

## Surface Defect Detection Technology Contributes to Shortening of Inspection Time

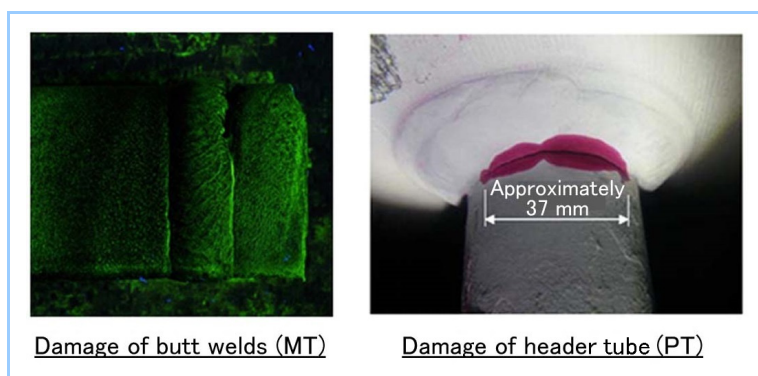


Mitsubishi Hitachi Power Systems, Ltd.

Welds of a thermal power plant boiler, which may be damaged by thermal fatigue cracking, creep fatigue, etc., are surface-inspected using PT (penetrant testing), MT (magnetic particle testing), etc. However, PT and MT inspections require the removal of the high-temperature oxidized scale generated on the tube surface, and this preprocessing work takes time. Furthermore, because there are parts with complicated shapes and narrow areas depending on the equipment, the work efficiency of PT and MT may be lowered and that results in long inspection times. Accordingly, Mitsubishi Heavy Industries, Ltd. and Mitsubishi Hitachi Power Systems, Ltd. developed surface defect detection technology using Pencil ECT (Eddy Current Testing) as a technique for efficiently detecting the damage. This paper describes the characteristics of Pencil ECT and case examples of defect detection implemented on actual boilers.

### 1. Background

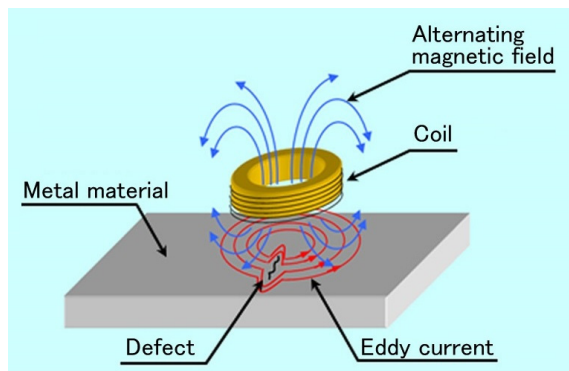
**Figure 1** shows examples of damage of boiler welds. Major damage occurring on boiler welds includes thermal fatigue, creep fatigue, etc. In periodic inspections, PT and MT are applied as an evaluation method of cracks caused by this damage. However, if high-temperature oxidized scale, etc., are generated on the surface of the inspection object, polishing such as blasting or grinding is required, and such preprocessing work takes time. In the case of PT, the detection of cracks utilizes the capillary phenomenon of penetrant and developer, so it takes time for the penetration of detecting liquid and for the detection of defects. Furthermore, when the inspection object has a complicated shape and exists in a narrow space, such as a header tube, the work efficiency of PT and MT decreases, resulting in longer inspection times. On the other hand, there is a growing need to shorten the periodic inspection process of thermal power plants to improve the operational rate, and the efficiency improvement of non-destructive inspection implemented during periodic inspection is required. Therefore, we developed a Pencil ECT (Eddy Current Testing) sensor that can efficiently inspect boiler welds.



**Figure 1** Boiler welds and examples of damage

## 2. Characteristics of Pencil ECT

**Figure 2** presents the principle of ECT. ECT is a technology to generate eddy current in a conductive specimen and detect defects existing on the surface of the specimen based on changes in the eddy current. Since ECT is a detection method that uses an electromagnetic reaction, it is characterized by being barely affected by scale. Using this characteristic, we developed a Pencil ECT sensor that can detect defects even when scale is adhered to the surface of the object being measured.



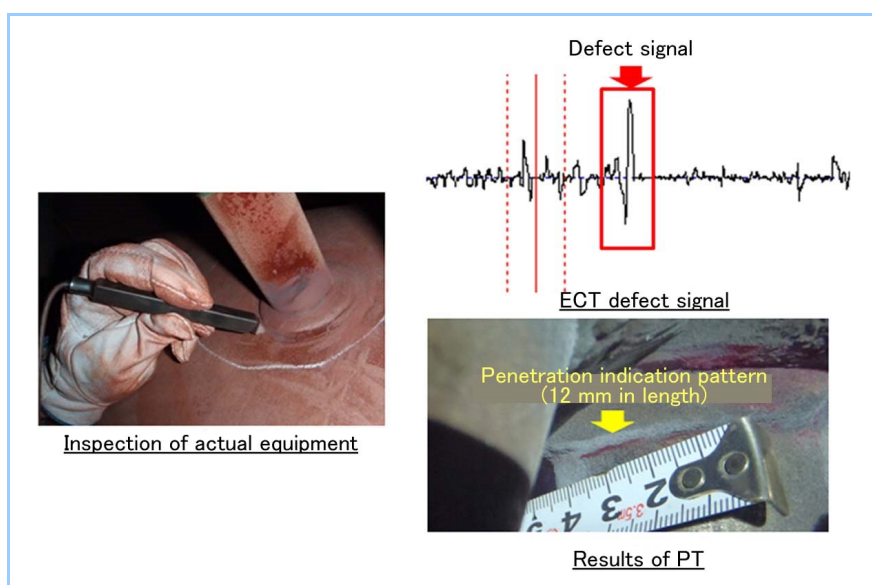
**Figure 2** Principle of ECT



**Figure 3** Pencil ECT sensor

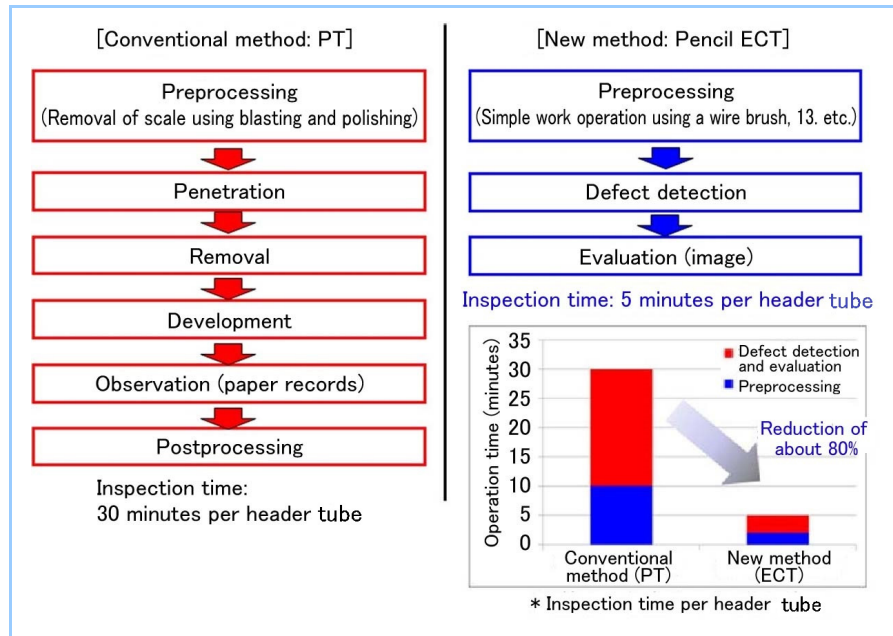
**Figure 3** shows the developed Pencil ECT sensor. The Pencil ECT sensor consists of a pencil-like holder and a small coil. The small coil is mounted on the tip of the sensor and embedded in a low friction material. By bringing the tip of the sensor directly into contact with the weld end, it is possible to detect a defect even in locations where the weld shape is suddenly changed. In addition, due to its pencil-like shape, the sensor is easy to hold and makes inspection relatively easy, requiring no advanced skills for sensor scanning. In some cases where the inspection area has a complicated shape and is a narrow space, such as a header tube, the magnetizing device for MT cannot be accessed. Due to its small size, Pencil ECT can access the narrow area easily. Pencil ECT can be applied to the inspection of cracks occurring on not only welds, but also element pipes, flat plates, etc.

**Figure 4** indicates an inspection example of a weld of a header tube in an actual boiler. As shown in the figures, it was confirmed that penetration indication patterns were detected as a result of PT implemented at the location where Pencil ECT detected a defect.



**Figure 4** Inspection example of header tube in actual boiler

**Figure 5** shows a comparison between the conventional PT method and the developed Pencil ECT for the operation time per header tube. While the operation time of PT is 30 minutes (including treatment of the surface) per location, that of ECT can be shortened to about 5 minutes under the same conditions, so the operation time is expected to be shortened by about 80%. This is greatly attributed to the reduction of the preprocessing time. The aim of this sensor is to shorten the preprocessing time, but time periods for defect detection and crack evaluation can also be saved, resulting in the improvement of the efficiency of all work operations. In addition, because the inspection records can be stored as digital data, the handling of records is easier than ever and it is possible to create a database. As such, many advantages can be expected by applying ECT.



**Figure 5** Inspection example of header tube in actual boiler

### 3. Future prospects

We have been working on the development of various inspection technologies for boiler parts/forms of damage to improve the operational rate of thermal power plant boiler facilities. This paper described Pencil ECT, which is one of the developed technologies. We will continue the application of this technology to actual facilities, and also promote further upgrades to contribute to the improvement of the operational rate of thermal power plant boiler facilities. The inspection technologies introduced here will be applied not only to boiler facilities, but also to chemical plants and various piping facilities.