

## Babbitt's 1839 invention still a critical component

The vast majority of bearings we work on at TCE are babbitt lined. Most, if not all, of your critical rotating equipment utilize babbitted journal and thrust bearings. Babbitt is used mainly because of its conformability and embedability properties; essentially the babbitt must keep the bearing from damaging the rotor. Conformability implies that the babbitt will conform to the rotor, therefore not damaging the journals when the rotor and bearing are in contact. The ability to embed allows particles from dirty oil to embed in the babbitt instead of trying to pass through the thin oil film, thereby damaging the journals. Other advantages of babbitt include: good load carrying characteristics, low friction, good run in properties, it "wets" easily, and babbitt resists corrosion.

In 1839 Isaac Babbitt (1799-1862), applied for a patent, in Boston, Massachusetts, for a bearing box lined with a soft, tin based, metal (white metal). The lining he used is very similar to the metals we use today. In the 1930's the metal was refined to be optimized for bearing applications. Today there are several different grades of babbitt metal, 8 of which are specified by ASTM, of these, 4 are lead based and 4 are tin based (Table 1). Critical rotating equipment in the process and power generation industries generally use ASTM B23 grade 2 babbitt, a tin based alloy. Less critical machines with "pillow block" type bearings may be lined with a lead based alloy used because it is cheaper and easier to line. Lead based babitt is fine for the less critical services where this type of bearing is used. However, the tin-lead eutectic (63Sn/37Pb) formed actually has a lower melting temperature (361° F) than either tin or lead by itself. That is why it is important that tin based babbitt have no, or very little, lead in it. For comparison Grade 2 babbitt has a solidus temperature of 466° F and a liquidus temperature of 669° F. Solidus is the temperature the babbitt just begins to melt, while liquidus is the temperature the babbitt is completely molten.

## Julia Postill joins TCE



*Julia Postill*

TCE/Turbo Components and Engineering is pleased to announce that Julia Postill has joined our company. Julia brings 18 years of experience working in an industrial climate with her to TCE. For the past eight years she worked at TurboCare in Houston. Julia has an MS degree in Mechanical Engineering.

At TCE, Julia reports to John Whalen, P.E., Manager of Engineering. Julia has recently completed two large projects with TCE where she designed three large tilting pad journal bearings for a steam turbine and a gas turbine. If you've worked with Julia in the past, you will understand how pleased we are to have her on our team. If you haven't worked with Julia, perhaps now is a good time for her to help with your bearing and seal needs.

### Copper backing

The basics of the babbiting process are rather straightforward, while attention to detail is very critical. Babbiting a new journal bearing involves machining the bond line just prior to babbiting, heating the bearing shell to casting temperature, tinning the bore of the bearing, pouring the babbit with the bearing spinning at casting speed, and cooling the outer shell. The casting temperature and babbit pouring temperature are determined by the babbit type. The casting speed is based upon the bearing bond line bore. The speed is sufficient to allow the correct centrifugal force of the babbit to the shell while being low enough to prevent centrifuging out the babbit alloy elements. The bearing is cooled from the OD so the babbit solidifies from the bond line in. The bearing bore is then rough machined and the bond line ultrasonically tested (UT'd).

### Copper backing

Often with hot running bearings it is possible to reduce operating temperatures by manufacturing new babitted parts with a copper alloy base metal. The copper

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ASTM B-23-83 <sup>A,B</sup> (reapproved 1988)								
Chemical Composition %	Alloy Number							
	Tin Base				Lead Base			
	1 UNS-55191	2 UNS-55193	3 UNS-55189	11 UNS-55188	7 UNS-53581	8 UNS-53565	13 UNS-53346	15 UNS-53620
Tin	90.0-92.0	88.0-90.0	83.0-85.0	86.0-89.0	9.3-10.7	4.5-5.5	5.5-6.5	0.8-1.2
Antimony	4.0-5.0	7.0-8.0	7.5-8.5	6.0-7.5	14.0-16.0	14.0-16.0	9.5-10.5	14.5-17.5
Lead	0.35	0.35	0.35	0.50	remainder <sup>c</sup>	remainder <sup>c</sup>	remainder <sup>c</sup>	remainder <sup>c</sup>
Copper	4.0-5.0	3.0-4.0	7.5-8.5	5.0-6.5	0.50	0.50	0.50	0.60
Iron	0.080	0.080	0.080	0.080	0.100	0.100	0.100	0.100
Arsenic	0.100	0.100	0.100	0.100	0.30-0.60	0.300	0.250	0.8-1.4
Bismuth	0.080	0.080	0.080	0.080	0.100	0.600	0.100	0.100
Zinc	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Aluminum	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Cadmium	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Total named	99.800	99.800	99.800	99.800				
Density (lbs./in <sup>2</sup> )	0.264	0.267	0.269	0.266	0.351	0.362	0.369	0.362

A - All values not given as ranges are maximums unless shown otherwise  
 B - Alloy No. 9 was discontinued in 1946 and numbers 4, 5, 6, 10, 11, 12, 16, and 19 were discontinued in 1959. A new number 11, similar to SAE Grade 11, was added in 1966.  
 C - To be determined by difference

# State Champs



The Texas Ice Hounds, sponsored by TCE, took the Peewee "B" Texas Amateur Hockey Association State Championship in Dallas. The team of 11 and 12 year-olds pictured above, also won the Houston Metropolitan Championship in their age division.

## TCE signs agreement with Kaydon Ring & Seal

TCE has signed an agreement with Kaydon to be their authorized sales, repair, and service center. Kaydon is your full service seal manufacturing source. Their engineered seal products include dry running gas seals, circumferential barrier seals, and low leakage oil films seals. With this agreement, it allows TCE to expand beyond the manufacture and repair of babbitted bearings and labyrinth seals to better provide for our customers. Please give us a call for further details.

## Tech paper available

As we mentioned in our last newsletter, TCE has many technical papers available on various topics ranging from thermoplastic labyrinth seals to babbitted bearing failure analysis. This quarter our feature paper is "Eliminating Oil Leaks By Optimizing Bearing Case Oil Labyrinths." This paper was authored by Skip Krieser of Farmland Industries and TCE's Manager of Engineering, John Whalen. The paper was originally presented at the 27th Texas A&M Turbomachinery Symposium in 1998. This paper will be presented again at the Ammonia Producers show in Baton Rouge April 20, 1999. Any piece of rotating equipment with oil fed bearings, such as turbines, motors, gearboxes, and compressors, are susceptible to oil leaks from the bearing case seals. This paper presents an introduction to the causes of oil leaks and some items to consider with the lube system. Seal installation is covered, along with possible intermediate fixes, as well as a thorough discussion of labyrinth oil seals covering existing design deficiencies and optimized seal design parameters. Case histories then follow. Please give us a call if you would like a copy of this paper.

## Babbitting

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alloy replaces steel and is 450% more heat conductive than steel. The bearing uses this high conductivity by pulling heat away from the babbitt surface and allowing the oil to carry the heat away. The hotter the bearing is running, the more effective this upgrade will be. It has been discovered, however, that copper has a strong affinity for tin, especially at elevated temperatures. As such, copper backed bearings can lose their bond as the tin between the copper and the babbitt is absorbed by the copper. This problem is satisfactorily addressed by utilizing a "barrier" layer between the copper and the tin. This barrier prevents the migration of tin into the copper. Prior to babbitting, the copper is plated with this barrier layer, thereby separating the tin from the copper.

### Fatigue

Another potential problem with babbitt is its relatively low fatigue strength, especially at elevated temperatures. When a babbitted bearing is subjected to continuous high vibration over an extended period of time, it is possible the bearing may fail by fatigue. This manifests itself by radial cracks in the babbitt surface propagating to the bond line and meeting up with other cracks thereby loosening sections of babbitt.

This problem is addressed by utilizing thin babbitt layers. Generally speaking, the thinner the babbitt (under 15 mils) the stronger the fatigue strength. Babbitt layers in the 5-7 mil thick range have proven effective in increasing fatigue strength while still being thick enough to realize the benefits of the babbitt metal. At TCE we recommend going to a good bearing grade bronze as the backing material when thin babbitt is utilized. This allows a good material to come down on should there be a catastrophic failure.

***"The thinner the babbitt, the stronger the fatigue strength"***

### Conclusion

It is impossible to give this topic adequate treatment in an article this short. We did attempt to provide a short introduction to babbitt, presented babbitting methodology, discussed babbitt specifications and melting temperatures, went over fatigue failure of babbitt alloys, and covered a serious concern on the use of copper alloy backing materials. We hope this proves useful and, as always, we welcome any questions or comments you may have on this, or any other bearing or seal topic.

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