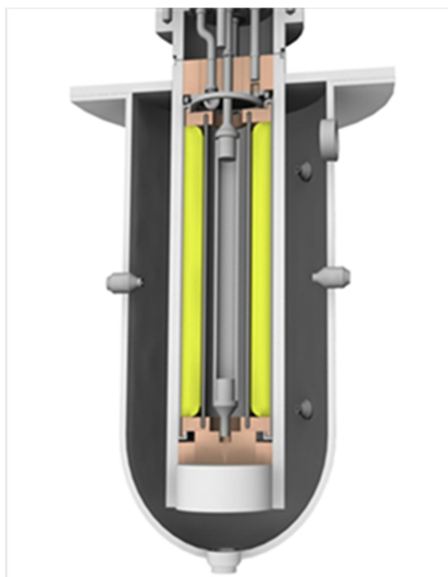
Cold Fusion Reaction Chamber and Heat Exchanger

The purpose of this blog is to provide the reader with additional technical details about design of cold fusion systems. The design of the reaction chamber and its surrounding heat exchanger in the following diagram is discussed as an example. This approach to building an operable cold fusion system would produce energy by nuclear fusion in its cathode of hydrogen and deuterium to produce 5.5 MeV of energy per reaction. Hydrogen and deuterium would be converted to helium-3 in the fusion process. The energy from each reaction (5.5 MeV) is produced as gamma radiation which, to be useful, would be attenuated in the reaction chamber and the heat exchanger.



Reaction Chamber Surrounded by Heat Exchanger for Community-Based Power System

Current Situation with Nuclear Fission Plants

"(Nuclear fission) is no longer a viable strategy for dealing with climate change, nor is it a competitive source of power. It is hazardous, expensive and unreliable, and abandoning it wouldn't bring on climate doom. The real choice now is between saving the planet and saving the dying nuclear industry." This analysis and assertation by Dr. Gregory Jaczko, Chairman of the Nuclear Regulatory Commission (2009-2012) in the Washington Post on May 19, 2019 (pages B1 and B4) indicates that the present nuclear power industry is dying *and may soon be extinct*. Nuclear industry representatives over the years apparently withheld information on the need to solve plant safety issues and “off-site” radiation release into local communities.

Now is an appropriate time to consider the benefits that could be provided by a new energy industry based upon cold fusion to replace fission-type power plants. Cold fusion could still make use of the much greater energy output from nuclear reactions than what’s possible with chemical systems, but not involve the dangers associated with present-day nuclear power plants or alternatives based upon nuclear fission. Expertise residing in the nuclear power industry could be retained and applied in cold fusion systems development. The Department of Energy (DOE) and Nuclear Regulatory Commission (NRC) would have regulatory responsibilities.

Reaction Chamber

The reason for the reaction chamber is to provide pressure, temperature and electric field conditions that facilitate hydrogen and deuterium absorption into reaction material (highlighted in the drawing) where cold fusion reactions occur. The reaction chamber contains a microwave loop antenna and a temperature sensor, and an anode in the center, surrounded by a cylindrical cathode which contains the reaction material. There is an electric heater in the anode that is used to increase the temperature of the inner surface of the cathode and the gas between the anode and cathode. A photograph of the reaction chamber was provided in an earlier blog. The system is designed to be operated with gas pressure as high as 1000 psi at 500^{o}C, but is expected to operate generally at approx. 150 psi and 300^{o}C. Although hydrogen and deuterium gases are supplied to the reaction chamber in the form of gas molecules, the region between the anode and cathode contains a mixture of molecules, ions and electrons, pressurized hydrogen and deuterium gas, elevated temperatures and strong electric fields. Microwaves are used during system start-up to jiggle electrons in the gas between the anode and cathode.

Loading of Reaction Material

In this particular design, loading of the reaction material can make use of a combination of high deuterium and hydrogen gas pressure in the reaction chamber, a high voltage electric field between the anode and cathode, and a thermal gradient through the cathode and reaction material. The electric field between the anode and cathode takes advantage of the reaction chamber’s cylindrical configuration to help transport positive gas ions into and through reaction material in the cathode.

Several ion forming mechanisms are involved. The most important is due to collisions of thermal electrons with gas molecules. The resulting mixture can contain many different species of positive and negative ions and molecules that interact with various probabilities. The positive ions of hydrogen and deuterium, however, will be repelled by the positive anode and attracted toward the negative cathode, and accelerated toward the cathode at different rates determined by their mass and electric charge. Thus, it will be possible to cause deuterium and hydrogen ions to move toward, impact with, and enter the surface of reaction material in the cathode. Movement of hydrogen and deuterium further down though the reaction material will be caused by thermal diffusion caused by the heat exchanger.

Heat Exchanger

The heat exchanger surrounding the reaction chamber extracts heat from the system and facilitates the thermal gradient through the cathode and wall of the reaction chamber. The heat exchanger is designed to remove heat quickly when reactions in the cathode begin to increase its temperature. It consists of a low volume, quick acting flash boiler that provides a mist of water or other coolant to the outer surface of the reaction chamber. The heat exchanger is also able to supply steam in a closed-loop configuration to downstream electric generators.