

Understanding Investment Casting Wax



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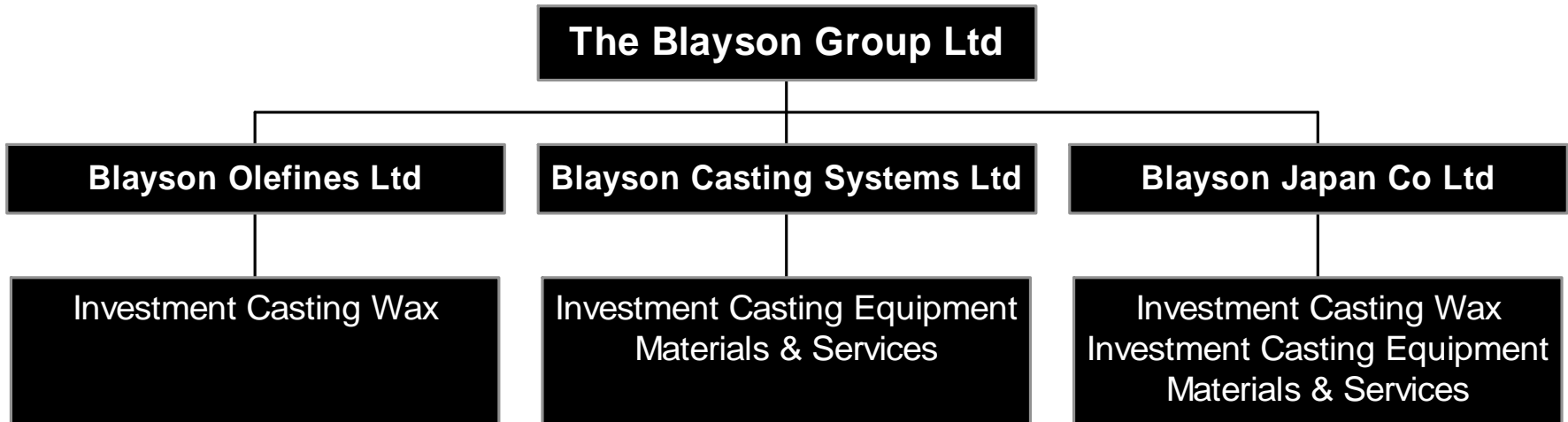
Blayson Olefines Ltd

Blayson

Agenda

- The Blayson Group Ltd
- What is Investment Casting Wax ?
- Structure of Investment Casting Wax
- Categories of Investment Casting Wax
- Properties of Investment Casting Wax
- Properties that Influence the Quality of Wax Pattern Production
- Quality Control of Investment Casting Wax

Company Structure



The main production company is based in Cambridge, UK. There is a second manufacturing unit located at Chiba, Japan.



Blayson supplies investment casting companies
in 57 countries around the world



Blayson Today

- The leading specialist manufacturer of superior investment casting wax
 - supplying global markets
 - with a full range of Virgin and Recycled wax products
- Stable independent company
- Recognised globally as a leader in wax technology
- Pioneer of the Reclaim and Reconstitution process for recycling Pattern Wax
 - reducing foundry costs
 - environmentally friendly
- Active member of investment casting industry organisations : ICI, EICF, cmf, JFS



Quality Control and Research & Development

- A dedicated team of technical staff
- Access to industry standard wax injection machines means trials can be carried out using customers dies
 - without interrupting production
- Industry standard testing
- Advanced rheological analysis
- SPC analysis software
- ISO 9001:2000 accredited





Investment Casting Wax

Wax is the oldest thermoplastic material known to man, as such it softens with heating – allowing it to be shaped

- Beeswax was utilized in the lost wax process by craftsmen in the ancient civilizations of China & Egypt
- Modern wax compounds are much more complex
- If the pattern is wrong, the casting will be wrong
- It follows that the choice of wax is critical

Modern Investment Casting Wax

- Modern blends are complex compounds containing many components including :
 - Paraffin Waxes
 - Microcrystalline Waxes
 - Hard Waxes
 - Resins
 - Polymers
 - Fillers
- Many of the above can either be naturally occurring or Petrochemical industry products

Structure of Investment Casting Wax

- Hydrocarbon wax, natural ester wax, many types of synthetic wax, and some of the resins used are compounds of simple straight chained carbon atoms (aliphatic compounds)
- Some of the resins and filler materials are compounds of more complex ring structured carbon atoms (aromatic compounds)
- The Carbon Chain length and complexity of the molecular structure influences wax properties and performance in the foundry

Formulation

- Many variations are formulated to suit the differing requirements of individual foundries
- Key properties such as melting point, congealing point, hardness, viscosity, expansion and contraction, setting rate, are all influenced by the structure and composition of the wax compound
- The complex composition shows itself in a physical behaviour different to that of other substances

Phase Changes of a Typical Wax

- Unlike other homogeneous chemical compounds, wax does not melt immediately on heating but passes through several intermediate states :

solid ➤ plastic ➤ semi-plastic ➤ semi-liquid ➤ liquid

Expansion & Contraction of Wax

- The structure and components used in an investment casting wax will influence the expansion and contraction
- 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

Categories of Investment Casting Wax

- Pattern wax
 - straight (unfilled)
 - emulsified
 - filled
- Runner wax
- Reclaim & Reconstituted wax
- Water Soluble wax
- other Special wax
 - dipping/patching/adhesive/repair

Straight (Unfilled) Pattern Wax

- This is the type most widely used in China
- Complex compound of many wax and resin components
- Surface finish normally glassy
- Wide range of properties available
- Can easily be recycled on-site by foundries
- Suitable for use as both pattern and runner wax
- With good process control can produce a wide range of good quality patterns
- High contraction and prone to cavitation/sinkage on thick sections
 - limits its capability to produce large complex parts

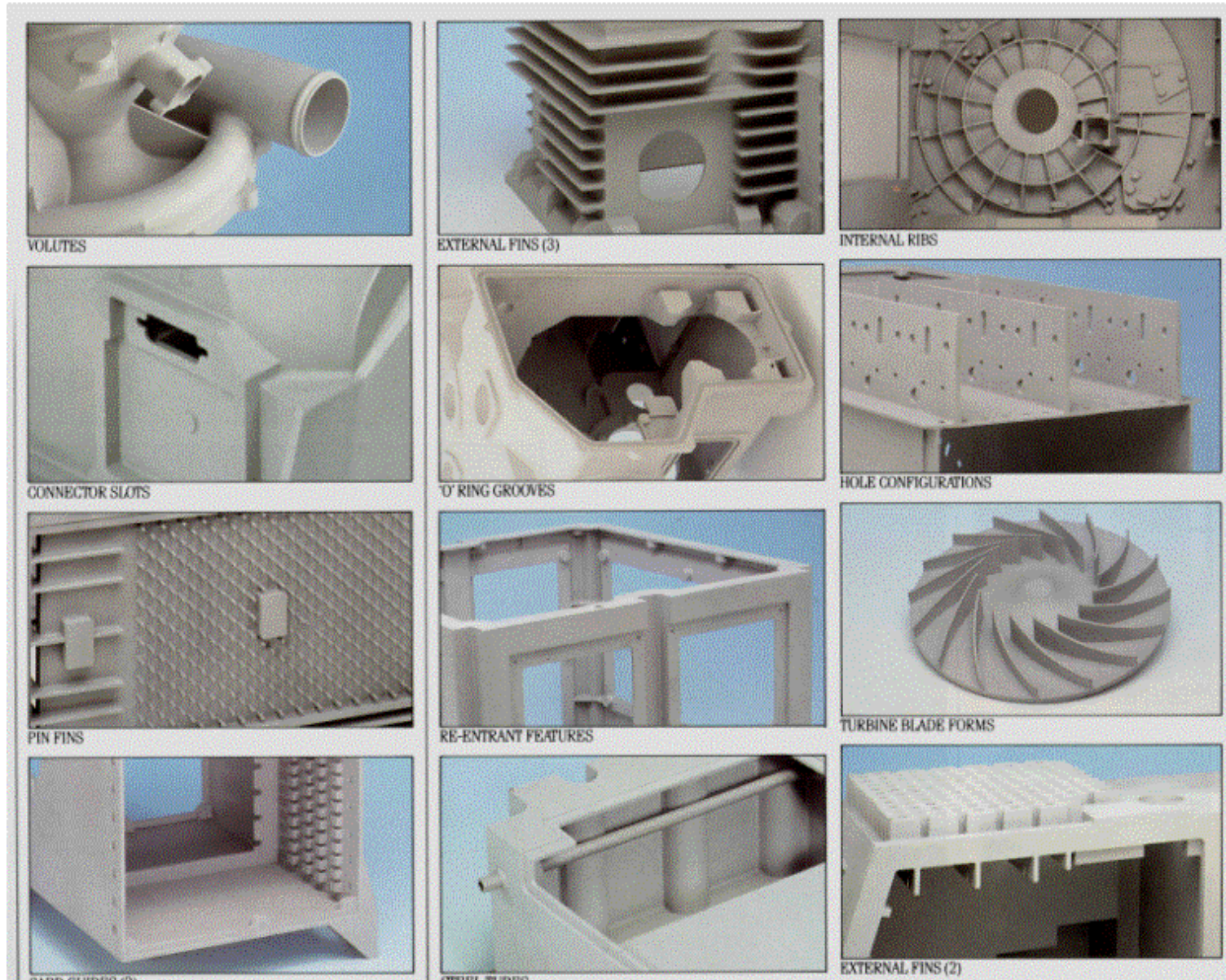
Emulsified Pattern Wax

- Base materials compatible with emulsifying agents and water
- Emulsified with 7 - 12% water
 - water acts partially as a filler and reduces cavitation
- Surface finish normally smooth
- Can be recycled for use on both runner systems and patterns
- Low die adhesion
 - useful where die lubrication is not possible
- Lower contraction than straight wax

Filled Pattern Wax

- This is the type of pattern wax most widely used in Western countries
- Base materials blended with a powdered, inert filler material such as Cross Linked Polystyrene
- Filler gives the wax greater stability, less contraction
 - excellent injection characteristics, wide contraction range
 - can be injected in all states, from paste to liquid
 - enables production of large complex castings or those with thin wall sections
- Dimensionally very accurate and repeatable
- With advanced technology it can be recycled by specialist companies
- Filled wax is essential for the production of large, complex and thin walled castings e.g. for aerospace

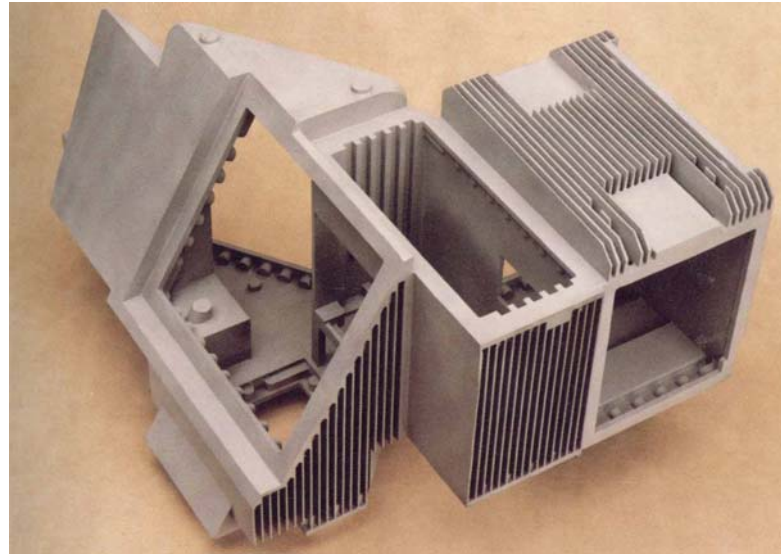
Examples of aluminium castings produced from Filled Wax patterns



Examples of Aerospace castings made from Filled Wax patterns



Boeing 747,767 – Ti alloy



Casing for control system, Al alloy



Boeing 777 APU duct- Ti alloy

Superalloys Ni base, vacuum cast castings for power generation
produced from Filled wax patterns



Examples of investment vacuum castings for surgical implants (knee and hip joints) made in Ti6Al4V and CoCrMo alloys from Filled wax patterns



Runner Wax

- In western foundries it is usual for a different wax to be used for runner/support systems
- Formulated for lower melting point and low viscosity for easy dewax
- Virgin products are available, more usually it is reclaimed from used autoclave wax
- 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 individual requirements

Specialist Wax

- Compounds used to help the production of finished wax patterns ready for assembly
 - soft repair wax
 - hard repair wax
 - adhesive wax
 - dip seal wax
 - rod wax
 - water soluble wax – for the production of soluble cores to make cavities in wax patterns

Reclaim & Reconstituted Wax

- Typically in Western countries wax is recycled by wax producers and not by the foundry
- Customers autoclave wax returned for reprocessing
 - cleaned & filtered
 - additives to adjust properties to specification
- Reclaim wax for runner systems
- Reconstituted wax for pattern production
 - Reconstituted Filled Wax
 - Reconstituted Emulsified Wax
 - Reconstituted Straight (Unfilled) Wax
- Environmental and economic benefits

Quality Control

- Important for both wax manufacturer and foundry to monitor wax properties
- Strict quality control procedures are essential
- Ensures consistency and compliance with specifications
- Industry recommended tests :
 - melting (drop) point
 - congealing point
 - ash content
 - penetration
 - viscosity

Key Properties for Wax Pattern Production

- Contraction and Dimensional Stability
- Congealing Point
- Melting Point
- Ash Content
- Hardness and Elasticity
- Viscosity
- Surface Finish
- Setting Rate
- Oxidation Stability
- Recycling

Points for Consideration in Wax Choice

- Wax type: Filled or Non-Filled
- Congealing Point range
- Melting Point range
- Hardness
- Type of parts produced
- Volume of production
- Injection machine type
- Injection cycle times
- Shelling materials and methods
- Size of shells and assemblies
- Price

Summary

- Investment casting wax compounds are complex containing many different components and with 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
- Blayson manufactures quality wax materials specifically designed to meet the needs of customers, offering good performance and excellent value and with good commercial and technical support