Cold Fusion Reaction Chamber

The design of the cold fusion generator discussed on this website was developed to bridge the gap between laboratory research systems and a commercially useful device, and to ensure it can be manufactured and supported by industry. The generator is designed to make use of pressurized hydrogen and deuterium gas and proton-deuteron (p-d) reactions since these are predicted to occur more easily in a cold fusion environment than some other types of nuclear reactions. Interested readers are encouraged to request a list of related technical references by writing to New Energy Power Systems, LLC, P.O. Box 3825, Fairfax, VA 22038.

The purpose of this blog is to discuss the reaction chamber that encloses the generator's active high-temperature and pressure components. The reaction chamber must be massive enough to absorb 5.5 MeV gamma radiation from the p-d reactions, converting this radiation into heat. The reaction chamber is also required to contain high gas pressures and temperatures during operation, and not leak with changes of pressure and temperature during generator startup and shutdown. It needs to have a large enough internal volume to contain an anode, the cathode where cold fusion reactions occur, and other supporting electrical components (e.g. temperature sensor). It should be able to be opened and closed when maintenance is required on internal parts. For convenience, the anode and supporting electrical components can be mated with the top. Pipes extending from the reaction chamber are used to connect with gas source and collection manifolds discussed below in another blog. The reaction chamber also needs to be surrounded by a heat exchanger to remove heat from its outer surface.

The reaction chamber in the above photograph was designed to satisfy these requirements. It was made from a large steel pipe (stainless type 316) available from France to a local shop, and is designated as the Mk12.31. Reaction chambers may also be obtained from the High Pressure Equipment Company in Erie, Pennsylvania (click on www.highpressure.com/products/reactors-pressure-vessels/bolted-closure-reactors/). The chamber is shown with reaction material (on the left) made by consolidating nickel powder under high pressure. The cathode consists of the reaction material wrapped in a metal casing or sleeve that is designed to provide thermal contact with the inside of the reaction chamber.

Attenuation of gamma radiation through the reaction chamber and heat exchanger can be determined by using an x-ray/gamma radiation calculator on the web; and, the National Institutes of Standards and Technology (NIST)'s XCOM database (click on www.nist.gov/pml/xcom-photon-cross-sections-database) can be referenced to determine the amount of gamma ray energy absorbed in various materials. Information in the below chart shows that only 6% of the energy from 5.5 MeV p-d reactions would be stopped by 2.5 mm of stainless steel, but that about 71% would be attenuated in 5 cm. This is about the distance through the cathode, a steel sleeve around the cathode, the reaction chamber wall and the heat exchanger/boiler wall. If the steel sleeve around the cathode were replaced by a tungsten sleeve, practically all radiation would be absorbed before exiting the wall of the reaction chamber.

Gamma Radiation Attenuation through Reaction Chamber

Effect	**Attenuation (%)**								
	Reaction Material			**Sleeve**	**Reaction Chamber Wall**		**Boiler Wall**		
Depth (cm)	0.25	0.5	1.0	1.5	2.0	3.0	4.0	5.0	10.0
Photoelectric	0.005	0.01	0.02	0.03	0.03	0.05	0.05	0.6	0.8
Compton	4.44	8.6	16.2	23.0	28.9	38.8	46.5	52.3	67.8
Pair Production	1.5	3.0	5.6	8.0	10.0	13.5	16.1	18.1	23.4
TOTAL	6.0	11.6	22.0	31.0	39.0	52.4	63.0	71.0.	91.6

As shown in the table, all of the primary radiation can be absorbed through a combination of the photoelectric effect, Compton scattering and pair production. For information on these effects, reference discussions in the text on "Radiation Detection and Measurement," by Glenn F. Knoll, John-Wiley & Sons, Inc., 2000.

During system operation, the amount of any leakage will need to be continually verified, for example with a standard gamma spectrometer located outside of the heat exchanger or directly above the top of the reaction chamber. If any of the radiation were able to make its way completely through the reaction chamber and heat exchanger, then it could be detected in the spectrometer as a "full-energy peak" at 5.5 MeV and as lower energies from partially absorbed radiation. The appearance of the spectrum can be estimated with "The Gamma Spectrum Generator (GSG)," (click on https://www.nucleonica.com/wiki/index.php?title=Help:Gamma_Spectrum_Generator%2B%2B) available from the Joint Research Centre Institute for Transuranium Elements in Karlsruhe, Germany.