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PRELIMINARY CONDUCTIVITY PROBE TESTS FOR SHAWINIGAN CHEMICALS LIMITED

by

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SUMMARY OF RESULTS

Preliminary tests on the possible use of a conductimetric probe to control caustic soda content in 30-35% cyanide solutions indicate that adequate sensitivity can be attained with a modified Foxboro Dynalog system, provided that temperature compensation is applied and the ammonia content of the test sample can be removed by sparging.

INTRODUCTION

In November 1962 a few tests were carried out in Ottawa to establish to what extent the conductivity probe system could be used to control the caustic soda content in sodium cyanide, as produced by Shawinigan Chemicals Limited, Shawinigan, Que. Typical conditions as supplied by Mr. Felix B. Popper are: 33-35% NaCN, 0.2-0.4% NaOH, temperature 30-35°C. Those early tests indicated that the existing conductivity system, as used on more dilute cyanide solutions, was barely sensitive enough to detect small changes in the NaOH content of concentrated cyanide solutions.

Subsequently the Foxboro system, which had been used in several plant tests on dilute cyanide solutions, was modified temporarily to improve its sensitivity and stability and a few further tests were run in cooperation with Mr. Ian Marrs of Shawinigan on April 22-23, 1963. These tests are summarized below. It will be seen that adequate sensitivity was obtained, but provision has to be made for temperature compensation.

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MODIFICATIONS TO THE FOXBORO CONDUCTIVITY SYSTEM

The Foxboro system consists of a stainless-steel "doughnut" probe and a Dynalog recorder unit, which had been modified slightly for operation with the conductivity probe.

For the tests on high-conductivity cyanide solutions, modifications were made on the Dynalog unit to obtain maximum gain in the range desired. On the original unit the 1000 cycle signal source is applied to the primary coil of the probe through a Helipot and a series capacitor. Since the probe unit is a voltage step-up transformer, the series capacitance is used to limit the power input to the unbalance voltage amplifier. In this way the full range of the Helipot is used without danger of overload. It was found through loop resistance measurements with a decade resistance box that there was some nonlinearity in pen position (Dynapoise capacitor position) and signal variation. A slight increase in sensitivity could be obtained by operating on the high-voltage end of the chart. As the range required for cyanide tests was small, the input to the probe was increased to maximum by reducing the coupling capacitor C_1 from $1\mu F$ to $0.002\mu F$ and by unbalancing the bridge slightly to operate at the most sensitive portion of the scale, which is nonlinear with respect to loop resistance. The relevant part of the circuit as modified is shown in Figure 1.

TEST DETAILS

A beaker with the cyanide solution was set up in a constant-temperature bath within a ventilated enclosure. Variations in recorder reading were correlated at each stage with the equivalent variation in resistance in a resistive loop, which would give the same result on the recorder. This served to check the stability of the system and at the same time provided comparative data for any "dry" measurements done in air.

Four series of tests were carried out. These are summarized in Tables 1 and 2. The main purpose of the tests was to explore the relative effect on conductivity of various concentrations of cyanide, ammonia, sodium carbonate and sodium formate, all of which might be expected to occur in the plant solution. The resistance readings could not be read to better than 0.1 ohm owing to the sluggishness of the null balance of the recorder.

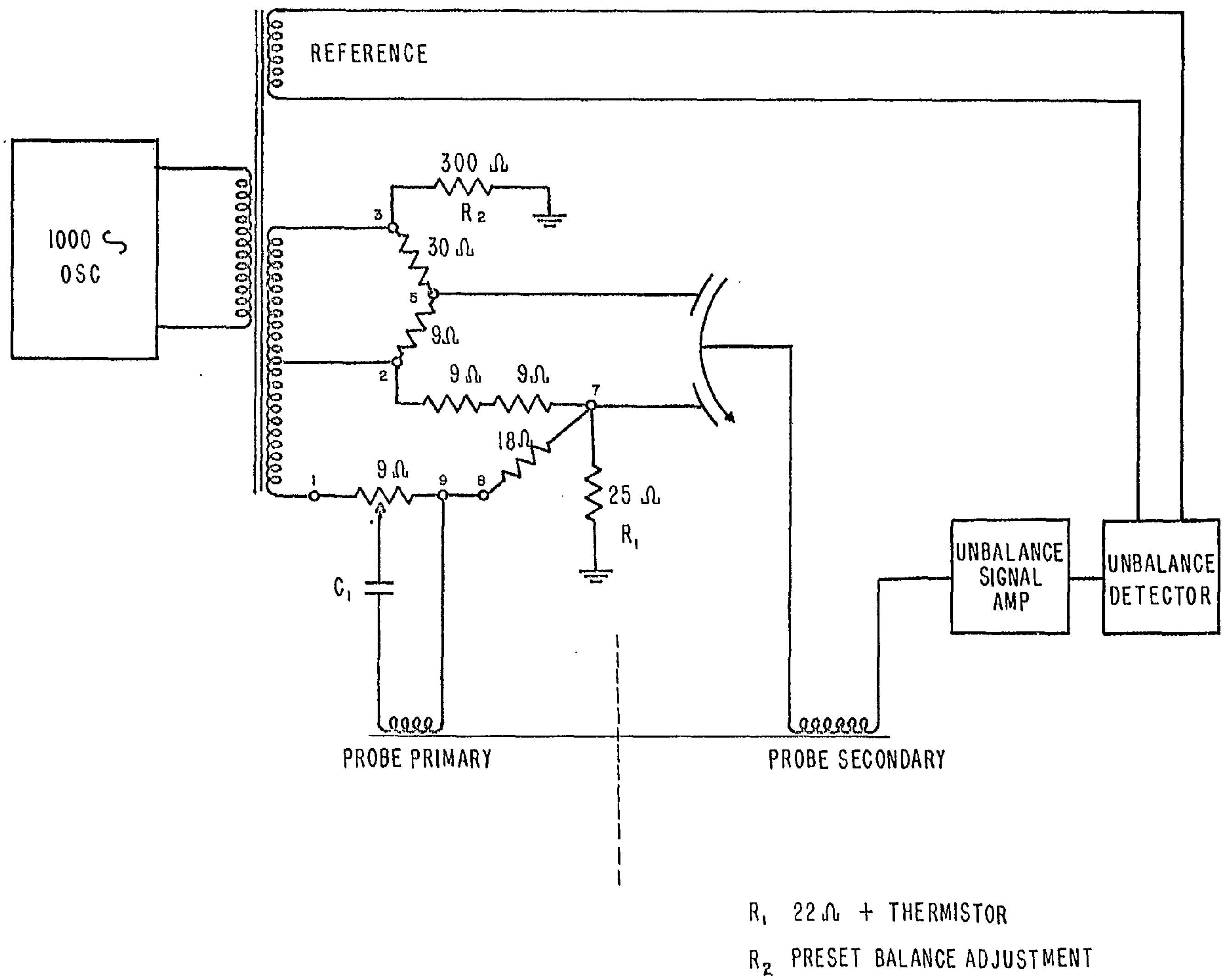

Figure 1. Modified Dynalog circuit

TABLE 1

Series A. Cyanide tests, April 22, 1963

Sample No.	Composition	Dynalog scale reading (mV)	Equiv resistance (ohms)
1	32% NaCN	80	17.5
2	38% NaCN	77.8	17.5
3	32% NaCN + 0.5% NaOH	92	16.9
4	32% NaCN + 0.2% Na_2CO_3	77	17.52
5	32% NaCN + 1% NH_3	90	16.92
6	32% NaCN + 2% NaCOOH	85	17.5

Series B. Effect of caustic soda addition,
0.5% NaOH added to five of the Series A samples

1B		84	
2B		76	
4B		72	18
5B		84	
6B		80	

Readings decreased for all samples due to temperature variations; this masked the effect of NaOH additions.

TABLE 2

Series C. Temperature characteristics, April 23, 1963
Fresh solution, 32% NaCN

Sample No.	Composition	Temp. (°F)	Scale reading (mV)	Resistance (Ω)
1A	32% CN	82	85	
1C	32% CN + 0.5% NaOH	80	88	17.2
	"	76	83	17.6
	"	72	76	18.0

These results have been plotted in Figure 2.

Series D. Constant temperature test

Sample No.	Composition	Temp. (°F)	Scale reading (mV)	Resistance (Ω)
1D	32% NaCN + 2% NaCOOH	80	70	17.7
1Da	same + 0.5% NaOH	80	73	
2D	32% NaCN + 0.2% NaOH	81	91.5	
2Da	same + 0.4% NaOH	80	100	16.3

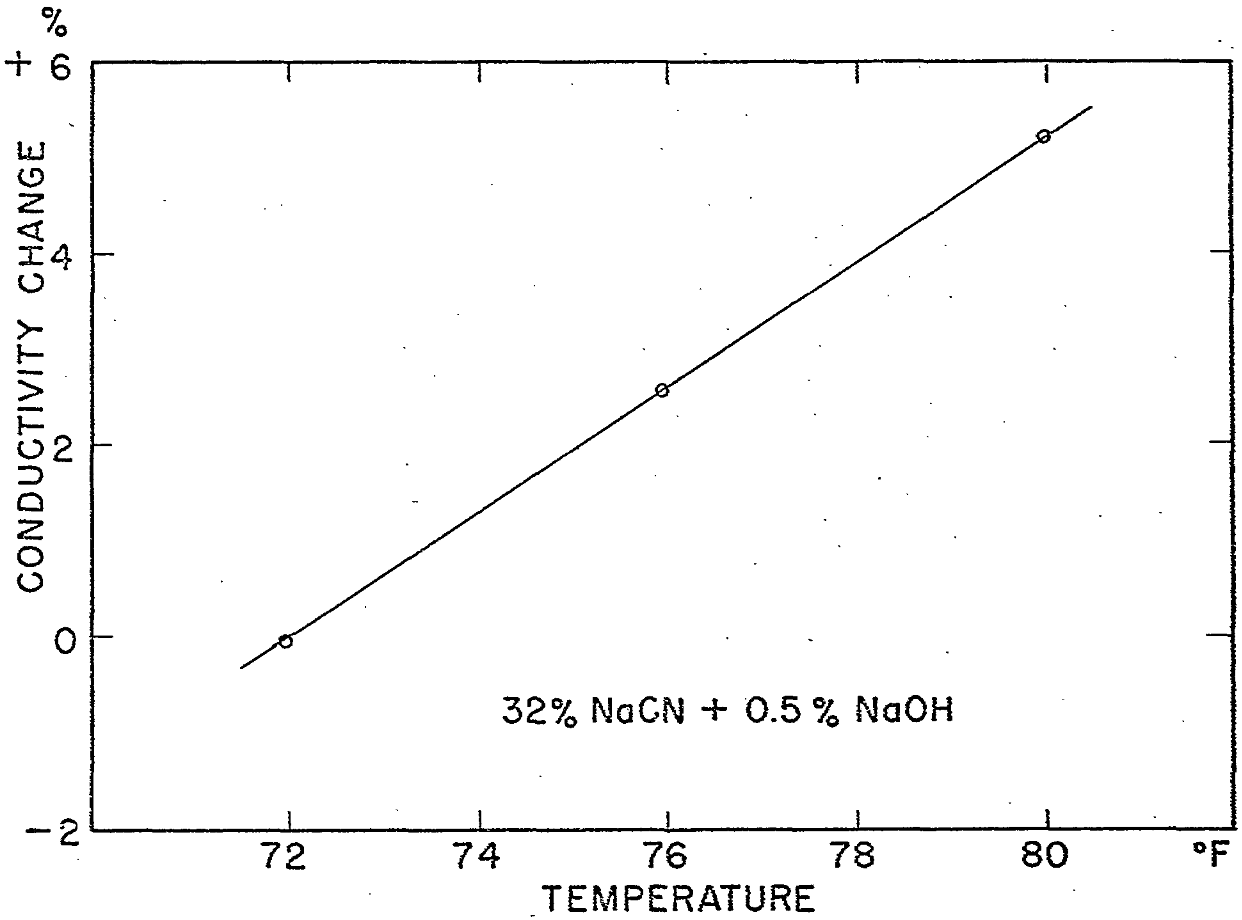

FIGURE 2 TEMPERATURE CHARACTERISTICS FOR CYANIDE SOLUTION.

CONCLUSIONS

The results are not quite complete, but the following conclusions may be drawn:

1. The sensitivity of the system is adequate to indicate and control a variation of $\pm$ 0.1% caustic in a solution containing 32% NaCN + 0.3% NaOH.

2. For stable control, temperature compensation is essential. For the Foxboro unit this could be accomplished by replacing all or part of a detector bridge resistor by an appropriate thermistor. (Tests are under way to select such a component).

3. Ammonia in the range considered, up to one per cent, has a measurable effect on conductivity. It would probably be quite feasible to remove the ammonia from the solution passing the conductivity monitor by bubbling air through the sample volume.

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