Science & Technology

MHD: efficient power production

by Marsha Freeman

Magnetohydrodynamics has the capability of direct production of electricity at increasing efficiencies and without environmental problems. Part 1 of our series.

Since 1832 and the experiments of Michael Faraday it has been known that if an ionized fluid is passed across the line of force of a magnetic field, an electrical current is produced. This method of generating power without any moving parts is known as magnetohydrodynamic (MHD) direct energy conversion and it can be used with any fuel, in space and in industry, and is the best means found yet to take the products of combustion or heat and turn them into the highly organized form of energy in a power grid. As such, it is an important part of the high-technology alternative to the Carter administration's proposal for inefficient and costly synthetic fuel and alternative energy programs.

MHD electric power conversion is an extremely flexible technology. Generators can be built in the range of 30 megawatt devices for scientific experiments and as portable power sources. (Such devices are operational in the Soviet Union now.) And baseload electric power generators for commercial utility systems will likely use MHD systems with a 1,000 megawatt capacity.

The working fluid in the generator can be combustion products, including oil, natural gas, coal, or chemical rocket fuel, where the fuel is partially ionized in the process of burning at high temperatures. Or at the lower temperatures available from fission reactors, the working fluid can be liquid or vaporized metals such as sodium as well as noble (inert) gases. With thermonuclear fusion, the nuclear combustion process of fusion will eventually provide a high-temperature plasma as the working fluid.

MHD generators can be designed in either open-cycle or closed-cycle configurations, depending on the working fluid. If the fluid used is the combustion product of a fossil fuel, the exhaust gas from the MHD generator can have its heat transferred to a conventional steam turbine cycle for additional power generation—an open cycle. With a liquid metal that is heated by an external heat source, such as a nuclear reactor or coal combustion, the working fluid is recirculated after power is drawn off from the MHD generator and is reheated and reused—a closed cycle.

The four major parameters that must be in precise balance for efficiency of conversion and for the production of large power loads are the electrical conductivity of the working fluid, the velocity of the fluid through the channel or containing vessel, the strength of the magentic field and the configuration of the electrodes to most efficiently draw off the current produced in the generator.

Each of these parameters has expanded the technology and engineering capabilities of industry and, in some cases, has helped pose whole new problems and solutions in power engineering.

- In order to bring the electrical conductivity up to required levels in working fluids made up of combustion products, researchers have developed a chemical seeding process.
- To increase the flow rate of a gaseous fluid beyond the speed of sound, nozzle systems are used that compress the gas and then expand it as it accelerates in the MHD channel.
- For baseload power systems, where the magnetic fields must create a Lorentz force large enough to separate enough of the charged particles in the working fluid to make the system economical, researchers developed superconducting magnet systems. Basically, the Lorentz force is the force created on the charged particle when a flow of charged particles is passed through a magnetic field that is at right angles to the direction of fluid flow. The particles separate by charge, providing the electric potential by which a current can be drawn off when a load is attached.
- Finally, working out the complexity of the magnetic and electrical fields in the MHD generator has led to the design and engineering of sophisticated generators that capture only the Faraday current (the current produced as the result of the Lorentz force that is perpendicular both to the direction of fluid flow and to the magnetic field) or only the Hall current (the electric field induced by placing a current-carrying conductor in a magnetic field) or that optimize the system by making use of both.

Research and experimentation in MHD for numerous applications is ongoing in the United States, the Soviet Union, Japan, Great Britain, the Netherlands, France and West Germany. In the next installments in this series on the technology of magnetohydrodynamics, *EIR* will review the various approaches (fossil, nuclear and fusion) and its applications.

Our thanks to the Fusion Energy Foundation and its magazine Fusion *for providing much of the information for this series.*