



## Non-Destructive Testing on Bearings – Extent and Application Notes

### 1 Application Range

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

The base material must be suitable for the manufacturing of composite white metal bearings, for the selection and suitability of materials see /1/.

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 referred extent of testing and acceptance criteria do not represent the sole and exclusive criteria for the functionality of a bearing. In fact, they are intended to enable the inspector to take positive decisions about acceptance, on his own responsibility. However, any non-conformity to the referred acceptance criteria does not necessarily cause the bearing to be unusable. Any deviations to the acceptance criteria shall be evaluated by the technical responsible, taking into account the operational conditions of the bearing, with regard to their consequences for function and operational safety. Only then, a decision about usability of the bearing shall be taken.

Basically, all referred acceptance criteria can not be fulfilled across the whole range of application process safe without the need for corrective actions and rework. This is not required technically, neither is it reasonable commercially. For any corrective actions, of course, the same conditions of the original coating apply, i.e. use of identical babbitt metal with its usage conditions.

### 3 Testing Methods

#### 3.1 Ultrasonic Testing of Bond (UT)

Objective: Verification of bond between babbitt metal and backing material in the area of the sliding surfaces

Basis: ISO 4386-1

To be performed with the bearing pre-machined or finally machined

In any case test class 3, i.e. complete coverage of the sliding surfaces

Sliding surface = areas which contribute to the hydrodynamic or hydrostatic function of the bearing, e.g. bearing bore, taper land faces, hydrostatic pockets.

Excluding, however, e.g. oil drain grooves, lubricating ring grooves, oil channels

### 3.1.1 Acceptance Criteria

Basically, defect groups per ISO 4386-1, i.e.

Defect group A only for new manufacture with steel backing material per 1, without voids or variations in wall thickness, in particular without dovetail grooves or other clamping grooves.

The demand for the freedom from defects (defect group A) cannot be maintained without limitation. With the increase of bearing size, bearing weight is increasing as well. One important criterion for the quality of a babbitting process is the speed of cooling. By nature, cooling cannot be as quick with large, thick-walled bearings as it is with smaller dimensions. Consequently, it is not only due to statistics, but also physics, that it is easier to produce a smaller bearing without defects. Moreover, the freedom from defects is not required technically, neither is it reasonable commercially. Therefore, with large bearings, the demand for the freedom from defects (defect group A) shall be limited to the highly loaded areas of the sliding surfaces.

For bearing regeneration, in principle defect group C, on the condition of backing material per 1, otherwise defect group D.

### 3.2 Dye Penetrant Testing (PT)

Basically, dye penetrant testing is a method for the detection of surface cracks.

Objectives when applied to bearings are the following:

- Verification of bond between babbitt metal and backing material in the area of the bond line, i.e. the boundary line between babbitt metal and backing material circumscribing the babbitted area.
- Verification of the freedom of cracks in the area of the sliding surface

Basis: ISO 4386-3

In any case testing of sliding surfaces and bond line (see above). No testing (or evaluation of indications) on other surfaces, e.g. oil drain grooves, lubricating ring grooves, oil channels.

Being a method for detecting surface cracks, dye penetrant testing can appropriately only be applied to finally machined bearings. The application to pre-machined components can have informative character only, acceptance criteria cannot be applied. Especially, it is basically impossible to conclude from the dye penetrant test result on a pre-machined part what the test result on the finally machined part later on may be.

For the evaluation of indications it is essential to observe the tested surface continuously, immediately after the application of the developer (see ISO 4386-3: 7). This is of special importance in order to determine different causes of indications. The comparison of the indications with the acceptance criteria is only allowed after limited, correct development time; exceeding the development time leads to unpredictable growth of the indications which cannot be evaluated.

#### 3.2.1 Acceptance Criteria

New manufacture: Class B

Regeneration: Class C

In the case of bearing regeneration, indications on the bond line cannot be evaluated as here – differently to new manufacture – there is no machining allowance, i.e. this zone can not be machined after coating with babbitt metal.

In all cases of linear indications on the bond line, the bond on the edge zone shall be tested by UT. If bond is verified, this test is leading (see ISO 4386-3: 1a) und 8.1). Here, ultrasonic and dye penetrant testing are not independent but complement one another.

### **3.2.1.1 Potential Causes of Indications**

Indications are not only caused by flaws or cracks but can also be caused by phenomena which in no case represent defects of the subject bearing. Frequently, these are traces of tools, machining grooves or scratches in the babbitt metal, but may also be large crystals, torn out of the babbitt metal by the machining operation (see ISO 4386-3:8.2). In order to differentiate these, it is helpful to wipe off the developer dryly and re-apply the developer immediately. If no further indications appear, then the above mentioned, superficial causes apply.

### **3.2.1.2 Microporosity**

Differently to the above mentioned acceptance criteria, microporosity is detected and evaluated using the following procedure. The visual, ultrasonic and dye penetrant methods are used: Immediately upon drying of the developer, the potential development of individual indications > 1.5 mm is verified. In this case, these indications are evaluated using the appropriate defect class. If the indications are smaller, they might be micropores which can be situated very close one to another, so that, at the time of final evaluation, a uniform red surface has developed, making it impossible to differentiate individual indications. In this case, clean the surface from test fluids and test visually, for visible pores. If no pores can be detected without auxiliary means (magnifying glass), then microporosity is confirmed. If pores can be detected, then these are allowable up to a maximum real size of 1.0 mm, if they appear in a scattered way and no linear alignment with a distance  $\leq 2$  mm is formed. In the area of microporosity, the potential for ultrasonic testing may not be disturbed, i.e. the bond echo from the babbitt metal to the backing material must be detected. Additionally, areas of microporosity may not exceed 30% of the sliding surface and must not have any bond defects, detected by UT.

## **4 Bearings out of the Application Range per 1**

For the new manufacture and regeneration of bearings with backing material which does not fulfil the criteria per 1 (i.e. bearings made of nodular cast iron, grey cast iron), none of the mentioned criteria for non-destructive testing are applicable. These basically ancient designs originate from a period when the above mentioned non-destructive testing methods had not been developed or applicable. These designs do not require complete intermetallic bond between babbitt metal and backing material. Operational safety is realized by positive locking, e.g. dovetail grooves. For such bearings, a visual test is appropriate and sufficient.

## **5 References**

/1/ Gleitlagertechnik Essen – Base Materials for White Metal Bearings.doc Issue: 08.05.2013