# 'PTFE Bearing Technology – An Alternative to Whitemetal'

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**Abstract**

*Michell Bearings has developed PTFE bearing technology for thrust and journal applications. This type of bearing is known to offer several advantages over the more traditional whitemetal type. The paper describes the PTFE tilting pad thrust bearing together with the key advantages of the product compared with whitemetal. The advantages are demonstrated by a case study involving the retrofit of a problematic whitemetal thrust bearing with PTFE on a pumped storage hydrogenerator. The paper goes on to cover recent developments of PTFE in tilting pad journal bearings.*

**Introduction**

In 1839 an American by the name of Isaac Babbitt invented a bearing alloy that was to later bear his name – Babbitt Metal. More generally known in other parts of the world as whitemetal, the material is an alloy of tin (sometimes lead), copper, and antimony. Tin based whitemetals have been the predominant material for a wide variety of hydrodynamic bearings for many years. Their use for thrust surfaces pre-dates the invention of the tilting pad bearing at the start of the last century. The strengths and weaknesses of the material are well known [1]. On the positive side, whitemetal provides a dimensionally stable surface that is easily repaired or replaced, and it is forgiving in the sense of being able to absorb into its surface hard particles of detritus without causing further damage. On the down side whitemetal has a relatively low melting point and this leads to an upper limit on the temperature possible during hydrodynamic bearing operation. If the limiting temperature is exceeded, catastrophic failure of the bearing is likely to ensue within a very short period of time. The effect of the whitemetal temperature limit is to restrict the maximum duty (expressed as a combination of speed and load) permissible in any particular bearing. As a further consideration, it can be noted that the main constituent of whitemetal, namely tin, is an expensive commodity which has often been in limited availability in many parts of the world.

With the development of the tilting pad and taper-land hydrodynamic thrust bearing at the beginning of the twentieth century it was natural for engineers to continue to work with the material they knew. Although other materials have been developed for hydrodynamic bearing surfaces, including, for example, copper-lead alloys, whitemetal has remained the world's preferred choice for most industrial applications.

Almost one hundred years after the invention of whitemetal another significant bearing material was to emerge. In 1938, Dr Roy Plunkett, a worker at the DuPont research laboratories (Jackson Laboratory in New Jersey), was working with gases related to Freon refrigerants. Upon checking a frozen, compressed sample of tetrafluoroethylene, he and his associates discovered that the sample had polymerised spontaneously into a white, waxy solid to form polytetrafluoroethylene or PTFE. The material these days is better known throughout the world by its DuPont tradename of Teflon.

**PTFE and Hydrodynamic Bearings**

PTFE is now well established as a material for dry rubbing bearings, however its use as a hydrodynamic bearing lining is relatively recent. Originating in Russia and China for use in hydrogenerator thrust bearings, the use of PTFE faced thrust bearings is extensive and is attracting much attention in other parts of the world. In the west, particularly the Canadian hydro industry, a number of units have been fitted with PTFE thrust bearings [2].

The construction of the PTFE bearing is similar in many respects to conventional whitemetal lined tilting pad bearings, however the whitemetal is entirely replaced by a composite PTFE/wire layer and this offers several advantages [3][4]. Fig. 1 shows a cross section through a typical PTFE faced thrust pad. The pad is generally sector shaped, has sufficient thickness to support the hydrodynamic loading resulting from the sliding motion, relies on some form of pivoting mechanism to produce a convergent film shape, and uses oil as the working medium.

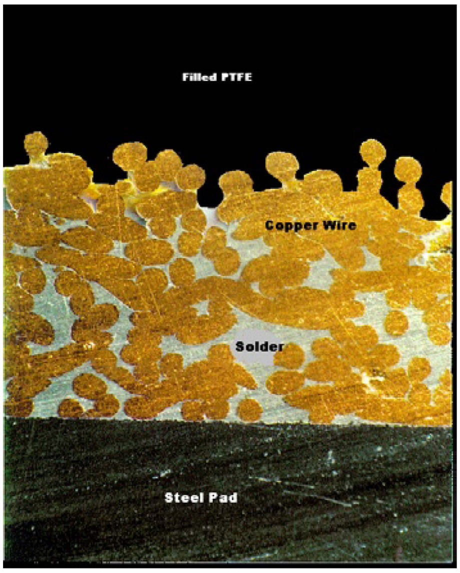


Fig. 1, Cross section through a PTFE faced pad

It is the nature of the pad surface however that sets it apart from the more familiar whitemetal or babbitt version. In the latter a relatively thin layer of the tin or lead based alloy is metallurgically bonded to the substrate of the pad, often (in the case of older designs) with the addition of dovetail retention grooves. This surface is then machined to a flat or slightly crowned profile. Leading edge chamfers or radii are then added to help induce the hydrodynamic action at start up. In some cases high pressure oil injection is added to assist start up under heavy loading, typically at mean specific loads >2.4 MPa (350 lbf/in$^2$).

By comparison the PTFE faced pad has a relatively thick layer of a PTFE/wire mesh composite attached to the surface of the pad instead of the whitemetal. The method of bonding the PTFE to the pad is the key to the successful operation of the pad as the wire not only provides the means of attachment, but also serves as a compliant layer which allows expansion and contraction of the PTFE in operation. It is worth noting that the coefficient of linear expansion of the PTFE is an order of magnitude greater than that of the supporting steel of the pad. Attachment of the PTFE by adhesives, as is often done in some simple slide bearings used on bridge supports for example, would rapidly fail at the joint due to the differential expansion rates encountered at the sliding speeds typical of hydrodynamic bearings.