Fluoralyzer™

MAGNETIC RESONANCE -- A NEW INDUSTRIAL TOOL FOR PROCESS CONTROL ON-STREAM ANALYSIS

HOW DOES THE FLUORALYZER[tm] MEASURE FLUORINE?

Fluorine is measured atomically in any phase - solid, liquid or gas - by flowing a slurry or solutions containing fluorine through a tube surrounded by magnets. Fluorine atoms are oriented (polarized). Polarized atoms of fluorine will absorb radio frequency energy of a certain frequency. A radio transmitter with correct frequency f polarized fluorine is arranged to beam into the flowing stream. Each polarized atom of fluorine after absorbin radio energy retransmits the energy at a specific frequency - in essence becoming a tiny radio station. This measurement technology is magnetic resonance.

The measurement process is based on radio energy received by the sample in short pulses. Polarized fluorin atoms immediately emit a response pulse that rapidly decays to zero. Decay takes place in a time period determined by properties of fluorine in the sample. Decay of the pulse response is referred to as "free inducti decay" (FID for short). The FLUORALYZER[tm] is provided with detectors set to fluorine frequency, and the amount (intensity) of fluorine RF transmission indicates how much fluorine is present. Measured voltage intensity is converted by calibration to per cent fluorine content of the flowing sample. If a slurry flow is measured, and the carrying liquid is water containing no dissolved fluorine, slurry per cent solids is determine by simultaneously measuring hydrogen by the same procedure as fluorine. The instrument technique in this application is an analog measurement of fluorine and hydrogen peak response voltages of respective pulse decay. Alternatively, slurry per cent solids (pulp density) can be measured with an independent instrument. In that case, a measurement of hydrogen by analog MR to determine pulp density becomes unecessary.

Fluorine measurements when fluorine is contained both in solid and fluid states are determined by a digital process. Voltage readings are made through the time span that decay of pulse response occurs. The values a stored as digital equivalents to enable computations. By this means, a complete FID characteristic response determined. Mathematical analysis of the FID result leads to calculation of quantitative values for fluorine pe cent in each of fluid and liquid states.

DOES SIZE OF SOLID PARTICLES CONTAINING FLUORINE OR VARIATION IN CHEMICAL FORM OF FLUORINE INTERFERE WITH MEASUREMENT?

The answer for practical purposes is no.

When radio energy is transmitted into the flowing slurry there is no influence of solids or other materials in penetration of RF energy beamed through solids and water at the frequencies used. Likewise, retransmitted F energy is neither absorbed nor changed by solids or liquids in the slurry to measurable extent. The result is magnetic resonance has unique ability to specifically measure fluorine, hydrogen, and other amenable elements. The technique is simple and without sources of significant interference. Chemical or crystalline for of fluorine do not influence the process of magnetic resonance to activate each fluorine atom in the flow stream, and to retransmit absorbed RF energy at resonant frequency for measurement.

Time required to polarize atoms can be different according to crystalline state and phase state of matter containing the element. Because the polarization stage takes place before initiating magnetic resonance pulsing when activation and measurement take place, a difference in polarization time does not introduce err when insufficient polarization time is provided for all forms of fluorine present. Instrument design requires providing required polarization time for all constituents of slurry and liquid phases containing fluorine.

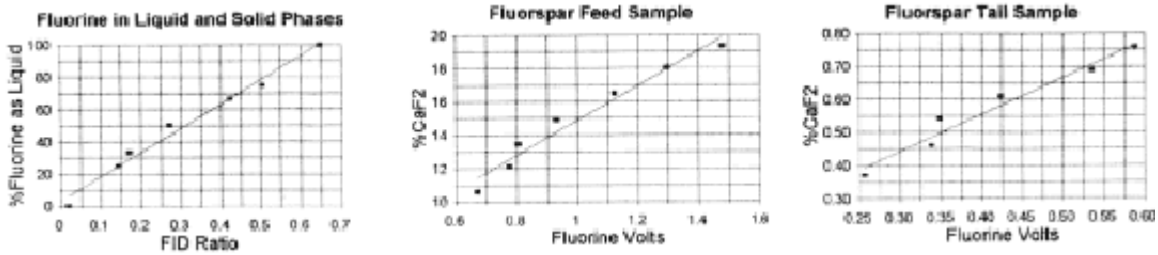
DOES MAGNETIC RESONANCE EMPLOY RADIOISOTOPES OR BIOLOGICALLY INTERACTIVE RADIATION?

Safety hazards associated with X-ray analysis, gamma-ray neutron analysis methods, and other high energy radiation measurement techniques do not exist with magnetic resonance. No radioactive isotopes or other sources of biologically damaging radiation are involved with magnetic resonance on-stream analysis.

HOW MUCH EXPERIENCE HAS THERE BEEN WITH MAGNETIC RESONANCE ON-STREAM ANALYSIS TO ASSURE RELIABILITY OF AN INSTALLATION?

Field experience using magnetic resonance on-stream analysis has been with phosphorus process control applications. These have been employed since 1988, and are the first known installations of magnetic resonance on-stream analysis in industry. Phosphorus measurement accuracy is about 0.05 per cent standard error in phosgypsum slurry from phosphoric acid production, containing about 40 per cent solids with one per cent phosphorus in phosgypsum solids.

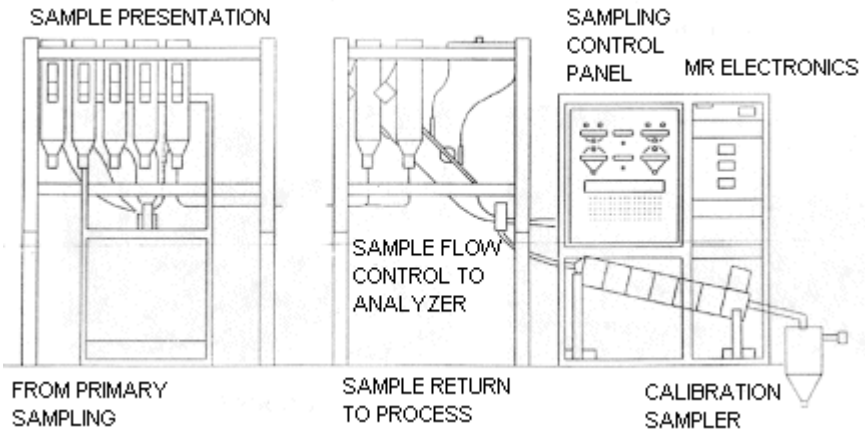
Industrial magnetic resonance analysis units are modified to required sensor configurations and RF frequencies according to respective application. A FLUORALYZER^{tm} has been assembled and tested for measuring fluorine in mineral slurry flows. Sensitivity to fluorine concentration in solids at about 25 per cent water slurry about 0.05 per cent F in solids.



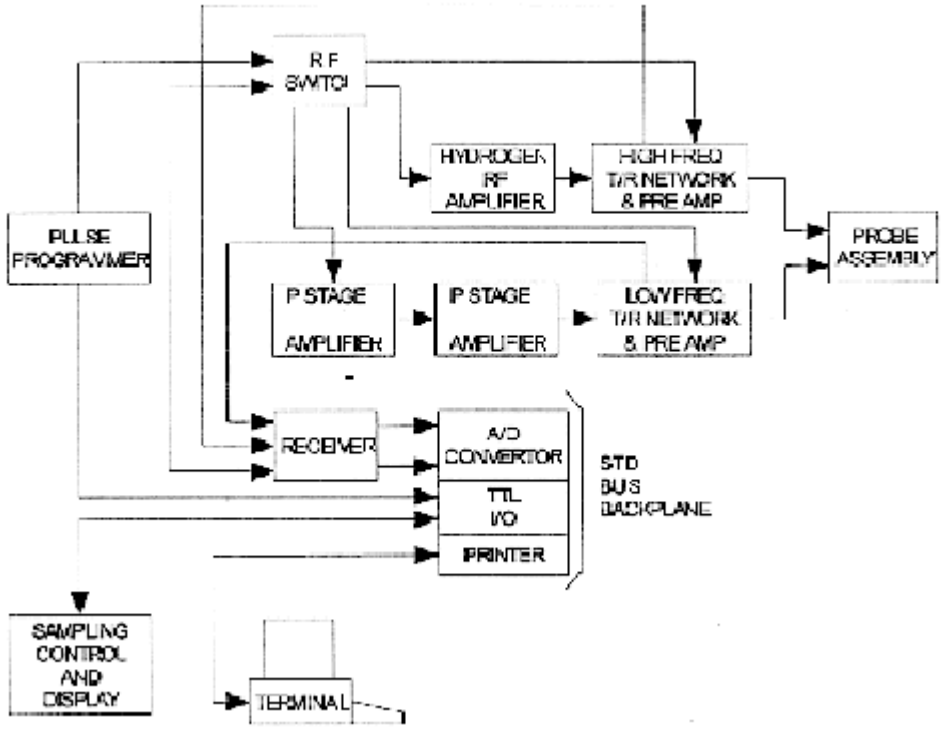
EXAMPLES OF CALIBRATION DATA FOR FLUORINE MR ANALYSIS

DESCRIPTION OF THE FLUORALYZER^{tm}

The two principal components of the FLUORALYZER^{tm} are the sensor and electronics cabinet, and the sample presentation unit as illustrated in the below figure. The illustration shows a slurry flow analyzer, with slurry sample from the process flowing through a sample tube as shown in the lower chamber of the temperature controlled cabinet where polarization and sensor magnets are installed with associated components. Supporting electronics with an onboard microcomputer (system processor) and sample control panel are mounted in the upper part of the cabinet. The cabinet is approximately 5-ft. high by 5-ft. length by 3-ft. width. It includes a power stabilizer and a utility panel for 115 V. single phase 60 hz. power (alternative power supplies can be provided).



FLUORALYZER[tm] ON-STREAM ANALYZER SCHEMATIC ARRANGEMENT



FLUORALYZER[tm]COMPONENT BLOCK DIAGRAM

Sample presentation for up to eight sample streams is controlled by valves and slurry sample splitting apparatus as indicated in the figure. Water flushing is carried out between each sample measurement. Operator selection of flow streams to be measured is enabled through an external keyboard display terminal connected to the system processor or by manual switches provided with the sample control panel. All sample handling and presentation functions are under control of the system processor.

Correctly planned and designed primary sampling and sample presentation for plant process control, whether a slurry application or more simply handled solutions, is a critical requirement for practical and effective functioning of the system. In addition to design and development of on-stream analyzers, HRCS is a manufacturer of widely employed bulk sampling equipment applicable to all process industries.