[Journal of the Arkansas Academy of Science](https://scholarworks.uark.edu/jaas)

Volume 34 Article 31

1980

Factors Affecting the Sr-90 Concentration in Dardanelle Lake, Arkansas

David M. Chittenden II
Arkansas State University

In the Colorado River of the early 1950's, before the system of dams was completed, the TDS did vary over a wide range, 400-1200 mg/l, during the year, but the minimum occurred during the summer, corresponding to a maximum in the volume of water passing along the river. There seems to be no such correspondence in the Arkansas [see (Chittenden, Proc. Ark. Acad. Sci., 33:25-27, 1979) for the discharge at the dam for most of the 1976-1977 period].

The average concentration of Na^+, K^+, and total hardness in the world's rivers has been estimated (Livingstone, D. A. 1963. Chemical composition of rivers and lakes. U. S. Geol. Surv. Prof. Paper 440-G, U. S. Government Printing Office, Washington, D. C., 64 pp.) to be respectively, 6.3. ppm, 2.3 ppm, and 21.8 ppm. In the Arkansas River, only the K^+ is "normal", Na^+ ranges from 6-23 times the average and total hardness from 1.5-3 times the average.

The maximum in June may be connected with preparation of agriculture land for planting and with the volume of spring precipitation. The marked maximum in autumn may be connected with the disturbance of the soil at the end of the agricultural growing season. Intensive agricultural activity and irrigation may be causing an increase in the already high salinity in the waters of the Arkansas River.

Further measurements over the next eighteen months should further elucidate the trend in the variation of the TDS. If this trend is a monotonic increase, the problem of water quality in the Arkansas River will be as serious as that in the Colorado River.

D. M. CHITTENDEN, II, Department of Chemistry, Arkansas State University, State University, Arkansas 72467.

FACTORS AFFECTING THE Sr-90 CONCENTRATION IN DARDANELLE LAKE, ARKANSAS

Variations in the Sr-90 concentration and in the amount of $Ca^{2+} + Mg^{2+}$ present in the water of Dardanelle Lake seem to be related in samples collected near the outlet for reactor cooling water (Station 1) and at the dam (Station 4). This dependence was first noticed as a variation of Sr-90 activity with total dissolved solids (TDS). Most of the Sr-90 released by the reactor leaves the lake in solution but some remains behind in the form of ions adsorbed on the surface of sediment particles.

The release of this adsorbed Sr-90 is postulated to be an ion-exchange type of process:

$$Ca^{2+} + {}^{90}Sr^{2+}\underline{\quad\quad}\text{sediment} \rightleftharpoons {}^{90}Sr^{2+} + Ca^{2+}\underline{\quad\quad}\text{sediment}$$

The concentration of Sr-90 activity can be expressed as:

$$A_{90} = B_o + B_1(A_r) + B_2(C) \tag{1}$$

where A_{90} = the concentration of Sr-90 activity (pCi/l) in lake water
A_r = the concentration of all the activity released by the reactor (pCi/l)
C = the concentration of $Ca^{2+} + Mg^{2+}$ (ppm)
B_o = Sr-90 from fallout present in lake water (pCi/l)
B_1, B_2 = constant coefficients

For studies prior to 1979 (Chittenden, Radionuclides in the Arkansas River, upstream and downstream from the Nuclear I power generating facility, 27 pp, 1978.) only the TDS values were determined. It was found that the concentration of $Ca^{2+} + Mg^{2+}$ was a fairly constant $(10 \pm 1)\%$ of TDS. Thus

$$C = (0.10 \pm 0.01)(TDS) \tag{2}$$

Combining equations (1) and (2),

$$A_{90} = B_o + B_1(A_r) + B_3(TDS) \tag{3}$$

where $B_3 = B_2(0.10 \pm 0.01)$

The data for the individual collecting stations (Chittenden and McFadden, Proc. Ark. Acad. Sci. 32:31-34, 1978.) were treated statistically using the MINITAB package available on the Harris/7 system at Arkansas State University. Regression analyses were used to derive the coefficients for equation (3) and correlation coefficients were calcuated for Sr-90 activity and TDS. Table 1 summarizes these values.

Table 1. Results of Statistical Analysis of Data

Station	1	2	3	4
Location	Downstream	Upstream	Upstream	Downstream
Amount of Sr-90 Adsorbed	High	Low	Low	Moderate
B_o	0.45	0.63	0.91	0.56
B_1	0.00	0.067	0.00	0.048
B_3	9.2E-4	0.0E-4	0.0E-4	3.4E-4
r	0.82	0.06	0.00	0.45

Note: $9.2E-4 = 9.2 \times 10^{-4}$

There is no correlation between Sr-90 activity and TDS at the upriver stations (2 and 3), where there should be no appreciable amounts of Sr-90 adsorbed on the sediment. At Station 1, where the highest concentrations of adsorbed Sr-90 would be expected, the correlation is quite good. At Station 4, approximately two miles downriver from the reactor where there may be some deposition of suspended sediment, the correlation is modest.

Preliminary data gathered since August, 1979, indicates that the correlation coefficient of Sr-90 activity with total hardness (Ca^{2+} + Mg^{2+}) is >0.9 at Station 1.

Thus, it seems likely that the release of Sr-90 adsorbed on sediment is a significant source of that radionuclide in water downstream from the reactor.

D. M. CHITTENDEN, II, Department of Chemistry, Arkansas State University, State University, Arkansas 72467.

THE USE OF A CALCULATOR CHIP FOR REALTIME DATA PROCESSING

The problem of collecting data in a digital form ordinarily might be handled by dedicating a microprocessor system to the task of collecting the data from the sensor, processing that data and finally outputting the data in an intelligible form. However, the power of a microprocessor system may be a case of "overkill' if it is to be dedicated to one or more relatively slow speed tasks. In place of a microprocessor system, one may find that a low cost calculator chip such as found in readily available four function calculators can provide the computing power along with a degree of programability necessary to carry out the required tasks for a small processing system.

The problem of interest here is to design a digital system which measures rate of fluid flow, elapsed time and total travel distance. A calculator chip is used to process and display total volume, rate of flow, total distance and elapsed time. The data are displayed by (seven segment), L.E.D.'s. The particular data displayed are switch selected by the operator.

The circuit (Fig. 1) consists of five principle blocks, numbered 1 through 5 for discussion. The time base for the circuit, (block 1), a 555 timer wired as a bistable multivibrator, drives a series of J-K flip-flops and gates to produce a nonoverlapping two-phase clock output, (after Heathkit Digital Techniques, 1975, page 7-99). The phase one, (1), increments a counter which addresses the program stack while the second clock phase, (2), drives the multiplexer that carries out the instructions stored in the stack.

A 3-input nand gate stops the clocking of the J-K flip-flops when a stack instruction commands it. This feature is useful for extended periods of data collection.

The memory, (block 2), contains the program stack and is sequentially addressed by the 6-bit counter mentioned earlier. The program stack consists of 4-bit commands sent in parallel to two tri-state buffers, (blocks 3 and 4). The buffers direct the 4-bit control information to one of two multiplexers; these multiplexers carry out the instructions provided by the 4-bit control code by activating one of sixteen output lines of the multiplexers.

Switches, (block 2), are used to program the stack. Switches A through D provide the 4-bit code which is loaded by switch W. E. at a location provided by the stack pointer. The stack pointer is incremented by switch INC: switch RST is the resent switch which initializes the stack pointer, (address 000000).

The tri-state buffers, (blocks 3 and 4), are activated by the outputs Q; Q of a J-K flip-flop. This provides an alternate activation scheme for the buffers insuring only one is active at a given instant.

The 4-bit stack commands are normally channeled through the buffer of block 4 to the multiplexer contained therein. This addresses one of the 16 mutually exclusive lines of the multiplexer whenever the two clock pulse is low. The activated line performs the specific function wired to it, (e.g., register shift, data clear, latch enable, or multiply, etc.). The multiplexer interfaces to the calculator chip, (block 5), through PNP transistors acting as on-off switches.

The block 3 buffer is used for direct entry of program constants to the calculator chip. These constants are used in the data processing stage of the function. Data are entered by reversing the states of the two buffers. Once data are entered, the buffers are returned to their normal state.

With the buffers in their normal state, data are entered from the counters via a tri-state data selector. The selector enable and selection lines are both driven by the multiplexer of block 4. The counters are each 3-digit decade counters with an internal left circulating shift register, which determines which digit is displayed at the output line. The chips may be latched, reset and selected independently, so that data entry is not interrupted during chip selection.

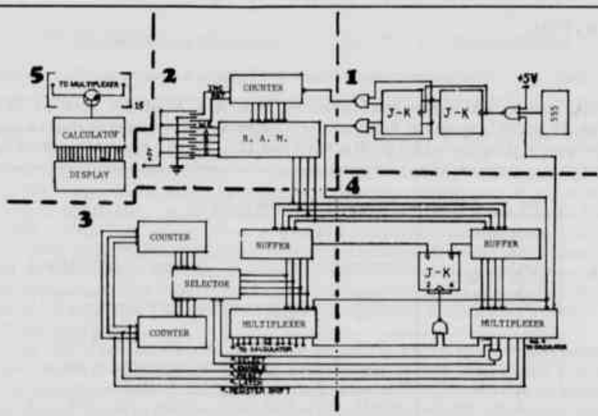

Figure 1. Schematic interface circuit. Lines Inc., RST. W.E. and A-D (block 2) are on-off switches.