INTRODUCTION TO COMPONENT REFURBISHMENT

BACKGROUND

The life limiting factors of hot section components are the resistance against hot corrosion of the component surface and undesirable changes in the core of the material like aging reactions occurring in the microstructure of the alloy (e.g. growth and agglomeration of the Ni_3Al [gamma prime] phase, which is responsible for the physical and mechanical properties of nickel base superalloys at high temperature) or micro crack formation.

Life extension of hot section parts by repair and refurbishment is today state-of-the-art and an important aspect in the economy of power generation.

PROCESSES FOR REFURBISHING / REPAIR OF HOT SECTIONS PARTS

The relevant processes for refurbishing hot section parts:

- ***Stripping***
- ***Rebuild part shape***
- ***Rejuvenation***
- ***Recoating***

Stripping

The most common method to remove coatings after service is chemical stripping. The chemical stripping can be assisted by grinding and grit blasting.

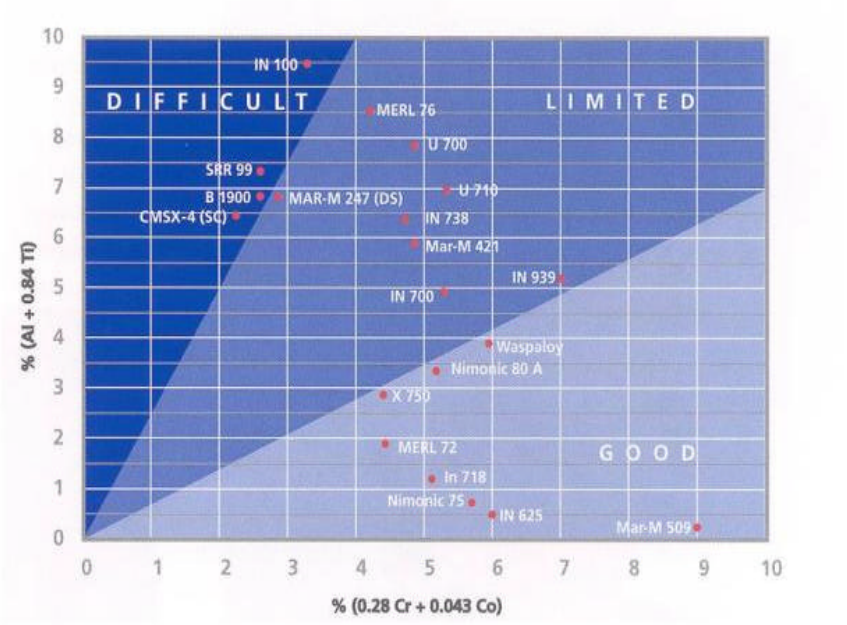
The process for chemical stripping has to fulfill requirements for the type of coatings (overlay or diffusion coatings), the chemical composition of the coating, the thickness distribution of the coating and also the chemical composition of the base material. The stripping process has to be properly designed and controlled to remove only the coating and the few micron thick diffusion zone. Root surfaces and inside internal uncoated cavities have to be masked to avoid chemical attack by the acid solution.

Rebuild part shape

The methods for rebuilding the part (welding, brazing, deposit of parent material by vacuum plasma spraying, laser cladding) are associated with the selection criteria for the chemical composition of the filler alloy and therefore with the required performance of the repaired part.

- **Welding**

The weldability of nickel base superalloys is a function of their chemical composition. The main risk is the formation of micro cracks in the weld or in the heat affected zone. Effective solutions are preheating of the part to be repaired and the control of the heat input into the base material. The big advantage of automated welding systems is a very low heat input during welding. This minimizes the impact on the base material.



- **Brazing**

Brazing is used to repair small cracks on components which are not highly stressed, e.g. vanes. For a successful brazing, the cracks must first be chemically cleaned by using fluoride ions or hydrogen cleaning processes (e.g. Dayton process) to remove oxides from crack surfaces. The brazing material will infiltrate the crack surface by capillary forces. Process control is of very great importance.

- **Deposition of parent material by vacuum plasma spraying**

In addition to applying coatings, vacuum plasma spray technology (VPS) is also employed to repair damaged blades and vanes through the deposition of superalloy of the same material as the base material. Vacuum plasma spraying allows the original part geometry to be restored, because material of several millimeter thickness can be deposited. This method is preferred for repairs of large areas.

- **Laser cladding (laser welding)**

Laser is a highly focused power source. This fact leads to major advantages for the process, laser welding, as a rebuilding approach. These advantages are as follows:

- There is no limitation in the material for build up welding, material build up with material similar to the component to be repaired is possible.

- The risk for crack formation in the welding area can be minimized by exact control of the welding process parameters.

- A perfect metallurgical bond with the parent metal can be achieved.

- The dilution zone in the build up welding is kept very small.

- The phase precipitation in the deposited material can be controlled, therefore the hardness of the deposit can be influenced.

Rejuvenation heat treatment

Vacuum heat treatments play an important role in the repair process for restoring the micro-structure of the repaired component. The parameters of temperature level and temperature versus time have to be adjusted for each material and specific purpose. The order of sequence within the repair procedure is also of importance.

Hot Isostatic Pressing (HIP) can help to heal any creep and fatigue damages accumulated during service.

Recoating

At the end of the repair process, in most cases coatings [hot corrosion resistant coatings e.g. MCrAlY type coatings, thermal barrier coatings (TBC)] must be reapplied, using processes and coating composition similar to that used in the original manufacture of the components.

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