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Working Performance of Focused Ultrasonic Search Units Utilizing a Modified 725 Immerscope

W. A. Dudley

December 8, 1971

MOUND LABORATORY
Miamisburg, Ohio
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MONSANTO RESEARCH CORPORATION
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U. S. ATOMIC ENERGY COMMISSION
U. S. Government Contract No. AT-33-1-GEN-53

Monsanto

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LEGAL NOTICE

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ABSTRACT

The purpose and method employed in-house to quickly ascertain instrument-coupled working performance of focused search-unit piezoelectric materials of similar physical characteristics is illustrated by comparative presentation of data obtained for lithium sulfate and lead metaniobate "units" utilizing a custom built 725 Immerscope.

INTRODUCTION

The present commercial availability of piezoelectric materials other than lithium sulfate for use in ultrasonic high resolution applications, and at competitive cost, makes "in situ" performance checkout more feasible. Conventional immersion pulse-echo operating procedure, utilizing a given analyzer (at fixed control settings) and an adequate flaw standard, permits almost instantaneous checkout over a known dynamic range.

PURPOSE

Our present inventory of search units consists primarily of a variety of specialized "lithium" units for which purchase was dictated by test specifications or past availibility. Now, as a result of present market selectivity and cost competitiveness, other piezoelectric materials of equivalent or superior advertised rating can be periodically purchased and their working performance with our instrumentation comparatively checked out; thus, hopefully expanding our inspection capability consistent with "search unit" state-of-the-art development.

EQUIPMENT

a. 725 Immerscope (modified for working acceptance of R_4 P/R Module).

b. $725R_1$ P/R Module.

c. $725R_4$ P/R Module.

d. 543B Tektronix Oscilloscope (Type "L" plug-in).

e. Automation Industries Resolution Block, Type 57C3640.

f. 22-MHz, lead metaniobate search unit, S/N 10365, 1 in. focus, 1/8 in. diam.

g. 10-MHz, lead metaniobate search unit, S/N 10366, 1 in. focus, 1/4 in. diam.

h. 25-MHz, lithium sulfate search unit, S/N 17892, 1-1/2 in. focus, 5/16 in. diam.

i. 10-MHz, lithium sulfate search unit, S/N 17844, 1 in. focus, 1/4 in. diam.

EXPERIMENTAL SETUP

For each lead metaniobate unit and its "lithium equivalent", the focal point was normalized at top surface of the resolution block. A subsequent manual scan of a portion of the block's no. 3 series holes was performed to obtain video amplitude versus depth response data. In most cases, the surface and defect return echoes were separately monitored*.

DATA

a. Table No. 1 gives comparative performance data for the lead metaniobate, 22-MHz unit and lithium, 25-MHz unit for utilization of the 725R$_1$ P/R Module. Pulse voltage of 290 V (60 nsec duration) and receiver gain of 5.0 (scale index) maintained unless otherwise noted.

b. Table No. 2 gives comparative performance data for the above two search units utilizing the 725R$_4$ P/R Module. Pulse voltage of 180 V (50 nsec duration) and receiver gain of 2.5 (scale index) maintained.

c. Table No. 3 gives limited comparative performance data for the lead metaniobate, 10-MHz unit and lithium, 10-MHz unit utilizing the 725R$_3$ P/R Module. Pulse voltage of 290 V (60 nsec duration) and receiver gain of 8.75 (scale index) maintained.

CONCLUSIONS

a. The lead metaniobate, 22-MHz unit coupled to the specialized 725 Immerscope display and either available P/R module functions as a high gain 10-MHz unit that is critically damped. In this capacity, its performance shows superiority in penetration and resolution to its 10-MHz focal short counterparts.** The noted loss of the 22-MHz unit's (lower gain) high frequency spectral content, per reference of the manufacturer's measured frequency spectrum data, is not unexpected when coupled to either of our Immerscope's available pulser/receiver modules.

b. The limit of resolution (near interface) capable with the lead metaniobate, 22-MHz unit per coupling to the Immerscope system has

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* The unfiltered Rf form of the echo of interest was internally connected from the analyzer circuitry to the input of the Tektronix scope, thus allowing the dominant working frequency of the search unit, in its passive mode, to be measured.

** No effort is made to degrade the 10-MHz "lithium" unit used in this comparative effort. Its working performance with a Branson Sonoray 600 Analyzer (utilizing a Model 623 P/R module) in a critical application is quite adequate. This "lithium" unit is approximately 3 yr old and most likely has dropped some in gain over this time span although its beam profile characteristics have been maintained.

not been fully determined; however, it might compete to some degree with the "lithium", 25-MHz unit for thin materials. A separate limited comparative setup for both units utilizing the R_4 P/R module was made on a 0.040 in. diam hole with 0.020 in. metal travel (Automation Industries flaw standard 57A6081). In this application nearly identical results were obtained for each unit.

Table 1

PERFORMANCE DATA UTILIZING 725 IMMERSCOPE AND R, P/R MODULE

Lead Metaniobate, 22-MHz Search Unit

Defect Depth (in.)	Analyzer Video Amp. Response 1st Echo (%)	2nd Echo (%)	3rd Echo (%)	Receiver Bandwidth Center Frequency (MHz)	Measured Frequency of First Echo (MHz)	Surface Echo (MHz)
0.2	Not Detectable			25	-	-
0.2	32	-	-	15	10	10
0.2	36	6	-	10	10	10
0.2	45	4	-	5	10	10
0.3	33	-	-	10	10	11
0.1	45	34	3*	10	10	11
0.075	28	34	5	10	10	10
0.050	-	-	30	10	10	Distorted

Lithium Sulfate, 25-MHz (Receiver Gain 5.0 Unless Otherwise Noted)

0.2	Not Detectable			25	-	Not Measured
0.2	15	-	-	15 (8.5 receiver gain)	12.5	Not Measured
0.2	25	-	-	10 (8.5 receiver gain)	10	Not Measured
0.2	26	-	-	5 (8.5 receiver gain)	7	Not Measured
0.2	-	-	-	10	-	Not Measured
0.1	3*	-	-	10	-	Not Measured
0.075	3*	7	-	10	-	Not Measured

* Denotes signal amplitude just resolvable.

Table 2

PERFORMANCE DATA UTILIZING 725 IMMERSCOPE AND R_x P/R MODULE

Lead Metaniobate, 22-MHz Search Unit

Defect Depth (in.)	Analyzer Video Amp. Response				Measured Frequency of First Echo (MHz)
	1st Echo (%)	2nd Echo (%)	3rd Echo (%)	4th Echo (%)	
0.050	100	90	40	20	12.5
0.075	100	80	37	17	12.5
0.100	98	68	24	12	12.5
0.200	74	24	-	-	12.5
0.300	70	-	-	-	12.5
0.400	47	-	-	-	12.5
0.750	17	-	-	-	12.5
1.000	12	-	-	-	12.5
		Lithium Sulfate, 25-MHz			
0.050	85	30	17	11	25.0
0.075	65	18	11	-	25.0
0.100	45	11	-	-	25.0
0.200		Not Measured			

Table 3

PERFORMANCE DATA UTILIZING 725 IMMERSCOPE AND R_1 P/R MODULE

Lead Metaniobate, 10-MHz

Defect Depth (in.)	Analyzer Video Amp. Response (%)	Ringout Damping (in.)
0.2	35	0.15

Lithium Sulfate, 10-MHz

0.1	20	0.10
0.2	5	0.10