean Mold Vents, Increase Size & Quantity of Vents • Reduce Air Pressure • Hold Mold Firmly/Keep Locks Aligned • Allow Mold to Cool
Excessive Pattern Shrinkage	• Reduce Wax Temperature • Use a Low Shrink/Low Sink Wax • Use Warmer Mold • Increase Pattern Dwell Time • Increase Air Pressure • Increase Sprue Size
Sink Area on Large or Heavy Patterns	• Reduce Wax Temperature • Use a Low Shrink/Low Sink Wax • Increase Pattern Dwell Time • Increase Air Pressure • Increase Sprue Size
Air Bubbles in Pattern	• Reduce Wax Temperature • Increase Wax Temperature • Reduce Air Pressure • Make Sure Wax Pot is Full • Minimize Trapped Air in Wax • Fit Mold Properly & Securely Onto Injection Nozzle
No Mold Fill or Partial Mold Fill	• Increase Wax Temperature • Use Warmer Mold • Clean Mold Vents, Increase Size & Quantity of Vents • Increase Air Pressure • Increase Sprue Size • Reduce Mold Release Spray/Do Not Use Talc • Use More Fluid Wax to Fill Thin Sections • Make Sure Injection Nozzle is Not Clogged • Do Not Hold Mold too Tightly

3.CONCLUSIONS

In the future the industry is likely to become more sophisticated and therefore “lost wax” and its quality control will increase in sophistication also.

The wax of the future should be a low price, high quality material that can be reclaimed. Computer simulation [2] of the wax injection Process, using MoldFlow software, gives us a good insight to design changes that may be required to achieve a good part. The operator can make quick gating design modifications that can lead to elimination of defects in production.(Fig. 4)

Leads to substantial time and cost savings, computer analysis provides the means for verifying design ideas and viewing the effects of “what if's” at minimal costs by avoiding time-consuming and expensive rework and retooling. (Fig. 5). In the meantime investment casting industry will continue to grow and remain one of the essential strategic industries of the world. IGT (Industrial Gas Turbines), aircraft army, medical implants, automotive, commercial market .

The application of RP&RT techniques to produce sacrificial patterns as substitutes for the traditional wax pattern employed in "lost wax" process are, and will be, the solution that allows this process optimization.

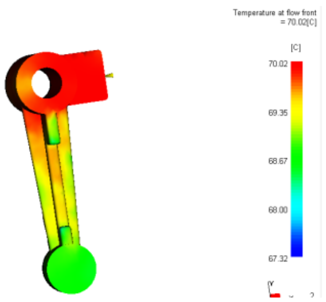

Fig.4 Simulation, Temperature at flow front

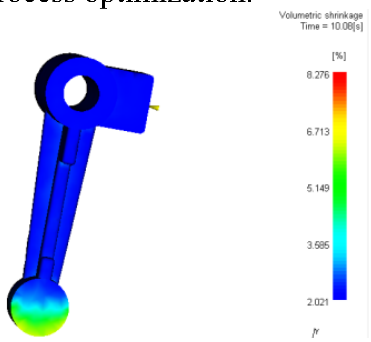

Fig.5 Simulation, Volumetric shrinkage

4. REFERENCES

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[2]Adrian S. Sabau *Oak Ridge National Laboratory Predicting Pattern Tooling and Casting Dimensions for Investment Casting Phase II*. 2006

[3]Horacek Milan. Bruno University of technology. *Latest Trends in Investment Casting Technology.*

[4]http://www.kindt-collins.com/waxes/ferris/i*njectionwax-troublesh*.html

DEFECTELE MODELELOR USOR FUZIBILE DIN CEARA

Rezumat: Este cunoscut faptul că turnarea cu modele uşor fuzibile debutează cu executarea unui model de ceară. Acesta se realizează prin injectarea cerii în cavitatea unei matriţe, ceara copiaza fidel şi cu acurateţe forma respectivei cavităţi. Se are în vedere şi contracţia materialului ce urmeaza a fi turnat în cochilie. Această piesă de ceară, model, este apoi cufundat într-o baie de vopsea refractară şi nisip de zirconiu. Pentru a obţine o suprafaţă de calitate ridicată se utilizează nisip de zirconiu şi vopsea refractară cu o granulaţie foarte fină. Cochilia se incalzeşte pentru a se topii şi evacua ceara din cavitate, apoi se calcinează la temperatură ridicată. Inainte de turnarea metalului topit , cochilia se preâncălzeşte iar metalul se toarna în cavitatea astfel obţinută.
Pentru a obţine piese de înaltă precizie şi calitate este esenţială înţelegerea procesului de injectarea cerii în matriţe.

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