Extract from Course F5: *Brazing tungsten carbide with or without PCD inserts*

………………………… In the preceding paragraph reference has been made to 'wetting'. The technical aspects of wetting are quite complex. Put simply, it can be demonstrated that when a molten alloy is in contact with a heated, chemically clean, surface of another metal it is *generally the case* that the molten metal will dissolve a minute amount of the metal upon which it is standing. In such circumstances it is said that the molten metal has 'wetted' the solid metal. Indeed it is easy to prove that in the case of satisfactory brazing the molten filler material *invariably* dissolves a small amount of the parent material.

From the above it is clear that the ease, (or otherwise!), of wetting of the parent material is a 'pointer' to anticipated success of the overall process. Joints on metals that wet easily are likely to be sounder than those produced on materials that are difficult to wet. The corollary is clear, there are some materials that are constituents of parent materials that impede wetting because of the difficulty that the brazing alloy has in taking those materials into solution. Where tungsten carbide is concerned it is additions of titanium- and/or tantalum-carbide that should cause 'warning-bells' to sound! There is clear evidence to support the view that even only small additions of these materials will have a very marked effect upon the ease of wetting, and the consequent 'soundness' of the joint. Some of the worst excesses of this problem can be mitigated by the use of fluxes that contain a small amount of elemental boron, (the so-called 'black' fluxes), but it is best to avoid the use of such materials if at all possible.

1. The problem of stress

The two basic components comprising the brazed joint, *i.e.* the steel backing piece and the insert of tungsten carbide, have widely differing coefficients of linear expansion. In general terms, that of the backing material is three that of the carbide, and in extreme cases four times! (**Table 1**). This factor is of ***fundamental importance*** in terms of the joint integrity and life of the finished tools. Clearly, the larger the tool the greater is the influence of this factor on the overall success, or otherwise, of the brazing operation.

Material	**% increase in length when heated from room temperature to 700ºC**
Tungsten carbide	0.4
Low carbon steel	1.22
Carbon steel	1.22
Low alloy steel	1.19
304 stainless steel	1.63
310 stainless steel	1.45
316 stainless steel	1.63
Ferritic stainless steel	1.09
Cast iron	1.10

Table 1: The coefficient of linear expansion of materials that might joined by brazing

Their shape and mode of operation determine the configuration of practically all carbide-tipped tools. As a consequence, the **only** design parameter under the control of the tool manufacturer is the dimension of the joint gap between the carbide insert and the backing piece! There is absolutely no doubt that the dimensions of these gaps are critical in terms of the integrity of the brazing alloy layer in finished tools. If they are too small, stresses will arise from differential contraction of the parts as they cool from brazing. **Fig 2** shows a commonplace type of joint between steel and tungsten carbide.
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