LOW COST DATA COLLECTION TO SUPPORT IMPROVED OPERATION OF RADWASTE EQUIPMENT

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ABSTRACT

A data collection and management system called PROCTOR has been developed and tested to provide low cost monitoring. It has been used over a six month period to collect filter test data at the Grand Gulf Nuclear Plant. It is also being used to develop a chemistry monitoring system for a Carolina Power & Light plant. The signal conditioning hardware is industrially hardened and designed for ease of installation. The software supports simple configuration, screen displays, graphics, data storage, on-line calculations, signal linerization, conversion to engineering units, alarming and an interface to LOTUS 1-2-3 tm (a). It is designed for customizing to specific utility application needs. Applications from several instruments to several hundred can be monitored with PROCTOR.

INTRODUCTION

The factors leading to large waste volumes from liquid radwaste processing are many and varied. To reduce waste volumes, it is important to identify each factor and its relative contribution. Data collection is essential in this process. In many plants, however, collection must be done by hand. Process computers are a relatively recent addition to radwaste systems and their primary function is still control of the process, rather than monitoring or storing data.

There is a significant need for a low cost, automatic method of collecting, monitoring and managing data from various parts of the radwaste system. Unfortunately, radwaste budgets do not allow for the purchase of expensive, turnkey computer monitoring systems. Alternatively, neither operations nor engineering is typically able to justify the manpower needed to develop single application software for existing computers or less expensive data loggers.

To address this need, Impell has developed a powerful IBM micro-based system called PROCTOR. It is low in cost; provides on-line data collection, monitoring and management; and is quick to configure. The software is written to be flexible and can be adapted to many different applications. The system, operating on a COMPAQ portable computer, was used to support testing of a backflushable filter at the Grand Gulf Nuclear Station. An interface with LOTUS 1-2-3 considerably reduced the time needed for reporting and graphing the data.

DATA ACQUISITION SYSTEM DESCRIPTION

The PROCTOR system is packaged complete and ready to use for either portable or permanent applications. Included in the portable system is the software, documentation, signal conversion hardware, portable cabinet, power supply and externally located termination strips for easy hookup. The IBM or compatible microcomputer can be supplied with the system or by the end user. For permanent installations, the input hardware can be located in existing termination panels in place of the portable cabinet.

The basic software package currently supports monitoring, displaying, trend graphing, alarming and storing instrument input and calculations. It can handle from several to several hundred instruments. The historical data file is compatible with the LOTUS 1-2-3 software package for additional data reduction, plotting and report generation. Signal linerization and conversion to engineering units are provided by the software. Configuration does not require programming and can be done by the user. Development of screen displays or calculations can be set up for a particular application and delivered with the system. Optionally, more sophisticated users can program their own screen displays and calculation routine and link them with the main program.

Signal Conditioning

Signal conversion hardware, supplied by OPTO 22, supports both analog and discrete input and output. Instrument input is brought in through signal conditioning modules with up to sixteen located on each rack-mountable board. Modules are available for voltage, current, thermocouple, pulsed, discrete and BCD. I/O boards and the computer are connected in a daisy chain fashion by a single shielded cable containing two twisted wire pairs. Each cable run can be up to 2000 feet. The I/O boards are industrially hardened and can be located in termination panels near the instrumentation to reduce wiring requirements.

Configuration

Configuration of input signal characteristics is done through a screen entry form. It does not require programming and can be done quickly and easily by the user. The format is simple and default values are provided for typical setups. Only four fields need be entered for standard input signals.

Three different types of input channels are available: instrument, calculation and manual. Input for the instrument channels comes from field instruments through the OPTO 22 hardware. Input for manual channels comes from an initial default value and can be updated by the operator in real time. Input for calculation channels comes from the

(a) LOTUS 1-2-3 is a registered trademark of the LOTUS Development Corporation.

calculation routine. All three are treated the same and can be displayed, stored, graphed or alarmed.

Screen Displays

A standard screen display is provided which is set up during configuration. It presents each channel's description, engineering units and current value as well as minimum, maximum and average values for a user-specified time period. Alarm and trend-graph screens are also provided. The trend graph charts historical values up to a user-selected length of time along with current values. Three channels of input can be displayed at once and all channels can be accessed without reconfiguring.

The capacity for up to six additional custom screens (either text or graphics) is provided allowing the creation of application-specific screens. This feature allows for display of specific groupings of channels or for a different data format. In addition to text display, interactive graphics screens can be developed. Examples include process flow diagrams as well as displays of tank levels or valve lineups.

Calculations

A calculation function provides on-line analysis. Equations can be implemented from simple calculator functions to more complex enthalpy or curve fitting algorithms. Manual entry channels can be used for application specific constants which change infrequently or for data entered periodically by the operator. For instance, mass balances can be calculated from manually entered influent isotope concentrations, flow rates and decontamination factors. Heat balances for an evaporator can be calculated and displayed on-line. Economic calculations can be added to indicate current and projected costs of processing.

Alarming

An alarm range can be specified for each channel during configuration. When a signal goes into the alarm range, it is displayed in red on the current display screen, logged in the alarm file and also written to the system printer for alarm logging. An alarm summary screen is provided to display the alarm file. In addition, digital output signals can be generated to drive annunciators on a remote control panel.

Storing Data

Storing data is supported for any of the channels selected during configuration. Data is written, after each scan, to a data file on the hard disk. The old file is closed and a new file opened after a user-specified period of time, such as one day or one week. These files can be copied to floppy disk for analysis with LOTUS. A feature is included which converts the data file to LOTUS .wks file format.

LOTUS 1-2-3

LOTUS 1-2-3 provides an electronic worksheet with graphics and information management capacity. It is a flexible easy-to-use program which allows the engineer to develop reports and graphs or perform database searches and sorts in minutes instead of hours. It has more calculational ability than a scientific calculator and, in addition, provides a high level language for programming, including IF-THEN logic. LOTUS can be configured for screen entry forms with protected fields for technicianlevel operation of repetitive processes. For instance, a spreadsheet can be developed to automatically extract the previous seven days data from the PROCTOR-generated historical data file, perform various calculations on the data, format a report and print it out. If a number of such operations are normally carried out during the week, a menu can be developed to make selection easy.

MP&L BACKFLUSHABLE FILTER MONITORING APPLICATION

The Impell backflushable filter was installed in a 10 gpm test configuration at the Grand Gulf Nuclear Station in July, 1985. The purpose of the test was to establish the amount of Ecodex required for precoat and body feed for efficient operation. Use of the PROCTOR data acquisition system significantly reduced the effort required to gather and subsequently analyze the data. In addition, reliability and frequency of the test data was substantially increased.

A total of eighty five runs were monitored over six months. The PROCTOR system operated well on all runs with no loss of data. Conditions were typical of an operating plant environment in that the computer and I/O hardware were located in a truck bay with temperatures often exceeding 40° C. The technician performing the tests had no prior computer experience. Only several hours of training were required for him to use the system.

For each run, measurements of total flow, flow rate, differential pressure and temperature were taken every minute. Run duration varied from 20 minutes to four hours depending on influent water concentrations and Ecodex feed. The monitored values as well as calculation results were displayed on the monitor in real time to track progress of the test. The computer was separated from the instrumentation by 250 feet of wire. After each test, a single command was available to copy the historical data file to a floppy disk for later analysis and to restart monitoring for the next test.

For analysis, each run file was converted to a LOTUS .wks file and graphs of flow vs. differential pressure were automatically created and plotted. A typical plot is shown in Fig. 1.

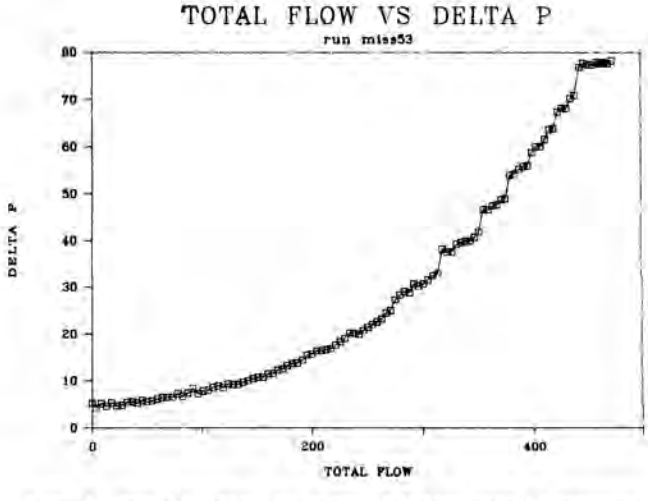

Fig. 1 Run 53 Total Flow vs. Differential Pressure

Calculations were also performed using LOTUS 1-2-3 to determine dirt loadings and precoat and body feed effects. The completed worksheet is shown in Table I. Totaling and averaging runtime data is very easy and convenient with LOTUS. The entire process required less than five minutes per run (exclusive of actual plotting time).

For a full-sized filter system, additional analysis could be added. A turbidity meter would provide accurate on-line analysis for dirt loading of the filter and Ecodex efficiency. Manual entry of the Ecodex and burial costs would allow on-line calculation of the economic performance of filter. A LOTUS file should be set up to provide weekly management reports summarizing daily performance and system economics. Automatic metering of Ecodex can be supported by PROCTOR based on increase in pressure drop. This control approach was found to be very simple and efficient over varying ranges of influent concentrations.

OTHER DATA COLLECTION & MANAGEMENT APPLICATIONS

The PROCTOR system provides a cost effective approach for monitoring a number of radwaste and chemistry applications. For short term testing, the standard display and configuration allow quick and easy monitoring. Configuration and setup to monitor a radwaste filter for total flow, flow rate, differential pressure and valve alignment can be accomplished in less than a morning. Other short term applications include monitoring sump pump run times, flow rates, evaporator heat balance or heater drain outlet temperatures. The tests can be run for a day or for as long as several months to determine sources and volumes of leakage. Temporary wiring can be run from the portable cabinet to the termination panel or directly to the signal transmitters and the computer nearby. Connections to the PROCTOR system are made to externally accessible terminal strips for ease of installation. A design change request should not be necessary.

Long term monitoring applications can be developed quickly and designed to specific utility specifications. PROCTOR is an extremely flexible program. The software has been developed in a fashion that allows the addition of features for specific applications. The additions can be made for the original installation or later as needs change.

A recent example of this flexibility is a chemistry monitoring system being developed together with Carolina Power & Light for a plant in North Carolina. This application of PROCTOR provides an interface between chemistry monitoring instruments and CP&L's Chemistry Data Management Program (CDMP) which resides on their IBM mainframe computer. The previous approach with CDMP was to use manual data entry. The capability to write a CDMP compatible batch input file was added to PROCTOR as well as

TABLE I

Impell Backflushable Filter Test System
Grand Gulf Station Test Runs

RUN	PRECOAT	BODY FEED	TOTAL ECODEX	TOTAL ECODEX	FLOW RATE	TOTAL FLOW	TOTAL SUSPENDED SOLIDS	TOTAL DIRT	ECODEX /GALLONS		ECODEX /LB DIRT
	ML	ML	ML	LBS	GPM	GAL	PPM	LBS	ML/GAL	LBS/1K GAL	LB/LB
1	600	0	600	0.25	4	150	39	0.049	4.0	1.69	5.21
2	600	0	600	0.25	4	157	35	0.045	3.8	1.62	5.55
3	600	0	600	0.25	3	190	34	0.028	6.0	2.54	8.97
4	600	0	600	0.25	4	120	35	0.035	5.0	2.12	10.16
5	600	0	600	0.25	4	108	40	0.035	5.7	2.42	7.26
6	600	0	600	0.25	4	85	381	0.270	7.1	2.99	0.94
8	400	0	400	0.17	4	72	344	0.206	5.6	2.35	0.82
10	800	0	800	0.34	4	55	900	0.329	14.5	6.16	1.48
11	400	0	400	0.17	4	56	530	0.348	7.1	3.03	0.68
12	400	0	400	0.17	4	50	594	0.331	8.0	3.39	0.73
13	400	0	400	0.25	10	27	558	0.170	14.2	6.07	1.50
14	600	0	600	0.25	4	18	50	0.009	33.3	14.12	33.87
15	600	0	600	0.25	4	250	47	0.098	2.4	1.02	2.59
16	600	0	600	0.25	4	85	57	0.040	7.1	2.99	4.29
17	600	0	600	0.25	4	35	70	0.020	17.1	7.24	12.44
18	600	0	600	0.25	4	55	65	0.030	10.9	4.62	8.53
19	400	0	400	0.17	4	63	34	0.018	6.3	2.61	9.20
20	400	0	400	0.17	4	50	34	0.014	8.0	3.39	11.95
21	600	0	600	0.25	3	50	35	0.015	12.0	5.08	17.42
22	600	0	600	0.25	4	75	38	0.024	8.0	3.39	10.70
23	600	0	600	0.25	4	66	34	0.019	8.8	3.74	13.19
24	600	0	600	0.25	4	70	32	0.019	8.6	3.63	13.61
25	600	0	600	0.25	4	88	112	0.082	6.8	2.89	3.09
26	600	0	600	0.25	4	78	72	0.047	7.7	3.26	5.43
27	400	202	602	0.26	4	130	72	0.078	4.6	1.96	3.27
28	126	121	247	0.10	4	125	130	0.136	2.0	0.84	0.77
29	127	182	309	0.13	4	124	163	0.168	2.5	1.06	0.89
30	34	48	72	0.03	4	30	114	0.029	2.4	1.02	1.07
31	253	140	413	0.17	4	133	125	0.138	3.8	1.54	1.48
32	600	0	600	0.25	4	72	143	0.086	8.3	3.51	2.96
33	126	164	290	0.12	2	120	140	0.140	2.4	1.02	0.88
34	126	322	448	0.19	4	230	235	0.451	1.9	0.83	0.42
35	126	246	372	0.16	4	267	270	0.446	1.8	0.76	0.34
36	84	139	223	0.09	4	154	748	0.961	1.4	0.61	0.10
37	84	112	196	0.08	4	137	2572	3.939	1.4	0.61	0.01
38	126	322	448	0.19	4	984	1665	3.944	1.6	0.67	0.05
39	0	0	0	0.00	4	50	190	0.079	0.0	0.00	0.00
40	126	122	248	0.11	4	128	84	0.090	1.9	0.82	1.17
41	126	163	289	0.12	4	162	78	0.105	1.8	0.76	1.16
42	126	266	392	0.17	4	323	223	0.599	1.2	0.52	0.28
43	126	240	366	0.16	4	323	154	0.415	1.1	0.48	0.37
44	0	0	0	0.00	4	73	473	0.288	0.0	0.00	0.00
45	126	173	299	0.13	4	107	66	0.059	2.8	1.18	2.15
46	126	122	248	0.11	4	102	56	0.048	2.4	1.01	2.21
47	126	122	248	0.11	4	108	55	0.048	2.3	0.97	2.20
48	126	39	165	0.07	4	32	196	0.034	5.2	2.18	2.08
49	126	36	162	0.07	4	62	111	0.057	2.6	1.11	1.20
50	126	163	289	0.12	4	217	103	0.186	1.3	0.56	0.66
51	126	132	258	0.11	4	189	329	0.518	1.4	0.58	0.21
52	126	163	289	0.12	4	340	102	0.289	0.9	0.36	0.42
53	126	266	392	0.17	4	673	177	0.698	0.6	0.25	0.24
54	126	101	227	0.10	4	101	116	0.098	2.2	0.95	0.98
55	126	122	248	0.11	4	121	105	0.106	2.0	0.87	0.99
56	126	142	268	0.11	4	186	200	0.310	1.4	0.61	0.37
57	126	101	227	0.10	4	134	509	0.569	1.7	0.72	0.17
58	126	142	268	0.11	4	220	131	0.240	1.2	0.52	0.47
59	126	225	351	0.15	4	451	80	0.301	0.8	0.33	0.49
60	126	204	330	0.14	4	402	130	0.436	0.8	0.35	0.32
61	126	225	351	0.15	4	422	199	0.700	0.8	0.35	0.21
62	126	157	283	0.12	4	249	83	0.172	1.1	0.48	0.70
63	126	204	330	0.14	4	400	113	0.377	0.8	0.35	0.37
64	126	142	268	0.11	4	489	112	0.457	0.5	0.23	0.25
65	126	122	248	0.11	4	257	34	0.073	1.0	0.41	1.44
66	126	101	227	0.10	4	319	412	0.753	1.0	0.44	0.13
67	126	142	268	0.11	4	771	56	0.127	1.0	0.42	0.90
68	126	157	283	0.12	4	326	41	0.115	0.8	0.36	1.04
69	126	174	300	0.13	4	1393	83	2.285	0.1	0.04	0.06
70	126	81	207	0.09	4	334	89	0.125	0.6	0.26	0.70
71	126	101	227	0.10	4	519	73	0.328	0.4	0.18	0.29
72	126	0	126	0.05	4	260	7	0.015	0.5	0.21	3.42
73	126	140	266	0.11	4	1000	7	0.038	0.3	0.11	1.93
74	126	101	227	0.10	4	59	74	0.036	3.8	1.63	1.44
75	126	122	248	0.11	4	83	89	0.048	3.0	1.27	2.20
76	126	30	156	0.07	4	85	101	0.072	1.8	0.78	0.92
77	126	54	180	0.08	4	105	102	0.089	1.6	0.68	0.82
78	126	204	330	0.14	4	239	76	0.151	1.4	0.58	0.92
79	126	121	247	0.10	4	116	71	0.069	2.1	0.90	1.52
80	126	80	206	0.09	4	63	89	0.047	3.3	1.39	1.67
81	126	105	231	0.10	4	81	191	0.129	2.9	1.21	0.76
82	126	328	454	0.19	4	156	69	0.090	2.9	1.23	2.14
83	126	164	290	0.12	4	112	70	0.065	2.6	1.10	1.86
84	126	150	276	0.12	4	160	138	0.184	1.7	0.73	0.66
85	126	300	426	0.18	4	259	154	0.333	1.6	0.70	0.54
Totals			36038	12.73		17605	16116	21.94			
Averages						213	141.34		1.71	0.72	0.53

on-line trend graphing of any of the configured channels. The user can select up to three trends at a time for the previous 24 hours.

Other practical uses for the PROCTOR system for permanent monitoring vary from single components (such as an evaporator or solidification unit) to a complete radwaste water tracking system. In the latter case, instrument input is generally available for pump run times, tank levels, flow rates, pressures and temperatures. This data can be used to calculate in real time and display to the operator such information as total water processed, filter efficiencies, demineralizer bed DF, evaporator efficiency, tank levels and tank level alarms to name a few. Graphics can be added to display the process flow with interactive tank levels and valve lineups. Historical data files can be used to generate weekly management reports.

CONCLUSION

The PROCTOR Data Collection and Management System provides a cost effective, labor-saving method for discovering the sources of excess liquid volumes and monitoring equipment performance and economics. It provides on-line calculations to display the cost penalties or benefits for a particular approach to processing the current waste streams. In addition, it retains an easily accessible historical record of system performance to be used for reporting and further analysis.