ABSTRACT

Metal dusting occurs in carburizing atmospheres at intermediate temperatures (approximately between 430^{o}C and 900^{o}C), with the maximum rate of attack occurring at about 600°C to 700^{o}C, depending on alloys and environments. Attack is in the form of small pits or general uniform waste that yields a crumbly residue (dust) composed of graphite, metal, carbides and oxides (called coke).

The objective of this work was to determine the influence of carbide-forming elements, like titanium and niobium, on the metal dusting rate of commercial alloys. These results are used in development of alloys to combat metal dusting. Similar grades of stainless steels were exposed to metal dusting conditions and their performance compared. For austenitic stainless steels, **Type 304L** stainless steel was compared to **Type 321** (i.e. essentially Type 304 with titanium added) and **Type 316L** stainless steel compared to that of **Type 316Ti** (Type 316 with titanium added). The performance of a ferritic grade with similar chromium content as Type 304L and Type 316L was also included (i.e. **Type 430**), and also compared to a stabilised grade, **Type 441** (Type 430 with both titanium and niobium as carbide-formers). This indicated the characteristics of chromium and carbon migration, the formation of carbides, and their subsequent oxidation, on the mechanism for metal dusting.

The results indicated that the alloys that contained carbide-forming elements initially degraded to a lesser extent. In addition, it was also observed that the ferritic alloys were initially more resistant compared to the austenitic alloys. This is counterintuitive, since Type 316L is regarded as being more “corrosion resistant” than Type 430. The increased corrosion resistance is attributed to greater mobility of chromium in a ferritic structure, compared to an austenitic structure, to replace chromium that is used to form and repair chromium oxide scale on the surface. This is also important information that will help with alloy development.

The importance of a high chromium content, and other elements that promote a stable oxide film at the operating conditions, as well as a ferritic structure, are highlighted as possibilities to develop alloys to mitigate attack by metal dusting. The negative effect of carbide-forming elements during prolonged exposure indicates that those elements should be avoided.