A computerized, wireless instrumentation has been developed for testing and evaluating quenchants and quenching systems.

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A system for testing and evaluating quenchants and quenching systems has been introduced by IVF Industrial Research & Development Corp. in Sweden. The ivf SmartQuench has three main features: a small, handheld data acquisition unit, advanced computer software, and wireless data transmission between the data acquisition unit and computer. This design facilitates testing on-site in quench tanks as well as in the laboratory. Cooling-curve evaluation is an application of the flexible, user-friendly software.

User needs prompt development
One of the most critical aspects of the heat treating process, and usually the least controllable, is quenching. Improper selection or application of a quenchant, or a drift in its cooling characteristics during its lifetime, may cause large, unexpected costs due to products not meeting specifications; for example, the costs for straightening, rework, or even rejection.

Increased awareness of the importance of quenching came as a result of the introduction of new ISO and ASTM standards for testing cooling media (hardening oils and polymers) during the 1990s. Today, these standards have gained widespread international acceptance, and the number of heat treaters that use them is steadily increasing.

Another reason for this growing awareness is the availability of commercial, computer-based instruments designed for testing quenchants in accordance with these standards. One of the first instruments of this kind was the ivf quenchotest. It was introduced in 1985, and more than 300 units have been sold in 26 countries. Similar devices were subsequently developed by other manufacturers.

These instruments have allowed quenchant suppliers to ensure the quenching performance of their products before shipment, and have allowed heat treaters to check the quenchants before accepting them and to monitor them while in use. Heat treaters also have a tool by which they can compare quenchants from different suppliers. In addition, if the results of hardening deviate from expectations, the user has a tool for analyzing to what extent, if any, the nonconformance is related to the quenchant’s characteristics.

With the devices currently on the market, a cooling curve is produced showing temperature vs. time and cooling rate vs. temperature in the center of a test probe immersed in the quenchant. However, some users have asked how the results should be interpreted. They ask, “What does a certain change in the cooling curve mean for my hardening performance?” “Can we continue to use the quenchant in our tank or should we recondition or even exchange it?” “What if we change to a competitor’s oil? How do they compare?” Questions like

Fig. 1 – The ivf SmartQuench system is used to test and evaluate quenchants and quenching systems. Measurement on-site is facilitated by the absence of a cable connection between the handheld data acquisition unit (at right) and the computer (at left) during recording. Cooling-curve evaluation is an application of the system’s software. Photo taken in IVF’s lab.
these can easily be answered with the new ivf SmartQuench. Details follow.

**Quench test and evaluation**

The ivf SmartQuench system (Fig. 1) was developed by IVF in close cooperation with two partners who assisted with the development of the software and the data acquisition unit.

**Data acquisition:** The battery-operated, handheld data acquisition unit is connected to the test probe by a quick-grip plug. As many as six measurements can be stored in its memory. The user can choose from a number of options regarding measurement times, sample rates, and modes of measurement, including automatic start of recording when a predetermined temperature is passed during quenching, normally 850°C (1560°F).

Three buttons control all functions, including test probe calibration.

More than one unit (with test probe) can be used in a measurement system. Reasons for choosing this option include a need for several measurements to be taken in a short period of time, and to make measurements simultaneously in more than one quench tank.

It also is possible to run tests with separate thermocouples attached to the data acquisition unit. Application: taking measurements of actual parts during hardening.

**Data transmission:** Recorded data are transferred wirelessly to the computer. Doing away with connecting cables simplifies testing on-site in the quench tank (Fig. 1). There also is no risk of measurement errors due to insufficient grounding of the test probe.

**Cooling curve analysis:** The system’s powerful software automatically records or calculates a large number of characteristics, such as the time to certain temperatures and the cooling rate at those temperatures. The user can edit the parameters to be chosen. Figure 2 shows an example of recorded cooling curves for four quenchants (two oils and two water-based polymers). A high-performance smoothing algorithm suppresses the usual “noise” in the recorded data.

The display also includes a bar diagram, showing the maximum cooling rate for each quenchant. Any other parameter, such as the cooling time to a certain temperature or cooling rate at a certain temperature, can be similarly displayed.

**Built-in software features**

Another feature of the software is automatic calculation of the “hardening power,” HP, of quenchants. The hardening power concept, which was first proposed by IVF some 15 years ago (see Ref. 1), is a way to interpret cooling curves and their relevance to the result of hardening. The HP value expresses the ability of a quenchant to harden steel by taking certain characteristics of the cooling curve into consideration. For examples of the application of the HP concept, see References 2 and 3.

Note that users can define their own “hardening power,” by taking advantage of an editable formula. The HP that results takes into account such factors as the grade of steel, part dimensions, and quenching conditions (See Fig. 3).

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Control limits: Users also can define the upper and lower limits within which a characteristic is allowed to vary. Control limits can be established for any of the recorded or calculated characteristics. This facilitates long-term monitoring of quenchants, and provides support for actions that need to be taken. Control limits for the process in Fig. 2 are shown as vertical lines in the bar chart.

Database filtering: An additional important feature is database filtering. With this option, an optimized selection of quenchants or quenching conditions (among those stored in the database) can be made. This is illustrated in Fig. 4. In this example, the quenchant will be selected from media that have a maximum cooling rate between 60 and 80°C/s (110 and 145°F/s) and a hardening power between 800 and 1000. Another condition that must be met is a value between 75 and 100 as calculated by a specific user-defined formula. The user can choose from among any of the parameters defined in the system.

Additional information about the use of numerical methods for quenchant characterization is found in References 4 and 5.

References

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Note: ivf SmartQuenchTM is a registered trademark of IVF Industrial Research & Development Corp., Mölndal, Sweden (www.ivf.se, www.ivfsmartquench.com).