Feature

By Robert Ward

Advances in Eddy Current Inspection Technology

Eddy current testing has evolved in reaction to technological advances over the past decades, bringing it to new levels of value and performance

With the portable Mentor EM from GE, there are no physical dials or other external variables on the device to affect test results; the probe used to perform the inspection is the only external feature. (All photos courtesy of GE Measurement and Control.)

Eddy current testing (ET) is fundamentally the same as it was when first introduced in 1879 by David Hughes, yet it remains among the best inspection techniques for use in many cases today. While the technology itself is unchanged, its applications have become much more sophisticated, particularly over the past twenty years. Inspection professionals across manufacturing, oil and gas, aerospace, power, and various other industries are able to perform inspections plus detect and size flaws with greater speed and accuracy than ever before.

How and when ET is used has changed remarkably, and the digital age has brought transformational change for inspection technology. Recent advancements in eddy current tools have simplified not only the inspection process, but also the training and collaboration processes involved across industries, increasing the scope of applications and usefulness of the technology. As inspection technologies become more advanced, the need to recruit, train, qualify, and retain skilled nondestructive examination (NDE) personnel becomes increasingly important, especially in an industry where the workforce is rapidly aging.

The Move from Analog to Digital

One of the key benefits of ET for inspection technicians is its transportability, which can be traced back to the early 1990s. This was a turning point for the technology because it allowed technicians to bring the technology they needed into the field. The transition from large, analog technology to more compact, digital systems allowed inspectors to adapt the testing process for more NDE applications. For its previous 100-year history, performing ET required the equipment under review to be brought to a laboratory; now, inspectors could bring the ET equipment to the object in the field.

Of course, transportability is a relative term, and in its first outside-the-lab incarnations, ET equipment was transportable on par with a refrigerator or a safe. The difference was significant enough, however, that ET could now be performed on equipment in the workplace. In the early field inspections, ET was used to check steam generators at nuclear power plants, to ensure that high-pressure radioactive steam from inside the reactor was not escaping to the environment.

As the technology improved, the number of industries and applications using ET grew. Given the increasing number of facilities and systems that required constant inspection, performing and staffing regular inspections became a major challenge — especially for teams that were top heavy with advanced inspectors. In the 1990s, the company Zetec introduced a new method where an on-site team transmitted inspection data to a centralized analysis team using a satellite or online connection. This advanced process relieved the need for the experts to remain on site for analysis and final decisions. Zetec improved the productivity of Level III inspectors by enabling a given crew to support testing at multiple sites simultaneously. The Internet made data

The recent emergence of powerful, networked portable devices is one of the notable trends in eddy current testing today.

With today's eddy current equipment, complex inspection projects can be completed in less time, with fewer staff involved, and with far greater confidence in the data.

transfer even simpler and, not long after, software emerged to improve the quality and analysis of data, laying the foundation for how ET is used today.

Making Smarter Machines

Eddy current testing equipment has tremendous sensitivity. The technology can detect defects that are well defined and discern defects even through significant noise in the data signal. This also means that very minor patterns in a sample — for example, tooling marks left by the process of lathing during manufacture — could give a response very similar to a defect signal. Noise, or signal interference, can be caused by naturally occurring factors such as temperature, changes in conductivity, and magnetic permeability.

The creation of noise-filtering technology opens the use of ET to a broader, constantly growing range of applications. Researchers discovered that various types of signal noise occurred in recognizable or predictable patterns. Anticipating and eliminating these effects using software-based processing on the source data essentially erases noise signals and leaves the rest of the picture, allowing ET to reliably provide clear diagnostic images.

The effect of noise-filtering algorithms on ET has been profound. Research led by Professor Lalita Upda at Michigan State University validated the accuracy of noise filtering algorithms and led the Electric Power Research Institute, a worldwide consortium of utility companies, to recommend to member utilities that use of defect recognition software be the primary means for signal identification. Experts are used in supporting and verification roles, to corroborate and validate the indications called out by the software.

Advancements in technology have vastly improved the inspection process. For instance, the nuclear plant steam generator inspection that originally required six inspectors working up to 28 days can now be completed in under a week — with half the staff and with far greater confidence in the data.

With technological advancements also come training advancements. Because ET devices provide clear interpretations of scan results, less experienced inspectors are capable of making critical decisions that previously required the approval of Level II and III certified inspectors. Moreover, as ET equipment becomes smaller and less costly, its use expands far beyond the nuclear reactor, airplane manufacturing floor, and petrochemical processing operations that have long been its focus. One can now find high-end auto mechanics using ET equipment to detect whether parts are suitable for use or require replacement.

New Frontiers for Eddy Current Testing

There are a number of current and emerging trends that promise to further revolutionize ET for the next phase of inspection. One notable trend is the recent emergence of powerful, networked portable devices.

Previous generations of inspection technology often required the testing technician to carry cumbersome equipment, diagrams, maps, and numerous other paper documents for information on the testing process and the standard requirements for the test. Given the complex and often harsh industrial environments inspectors work in, this process was far from ideal and introduced a number of variables that could affect the accuracy of test results.

This year, GE launched Mentor EM. With this portable device, the testing process is automated on-screen, including all relevant information on test metrics, procedures, and standards.

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Where previous ET devices have been standalone units that perform a reading — essentially like a very advanced pocket compass — Mentor EM incorporates a comprehensive information system. Not only can technicians capture its readings onto a network database, but future versions of the system will be capable of finding and opening information on the network. The inspector can be relieved of carrying paper documents, which instead are directly viewed on the instrument's tablet. Printed documents expire; online documentation can be managed to provide only current information.

The new system also has the ability to create standardized inspection workflows. It can automate the test process, which again is a seemingly small advancement that could have tremendous implications. Large organizations with numerous inspectors at multiple facilities might find that their ET is performed differently, with slightly different results achieved by each individual. By developing a standard practice, the company can be confident that all of its weld inspections, for example, are being performed in exactly the same way, with results that can be duplicated by any one of its test technicians.

Through the use of connectivity technology, technicians can bring others into the inspection process as needed, without having to wait for them to physically arrive on site, saving time and money. In addition, a higher-level engineer located anywhere in the world can work with the inspection technician, directing all of his or her actions to achieve unambiguous results. The equipment also offers the foundation for a broad rethinking of the process of ET inspection within a company, perhaps realizing untold means of efficiency or advancement of skill and corporate knowledge.

Conclusion

Eddy current inspection has become one of today's most useful and essential modalities for NDE. It has achieved this status by evolving in reaction to technological advances over the past decades.

As of 2014, a number of new advances have been introduced to ET, including networked communications, collaborative features, and an application programming interface, that promise to expand the horizons of this test modality dramatically, making it feasible for a far wider range of applications and bringing new technicians and operators up to speed more quickly and efficiently.

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