[2010-05-04] **Rhenium: Is it Critical?**

Much attention around the world is being given to the subject of criticality in metals. So let us examine Rhenium against this set of criteria.

So what is a critical metal? According to the U.S. Academy of Sciences, it is defined as 'a metal without which an object cannot be made'. Thus, metals on the list include elements such as neodymium, dysprosium or terbium; rare earths essential to the production of permanent magnets and so to the function of wind turbines, and inflight aerospace equipment. On this basis, Rhenium, some would say, is critical, because it is asserted that 2nd generation nickel base alloys containing Re 3% are un-substitutable for the manufacture of single crystal blades for gas turbine engines. Only Re-bearing alloys, it is said, allow the highest operating temperatures and produce the outcome of reducing nitrous oxide emissions to the upper atmosphere, increasing fuel efficiency and adding longevity and creep resistance to the blades.

However, our views need to be challenged in order to prove their veracity. If we are right, we need to be able to respond to the views expressed recently in an article in the *Journal of Metals* of Jan 2010, authored by three GE materials scientists, entitled *'Rhenium Reduction - Alloy Designs using an Economically Strategic Element'*.

The article, while acknowledging in its title the 'strategic' nature of Rhenium, nevertheless attempted to show several ways in which GE are working to reduce their exposure to this valuable element. Four ways were cited:

1. Introduction and application of a new Rhenium bearing alloy, with 50% less Re content than conventional 2nd generation alloy (called N515 containing Re 1.5%),

2. Introduction of an alloy with zero Rhenium (N500 Re 0%),

3. Reverting of cleaned casting scrap into super alloy heats

4. Recycling and recovery of Re units from spent nickel base alloy, too contaminated to be used as revert.

When Re metal prices reached US$ 12,000 per kg in Aug 2008 it caused anguish amongst Rhenium's main exponents in the super alloy and aero engine industry. But the debate now centres on whether such costs can be mitigated by reducing or removing the need for the metal. The article in *Journal of Metals* is clear that GE is making the new alloys part of their strategy, and anecdotal evidence confirms that commercial quantities of N515 have been made and used.

However, while GE extols the speed with which these new 'replacement alloys' have been developed, one of the key sentences in the article reads as follows: *'Rene N515 [Re 1.5%] and Rene N5 [Re 3%]are similar in oxidation resistance capability at 1175 degrees centigrade'.*

It is here that the battle over Rhenium needs to be fought - for 1175 degrees centigrade is not an operating temperature that will power the GP7000, the Trent 1000 or GEnx. It is possible that the CFM56, the world's best selling engine, with additional cooling, may be adapted to use the new alloy, but the larger engines need to run at higher temperatures for which no other alloys other than the current 2nd generation [Re 3%] and third generation [Re 6%] may apply. Nor, we believe, will it be possible for the ratings of the Joint Strike Fighter to be achievable in any other way. In an article by Ken Harris of Cannon Muskegon, (one of the key developers of CMSX-4 [Re 3%]), presented to *The Turbo Expo*, *Florida* in 1997, he mentioned turbine inlet temperatures targeted to reach 1650 degrees centigrade.

Whether any of the current generation of alloys can or cannot operate at temperatures of this nature, the prime aim of any turbine maker is to increase operating temperatures. So, while it may be possible to reduce Re content and apply such alloys in some circumstances, the issue for airlines and aero-engine makers is one of 'cost versus performance'. As Dr Malcolm Thomas, of Rolls-Royce Plc mentioned at AMMs aerospace conference in Pittsburgh, April 15th 2010, 'If I can make my engine operate a few degrees higher than my competitors, what am I going to do?' Pratt and Whitney were in the room to hear this and so were 200 others gathered from around the aerospace industry; and there was no one to disagree.

In reality, Rhenium remains critical i.e. un-substitutable, if we mean that we continue to strive for all the outcomes that Rhenium contributes to. This author, at least, believes Rhenium is not going out of fashion any time soon. But even so, this belief neither conflicts nor detracts from the need to conserve units of Rhenium wherever they may be found, nor with the aim to reduce the wastage of units that are lost to stainless steel at end of life, nor, where possible, to reduce Rhenium's use where it is 'not as critical'. Perhaps in this way the turbine industry will be able to muddle through on the 45 mt of primary supply per year currently produced and what little may be recovered from scrap. Until or unless new supply can be brought on stream, the trajectory for Rhenium remains extremely steady and its value will remain commensurate with the outcomes Rhenium brings to mankind.

Additional information: This article is also avaliable at www.metalprices.com under Rhenium section.