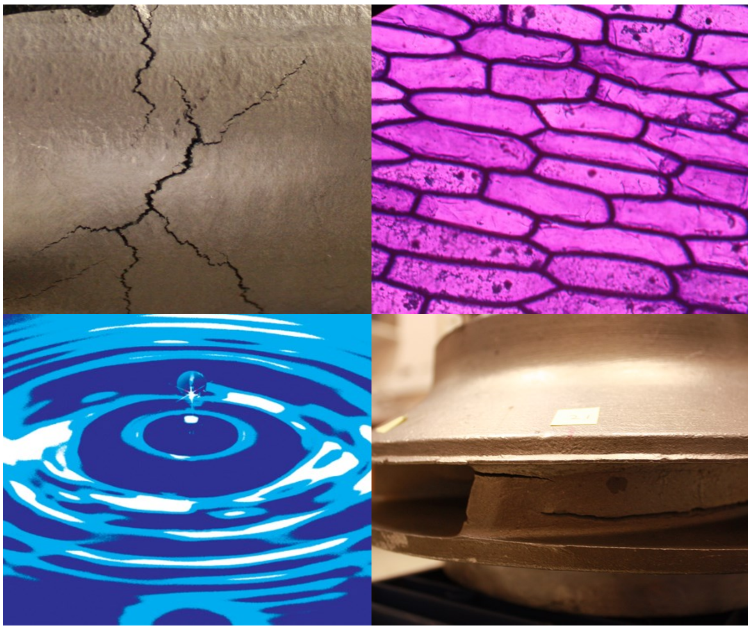


ACOUSTIC AGREE

White paper on the

NAW®-technology

provided by Acoustic Agree AB

A new NDT-method that does it all!

The NAW®-technique offers large quality and cost advantages.

One of the problems many industries and their customers face is imperfections such as cracks, delamination and other flaws that decrease the durability of their product. These imperfections originate from the material used, occur during production or arise when the product been used for a while. All of these situations will ultimately cost money.

Making high quality products using faulty components is impossible. Ensuring that incoming material keeps an appropriate quality level is necessary. It is always best to sort out faulty components as early as possible in the production before too much value has been put in that will need to be scrapped. But how?

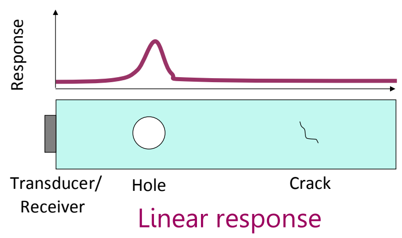
Processes during production such as shape changes through rolling, hard turning, milling and during stamping can cause cracks of various size. If those cracks are big enough or happen to be unfortunately placed they can start to propagate when the product is used. Many companies try to sort out the worst products in an attempt to avoid unhappy customers, save money, save credibility and even save lives. It is key to have control and knowledge of what happened within the material during the production steps. This should be done fast, inexpensive and non-destructive. But how?

Very few products can last forever and therefore maintenance is important. Critical parts should be replaced or repaired before they cause failure or damage to the rest of the system or lead to personal injury. On the other hand those parts shouldn't be changed earlier than needed either, since that would lead to unnecessary cost. Today the maintenance intervals are often calculated based on statistics. It would be more cost efficient to have the possibility to investigate the current "health status" of the part or even having a monitoring system send a notice before a failure allowing a time for preventative maintenance. But how?

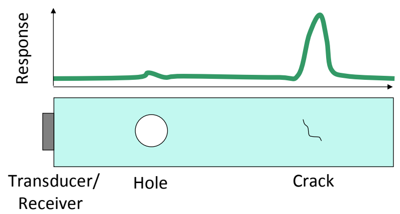
One widely used technique used in an attempt to find these kinds of problems is ultrasonic inspection. Conventional industrial ultrasonic inspection can detect embedded defects in fairly thick material as well as in welds. It can detect delamination and be used to measure thicknesses. But this method requires experienced operators to ensure reliable results. Conventional ultrasonic inspection is also limited by complex geometries and that the fact that this way of measurement is very time consuming.

In the conventional industrial ultrasound inspection method a sound wave is sent into the object and collected at the same place. The measurement using conventional ultrasound inspection will visualize the echoes present below the specific measurement point. Cracks and other defects will be shown as an echo in the signal as well as drilled holes and other geometry variations. One drawback is that a drilled hole between the transducer and the crack will shadow the crack and only the drilled hole will be seen as an echo. This means that to get a complete evaluation of the object it needs to be scanned thoroughly which takes unnecessary time. Especially if the result in the end shows that the part is intact!

Other common techniques include x-ray, penetrant testing, Eddy Current and visual inspection, to mention a few. They all have their benefits, but also their drawbacks. They all require experienced operators to interpret the results and most have a limited inspection depth even in the simplest geometries. X-ray is limited by complex geometries and the need of barriers due to radiation. Penetrant testing requires many steps including fluids to reach a result, and Eddy Current is only adaptive on electrically conducting materials. And none of these methods gives satisfactory results if the structure is large.



Linear response



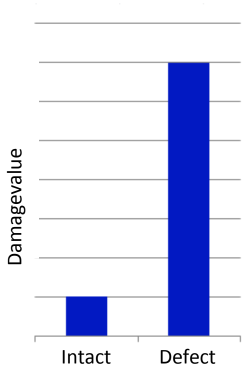
Nonlinear response

A solution to many of the problems is a change of technique. Acoustic Agree AB provides a relatively new way to investigate objects called NAW®. The technique uses ultrasound but instead of looking at one specific volume at a time the whole object is examined in just one measurement.

Using NAW®-measurement acoustic waves are propagated through the material and are collected anywhere on the object. The waves distort when propagating over the defect area. Cracks and other defects will influence the signal in a nonlinear way leading to that every defect slightly changes the signal, nonlinearly. When collecting the signal the result will show a total value of imperfections in the measured part. This value is called a damagevalue. By letting the signal propagate through the whole part the measurement is done quickly and complex geometries are no longer an issue. A drilled hole for example won’t add to the damagevalue as a crack, since the behavior of a crack is nonlinear. Now faulty (of defective) parts will be easy and fast to sort out.

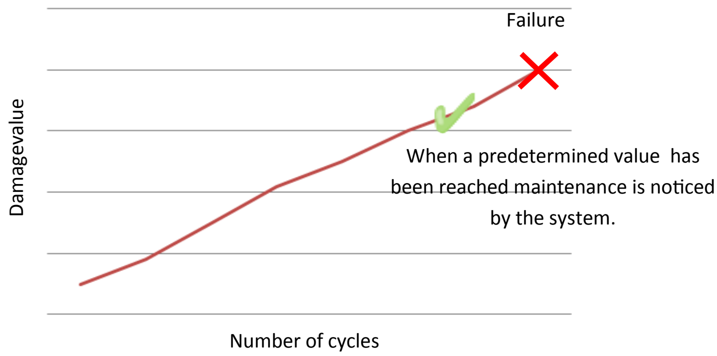
If a part containing defects is found it is possible to localize the defects by doing a few more narrow follow-up measurements. Another benefit is that the method can be used to examine any type of material from steel, cast iron, stainless steel, stone (granite, sandstone), titanium, rubber, glass, concrete to carbon fiber and sintered steel as well as layered geometries as glass fiber reinforced laminates and welds.

By knowing this it is now possible to quickly distinguish a part that contains defects from one that does not. The damagevalue of the intact part will be low. The damagevalue of the damaged part on the other hand can range from the double to up to hundreds times that value of a defect free part. This depends on the amount of damage in the defective part. Every small crack, delamination and imperfections down to the lattice structure will add to the damagevalue. Based on initial measurements a damage limit can be set, determining whether a part is to be considered intact or not.



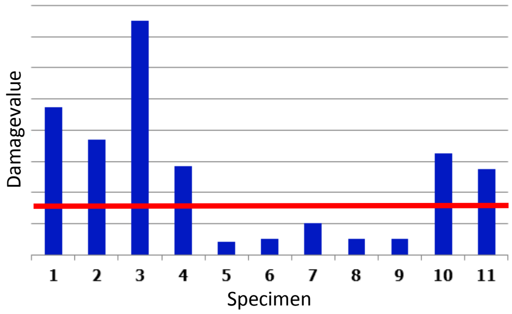
By implementing this new knowledge into an office receiving goods, a production line, a quality check office or in the hands of the staff doing maintenance it is possible to save both time and money in the testing procedures as well as further into the production chain. The receiving goods office could avoid letting bad material or components to be released into the production. The critical procedures during production can be monitored and the least good parts can be separated from the line to be discarded or repaired. By reducing the amount of bad parts going through the production line a lot of money can be saved.

The NAW®-method is fast. When the initial tuning is done the measurement can be done in a matter of seconds. The result shown is a value meaning that the operator handling the device easily can distinguish if the part is ok or not. The result can also be monitored by software in the case where NAW® is integrated in a factory production system or a similar monitoring system. When monitoring the fatigue of critical parts the damagevalue will rise as the fatigue of the material rises. The damagevalue gives a linear expression to the number of cycles exposed. The program then sends a "heads up signal" to the maintenance crew when a predetermined value has been reached. When using the NAW®-method the maintenance will take place when it is actually needed not when it is statistically calculated to be needed.



Industrial examples:

Investigation of manufactured products.



A set of 11 complete heat exchangers from a market leading manufacturer were investigated to see if the NAW®-method was able to find the fabricated internal damage. The test was performed as a blind test and the results are shown in the graph. The subsequent destructive testing verified the NAW®-result. The specimens 1-4 and 10-11 contained damage of various severity. The specimens 5-9 were considered intact and had only negligible defects.

Maintenance investigation.

An industrial high temperature and high pressure oven was investigated since it had started to leak. No cracks through the thickness were allowed. The oven had to be cold to be able to be investigated. The cracks were in room temperature compressed and thereby to small to be found with a helium sniffer. With the NAW®-technique it was possible to pinpoint the leakage area and the maintenance staff were able to repair the oven.

The NAW®-technique is a fast, reliable, easy-to-use non-destructive testing method. It is flexible in terms of geometry and material and is a strong challenger and complement to conventional methods. Since all evaluation is done by the software the NAW®-method is suitable for automated inspection in production lines as well as structural health monitoring.

Acoustic Agree AB offers complete measuring solutions for our customers using the NAW®-technique. Acoustic Agree AB offers sensors, amplifiers and software as well as an overall solution from specially application designed sensors to implementation in production.

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