TEA RESEARCH INSTITUTE OF SRI LANKA

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INDUSTRY GUIDELINES FOR COPPER ALLOY CAST COMPONENTS IN ROTORVANES

Introduction

Rotorvanes are used in manufacturing Orthodox broken type teas. These Rotorvanes consist of copper alloy cast components for effective maceration of tea. Quality of made tea and dhool production rate are affected as a result of *wear and tear* of the components. A study was conducted on sample components for chemical composition, hardness and microstructure and causes for high *wear and tear* were identified. This guideline briefs basic information on casting requirement, test method and quality requirement for the copper alloy cast components.

Scope

- Requirements for casting components and
- Test Method for cast components

Components

- Vanes for all sizes of rotorvanes
- Resistors for all sizes of rotorvanes

Requirements for casting components

- **Materials**
  - Main ingot materials needed are Cu, Sn and Zn.
    Or
  - Scrap materials with known chemical composition.
    It is highly recommended to work with a particular foundry to obtain cast components made of ingot material. When the cast components are wasted, it can be reused to maintain chemical composition in the cast components closer to the requirement. The cost of new components could be reduced with reuse of the material.

- **Method of casting**
  - Sand casting
  - Preparing quality green sand with the characteristics: refractoriness, chemical inertness, permeability, surface finish, cohesiveness, flowability, collapsibility, and availability/cost. (Described in Annexure A).
  - Melting order – 'Cu' first followed by 'Sn' and 'Zn' at the final stage.
    Losses of elements in the form of vapour occurs as the melting point of Cu, Sn and Zn vary as 1,085 °C, 231.9 °C and 419.5 °C respectively.
  - Casting components of different thicknesses at appropriate temperatures. Recommended casting temperatures for producing components of different thicknesses are given in Table 1.

Table 1. Casting temperatures for components of different thicknesses

Thickness of components	Casting temperature
< 15 mm	1,200 °C
15 - 40 mm	1,170 °C
> 40 mm	1,130 °C

Test Method for cast components

- Optical emission spectroscopy

Testing facility

- Industrial Development Board, Ratmalana and
- Department of Materials Engineering, University of Moratuwa.

Quality requirement for casted components

- Chemical composition (%) of Cast components,
    - Cu 86 – 89 %
    - Sn 9 – 11 %
    - Zn 1 – 3 %
    - Pb 1 – 1.3 %

    Range of percentage is given to the elements considering practical difficulties in achieving exact composition. Allowing lead is to improve the machinability. As the cast components are contacting tea, extreme care should be taken not to allow lead content exceed the maximum of 1.3%.

- Smooth Surface
- Free from flaws, seams, cracks
- Minimum impurities

Annexure A

1. **Green sand characteristics:**

   Refractoriness: The sand's ability to withstand the temperature of the liquid metal being cast without breaking down. Sand with too low refractoriness will melt and fuse to the casting.

   Chemical inertness: The sand must not react with the metal being cast.

   Permeability: The sand's ability to exhaust gases. This is important to avoid casting defects, such as blow holes and gas holes

   Surface finish: The size and shape of the sand particles defines the best surface finish achievable. Finer particles lead to producing a better finish. However, finer the particle, the permeability becomes worse.

   Cohesiveness (or **bond**): The ability of the sand to retain a given shape after the pattern is removed.

   Flowability: The ability for the sand to flow into intricate details and tight corners.

   Collapsibility: The ability of the sand to be easily stripped off the casting after it has solidified. Special additives can be used to avoid cracking and hot tears in the casting during cooling or with long freezing temperature ranges.

   Availability/cost: The availability and cost of the sand is especially important because for every ton of metal poured, three to six tons of sand is required. Although sand can be screened and reused, the particles eventually become too fine and require periodic replacement with fresh sand.

   It is economical to use two different sands,

   a. Facing sand - this sand will be built up around the pattern to a thickness of 30 to 100 mm.
   b. Backing sand - the sand that fills in around the facing sand. This sand is simply silica sand with only a small amount of binder and no special additives.

2. **Green sand additives**

   a. Base sand
      Silica sand of AFS grain size 50 - 60 is generally used.
   b. Clay
      The best bonding clays are bentonites.
   c. Coal dust
      Used mainly in iron foundries with some being used in non-ferrous foundries.
   d. BENTOKOL
      BENTOKOL additives are blends of natural clays to which have been added specially selected essential volatiles to provide both bond and volatile content.
   e. Water
      Water is needed to develop the clay bond but at times it causes casting defects.

Tea Research Institute of Sri Lanka
Talawakelle