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Instruments

MASTER

**AUTOMATIC SAMPLE CHANGER FOR
THE BERYLLIUM ANALYZER**

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J. D. Caylor

**UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE Y-12 PLANT**

operated for the **ATOMIC ENERGY COMMISSION** under **U. S. GOVERNMENT** Contract W-7405 eng 26

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ABSTRACT

An automatic sample changer with a sequential panel has been designed and built to operate the beryllium analyzer. The changer handles up to 45 samples and automatically changes the sample, operates the counting equipment, and records the counts. It is estimated that in the determination of beryllium, an activation and counting time of about five minutes per aliquant is saved. The analytical results obtained from its use are not significantly different from those obtained from the manually operated beryllium analyzer.

CONTENTS

SUMMARY	5
INTRODUCTION	6
AUTOMATIC SAMPLE CHANGER	7
Equipment Details	7
Overall Design	7
Redesigned Sample Tray	7
Sample-Handling and Changing Mechanism	7
Counting Equipment and Sequential Panel	11
Alarm System	11
Sample Holders	13
Operation of the Equipment	13
Results	13
Precision of the Analytical Results	13
Time Required for an Analysis	14
Discussion	14
ACKNOWLEDGEMENTS	15

SUMMARY

A sample changer with a sequential panel has been designed and built at the Oak Ridge Y-12 Plant^(a) to automatically operate a beryllium analyzer for determining beryllium. The changer has a track to handle up to 45 samples (2 11/16" D x 1" H) and a motor-driven chain with transporters to push the samples around the track and onto the tray. The tray of the analyzer was redesigned to receive and handle samples from the track and to position them exactly for activation and counting. The sequencer controls such operations as: inserting the sample into the analyzer, initiating the counting, recording the counts, and removing the sample.

The following significant improvements were noted:

1. As many as 45 samples can be placed in the sample track and the changer activated, the samples counted, and the counts recorded on chart paper without any attention from the analyst.
2. The changer saves about five minutes of operator time per determination for each beryllium analysis.
3. The analytical results are not significantly different from those obtained on a manually operated beryllium analyzer.

(a) Operated for the US Atomic Energy Commission by the Union Carbide Corporation's Nuclear Division.

INTRODUCTION

Manual operation of a beryllium analyzer^(b) is very monotonous and time consuming. Automation of the operation of the analyzer and changing of samples would provide for a large savings in operator time and effort, and would eliminate the monotony.

Many sample changers are available commercially for changing samples on alpha, beta, and gamma-counting equipment, but these changers are usually built into the equipment to operate it and cannot be adapted easily to a new system. Also, most of the changers and counters handle small-size sample containers; therefore, the large Teflon cups (2 11/16" D x 1" H) used for the aqueous solutions of beryllium samples would not fit in the sample position. In addition, these commercial changers are built with very little shielding and no place for the gamma activation source (Sb-124). It would probably cost about as much to adapt a commercially available sample changer to operate a beryllium analyzer and to change samples as it would to build a new sample changer. Then, there is the cost of the changer and counter associated with it.

The best approach appears to be to design and fabricate a new sample changer with a sequential panel to operate the beryllium analyzer and to automatically change the samples. The changer should be able to place a sample in the tray of the analyzer; move the tray and sample into the analyzer; and, after counting, record the counts, remove the sample, and insert another sample. The changer needs to handle up to 45 samples in large Teflon cups or in stainless steel dishes (1" OD x 5/16" H). This report describes the design and fabrication of such a changer.

(b) Kienberger, C. A.; *Determination of Beryllium by Gamma Activation*, Y-1733; Union Carbide Corporation—Nuclear Division, Oak Ridge, Y-12 Plant, Oak Ridge, Tennessee; September 14, 1970

AUTOMATIC SAMPLE CHANGER

EQUIPMENT DETAILS

Overall Design

An automatic sample changer was designed and fabricated to operate the manually operated beryllium analyzer,^(c) as shown in Figures 1 through 3. The changer was built on a laboratory bench around the lead pig of the analyzer. The pig, supported by two large metal pipes extending upward from the concrete floor, houses the Sb-124 source. A sequential panel was designed, fabricated, and combined as a unit with the counting equipment.

Redesigned Sample Tray

The tray (Figure 4) for handling the samples on the manually operated beryllium analyzer was redesigned to provide a sample path $2 \frac{11}{16}$ inches wide across the tray so that a sample can be pushed onto the tray and then forced off by another sample. This path is approximately the same width as the Teflon cups or aluminum sample holders so that there is no side-to-side movement of the samples. Since the original tray on the beryllium analyzer is three inches wide and the Teflon cups are only $2 \frac{11}{16}$ inches in diameter, the cup containing the sample is centered on the tray by Teflon spacers ($\frac{5}{32}$ " W) which were added to both sides of the sample tunnel.

The sample tray is designed for operation by an air cylinder connected to the plant air supply. The piston of the air cylinder is connected to the back end (Figures 2 and 3) of the sample tray and is operated by a control mechanism (Figure 5) consisting of two three-way solenoid valves mounted on the two inlets of the cylinder. The valves are operated by the sequential panel which receives its signals from the timer on the scaler or from any one of the three transporters on the sample transport mechanism (Figure 4).

Sample-Handling and Changing Mechanism

The sample-handling mechanism (29" W x 59" L x 9" H) consists of the sample track and a motor-driven chain with transporters (knobs) attached to push the samples around the track and onto the sample tray. The top and sides of the sample changer are made of Boltron plastic.

The sample track was fabricated large enough to handle 45 samples in Teflon cups or aluminum holders which are $2 \frac{11}{16}$ inches in diameter and one inch high. The bottom of the track has a continuous, $\frac{1}{2}$ -inch-wide opening in the center of it, Figure 4. Through this opening, strips of metal protrude on which are attached transporters to push the samples around the track. The strips of metal are fastened to a heavy linked chain and extend

(c) The beryllium analyzer was fabricated by the Boulder Scientific Company, Boulder, Colorado.

Figure 1. BERYLLIUM ANALYZER WITH ITS AUTOMATIC SAMPLE CHANGER AND SEQUENTIAL PANEL.

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Figure 2. DETAILS OF THE SAMPLE CHANGER.

Figure 3. LEAD PIG AND SAMPLE CHANGER.

Figure 4. REDESIGNED SAMPLE TRAY.

downward with an arm protruding outward to provide a contact or point for the transporter actuator located underneath the track and just ahead of the sample tray. A termination actuator is also located underneath the track and after the sample tray so that the contact point on the terminator transporter (red) can activate it, stopping the electric motor which rotates the chain and transporters.

The chain is guided at each corner by a cogwheel attached to the underneath side of the top of the changer and driven by an electric motor attached to the top of the changer.

Counting Equipment and Sequential Panel

The counting equipment consists of a preamplifier, amplifier, scaler, and digital recorder, Figure 1. The counting equipment, sample changer, and beryllium analyzer are controlled by the sequential panel, Figure 5. The sequential panel provides for the continuous gamma activation and counting of up to 45 samples loaded in the sample track.

Alarm System

An alarm system, using a timer, was designed and built into the sequential panel. The timer is set to ring a bell when the time for sample changing, counting, and recording is not completed in the regular period of time (5 minutes). Any interruption or delay of 1 minute in the automatic operation of the equipment will set off the alarm. When the scaler and recorder reset at the end of the counting operation, the timer also resets to time the next operation.

Figure 5. CIRCUITRY OF THE SAMPLE CHANGER AND SEQUENTIAL PANEL.

Sample Holders

The beryllium solutions are transferred to Teflon counting cups (2 1/2" D x 1" H) for activation and counting. The cups are fitted with a cap, having an outside diameter of 2 11/16 inches, so they will fit into the sample tray and track.

Holders for the stainless steel dishes (1" D x 5/16" H) are fabricated from aluminum. These holders (2 11/16" D x 1" H) are made with a cavity at the top and in the center that is of the right dimensions for the stainless steel dishes.

OPERATION OF THE EQUIPMENT

The sample changer is placed in operation by turning on the electric current and by pushing the "start" button on the sequential panel. This action starts the electric motor which, in turn, starts the chain with the attached transporters in motion. The transporters push the samples around the track until a sample contacts the specimen actuator in front of the lead pig. This actuator then signals the sequential panel which initiates the counting of the sample (or blank) in the lead pig. At the end of the counting period, the timer on the scaler signals the sequential panel which activates the solenoid valve, letting air into the cylinder and forcing the piston back into the cylinder. This action forces the tray out of the lead pig and across the track used for handling the samples. The electric motor then restarts and the transporters on the chain again push the samples on the track. The sample contacting the specimen actuator in front of the pig is pushed onto the tray, forcing the preceding sample on the tray off on the opposite side onto the sample track. The second sample on the tray is pushed up to contact the specimen actuator. Again, the actuator signals the sequential panel which operates the solenoid valve and air cylinder, moving the tray back into the lead pig for activation of the sample on it (Sample 2). The counts on the scaler are printed by the digital recorder as the scaler is reset, then the counting equipment starts counting the neutrons from the sample being activated. This sequence of operations continues; and, when the transporter comes near the tray, its contact arm activates the transporter actuator underneath the track and just ahead of the tray which, through the sequential panel, moves the tray into the pig. The transporter moves past the tray and continues to rotate until another transporter pushes a sample against the specimen actuator. This signal starts the same sequence of operation again until all samples on the track are activated and counted. The contact arm on the terminator transporter (red) activates the termination actuator which turns off the electric motor, stopping the rotation of the samples.

RESULTS

Precision of the Analytical Results

A large group of beryllium samples was analyzed for beryllium on both the manually operated beryllium analyzer and the automatic sample changer and analyzer. The analytical results obtained on the automatic sample changer and analyzer were not significantly

different from those obtained on the manually operated analyzer. Thus, there is no significant bias in the results.

Time Required for an Analysis

A total of 45 samples have been loaded into the sample track and counted without any operating assistance. An analyst, manually operating the beryllium analyzer, must be in constant attendance at the instrument for about four hours to count 45 samples; only about 20 minutes of operator time are required for the automatic equipment. Thus, the changer saves about five minutes of operator time per determination.

DISCUSSION

The need for spacers on the sides of the sample tunnel can be eliminated by designing and fabricating the width of the sample tray the same as that for the sample track. Plans are to replace the present pig with one having a tray approximately the same width as that of the sample track (2 11/16").

An additional improvement can be made in the operation of the tray by covering the slides with Teflon so that each sample holder will move more easily.

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