AUTOMATIC ON-LINE CHEMISTRY MONITORING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a system for automatically sampling, monitoring and analyzing power plant steam cycle water from a plurality of points in a power plant steam system and, more particularly, to a system for performing continuous on-line chemical monitoring using continuous on-line monitors, and semi-continuous on-line monitoring using an ion chromotograph unit, for controlling the monitoring with real-time feedback from the continuous on-line monitors and the ion chromatograph unit, and for automatically analyzing the monitored chemical characteristics.

2. Description of the Related Art

The control of impurities in power plant steam cycle water is recognized as being essential to the protection of a power plant's steam system against corrosion related failures. In spite of advances in methods for detecting and measuring impurities, or contaminants, at ultra-trace concentration levels, plant chemistry monitoring is, for the most part, based on the on-line monitoring of only a few chemical characteristics, such as conductivity, pH, and dissolved oxygen concentration. Many critical impurities which cause corrosion, such as chloride and sulfate, are checked only once or twice a day by laboratory analysis of grab samples. Grab sample data, since obtained only at long intervals, provides only a historical record of plant chemistry and is of little use in controlling the levels of corrosion causing impurities and thus in the prevention of corrosion related failures. Furthermore, on-line monitor information which is available, is provided only as strip chart records which require tedious operator analysis.

In current instrumentation, particularly cation conductivity monitors, the composition of the fluid sample, or solution, to be monitored is assumed at the time that the instrument is manufactured. The calculation of temperature compensated cation conductivity values, however, is dependent on the measured cation conductivity and solution composition. Thus, temperature compensated cation conductivity values will be erroneous if the actual solution composition differs from the assumed composition. The lack of real time feedback in prior monitoring systems prevents accurate temperature compensation since the actual solution composition cannot be factored into the temperature compensation.

Current monitoring systems also suffer from a lack of integrated calibration capability. Calibration is usually a scheduled maintenance operation; thus, calibration problems or equipment failures which occur between scheduled calibrations could go undetected and uncorrected until the next scheduled calibration. Moreover, as a scheduled maintenance operation, calibration has usually been performed manually as an off-line procedure using standards which may be significantly different than the sample, for example, highly concentrated buffer solutions.

Several systems have been developed to monitor power plant steam cycle water. U.S. Pat. No. 4,414,858, Peterson et al., assigned to the Assignee of the present application, discloses a system for sampling fluids with a plurality of fluid sample lines connected to various points in a power plant steam system. A valve arrangement connects a selected fluid sample line to an analyzer, and passes the non-selected fluid samples to a common drain line which is connected back to the power plant steam system. A microprocessor controls the valve arrangement in accordance with a set of stored instructions to selectively connect each of the sample fluid lines to the analyzer in a sampling sequence, and controls the analyzer with open loop control. Each fluid sample line also includes a sensor which provides an output signal to the microprocessor, which alters the sampling sequence if a particular sensor output indicates an alarm condition. This system provides only one on-line monitor per sample stream, and thus monitors one chemical characteristic of each sample fluid stream. Further, calibration of the sensors and the analyzer is performed manually in an off-line procedure.

Another system for monitoring steam producing water is disclosed in U.S. Pat. No. 4,472,354, Passell et al. This system uses ion chromatographic analysis to provide an ion profile of the steam producing water. Plural sampling systems collect the steam producing water supplied from a multiple number of points in a power plant steam system over a five to six-hour time period, called a fill cycle. At the end of the fill cycle, the water collected in a particular sampling system is supplied to the ion chromatographs. Thus, the system does not provide for continuous on-line monitoring of the steam producing water at each point in the plant steam/water cycle, but rather a periodic monitoring of a fluid sample collected over a five to six hour period to provide an ion profile of the steam producing water flowing in the plant. This system does not employ any continuous on-line monitors, and uses open loop control of the operation of the ion chromatographs. In this system, calibration is performed by diluting a standard solution with pure water and providing the diluted solution directly to the ion chromatographs in response to an operator decision.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a system for automatic continuous on-line monitoring of the water chemistry of each of a plurality of influent fluid sample streams from various points in a power plant steam system. The monitoring system of the present invention combines analytical instruments and monitors with computerized control and data logging. More particularly, a continuous monitor module including continuous on-line monitors and a calibration unit provides continuous on-line monitoring of each influent fluid sample stream, and an ion chromatograph unit provides semi-continuous monitoring of species for which no simple on-line monitor is available in a selected one of the influent fluid sample streams. The system is controlled by a control unit including a microcomputer or a minicomputer. The control unit receives signals representative of the monitored chemical characteristics from the continuous on-line monitors and the ion chromatograph unit, and uses these signals in a feedback loop to detect monitor failures, to determine the sequence in which the plural influent fluid sample streams are supplied to the ion chromatograph unit, to control operation of the ion chromatograph unit, and to automatically calibrate the continuous on-line monitors and the ion chromatograph unit. The control unit also logs data from the continuous monitor modules and the ion chromatograph unit, and interfaces