REMOVAL OF STRONTIUM 90 FROM MILK

Editorial note: This is summary of remarks by Dr. Sam R. Hoover, Assistant to the Administrator, Agricultural Research Service, U. S. Department of Agriculture, at a Radiological Health Press Seminar, Department of Health, Education, and Welfare, Washington, D. C., December 18, 1961.

The photographs which accompany this report were obtained through the courtesy of the Agricultural Marketing Service and Office of Information, U. S. Department of Agriculture, Washington, D. C.

This is a report on a research program initiated almost two years ago by three separate agencies of the U. S. Government to develop a standby process for the removal of radioactive contamination from milk.

Such process would become exceedingly important in the event of a nuclear attack, an accident in an atomic energy installation resulting in the release of large amounts of radioactive fallout, *or a vastly increased contamination of the atmosphere through an atomic testing program of far greater magnitude than any country has undertaken to date.*

Milk Is Safe

The safety of our milk supply was not in jeopardy when this research program was initiated: it is not in jeopardy today. Then a ban on nuclear bomb testing was being observed throughout the world, and the levels of atmospheric contamination from previous tests were receding. Now, nuclear testing has been resumed. But as you have learned from previous briefings in this series, *levels are still well below the point of any serious concern and are expected to remain so for the foreseeable future.*

Still, from a long-range viewpoint, it appeared then—and it does today—that we should be in a position to safeguard our supply of such a vital food as milk in the event of an emergency. Our primary concern is over strontium 90, the long-lived (28-year half life) component of radioactive fallout which is presenting the greatest hazard. When we started this work, there were indications that a process for removing strontium 90 from milk could be developed, but no private company could have been expected to underwrite the necessary research. Three governmental agencies were vitally concerned: the Atomic Energy Commission, which has manifold duties in nuclear research and in the uses of nuclear energy; the Public Health Service of the Department of Health, Education, and Welfare, which conducts a comprehensive monitoring program and keeps close count of food contamination with radioactivity as part of its responsibility of protecting the Nation's health; and the U. S. Department of Agriculture, which has responsibility for research in the production, handling, processing, and marketing of milk.

Research Began 2 Years Ago

Early in 1960 these three agencies entered into a cooperative agreement to underwrite jointly the cost of a program to develop a feasible process for removing strontium 90 from milk. The program was set up in the Agricultural Research Service's Eastern Utilization Research and Development Division in Beltsville, Maryland.

Today a pilot plant is in experimental operation at Beltsville. Milk obtained from cows fed radioactive strontium is being run through the equipment at the rate of 100 gallons per hour. Tests for the milk's radioactivity before and after passing through the equipment show that as much as 98 percent of the contamination is removed by the process. *No significant effect on the milk's chemical composition, physical stability, or flavor has been noted as a result of this treatment.*

Removal Process Is Simple

The process itself is quite simple. It is based on the well-known principle of ion exchange. The milk, slightly acidified, is filtered down through a bed of resinous material charged with a concentration of metallic salts similar to that found in milk. The metallic ions in the milk reach equilibrium with the ions on the resin, and the minute amounts of strontium ions in the milk change places with calcium ions on the resin. The milk, minus its radioactivity, is then restored to its original acidity and pasteurized and homogenized as usual. Periodically, the resin columns must be washed and regenerated with fresh salt solutions. The technical details of the process are covered in another statement, which is available at this briefing.

We are dealing here with minute quantities of radioactive materials. Strontium 90 gets into milk through plants eaten by the cow. Some of the radioactive material is transferred from the soil to the plant root by a process similar in principle to the ion-exchange principle we are using to remove it from milk. But most plant contamination from fallout is absorbed through the leaves. Ruminants take into their system only about 5 percent of the strontium 90 they ingest when feeding on these plants. And cows secrete in their milk only one-fifth of the strontium 90 they take into their systems each day.

Then why, if such infinitesimal quantities of radioactive contamination ingested by the cow actually show up in milk, are we so concerned about this commodity? We are concerned about it because milk is such a basic food, and because strontium is quite closely related, chemically, to calcium. Hence it replaces calcium in the bones and in the teeth. *With a standby process for removing strontium 90 from milk we can have reasonable assurance of the continued safety of this food, which is so vital especially to our children's health.*

Before this project was initiated, work had been done in other laboratories which gave us reason to believe that an ion-exchange process could be developed for removing strontium 90 from milk. In our work we have taken advantage of earlier research sponsored by the Atomic Energy Commission at the University of Tennessee, of studies undertaken by Dr. B. B. Migicovsky of the Canada Department of Agriculture, and of unpublished work done at the British Atomic Energy Research Establishment—Harwell, and at our own AEC's Health and Safety Laboratory. Our research has also been supplemented by studies at the Taft Engineering Center of the U. S. Public Health Service in Cincinnati, Ohio.

PROCESS IS READY FOR EMERGENCY ADOPTION

We now feel that the process is at such a stage of development that it could be adopted in case of an emergency. Research is continuing at our Beltsville laboratory to improve the effectiveness of the treatment and to decrease its cost. Now that we have one process developed to the pilot-range stage, we are ready to consider not only modifications to it, but other approaches that may offer further advantages.

REMOVING RADIOSTRONTIUM FROM MILK

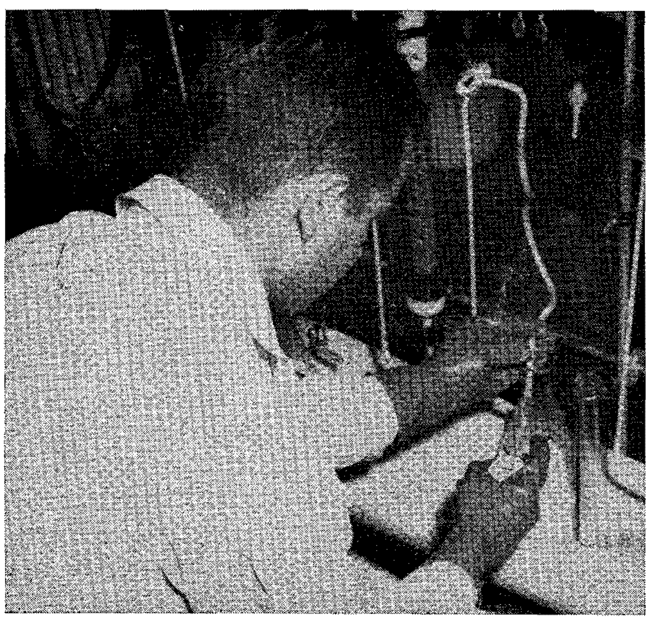

Figure 1. Scintists have succeeded in removing up to 98 percent of radiostrontium from milk by applying known ion-exchange principles, using modern, complex synthetic resins. Here USDA food technologist, David Easterly times the rate of flow through a laboratory-size column containing ion-exchange resin.

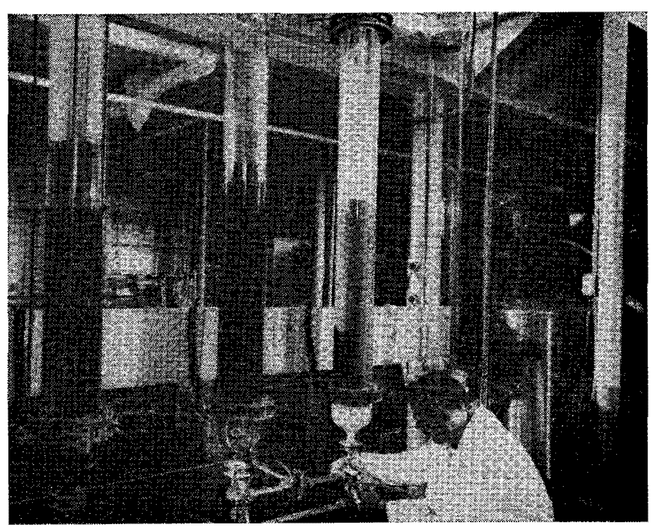

Figure 2. Here, the same process, advanced from laboratory to pilot-plant scale, is operated by dairy technologist William Mattingly. Milk is pumped from the tank at the right through one of the large columns packed with an ion-exchange resin. When the column becomes saturated with radiostrontium, it is washed and recharged for another run. Meanwhile, milk is being processed through another one of the columns. This pilot plant processes 100 gallons of milk an hour.

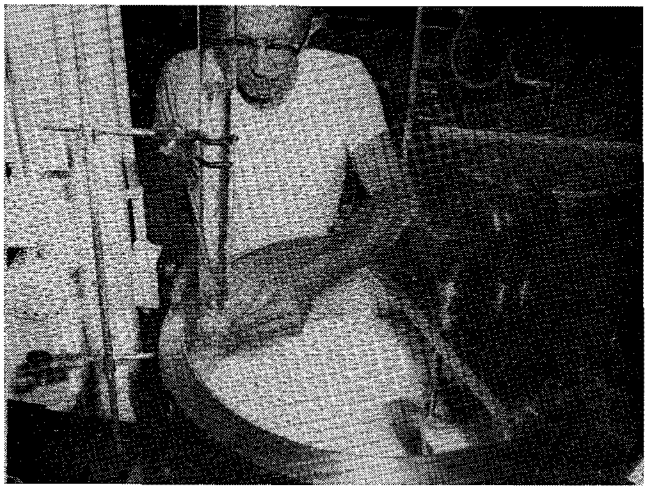

Figure 3. Scinetists found that for efficient radiostrontium removal, they had to increase the acidity of the milk. Here USDA dairy technologist, Homer E. Walter adds dilute citric acid to the milk preparatory to passing it through the "fixed-bed" ion-exchange resin column. By thus lowering the milk's pH from its normal 6.6 to 5.4, the percentage of radiostrontium removed by the process is raised from 60 to 98.

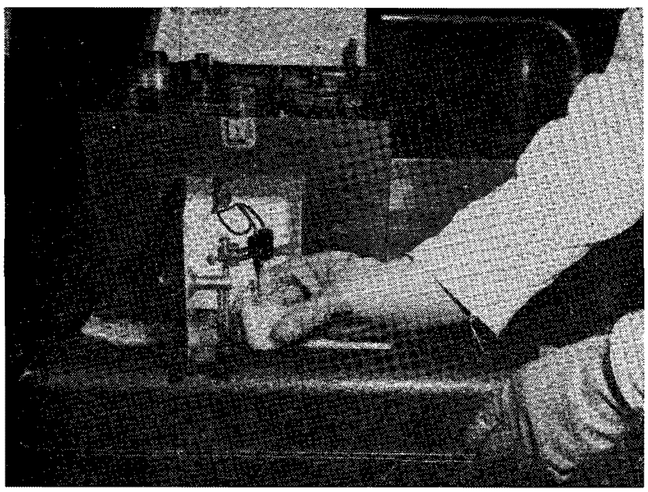

Figure 4. Milk samples are then given an acidity reading to make sure that the desired level of pH 5.4 has been achieved before putting the milk through the resin column.

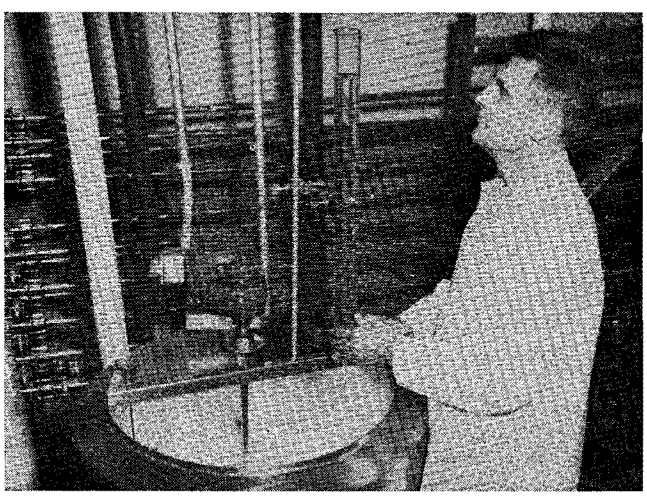

Figure 5. After passing through the ion-exchange resin, the decontaminated milk is neutralized. Here Dr. L. F. Edmondson, who heads the strontium-removal program, is adding a measured amount of dilute potassium hydroxide to restore the milk to pH 6.6.

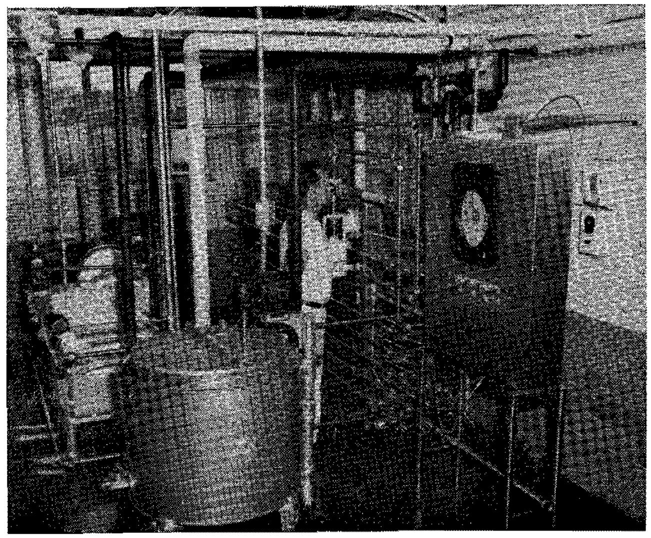

Figure 6.The milk is then homogenized and pasteurized using equipment similar to that in any small dairy. Here dairy technologist, Arthur M. Sadler is pasteurizing the decontaminated milk.

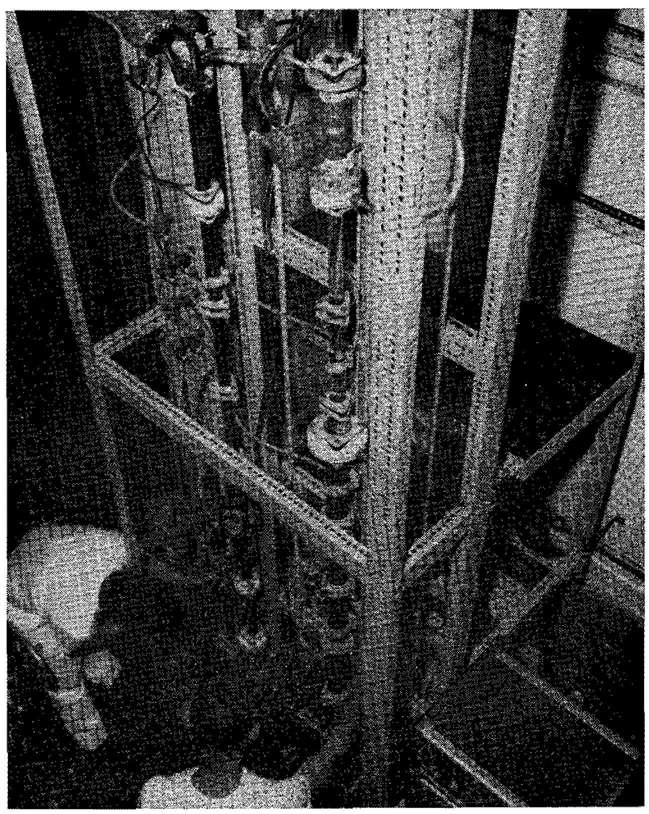

Figure 7. "Moving-Bed" Resin Contractor. Although proved effective by both laboratory and pilot-plant experiments, the "fixed-bed" method is not the only, or even necessarily the best, way of removing radiostrontium from milk by ion-exchange. Among other approaches under investigations is the "moving-bed" method, whereby the resin is pumped through the continuous column in one direction and brought into contact with the milk being pumped in the opposite direction. This has the advantage of constantly presenting fresh resin to the milk. The continuous contactor shown here, which operates in this way, is now under investigation as part of the radiostrontium-removal program. Electronically controlled and completely automatic, this machine removes the isotope from the milk and cleans and regenerates the resin all in one continuous process.

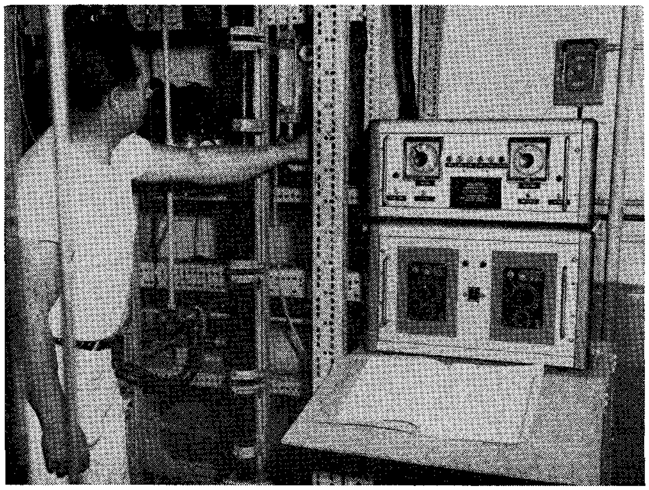

Figure 8. This electronic instrument panel, operated by Arthur M. Sadler, acts as the brain of the contactor, controlling its operations.

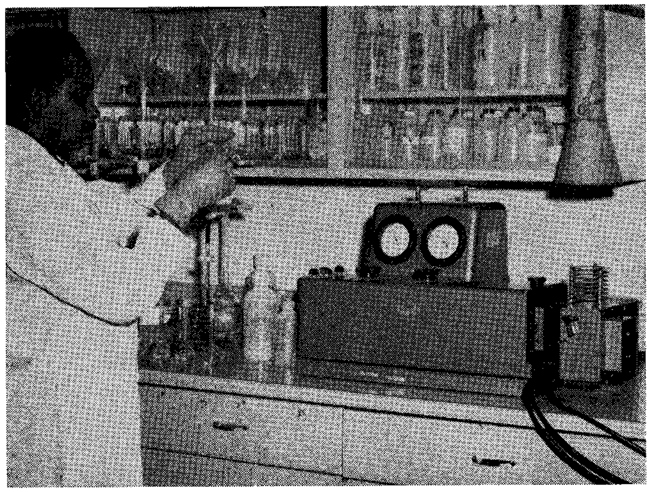

Figure 11. ARS chemist Fred W. Douglas, Jr., determines the calcium, potassium, sodium, and magnesium content in experimental milk samples. The resin mnust be treated with proportionate amounts of these minerals.

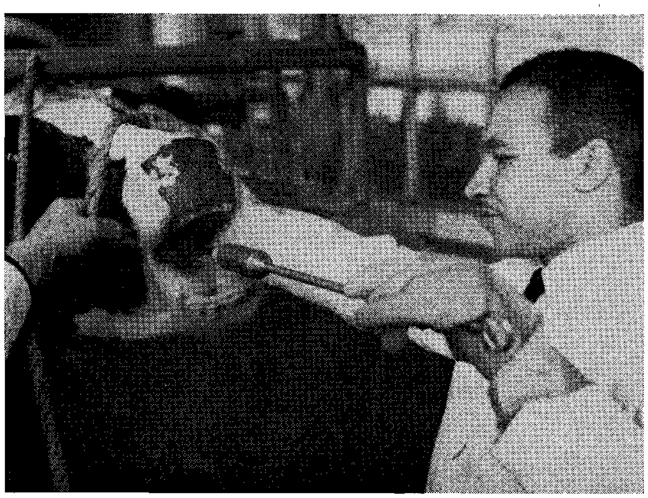

Figure 9. Milk from cows injected with radiostrontium is used for this experimental work. Also, "pure" milk samples, to which the isotope is added directly are used. Here Public Health Service officer Jesse Harris injects capsule of radiostrontium into cow's throat.

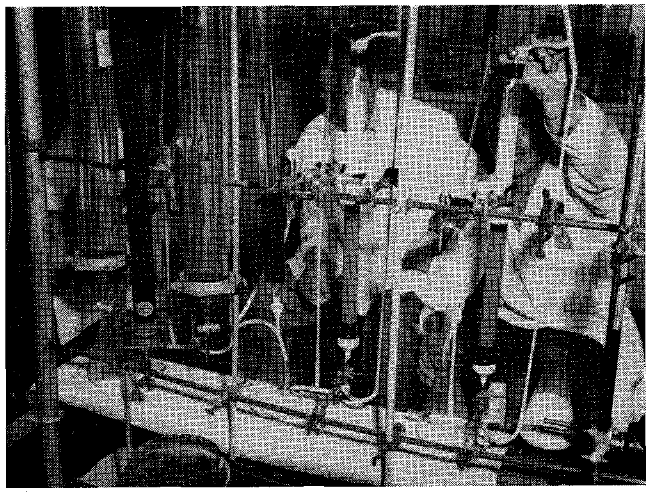

Figure 12. Tests runs on how well the resin is functioning are made in the laboratory. Adjustments in charging may be made based on these runs. David Easterly times the passage of milk through the resin as Jesse Harris directs the milk flow into cylinder.

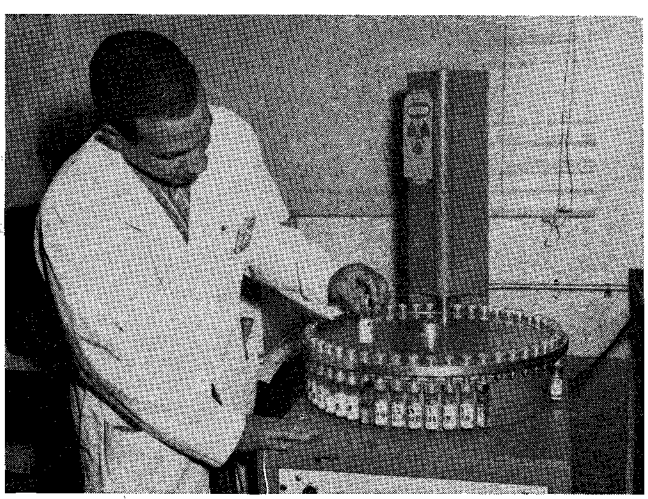

Figure. 10. Radiostrontium contamination is determined through gamma-ray emission before and after milk samples are processed. Jesse Harris loads the single-channel automatic scintillation counter which counts and automatically records data on 50 samples at a time.

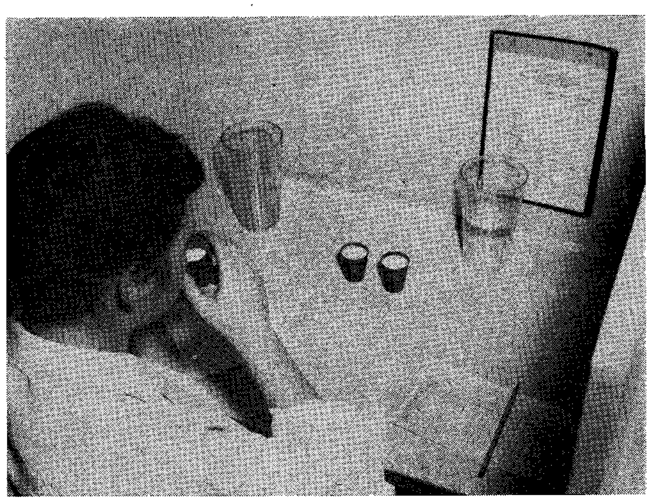

Figure 13. Normal milk put through all steps that would be required to remove radiostrontium is sampled by trained tasters to make sure that the process induces no objectionable flavor changes. Criticisms by by the tasters guide researchers perfcting the processing operation.