MAHLE

Motorsport

HIGH PERFORMANCE ENGINE BEARINGS - BMW S65/S85

Technical Information

BACKGROUND

The original connecting rod bearings for the S65/S85 engine were manufactured in MAHLE's bearing facility in Trento, Italy. However, at the time of manufacture, this bearing plant was owned by the Dana Corporation and still used Clevite 113 material, as displayed by the stamping on the bearing backing.

All MAHLE bearing facilities now tend to use the MAHLE "M" logo on the bearing backings except the motorsport division which still uses the "VP" logo to distinguish the genuine motorsport parts from standard production parts and to highlight the Vandervell racing heritage.

MAHLE MOTORSPORT BEARINGS FOR THE S65/S85

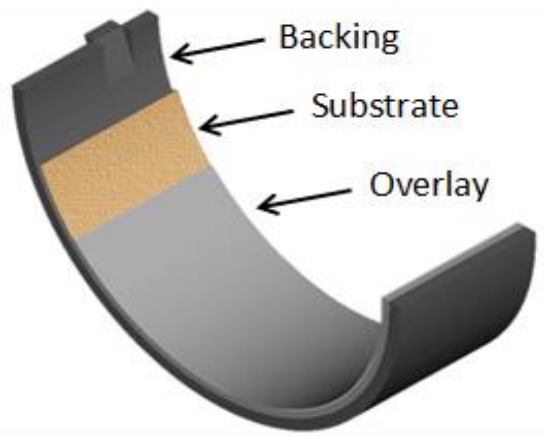
Before launching a connecting rod bearing for the S65/S85, MAHLE Motorsport were able to access useful design and development information about the Trento bearing from the MAHLE archives. This enabled useful improvements to be identified.

Material Selection:

An advantage in material selection was immediately available as all MAHLE Motorsport materials have been developed specifically for racing. This brings several advantages, some of which are listed below:

- A higher strength backing to maximise contact pressure between bearing and housing.
- A structurally optimised cast lead-bronze substrate for the best possible balance of strength and conformability.
- A race-spec lead-indium overlay for maximum conformability, compatibility, embeddability, and corrosion resistance.
- No requirement for a nickel barrier.

TRI-METAL BEARING



The range of racing materials available along with their multi-layer construction allows the right balance of properties to be selected, and so the bearing material can be customised to suit the application.

VP2A was selected for the S65/S85 application. This combination of strength and compatibility would provide a solid base for any bearing application, but examination of mid-life OE bearings showed overlay corrosion to be a significant factor

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influencing bearing wear rate, as shown in *Figure 1*. Whilst corrosion is largely caused by oil degradation and operating temperature, the use of a race-spec lead-indium overlay would help to resist the corrosion and reduce the wear rate.

Figure 1 – Overlay Corrosion.

Laser Marking:

Laser marking of the bearing identification, rather than conventional stamping, maximizes the efficiency of heat transfer from the bearing into the housing. This helps to stabilise the operating temperature of the bearing and protect the oil film thickness.

Bearing Clearance:

The key to successful bearing performance is sustaining an adequate oil film thickness during the engine cycle, and throughout the life of the bearing. The bearing shell is part of a complex system which generates the all-important oil film, and there are many influencing factors ranging from cylinder pressure and engine speed, to bearing width and of course, clearance.

The optimum clearance and safe clearance range would have been defined during the development of the engine, often using computer simulation, an example of which is shown in *Figure 2*. Therefore, this value and range should generally be maintained for any subsequent re-builds although there are cases where it makes sense to change it a little.

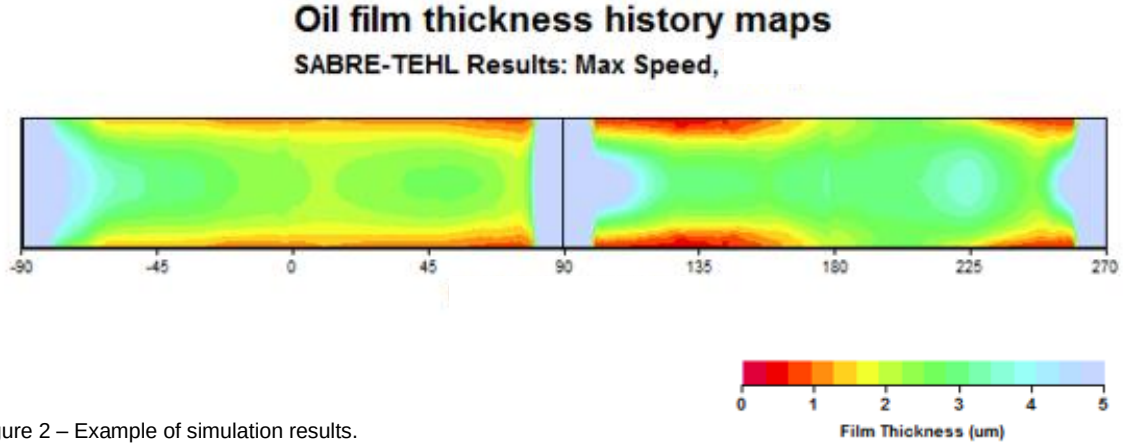

Figure 2 – Example of simulation results.

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The Trento bearing drawing specified a total clearance range of **0.029mm** to **0.062mm** which gives a mean clearance of **0.046mm**. It achieved this using 2 thickness grades, colour coded **Red** and **Blue**, as part of a simple grading scheme typical of BMW design practice. It is important to note that these clearance values include housing swell.

In defining the optimum clearance for an S65/S85 aftermarket bearing, MAHLE Motorsport has balanced its motorsport knowledge with the understanding of variation in the field. In motorsport, the engine assembly is very tightly controlled as is the operating environment on the track, so here the bearing clearance can be minimised to reduce oil flow. In the world of performance aftermarket there is a wider variety of engine assembly conditions and applications, so the sensible approach is to offer a little more clearance than the OE build but keeping the total range within acceptable limits to maintain a sufficient oil film thickness.

Therefore, the MAHLE Motorsport S65/S85 bearings have been designed to provide a mean clearance of **0.054mm**, which is 0.008mm more than the OE design. A single thickness grade is offered to simplify assembly, and gives a total clearance range from **0.027mm to 0.081mm**, as shown in *Figure 3*.

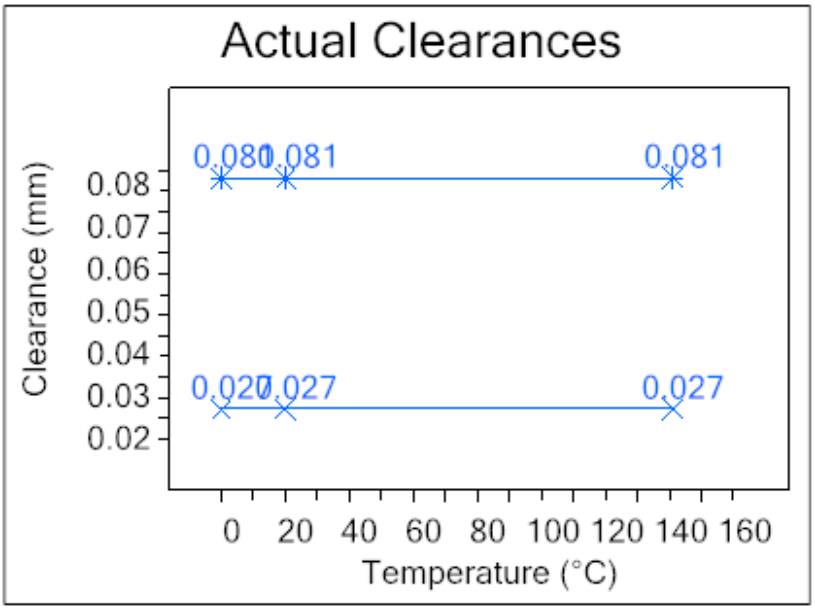

Figure 3 – SABRE-Fit Calculation of MMS of S65/S85 (includes housing swell).

UNDERSTANDING THE TOTAL CLEARANCE RANGE

The total clearance range is the difference between the maximum possible clearance and minimum possible clearance with respect to the tolerance values of all components in the assembly. These are as follows:

- Housing diameter.
- Shaft diameter.

- Upper bearing wall thickness.
- Lower bearing wall thickness.
- Upper bearing overstand.
- Lower bearing overstand

This gives a combination of 4 components and 6 factors that can influence the clearance range. However, the probability of combining these 6 factors at their extreme dimensions to give the maximum or minimum clearance is very low.

Therefore, a single bearing thickness grade will usually suffice for aftermarket re-builds, especially since measurement of the housing and shaft can usually be done to verify the build clearance.

INTERPRETATION OF USED BEARINGS

It is worthwhile further discussing the importance of bearing examination as it forms an intrinsic part of the MAHLE Motorsport design practice.

The bearing surface must have good compatibility and conformability to deliver the right level of surface modification. Lead-indium is particularly good at this as it offers the complete range, from **POLISHING** to **LIGHT WEAR** to **MODERATE WEAR** to **HEAVY WEAR** to – in the worst case - **WIPING**.

The bearing must deliver whatever level of surface modification is needed to dissipate heat, allow the oil film to recover, and ultimately prevent seizure.

The various levels of bearing wear are usually referred to as damage, but they are in fact seizure resistance mechanisms, and the greater the engine performance the more these properties are called upon.

Therefore, under the most extreme operating regimes the lead-bronze substrate may eventually become exposed. On lead-indium bearings, the greenish-grey copper-indium intermetallic will initially appear followed by the copper colour of the lead-bronze substrate, both have excellent tribological properties and will arrest the wear whilst allowing continued safe operation. So, bronze exposure does not mean the bearings are worn-out although it often makes sense to re-fit new bearings at this stage to recover the original clearance.

It is important to note that some bearing overlays contain tin and require a nickel barrier to prevent the loss of tin from the overlay into the substrate. Due to the colour of nickel, it may not be immediately apparent that it has become exposed in a similar manner to lead-bronze, but the problem is not simply that it may go unnoticed; nickel is not a bearing material and presents an increased seizure risk. Therefore, an exposed lead-bronze substrate is much better than an exposed nickel barrier.

With regards to the S65/S85 OE bearings. Despite the increase in clearance due to wear, examination has shown no subsequent damage to the exposed bronze substrate – no evidence of overheating or scuffing. This means an adequate oil film thickness has been maintained and suggests the original designed clearance range was entirely satisfactory.

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