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Analysis the Properties of Lost Wax Process and Its Use ability Exploring Possibilities

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ABSTRACT: *This paper briefly presents how investment casting wax was developed, with a summary of structure, categories of investment casting wax available, properties and wax pattern production. Possibilities of improving the recyclability of the wax are briefly discussed.*

Keywords: *Investment Casting Wax, Pattern Wax, composition and classification of wax, Quality and control.*

I. INTRODUCTION

The origins of precision investment casting or 'the lost wax process' as it is usually often known can be traced back to approximately 4000 B.C. in the ancient civilisations of South East Asia.
Traditionally used for the creation of jewellery and art objects, the need for mass production of near net shape components during the 20th century led to the industrial development of the precision investment casting process. Today this ancient process is more relevant than ever, influencing and enhancing our daily lives, through leisure pursuits, air travel, medical implants, power generation, and a multitude of other diverse applications.
Success in producing high quality castings in the metal of choice depends on the production of high quality patterns and runner assemblies. As the most widely used pattern material, due to it's ability to be shaped in either liquid, semi-plastic, or plastic states, wax is the key component. If the wax pattern is wrong, the casting will be wrong - it follows that the correct choice of wax type and product is critical.

II. COMPOSITION OF INVESTMENT CASTING WAX

Wax is the oldest thermoplastic material known to man and originally beeswax was used, but today the name 'wax' applies to any substance having wax-like properties.
Modern blends of investment casting wax are complex compounds containing numerous components:

- hydrocarbon wax
- natural ester wax
- synthetic wax
- natural resins
- synthetic resins
- organic filler materials
- water

Hydrocarbon wax, natural ester wax, many types of synthetic wax, and some of the resins used are compounds of straight chained carbon atoms (aliphatic compounds).

Additionally some of the other resins and filler materials used are compounds of ring structured carbon atoms (aromatic compounds).

Fundamentally the length and the complexity of the carbon chains of the various components influence the properties of the final wax. Accordingly many variations are formulated to suit differing foundry requirements and key properties such as melting point, hardness, viscosity, expansion and contraction, setting rate, etc are all influenced by the structure and composition of the wax compound.

The complex composition of modern wax products manifests itself in a physical behaviour different to that of other substances. Unlike other homogeneous chemical compounds, wax does not melt immediately on heating but passes through several intermediate states:
Similarly the structure and components used in an investment casting wax will influence the expansion and contraction characteristics:

- Like other materials wax expands on heating and contracts on cooling
- In comparison with a metal the expansion is relatively high
- Wax expansion and contraction rates are not uniform but vary with phase and structure changes during heating/cooling

III. CATEGORIES OF INVESTMENT CASTING WAX

Filled Pattern Wax

Filled pattern wax has the largest use of wax compounds currently produced. The addition of specialist filler materials gives excellent injection characteristics to the wax. The contraction range for filled pattern wax sets the standard for the investment casting industry with a wide variety of applications including the following:-

- Low to high viscosity wax
- Liquid Injection wax
- Paste Injection wax
- Screw Injection Technology wax
- Low expansion wax
- Automatic Injection machine wax

Emulsified Pattern Wax

These waxes have a low to medium range of viscosity, with excellent surface finish properties. Emulsified wax has a low adhesive factor and therefore they can easily be removed from a die cavity. These compounds are environmentally friendly due to the recycling process they offer. There are a variety of contraction rates to suit all types of investment casting applications. The properties of emulsified pattern wax can be summarised as follows.

- Low to medium viscosity
- Good surface finish
- Liquid and paste injection
- Low die adhesion properties

Straight Pattern Wax

This wax is used where specific specialist requirements exist. The wax range has a full spectrum of available compounds, from low viscosity to high and fast setting production materials. The main properties of straight pattern wax can be summarised as follows:-

- Good surface finish
- Can be designed for specialist requirements
- Flexible and tough compounds available
- High strength wax can be designed

Specialist Wax

These compounds are used to help in the production of finished wax patterns ready for assembly. As shown below they include wax for repairing, adhesive wax, wax for forming shapes and a range of water soluble wax.

- Soft Repair Wax
- Hard Repair Wax
- Adhesive Wax
- Dip Seal Wax
- Rod Wax
- Spiral Forming Wax
- Water Soluble Wax
- Very Strong and Tough Water Soluble Wax
- Fast and Total Dissolving Water Soluble Wax

Runner Wax

- Usually formulated with a slightly lower melting point than the pattern was in use, and with a low viscosity for easy dewax
- Virgin products are available, more usually reclaimed runner wax is used, produced from used wax from the autoclave
- May be straight (unfilled) or with a percentage of filler retained for improved injection, higher strength, faster setting with additives to adjust toughness, flexibility, melting point, rheology

Properties can be adjusted to suit individual foundry requirements

IV. RECYCLING

Investment casting wax can usually be recycled with significant environmental and economic benefits. The process involves returning autoclave wax from the foundry to the wax manufacturer for processing:

- cleaning & filtering
- using additives to adjust the properties to specification
  The resulting products are categorized as:
- Reclaim wax for runner systems
- Reconstituted wax for pattern production Reconstituted Filled Wax Reconstituted Emulsified Wax Reconstituted Straight (Unfilled) Wax

QUALITY

Wax properties are of critical importance to foundries for the production of good castings. Once a specification has been agreed it is essential that compliance with the limits is maintained and supported by process and quality control.

Key properties are:

- Contraction and Cavitation
- Congealing Point or Melting Point
- Ash Content
- Hardness and Elasticity
- Viscosity
- Surface Finish
- Setting Rate
- Oxidation Stability
- Reclaimability

Recommended *physical* tests for the control of investment casting wax are:

- Melting (drop) Point
- Congealing Point
- Ash Content
- Penetration
- Viscosity

V. CONCLUSION

Based on the above information, it can be concluded that there exists a potential for carrying out systematic investigations on recyclability of pattern wax. The future course of work should be aimed at studying properties like melting point and congealing point, repeated melting and cooling operation to find variation in melting point and congealing point. This would need analysis of the existing methods of recycling pattern-wax in a typical investment casting foundry. This could then lead to development of suitable alternate formulations.

VI. SUMMARY

- Investment Casting Wax compounds are complex
  They consist of many different components consequently they exhibit a range of properties.
- Wax Properties influence pattern behaviour in the foundry and ultimately the quality of castings produced.
  Correct product choice allied with strict process & quality control procedures is essential.

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