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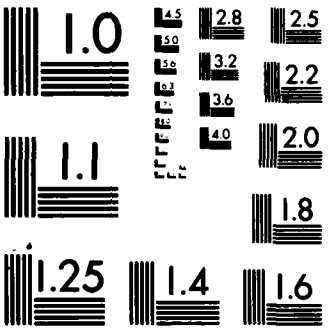

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TECHNICAL REPORT NO. 82-09

COMPARISON OF AN AQUEOUS AND A FLUOROCARBON BLOOD GAS CONTROL

by

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ABSTRACT

Two blood gas analyzer controls were evaluated, one with an aqueous base (G.A.S., General Diagnostics) and one containing fluorocarbon oils (abc, Instrumentation Laboratory, Inc.). On 32 consecutive workdays, pH, pCO_2 and pO_2 were measured using both manufacturers' controls for low, normal and high values. There were 22 occasions when values for G.A.S. solutions were out of the expected ranges, and only 3 occasions when values for abc controls were out of the expected ranges. For low pH, low and normal pCO_2, and low, normal and high pO_2 ranges, abc controls had standard deviations and coefficients of variation that were 30 to 70% lower than those for G.A.S. controls. The greatest difference in variation was observed with pO_2 values.

Although without refrigeration abc controls have a shelf-life of only 3 months and the cost per ampule is 17% higher, the abc controls produced less day-to-day variations than G.A.S. controls and are therefore better blood gas analyzer controls.

INTRODUCTION

Two commercially available control solutions for blood gas analyzers were evaluated: one was an aqueous solution and the other a fluorocarbon-containing emulsion. Measurement of pH, pCO_2, and pO_2 were made on 32 consecutive workdays to determine which solution would yield the more reproducible values and be more useful in alerting the operator to technical problems.

MATERIALS AND METHODS

An IL 813 Blood Gas Analyzer was used for all measurements.[1] The instrument was calibrated and operated according to the operator's manual by one of four medical technology students. Measurements were made on 32 consecutive workdays over a seven-week period.

Controls

Each control was stored, mixed and tested according to the manufacturer's instructions. G.A.S.,[2] an aqueous control available from General Diagnostics, was stored at room temperature. abc, a fluorocarbon-based control, manufactured by Instrumentation Laboratory, Inc.,[1] was stored at 4 C, but for 1 hour before use was maintained at room temperature.

Both manufacturers provided three control levels, with low, normal, and high values for pH, pCO_2, and pO_2. All three levels of abc and G.A.S. were tested on 32 consecutive workdays. The tests were paired so that the low pH controls, the normal pH controls, and the high pH controls, of the two manufacturers were run consecutively. The order of testing of the three paired controls was randomized from day-to-day.

Each day after calibration of the Blood Gas Analyzer, one pair of controls was assayed. If the value obtained for any parameter (pH, pCO_2, pO_2) was outside the acceptable range given by the manufacturer, the blood gas analyzer calibrations were re-checked and corrected, if necessary. If recalibration was required, testing of the first pair of controls was

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[1]Instrumentation Laboratory, Inc., Lexington, MA

[2]General Diagnostics, Morris Plains, NJ

repeated and then the other two pairs of controls were assayed. Thus, all data included in the analyses were obtained when the blood gas analyzer was properly calibrated. Recalibration of the instrument and reassay of the first pair of controls were required on 6 of the 32 days. The room temperature, instrument temperature, barometric pressure, and name of technician were recorded on each day. Room temperature varied from 18.5 to 25 C, with a mean of 21.3 C. Data were analyzed with the aid of a HP9845 computer[3] and an HP statistical analysis program.[3]

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[3]Hewlett-Packard, Lexington, MA

RESULTS

With the G.A.S. solution, there were 18 occasions when the pO_2 values were outside the range deemed acceptable from the manufacturer's instructions: on 11 occasions high pO_2 samples gave values beneath the acceptable range. On 7 occasions normal pO_2 samples gave values above the acceptable range. With the G.A.S. solution, one pCO_2 and three pH values were outside of the manufacturer's ranges.

With the abc emulsions, there were no pO_2, one pCO_2, and three pH values that were outside of the assigned ranges.

Table 1 presents a comparison of the mean of our laboratory measurements and the manufacturer's mean value: the means were similar for all of the solutions except for the G.A.S. high pO_2 solution. Our measurements of pO_2 for this solution produced a mean value that was at the lower end of the manufacturer's assigned range. Comparison of the standard deviation and coefficient of variation showed that the abc controls gave less variable results than the G.A.S. controls.

There was no significant correlation detected between observed blood gas control values and room temperature, instrument temperature, barometric pressure, or individual technician.

DISCUSSION

Both controls used in this study are available commercially in hermetically sealed glass ampules. The G.A.S. control contains a volume of 1-1/2 ml of an aqueous triethanolamine acetic acid buffer, sodium bicarbonate and dye at equilibrium with a controlled oxygen, carbon dioxide and nitrogen atmosphere. Because the solubility of the gases in the aqueous solution is low, contamination with room air alters the results significantly. Recommended storage temperature is 20-30 C and the shelf-life is 36 months. The list price is $1.88/ampule.

The abc controls contain a perfluorocarbon emulsion which increases the solubility for oxygen resulting in improved oxygen buffering capacity. Viscosity and density have been adjusted to match those of normal blood. The manufacturer claims an opened abc ampule will yield good results for 3 minutes rather than the 1-minute recommended limit of the G.A.S. control. This increased stability is due to the increased solubility of oxygen in fluorocarbon and to the small layer of foam which forms at the liquid-gas interphase. The 2 ml ampule volume and 3-minute stability allow 2 measurements from each ampule. Shelf-life is 3 months at room temperature or 18 months when refrigerated. The list price is $2.20/ampule.

G.A.S. aqueous controls were less expensive, required no refrigeration, and alerted the technician to a machine problem, but there were 22 out-of-range values with no apparent machine problems, as compared with 4 for abc. Also, abc controls showed less day-to-day variation than the G.A.S. controls. This smaller variation resulted in a narrower laboratory acceptance range for control values and should alert the technician to more subtle problems.

Table 1

Expected and Measured G.A.S. and abc Blood Gas Control Results

	Manufacturers' Expected Values			Measured Values		
	Mean	± 2 S.D.	Range	Mean	SD	Coeffient of Variation
pH						
G.A.S. level 1	7.08	.02	7.05-7.10	7.082	.024	.332
abc Acidosis	7.230	.018	7.21-7.26	7.249	.007	.092
G.A.S. level 2	7.410	.02	7.39-7.43	7.415	.007	.089
abc Normal	7.410	.016	7.38-7.43	7.426	.005	.073
G.A.S. level 3	7.620	.02	7.60-7.65	7.624	.006	.081
abc Alkalosis	7.629	.018	7.60-7.65	7.641	.006	.083
pCO_2						
G.A.S. level 1	20.0	2.0	17-23	21.0	1.20	5.71
abc Alkalosis	21.2	1.4	19-23	21.7	.84	3.88
G.A.S. level 2	42.0	2.0	39-45	40.2	1.05	2.48
abc Normal	41.3	1.9	38-44	41.3	0.71	1.71
G.A.S. level 3	67.0	4.0	62-72	66.0	1.58	2.40
abc Acidosis	63.4	2.8	59-69	63.9	1.54	2.41
pO_2						
G.A.S. level 1	146.0	6.0	139-154	139.8	4.52	3.23
abc Alkalosis	151.8	6.2	146-158	148.6	2.07	1.39
G.A.S. level 2	98.0	5.0	92-103	101.5	2.94	2.90
abc Normal	100.2	4.5	94-106	100.7	1.04	1.03
G.A.S. level 3	57.0	6.0	50-64	57.6	2.64	4.59
abc Acidosis	55.8	4.8	50-62	58.5	1.58	2.70

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Two blood gas analyzer controls were evaluated, one with an aqueous base (G.A.S., General Diagnostics) and one containing fluorocarbon oils (abc, Instrumentation Laboratory, Inc.). On 32 consecutive workdays, pH, pCO_2 and pO_2 were measured using both manufacturers' controls for low, normal and high values. There were 22 occasions when values for G.A.S. solutions were out of the expected ranges, and only 3 occasions when values for abc controls were out of the expected ranges. For low pH, low and normal

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ACKNOWLEDGMENT

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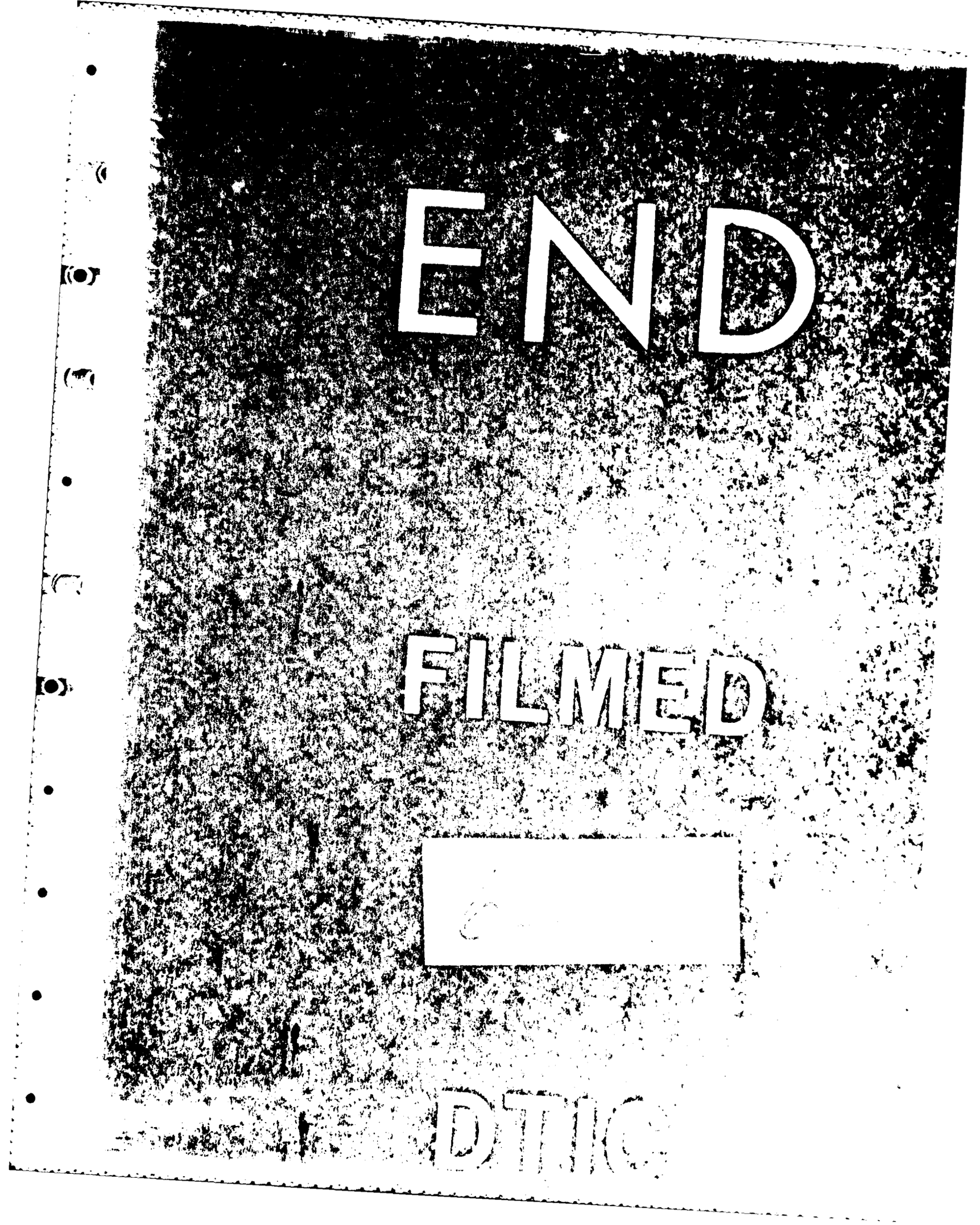
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