Corrosion and Metallurgy

On-Site Metallurgical Analysis

On-site Metallurgy

As one of many services, FORCE Technology offers metallurgical analysis of fully operational components or of stationary or non-removable machine parts, which we can analyse on-site, even without having to cut samples.

On-site analysis of a material's properties makes it possible to target further analyses, repairs and countermeasures in order to get the system back into operation again faster and at lower costs.

Materials Properties

We look at properties such as:

- Microstructure
- Crack type
- Defect types in the material
- Hardness (for tensile strength estimation)
- Type of alloy (possibly using PMI techniques).

2027-1-en

Metallurgical Testing

Using a relatively small number of tests, we can check components on receipt to determine, whether they meet the requirements and provide you with a detailed description of the metal's quality, its heat treatment, actual final structure and strength level.

Materials defects that can be typed and classified on-site as insignificant are often accepted, thus avoiding expensive repairs and delays. On the other hand, materials defects or structural changes that are erroneously classified as harmless, but which are actually critical, may have wide-ranging consequences such as shorter component lifetime or system failure.

Inspection

Too little or no inspection of metal components is often the cause for systems failing or extremely inconvenient repairs having to be made. Any metallurgical inspection has to be based on fundamental knowledge of relevant failure mechanisms and correction of conditions for failure if unforeseen damage should occur. This involves identification of the defect causing the damage — identification based either on experience with the system or on detailed examination of the damage.

The cause of damage can be determined by on-site non-destructive test methods. Cracks, for example, can be identified as fatigue cracking, creep, stress corrosion cracking or hydrogen embrittlement, or as pre-existing defects in the material. Information on the type of damage will then be used to determine changes to be made in operating conditions or materials selection so that recurrence of such damage is avoided.

In our experience, on-site metallurgical methods - unlike traditional NDT methods - can predict many structural failures long before they happen, failures that can be avoided by making limited repairs or changing operational procedures.

High temperature operation or unintended exposure to heat can result in gradual weakening in the metal strength due to structural changes that can be revealed and monitored by on-site microstructural analysis and hardness testing. Data from these test methods and from service logging can then be used to determine remaining lifetime of the material. The advantage is savings from planned repairs and replacement rather than waiting for failure to occur. This kind of testing is routine at many power and chemical plants.

After a fire structural integrity is a key issue. On-site metallurgical testing can reveal which components are actually damaged and must be replaced, and which components can be put back into operation again without risk.

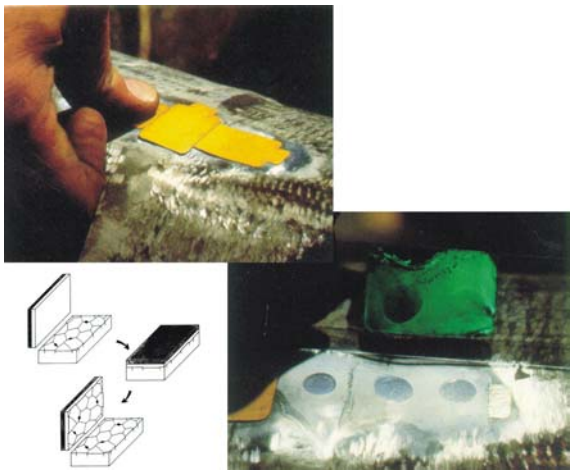
Replica Techniques

At FORCE Technology we have worked with replica over the last 25 years. In our work we apply both the replica technique using thin acetate foils as well as the replica technique using a two-component polymer silicone rubber.

- On smooth and prepared surfaces:

A material's microstructure can be determined by directly examining a polished and etched surface using portable microscopes. In most cases, however, even better results can be had by making a copy or replication of a prepared surface for subsequent laboratory analysis.

A replica of the surface is made by applying a softened plastic foil to the surface. This foil moulds itself to the metal surface when pressed. After its removal from the metal, the plastic replica provides an exact copy of the etched surface microstructure, which can then be examined under our laboratory's high-quality and very high-resolution microscopes.



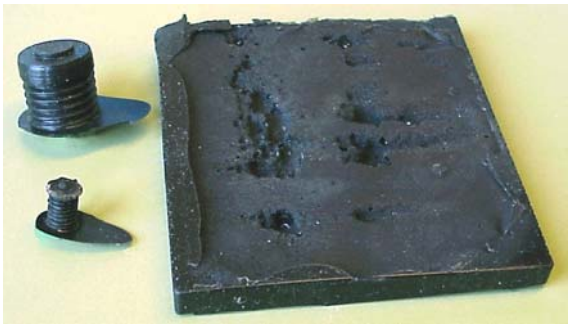
Such replicas can be stored for decades and subsequently used in comparative analyses. The replica technique can also be employed to determine types and causes of cracking, or to reveal whether cracks are propagating. An expensive repair of an insignificant defect will often be avoided this way.

The replica technique is widely used on high-temperature components in power stations and chemical plants; it enables inspection of the most critical parts of a plant during short shutdowns. The technique can also reveal whether an austenitic stainless steel has microstructural changes that could induce lower corrosion resistance than required.

- On complex and rough surfaces:

FORCE Technology also offers replica inspection using high-resolution silicone rubbers. This method allows the replication of rough, uneven surfaces even at elevated temperatures whether it be for metallurgical examination or documenting surface appearances. It opens the possibility of accessing remote and difficult-to-access-locations in applications such as boilers, engines, gearboxes, reaction vessels, pipes, tubes, dies, internal cavities, bolt-holes and a multitude of similar situations. Moreover, silicone rubber replicas are also applicable in sub-sea environments and in nuclear reactor installations.

After removal from test site the silicon rubber replicas are used for metallographic microstructure assessment, crack characterisation and for surface finish and profile measurements of for instance machine components.



Hardness Testing

Hardness testing provides indirect but vital information as to the tensile strength or wear-resisting properties of a material, information that would otherwise have to be gained from testing large specimens, cut out of the metal to be tested.

We have portable equipment for standardised tests such as Vickers, Brinell and Rockwell C, as well as more flexible equipment for Equotip and UCI testing.

Hardness measurements used to test high-strength construction steel ensure optimum properties. If the steel hardness in the heat affected zone is too high, the steel may be vulnerable to hydrogen embrittlement, which can lead to serious failures. Hardness testing can also reveal insufficient heat treatment or changes in strength properties, e.g. after a fire or equipment overheating.

If the metals used in a structure or machine have characteristics different than what is required, the consequences are often shorter lifetimes, expensive unscheduled shutdowns, or serious system failures. On-site testing of these materials can reveal any changes in properties or non-compliance with specifications and thus help keep repair an maintenance costs down.

Other services

Among other related testing services performed by FORCE Technology are:

- Roughness measurements
- Stress measurements
- Coating thickness measurements
- Measurement of stainless steels' ferrite content
- Chemical composition analysis.

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