Base Materials for White Metal Bearings – Selection and Suitability

1 Application Range

The following notes apply to the new manufacturing of composite white metal bearings.

The coating with high tin or high lead babbitt alloy is realized by suitable casting or welding methods, from the liquid phase of the babbitt metal. No metal spray coating.

Typical types of composite white metal bearings include integral or split journal and thrust bearings with fixed profile as well as journal and thrust pads. In this context, composite white metal bearings also include non-contacting seals, oil supply casings, sliding and guiding elements with similar design features.

2 Objectives

The selection criteria named here do not claim to be complete. They represent the state of the art with long-term positive experiences in numerous relevant references.

The materials referred to here are suitable for composite white metal bearings, equally and generally. For the selection of the individual material and the respective format of delivery, the following main criteria apply:

- Manufacturing Technology: Minimize machining effort by selection of a raw part close to the finished geometry. For example selection of a cast part for complex geometries otherwise to be machined “from the solid” with great effort.
- Price: The selection of the respective lowest price material in the required format of delivery is trivial. However, relations may change due to the market situation, so no general evaluation “expensive…cheap“ is possible but has to be verified in every individual case, also in short intervals.
- Target date: Selection of material and format of delivery available at short notice in order to realize a short-term delivery. For example selection of flame-cut components instead of cast parts, forged or rolled material. Here, the “marketability” of the materials has a big influence. Higher grade materials can be available more conveniently and quickly if there is great demand on the market and the respective production volume is higher.
- Mechanical strength: Rarely a criterion, as all materials suitable for composite white metal bearings are low alloy steels whose mechanical characteristics do not differ significantly from one another.

These criteria pretty well contradict each other, so that the selection in the individual case always requires judgement and prioritisation. Even with similar components, this selection process may lead to different results, occasionally, e.g. depending on the acceptable delivery period. The required quantity is another important factor, e.g. the production of an expensive casting pattern will only be convenient with higher quantities.

The higher Gleitlagertechnik Essen’s degree of freedom in the selection of materials, the better this conflict of objectives may be solved to the customer’s benefit. Customer specifications too restrictive without objective reasons, however, can lead to suboptimal solutions with regard to price, delivery period and possibly even quality. It is wise to formulate material specifications for composite white

metal bearings as “open” as possible, i.e. specify alternative materials or groups of materials. In all cases, Gleitlagertechnik Essen will review the specification in depth and make proposals for the substitution of materials where appropriate.

3 Characteristics of suitable materials

The most important criterion for base materials of composite white metal bearings is the ability and strength of the bond between babbitt metal and base body. The knowledge about suitable materials has been achieved empirically. There are no simple rules for the allowable (or suitable) mass fractions of individual ingredients; there are interdependencies between individual elements. The following limits have been established as indications:

Low carbon steel (C<0,2%).

Further limis of chemical analysis: Si<0,25%; Mn<0,4%; Cr<0,2%; Ni<0,5%

Not all the materials named here fulfil all these criteria at the same time; however, due to the interdependencies mentioned before, they are equally suitable without limitations.

4 Base material and format of delivery

All materials are untreated, normalized steels. As the consequence, the following compilation only refers to the generic material designations per EN 10025 without material numbers or identifiers for post treatment or quality groups.

Any further detailing of the specification, with respect to quality groups or material testing is a restriction of the material selection, with regard to the criteria given in 2, and should be reviewed for the stringent technical necessity. In general, the certification of mechanical characteristics from the batch of material used will be sufficient. Should characteristics from the individual component be required, this has to be agreed upon in advance, as the required samples have to be taken into account for the geometry of the raw component. As well, these additional requirements have an influence on price and delivery time. The same is true for third party inspections, e.g. by classification societies. The certification of all inspections as per contract is part of the product documentation.

Material	**Formats of delivery, typically and available**
C10	forged or milled rings, solid material
C15	forged or milled rings, solid material
C22	forged or milled rings
S235	flame-cut components, milled rings, tube, solid material
S355	flame-cut components, milled rings, tube, solid material
GS-38	cast parts
GS-45	cast parts

These are only the most popular materials, with a significant proportion in the scope of delivery. For many other materials there are positive references which should be reviewed in the individual case.

4 Hydrogen content of the base material, hydrogen effusion heat treatment

Atomic hydrogen is soluble in steel and a residual content of hydrogen is inevitable due to the production process. As the babbitt metal layer represents a diffusion barrier for this residual hydrogen, effusing hydrogen can recombine to hydrogen gas at the border between steel and babbitt metal and de-bond the babbitt metal in bubble shapes. With regard to this effect, a residual hydrogen content of <1,5 ppm is considered to be uncritical.

A sound analysis of the hydrogen content is only possible from the melt; a subsequent analysis from the raw or pre-machined solid part, however, is not, due to physical implications. As during further processing of the melt, there is the potential for re-accumulation of hydrogen, the requirement of hydrogen <1,5 ppm in the melt is not sufficient for the manufacturing of composite white metal bearings.

As a consequence of this, a reduction of hydrogen by hydrogen effusion heat treatment (German: “Wasserstoffeffusionsglühen”, abbr. WEG) is required in all cases. Due to the physical implications, this has to be performed below the temperature of microstructural transformation (low alloy steels ≈ 700℃). The time required is al function of wall thickness. At this temperature level, even with long-term exposure, the mechanical characteristics of the base material are not affected. The exact data are fixed within the internal guidelines of Gleitlagertechnik Essen and available upon request. Should the customer’s specification be different, conservative action is taken in all cases, i.e. the longer time is used respectively. Contradictory temperature specifications have to be resolved. The certification of hydrogen effusion heat treatment is part of the product documentation.

5 Other base materials, bearing regeneration

When re-generating bearings, i.e. new coating and re-machining of existing base bodies, the base material used in the individual case is most often unknown or – even worse – it is known to be a material today considered as inappropriate, e.g. bearings made from nodular cast iron or grey cast iron. In these cases, the negative evaluation of the material is opposed by the positive operational experience in the respective application. These basically ancient designs do not require complete intermetallic bond between babbitt metal and base body. Operational safety is realized by positive locking, e.g. dovetail grooves, and is assured after regeneration as well, unrestrictedly. In these cases it is essential to adapt the extent and criteria of non-destructive testing to the actual circumstances and requirements, see /1/. Repeated hydrogen effusion heat treatment as described in 4 is not required in the case of regeneration, due to the age of the base body.

6 References

/1/ Gleitlagertechnik Essen - NDT Bearings.doc Issue: 08.05.2013