

A better life through centrifuges

(As published in The Oak Ridger's Historically Speaking column on October 25, 2017)

My friend, Al Ekkebus, agreed to write an article for *Historically Speaking* on the history of centrifuge technology.

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As a guide with the American Museum of Science and Energy on tours of Manhattan Project sites, I hope to share information about Oak Ridge, our legacy activities, and current developments. While I am confident with the general information, I want our visitors to have a few tidbits to pass on to friends and neighbors at their next barbecue when someone asks "I know you recently went on a tour in Oak Ridge, what can you tell me about it?"

K-25 has a proud history with centrifuges, and recently I found that personal historical detail I was searching for: Oak Ridge National Laboratory biologists worked with centrifuges at K-25 and provided technologies to purify vaccines reducing side effects after inoculation.

A centrifuge is a rapidly spinning piece of equipment that can be used to separate mixtures in a gas or liquid into its constituent parts based on their density: the denser products will move outward from the spinning and the lighter products will be forced inward.

Centrifuges were one of 4 techniques tried at K-25 to achieve its wartime mission for enriching the U-235 from a level of 0.7% in naturally occurring uranium to eventually over 80%. Isotope separation using the gas centrifuge was first performed in 1934 at University of Virginia and despite initial promise for use on an industrial scale, this effort was terminated in January 1944 for reasons including machine failure.

Two enrichment methods were more successful in Oak Ridge: gaseous diffusion at K-25 and electromagnetic separation at the Y-12 calutrons. Research using thermal diffusion was also performed at K-25 and was abandoned in early 1945.

[The thermal diffusion Al mentions was the S-50 plant built at the K-25 site near what was at the time the world's largest steam plant intended to produce electricity for K-25, but at the time the barrier material for gaseous diffusion was not yet fully developed. So, the thermal diffusion plant code named S-50 produced slightly enriched uranium as feed material for first the calutrons at Y-12 and then the gaseous diffusion process at K-25. Then the product of both processes was fed into the Beta calutrons at Y-12, skipping the Alpha calutrons. It is estimated that by building the thermal diffusion S-50 plant, the war was shortened by three weeks – Ray]

After World War II, gaseous diffusion was the process favored by Western nations, while the Soviet Union developed effective centrifuges largely through the help of captured Luftwaffe scientists. One of the scientists, Gernot Zippe, came to the University of Virginia in 1958 and wrote a report for the US government describing the recent engineering efficiencies made in centrifuges.

The US government awarded a contract to Union Carbide Corporation in 1960 to build a series of centrifuges linked together, a cascade. Research to support this effort was performed at K-25, then called Oak Ridge Gaseous Diffusion Plant under the leadership of Paul Vanstrum and Dean Waters.

At ORNL's Biology Division, Norman Anderson tried to develop a program to physically isolate cancer cells, and began to think of a way to use the centrifuge technology in a joint program between the Atomic Energy Commission and the National Institutes of Health. Because this program used viruses, the project was relocated to ORGDP to eliminate exposure to ORNL's mouse colony.

The team was housed in the Powerhouse at the K-25 site [near where S-50 was located - Ray] with a framed single-page purchase order for "One coal-fired steam-driven electrical generating plant, 237 megawatt" mounted on the wall – quite a contrast to today's software licenses we have to frequently approve after reading.

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The Atomic Energy Commission – National Institutes of Health program led to a number of developments involving centrifuges. Earlier, vaccines were prepared by inoculating thousands of eggs with a live virus, waiting two weeks, cracking the eggs and removing the large debris from the mixture.

The resultant vaccine was more than 98% egg debris and 1% virus. For those with egg allergies, their reaction could be fatal, limiting inoculations to only those between 10 and 60 years of age, and others under medical supervision.

Working with Eli Lilly Corporation, the ORNL, ORGDP, and NIH team developed an ultracentrifuge that produced purified vaccine that reduced side effects by over a factor of 10 in clinical trials. This eliminated the age and supervision restrictions and also increased vaccine production!

These centrifuge efforts were recognized by the AEC and its successor agencies. Paul Vanstrum received the Ernest O. Lawrence Memorial Award in 1966 for “his outstanding technical administration and leadership in the development of isotopic separation processes for uranium and for his technical contributions in developing the zonal-gradient liquid centrifuge for biological uses”.

Norman Anderson received an AEC Citation and Gold Medal in 1972 for the invention and development of the ultracentrifuge and contributions to the development of a purified influenza vaccine.

Another benefit of the centrifuge was energy efficiency: they used only 2% of the energy of the gaseous diffusion. This work advanced to 1977 when President Carter decided to build the Gas Centrifuge Enrichment Plant in Piketon, Ohio.

Dean Waters received the Ernest O. Lawrence Memorial Award in 1978 for his centrifuge research that figured heavily in this decision. Who would have thought that less than a decade later, 1987, the ORGDP would be on standby status and all centrifuge work would be ceased?

The world is a better place and our lives are enriched through the biological advances enabled by centrifuges! Pun intended.

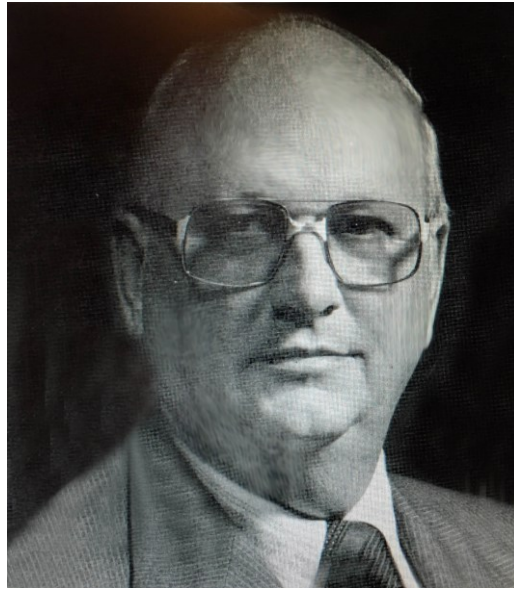
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Thanks Al! This brief history of centrifuge technology development has demonstrated the huge benefits derived from the advancement of technology. Al only touched briefly on the political implications and results of decisions regarding uranium enrichment using centrifuges.

The Atomic Vapor Isotope Separation process versus Gas Centrifuge competition which in 1986 resulted in the shutting down of gas centrifuge process and the more recent efforts of the U. S. Enrichment Corporation and later Centrus is another story! I am looking for someone to write that series!

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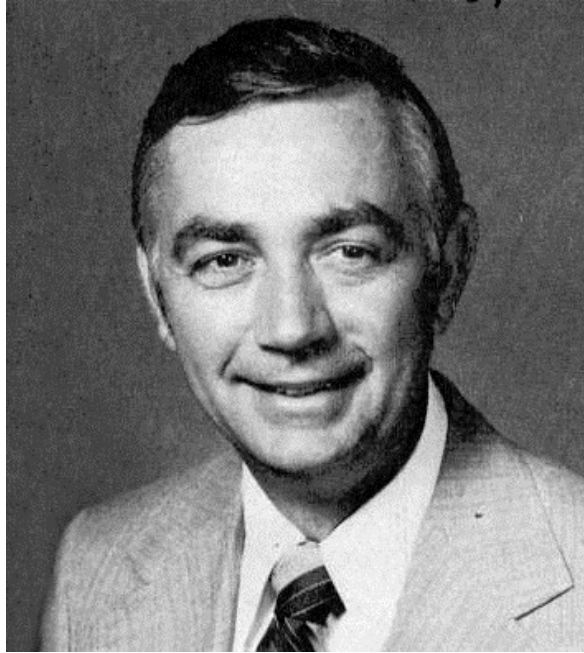
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