

## Extract from Course F18: *Furnace brazing stainless steels for automotive applications*

.....There are two atmosphere categories that have to be considered. These are:

1. Chemically **active** atmospheres.
2. Chemically **inert** atmospheres (including vacuum!).

### 1. Chemically **active** atmospheres

Atmospheres of this type **react** with the oxides present on the surfaces of the parent materials and brazing filler metals *removing them in the process*.

In those situations where an in-line continuous conveyor furnace is brazing **stainless steel** the 'active' ingredient of the atmosphere needs to be **ultra-dry and ultra-pure hydrogen**. When **mild steel** is being brazed under an **exothermic atmosphere**, the 'active' ingredients of the atmosphere are **carbon monoxide and hydrogen**. In both of these situations the mechanism of oxide removal is one of **chemical reduction!**

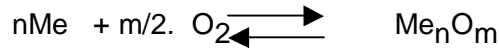
It is, however, very important for delegates to understand why it is very easy to braze mild steel in a furnace that is normally processing stainless steel under hydrogen, but why the brazing of stainless steel under an exothermic atmosphere is **not possible**. Further, it is **extremely important** to ensure that if consistently good results are to be achieved one should *never* process mild steel in a furnace that was installed with the primary objective of using it to braze stainless steels! This is a matter to which we shall return later in this monograph.

### Oxide films

One of the fundamental requirements for any successful furnace brazing operation is to ensure that the surfaces of the metals being brazed are free from oxide, or other films, which may inhibit wetting when the filler material melts. Thus the ease with which surface oxides can be removed from any given material is a function of the ease with which the oxygen ions can be detached from the metallic ions present in the oxide. Clearly, the degree of difficulty that is experienced depends upon the strength of the chemical bond existing between the oxygen ions and the metal involved.

The strength of such a bond can be assessed in several different ways:

1. By the *Heat of Formation*, **H**, of the particular oxide in question. (However, this will only provide an approximate guide).
2. More accurately, by the change in *Free Energy*, **F**, in the system during the reaction
3. From the maximum energy obtainable from the general chemical reaction:



where Me = metal and m = 1 mole of oxygen

As shown in **Table 3**, metals like gold, silver and palladium possess a low *heat of formation* value for their oxides and they can, as a result, be considered to be relatively unstable and can thus be decomposed readily. The oxides of metals such as copper, cobalt, nickel, iron and cadmium are higher on the stability scale and are therefore more difficult to reduce. Of higher stability still are to be found the oxides of chromium, manganese, titanium, aluminium and beryllium. In fact the various oxides of beryllium have a far higher degree of stability than virtually any other element. **Table 3**.....