Phospholyzer™

MAGNETIC RESONANCE -- A NEW INDUSTRIAL TOOL FOR ON-STREAM ANALYSIS, QUALITY CONTROL AND HIGHER PROCESS EFFICIENCY

HOW DOES THE PHOSPHOLYZER[tm] MEASURE PHOSPHORUS ?

By flowing slurry or solution containing phosphorus through a tube surrounded by magnets, phosphorus atoms are oriented (polarized). Polarized atoms of phosphorus will absorb radio energy of a certain frequency. A radio transmitter with frequency tuned for polarized phosphorus is arranged to beam into the flowing stream. Each polarized atom of phosphorus, after absorbing radio frequency (RF) energy, retransmits RF energy but at a different specific frequency -- in essence becoming a tiny radio station. The phosphorous measurement technology for this process is magnetic resonance.

The PHOSPHOLYZER[tm] is provided with detectors set to phosphorus frequency, and the amount (intensity) of phosphorus retransmitted RF energy indicates how much phosphorus is present. Measured intensity is then converted by calibration to BPL or P_20_5 content of the slurry. Simultaneously, hydrogen is measured by the same procedure to determine how much water is contained in the flowing slurry. These data enable calculation of slurry percent solids, and by further calculation BPL of solids in the slurry is determined.

DOES THE SIZE OF PHOSPHORUS MATRIX PARTICLES OR VARIATION IN CHEMICAL FORM OF PHOSPHORUS CAUSE MEASUREMENT PROBLEMS?

The answer for practical purposes is no.

When radio energy is transmitted into a 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, retransmission of RF energy from phosphorus atoms is neither absorbed or changed by solids or liquids in the slurry to a measurable extent. The result is magnetic resonance has unique ability to specifically measure phosphorus, hydrogen, and other amenable elements. The technique is simple and without sources of significant interference.

Chemical or crystalline forms of phosphorus minerals do not influence the process of magnetic resonance to activate each phosphorus atom in the flow stream, and retransmission of absorbed RF energy at phosphorus resonant frequency for measurement. Time required to polarize phosphorus atoms can be different according to crystalline state and phase of matter containing phosphorus. Because the polarization stage takes place in a flow stream prior to entering the magnetic resonance sensor where activation and measurement take place, differences in polarization times do not introduce error when sufficient polarization time for all forms of phosphorus is provided.

DOES THE METHOD EMPLOY RADIOISOTOPES OR OTHER BIOLOGICALLY INTERACTIVE RADIATION?

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

HOW MUCH EXPERIENCE HAS THERE BEEN WITH MAGNETIC RESONANCE ON-STREAM ANALYSIS TO ASSURE RELIABLILTY OF OPERATION?

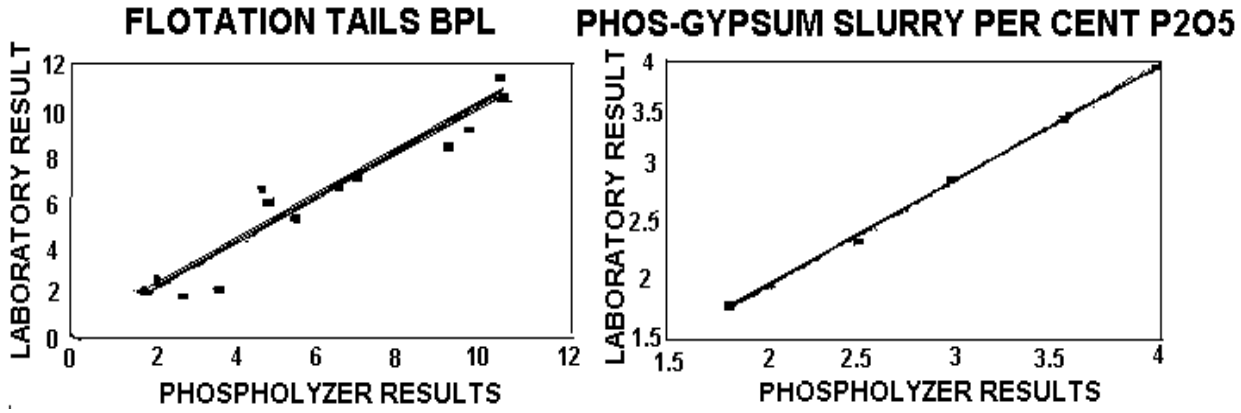
Two PHOS PHOLYZER[tm] on-stream analyzer systems have been installed as production units in phosphate benefication plants. The first unit operated intermittently on a semi-production basis for two years until mine shutdown May 1992. The second analyzer was installed in 1992 and has been on operational status since late 1993. The user encountered sample handling problems along the way not

associated with the PHOSPHOLYZERtm, but nontheless causing system downtime. These problems were overcome during the next year of operation and the second PHOSPHOLYZER[tm] system is now considered a "user friendly" production unit and is treated as such in routine operation. It has been incorporated into the plant distributed control system at the beneficiation facility with results of improved process efficiencies and better understanding of the phosphate flotation process.

HOW ACCURATE ARE BPL AND $P_2 05$ MEASUREMENTS BY ON-STREAM MAGNETIC RESONANCE ANALYSIS?

In summary, BPL measurements for tailings are about 0.5 BPL standard error for a typical range of 2 to 8 BPL for hour-to-hour processing of phosphate matrix in beneficiation. The figure below shows an example of data comparing BPL values from the Phospholyzer and laboratory tests on check samples.

Data for phosgypsum slurry and phosacid residue in wash water from phosacid reactor filter operation is illustrated in the below figure. Standard error values as low as 0.1 percent $P_2 0_5$ are attained with measurement of phosacid reaction residue



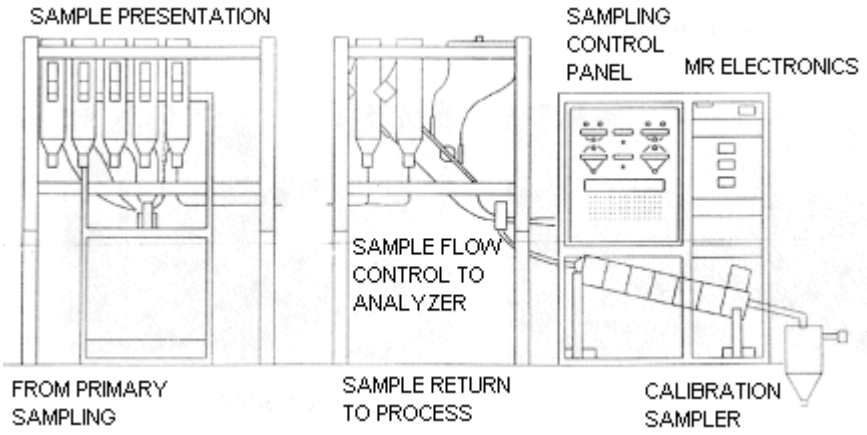
MEASUREMENT DATA FOR PHOSPHOLYZER[tm]

DESCRIPTION OF THE PHOSPHOLYZER[tm]

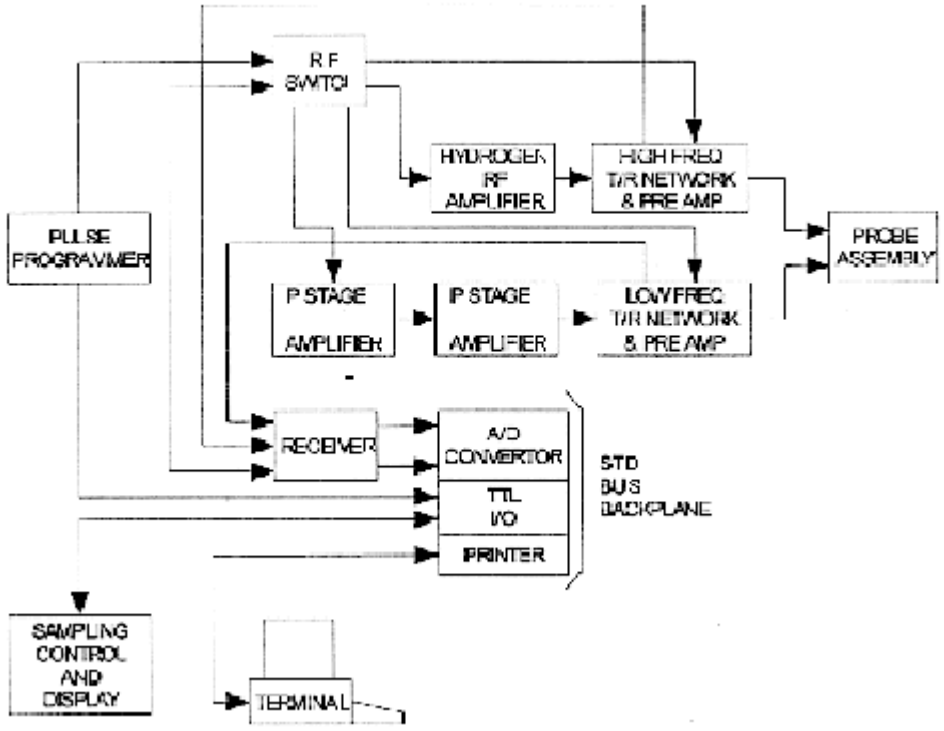
The two principle components of a PHOSPHOLYZER[tm] are the sensor and electronics cabinet assemblies, and the sample presentation unit as illustrated in the below figure. As shown, slurry sample from the process flows through a sample tube in the lower chamber of the ternperature controlled cabinet where polarization and sensor magnets are installed with associated components. Supporting electronic units with an on-board microcomputer (system processor) and sample control panel are mounted in the upper part of the cabinet. The cabinet is approximately 4-ft. high by 5-ft. length and 3-ft. width. It includes a power stabilizer,connections for 110 VAC single phase 50/60 Hz 10 amp power (alternative power sources can be accommodated), and a utility panel with access for signal analysis, test instrument power and system processor RS-232 port.

Sample presentation for up to eight slurry sample streams is controlled by valves and slurry sample splitting apparatus as indicated by 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 and display terminal connected to the PHOSPHOLYZERtm system processor or by manual switches installed on 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 of phosphate matrix slurries for beneficiation plant process cqntrol is a critical requirement for practical and effective functioning of the system. HRCS is broadly experienced in this field. In addition to design and development of on-stream analyzers, HRCS is a manufacturer of widely employed bulk sampling equipment applicable to all minerals processing industries.



PHOSPHOLYZER^{tm} SCHEMATIC ARRANGEMENT



PHOSPHOLYZER^{tm} COMPONENT BLOCK DIAGRAM