Plant Maintenance Services for Renewable Energy (Solar and Wind Power)

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Abstract

With growing concerns regarding environmental challenges and the need to take measures to deal effectively with Climate Change, renewable energy sources such as solar power, wind power, have generated more interest year after year. On July 1, 2012, the Feed-in Tariff of renewable energy was introduced in Japan and the renewable energy resources will be more widely accepted in the future in Japan.

Facilities of power generation using natural renewable energy are always exposed to natural threats. In order to prevent the reduction of availability caused by failures and manage facilities efficiently, preventive maintenance is the most essential factor.

As a heavy electrical supplier, we have delivered a variety of power generation systems, distribution systems, and power conversion products. As a service to the installed units, we have implemented maintenance technologies and preventive maintenance techniques. We provide these services to renewable energy plants by drawing on these engineering resources and by applying new facility diagnosis products.

1 Preface

We began accumulating our maintenance-related technologies for solar power since 1996 and for wind power in 2003. At this time, we shipped such energy source units to project sites for the first time ("First Shipment"). As a supplier, we have installed many renewable energy-related products to many customers ever since.

Compared with conventional products, many of these systems are designed to simplify maintenance. Compared with indoor types of products, outdoor products which are continually exposed to the natural environment have more incidences of failures due to the fact that these products are directly impacted by climatic conditions, temperatures, humidity, vibrations, etc.

In addition, solar power systems require a large installation area and facilities of wind power generation are installed in a remote locations, distant from power demand such as on mountains or along the seaside. If failure occurs, it takes a lot of time to recover the system and the availability rate of the power drops. Remote monitoring of daily operating conditions is carried out at Meiden Customer Center (MCC), and in the case of such an error code, MCC immediately analyzes the cause of the failure and takes prompt measures for the system recovery in order to improve availability of power.

Ever since the First Shipment, we have made every effort to deliver consistent maintenance for installed units. Most recently, the need for preventive maintenance has increased in order to curb the unexpected occurrence of lost profits.

This paper introduces some examples of preventive maintenance by using newly adopted diagnostic equipment in addition to conventional inspection items.

2 Maintenance of Solar Power Generation System

2.1 Thermal Image Diagnosis on Solar Panels

Thermal image diagnosis has been actively utilized as a facility diagnostic technique to discover the presence of abnormal overheating due to loose screws around the terminals. An example of thermal image diagnosis adopted for solar panel maintenance is introduced below.

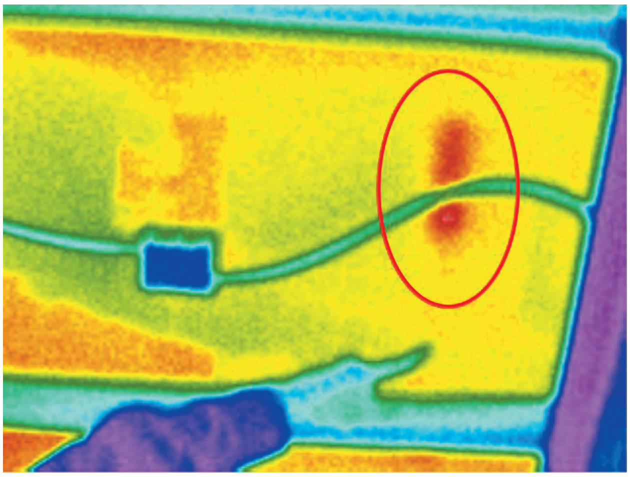

Fig. 1 Thermal Image Diagnosis on Rear Surface of the Panel

A thermal image is shown, where a hot spot is detected by a thermo tracer attempted from the rear surface of a solar battery panel.

Presently, with the Power Conditioning Subsystem (PCS) having a larger capacity, the number of solar panels handled by a single PCS unit amounts to a few hundred panels. In the case of a mega solar, solar panels in units of a thousand will be installed in the system as a whole.

Meanwhile, maintenance for solar panels is generally carried out by visual inspection and this takes much time and is labor-intensive. As a new initiative, we are promoting the introduction of thermal image diagnosis for verification so that any symptom of potential failure in a solar panel can be identified. An example of thermal image diagnosis follows below. **Fig. 1** shows an example of thermal image diagnosis that discovered a hot spot on the surface temperature distribution during diagnostic services over the rear surface of solar panels. When we made a visual check over the surface of the solar panel where the hot spot was located, we discovered a spot of peeling (see **Fig. 2**). As a result of detailed inspection on the peeling spot, we were able to finally discover a pinhole (see **Fig. 3**).

2.2 Proposal of Precise PCS Inspection

The PCS is used to invert the DC power of solar panels into stable AC power, a grid-connected with a utility power network. PCS's major components are inverters, control circuit, and a grid protection unit.

In the conventional design, the system protection unit was equipped with a general-purpose grid-connection protective relay. Today, however, functions of this relay are integrated into a control PCB. By using our proprietary dedicated tools, we can check the PCS functions, measure the characteristic values, and carry out overall protective relay tests.

We make an inspection proposal to our customers to carry out precise inspections including the protective relay test, so that our customers can constantly operate and manage their facilities under the best conditions.

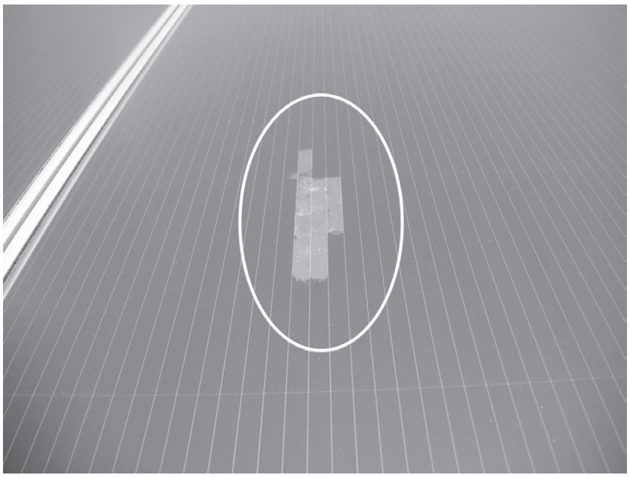

Fig. 2 Peeling on Front Surface of the Panel

A section is shown, where part of the front surface is peeling off in solar battery panels.

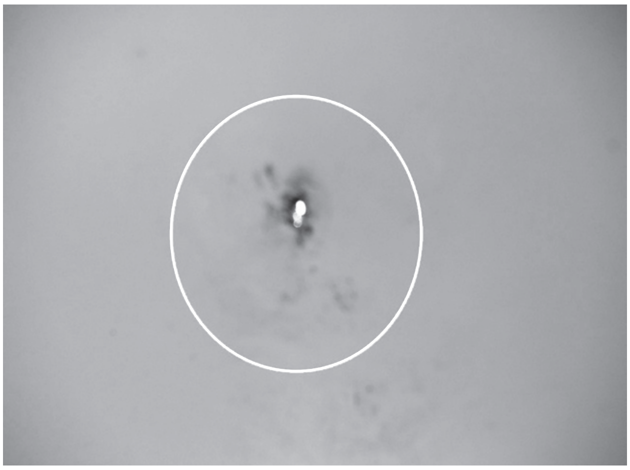

Fig. 3 Pinhole Located Near the Peeling Spot

A pinhole is detected in the vicinity of the peeling spot in the solar battery panel.

3 Maintenance of Wind Power System

3.1 Bearing Deterioration Diagnosis

After a long duration of operation, bearings used in a wind power generation system are prone

Fig. 4 Bearing Deterioration Diagnosis

The conditions of deterioration diagnosis are shown for large-sized bearings located in the main shaft.

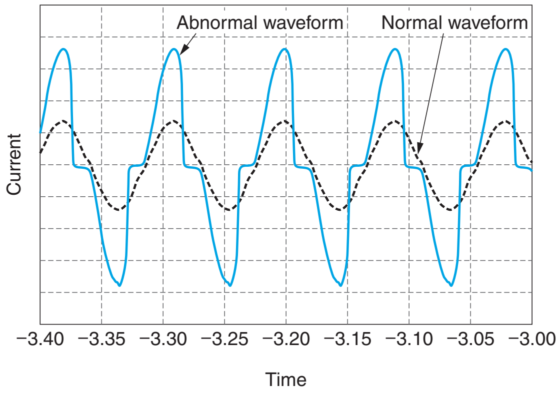

Fig. 5 Abnormality in Output Current Waveform

An example is shown of converter output current waveforms. The current waveform looks substantially distorted and an adverse influence upon the utility power system is likely if operation of this equipment is continued further.

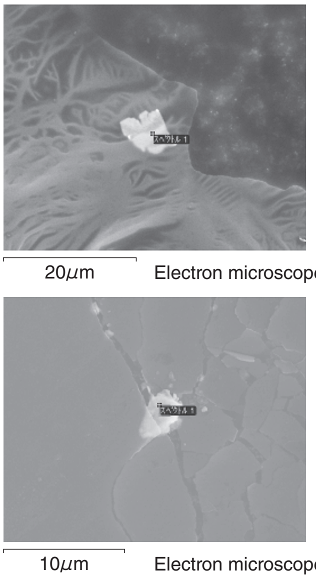

Fig. 6 Example of Foreign Substance Analysis for Grease

By grease analysis to find out foreign substances if any, it is possible to predict the state of deterioration in parts or grease itself.

to increased mechanical failures. A possible cause of deterioration is due to metal wear and fatigue. One diagnostic approach, in this section introduced is the Acoustic Emission (AE) method that is used for bearing deterioration diagnosis (Fig. 4).

Bearings are generally checked based on the result of an evaluation with the use of a listening rod. This method is considered to be influenced by servicing personnel's personal level of expertise; even by measurements with a vibrometer, an early stage of deterioration cannot be discovered in some cases. In order to check the presence of deterioration at an early stage, periodic and quantitative diagnosis is indispensable and bearing deterioration diagnosis by the AE method is effective. Second failures due to bearing destruction and resultant lost profits can be avoided in advance.

3.2 Converter Check

For the wind power systems inspected by the Company, the rotor of the induction generator is linked with a converter so that the phase, power factor, and active power can be controlled. Converters for such model are generally imported products. Compared with Japanese converters, detailed inspection items specified by the supplier are minimal; as such, it is difficult to assess the symptom of a failure.

Drawing on past cases of inspections of converters and inverters, this section introduces an example of prevention of dependent failures by measuring output current waveforms in converters. Fig. 5 shows abnormality in an output current waveform. By this measurement, the defective component could be located and the occurrence of a dependent failure could be avoided by the replacement.

3.3 Cooperation with Various Diagnostic and Analytical Centers

The wind power system's maintenance key products are composed mainly of the gearbox, and large-sized bearings inside the tower and a transformer outside the tower. Various kinds of grease oils are used in the gearbox. If the composition of these oils is periodically analyzed, it is possible to determine an adequate timing for the replacement of lubricants. In addition, the status of facilities can also be identified. Fig. 6 shows an example of foreign substance analysis for grease.

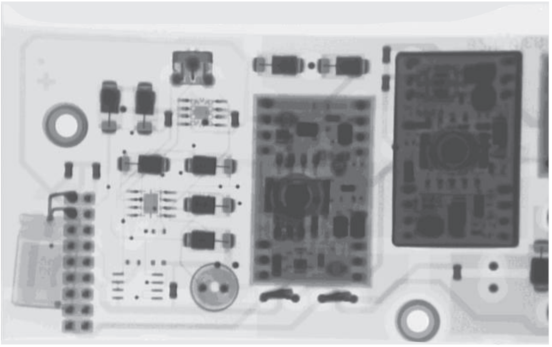

Fig. 7 Example of X-ray Inspection

An example of an X-ray inspection for PCB is shown. The presence of patterned damage and/or cracks can be identified by a non-destructive inspection.

Contents of new inspections can be defined by making a micro surface inspection, non-destructive inspection, and metal analysis for faulty parts and components. Fig. 7 shows an example of an X-ray inspection.

4 Postscript

This paper introduced efficient preventive maintenance with the use of diagnostic equipment. In addition to this approach, we are now promoting the upgrading of our fundamental maintenance expertises. At Meiden Technical Center situated in Numazu City, Shizuoka Prefecture, we have a real model of the solar power system to implement the training of solar power maintenance techniques. In regard to wind power systems, we received authorized supplier education programs by the overseas wind turbine supplier for the purpose of further improving our technical capabilities.

We will continue to accumulate practical servicing data using new diagnostic techniques and intend to offer facility maintenance services throughout the lifecycle of the installed system.