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UCRL-1024
Technology - Materials
Testing Accelerator

UNIVERSITY OF CALIFORNIA
RADIATION LABORATORY

Contract No. W-7405-eng-48

CALIFORNIA RESEARCH & DEVELOPMENT COMPANY
Contract No. AT(11-1)-74

MINUTES OF MTA PROGRESS MEETING HELD NOVEMBER 28, 1950

Russell H. Ball

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MINUTES OF MTA PROGRESS MEETING
HELD NOVEMBER 28, 1950

Present: UCRL: Alvarez, Baker, Brobeck, Cork, Farly, Judd, Kilpatrick, Latimer, Longacre, Martin, McKissen, McMillan, Norton, Panofsky, Serber, Twitchell, Van Atta, Wallace

CR&D: Cope, Crandall, Hansen, Hetzner, Hildebrand, Lavender, Kent, Maker, Waithman

AEC: Ball, Fidler

G.E.: Webster

Westinghouse: Hulse

Hildebrand said that bids are still being analyzed for the L-1 power supply. There are several alternatives which must be considered, the cheapest of which is somewhat less expensive than Mark I and the most expensive of which is considerably more expensive than Mark I. In addition to the cost, the completion date is also significantly affected by the choice of alternatives. A duplicate Mark I cavity utilizing a smaller motor alternator would be the least expensive and most rapidly completed additional test cavity.

Baker said the B-1 test cavity is now maintaining a vacuum of 0.03 μa. They have not yet successfully excited the cavity. A determination is now being made of the pre-excitation power required. Pre-excitation power of 100 kilowatts has been tried and was not sufficient. It is estimated that multipactoring between the high voltage sphere and the liner would occur at 5000 volts; however, the oscillator is now locking at 50 volts. It therefore appears that the present problem is one of gas discharge rather than multipactoring.

Longacre reported that a more powerful oscillator has been satisfactorily coupled to the electron model of Mark I and that the beam obtained is better focused than previously obtained. They have been able to reduce the amount of biasing required on the drift tubes. It appears that the drift tube magnets of this model will require replacement due to vacuum and electrical leakage. The electron beam obtained is less than during previous operation, due primarily to a leakage of magnetic flux from the first drift tube magnet into the ion gun.

Cork reported that the injector has now supplied 2.5 amperes at 60 kilovolts. With this beam they have reached the limit of the power supply available in Building 16. They have tried spiral tungsten filaments with good results.

The filament life has varied between 5 and 50 hours, depending upon experimental conditions, being primarily dependent upon filament temperature.

Hetzner summarized the contents of a recent report on CRC studies on a Mark I production target. He said the CRC has been provided with a laboratory about one mile north of the town of San Pablo (a 30-minute drive from the Radiation Laboratory). The building being used was formerly a pipeline department office of the Standard Oil Company which was later converted to an agricultural laboratory for CRC but has been idle for the last two years. At the present time about 12 CRC people are assigned to this laboratory, which has been occupied since October 9, 1950.

He said they were assigned the problem of designing a target for Po production in connection with Mark I operations and a physical separation process for Po recovery. Initially they were told the Mark I production target would utilize a deuteron beam. Since the maximum cross-section for polonium production using deuterons lies near 30 Mev, which is the beam energy of Mark I, satisfactory output required the use of windows or cladding materials as thin as possible. For this reason it was originally decided to work on a solid bismuth target employing the thinnest possible aluminum cladding. It subsequently developed that the isotopic composition of proton-produced polonium was superior to the deuteron-produced material and they were told to consider polonium production using a proton beam. Throughout their current design studies they have assumed the beam from Mark I would have a diameter between one and 3 feet and a ratio of maximum to average energy density of 50 to one, this latter figure being reduced to 4 to one by the use of a beam precessor. They were requested to provide a workable target for either a pulsed beam of 50-milliamp average current or CW operation with a beam of 250 milliamps. They have visited various AEC laboratories which appeared to be sources of useful information on these problems, including the Mound Laboratory. In addition to process design work, additional studies will be required on the fundamental problems of the diffusion of polonium and radiation damage of structural materials.

In the original considerations of a solid target the most critical problem was to develop a satisfactory bond between bismuth and aluminum. Two satisfactory processes have now been developed. The first of these is to clean the aluminum with HF and flux the metal with a Na, Li, K halide mixture. The bismuth is then cast onto this surface. A second and preferred technique involves scraping molten bismuth onto the aluminum surface and then casting the body of the bismuth metal.

Among the various types of targets which have received some consideration are those that involve the use of solutions, slurries, rotating discs, drums, vapor systems, cascading liquids, circulating or static molten systems, canned pellets, canned wafers, simple flat plate targets, etc. They are trying to narrow consideration to a target design of the simplest possible mechanical design which will accomplish the required function and upon which development can be completed in a reasonable time. Two major types of target design remain for consideration--namely, those using solid and those using circulating liquid

bismuth.

Data relative to the design limitations on temperature excursion, together with the required target diameter, and distance of the target from the last drift tube for these two types of target are tabulated below:

Table 1

TYPE OF TARGET	Allowable $\leq \Delta T$	Target Diameter	Distance from Last Drift Tube	Maximum Temperature in Target
Solid				
Pulsed	$\leq$ 10° F	24'	118'	240° F
	$\leq$ 30° F	24'	118'	240° F
CW	$\leq$ 10° F	24'	118'	300° F
	$\leq$ 30° F	17'	72'	300° F
	Max. Tube Temperature			
Circulating Molten				
Pulsed	900° F	9'	48'	
C.W.	900° F	17'	75'	

Presently envisioned solid targets would use one of two designs. The first would consist of a 3-inch circular aluminum tube of 20-mil wall thickness within which would be placed a tight fitting aluminum tube of 250-mil wall thickness from which latter tube a portion of one side has been machined off to leave a pocket in which solid bismuth would be placed. These tubes would be disposed in a double bank and the bismuth pocket would be of such a contour as to provide a uniform 70-mil path to all of the beam incident on the tube. See Figure 1.

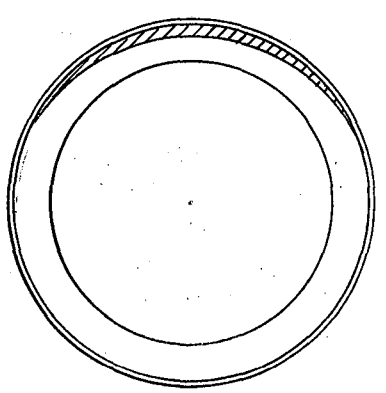

Figure 1

The second design would consist of flat plates of 70 mil bismuth clad on the beam side with 20 mil aluminum and backed with a heavy aluminum plate. The circulating molten bismuth target would utilize 1" diameter tubes of 20 mil wall thickness, made of low chromium-molybdenum steel through which the metal would circulate. The molten target would degrade the protons within the bismuth from approximately 26 Mev to zero.

The target using circulating molten bismuth seems more certain of success at the moment and is therefore receiving the higher priority. It is recognized, however, that solid targets are worthy of considerable attention, especially since with a solid aluminum clad target using a pulsed beam of 50-milliamp average current the polonium production would be 12.8 curies per day while with the molten bismuth circulating in stainless-steel tubes the product would be cut to 10.8 curies per day. This 20% difference in production amounts to an economic advantage of approximately one million dollars per year in favor of the solid target.

CRC will undertake to study the diffusion of polonium through stainless steel in the neighborhood of 900° F at concentrations of one ppm of polonium in bismuth. In a solid target the maximum temperature under pulsed operation would be 240° F, while under CW operation it would be 300° F and polonium diffusion through the aluminum cladding will have to be studied here also. It will also be necessary to study radiation damage of stainless steel in the temperature range between 600° and 900° F and of aluminum in the range 100-300° F under maximum flux of the order of 10^{14} protons/cm^2/sec. Mound has begun a study of polonium diffusion through copper and stainless steel at ORNL's request. CR&D and UCRL have requested Oak Ridge to undertake studies of radiation damage and thermal cycling damage on solid bismuth. The immediate plan with regard to the circulating liquid bismuth target is to build a pilot unit in which such problems as pumping, corrosion, erosion, control instruments, etc. can be investigated. A centrifugal rather than an electromagnetic pump has been chosen for this pilot unit primarily on the basis of its efficiency of 40% compared to 2% for the E-M pump. Argonne has operated this type of centrifugal pump with liquid metals for as long as 5000 hours without difficulty. CRC is not prepared to undertake pilot plant studies of solid bismuth targets. The problems in this latter case which require investigation are those of grain size and ductility and the effect upon these characteristics of impurities, casting temperature, and casting cycle. The effect of these variables upon ductility and strength of the bismuth will determine the maximum allowable temperature swing.

Two units are nearing completion in which solid bismuth will be subjected to thermal cycling. Solid bismuth has been thermally cycled by resistance heating between 250° and 300° F for one week. The number of cycles involved is equivalent to 4 minutes of pulsed operation. No thermal cycling damage was noticeable. Another important problem is that of devising a means of examination of target elements to locate faulty heat transfer bonds. It is felt that this can be accomplished through the use of ultrasonics. It is also hoped to have firmly in mind by early 1951 a satisfactory means of fabricating the

necessary target elements.

Consideration is also being given to hazards resulting from rupture of various target designs. Although the rupture of any target would be very undesirable, that of a liquid system in which the bismuth is under pressure would undoubtedly be the worst case. They have under consideration methods which may prove capable of detecting incipient rupture of a solid bismuth target. In addition to the economic advantage mentioned above for the solid bismuth target there is the added convenience that since it would be clad in aluminum rather than stainless steel the gamma activity would be of shorter life and would decay to low level in a period of about 3 days. However, in view of the lack of sufficient information on the metallurgy of bismuth, major short range emphasis is presently being placed upon the liquid target.

CRC has also undertaken the study of molecular distillation for the removal of polonium from molten bismuth. They have found that the enrichment factors obtained are approximately 1% of those calculated on the basis of the vapor pressures of bismuth and polonium.

First stage enrichments will be of the order of 30 to 50 and this will probably be adequate to attain the polonium concentration desired by Mound. These distillation experiments indicate that the rate of diffusion of polonium will likewise prove to be less severe by perhaps one or two orders of magnitude than present estimates indicate. The separation of bismuth and aluminum of a solid bismuth target may be handled either by heating target elements above the melting point of bismuth to effect the separation or by simply shipping the tubes directly to Mound where the aluminum cladding and backing could be dissolved.

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