comes from water running over asbestos-containing rocks. Ingestion of fibers may also result from water pipes made of an asbestos cement or from use of asbestos filters for clarifying beverages.

Studies of industrial workers who are exposed to high levels of asbestos indicate that the fibers may be responsible for cancer outside, as well as in, the lungs. "People who breathe in asbestos, also swallow asbestos," explains Arnold L. Brown of the Mayo Clinic in Rochester, Minn. Inhaled fibers are swallowed as they are cleared from the lungs. Among people occupationally exposed to asbestos, researchers have observed a three- to fourfold increase in gastrointestinal cancers. (The increase in lung cancer is more substantial—20-fold for workers who smoke.) The gastrointestinal cancer evidence is "certainly suggestive," Brown says.

Animal experiments have provided contradictory data on whether asbestos fibers can penetrate the lining of the gut and damage various organs. With scanning electron microscopy, Brown and colleague Alan R. Storeygard have now caught fibers in the act.

The researchers injected a suspension of asbestos fibers into a region of a rat's intestine that had been tied off. The fiber concentration of the suspension was much higher than that in any drinking water supply. After one hour, Storeygard and Brown removed the tied-off section and prepared a sample for microscopy.

Micrographs revealed asbestos fibers impaling cells in samples from three of the five rats exposed to the suspension. No fibers were seen in cells from rats exposed only to a salt solution. A few asbestos fibers were found enmeshed in the layer beneath the intestinal lining cells. This layer is the loading area for ingested material to pass into blood vessels for distribution throughout the body.

Microscopic analysis of composition confirmed that all except one of the identified fibers is asbestos. The fibers were large, 0.4 to 1.4 microns in diameter and 5.0 to 30.0 microns in length. Other researchers report the presence of smaller fibers, generally less than 2 microns in length, in the intestinal lining, blood and several organs after feeding animals asbestos or injecting it into their stomachs. Brown suggests that in his experiments the small fibers may not have entered the lining cells or, alternatively, may have entered more rapidly than larger fibers. "We need to stop the experiments at shorter times," Brown says.

"The observations reported herein provide confirmatory evidence that asbestos fibers can cross the epithelial lining of the intestine," Storeygard and Brown conclude in the December MAYO CLINIC PROCEEDINGS. Brown intends to continue exploring how fibers penetrate different cells and, using electron microscopy, to map the path of asbestos fibers through the body. □

U.S.-Soviet MHD plant generates first power

Just outside Moscow on Dec. 16, U-25B, the newest project in the joint U.S.-Soviet MHD program, began producing electricity and sending it into the Moscow power grid. MHD, which stands for magnetohydrodynamics, is an "advanced" technology that converts heat directly into electricity.

In an MHD generator, an electric field is set up by moving ionized gas, or plasma, through a magnetic field. In U-25B the plasma is produced by burning natural gas. As the plasma is blown past a magnetic field, perpendicular to the plasma flow, ions are deflected to electrodes, setting up the current. Although simple in concept, several of the world's technological superpowers have worked on the design of a reliable working generator for much of the past 20 years with only varying signs of success. Operation of U-25B raises hopes that MHD will soon prove commercially feasible.

In a binary, open-cycle MHD steam generator, such as U-25B, fuel is burned along with a seed material, such as potassium; seed increases plasma conductivity. A heater preheats incoming, compressed outside air as it heads for the burner. Hot gases exiting from the MHD generator pass through a conventional steam generator, the second phase of the binary system. This "bottoming cycle" uses waste energy from the gas, which is no longer hot enough for MHD, to drive steam turbines that power the compressor and an electric generator. Exhaust gases from this stage flow through a seed-recovery system.

Advantages of MHD include simplicity — it has no moving parts — and sulfur removal from fuel. The seed combines with the sulfur and both are removed during seed recovery. Another major advantage is high plant efficiency—perhaps 50 or 60 percent when compared with conventional power-plant efficiencies, on the order of 25 percent for conventional nuclear plants and 35 percent for conventional coal-fired systems. It's the high operating temperatures required of MHD plasmas that permit the theoretically higher energy extraction, hence efficiency, predicted of MHD power systems.

But the high temperatures also present disadvantages — including nitrous-oxide formation and a caustic operating environment for such crucial system components as gas channels, electrodes and air heaters. Slag buildup from coal ash plagues coal-fired models. Although slag acts as a protective coating for walls, replenishing seed lost as it combines with slag is both expensive and inefficient. Scaling components up to commercial size presents other problems.

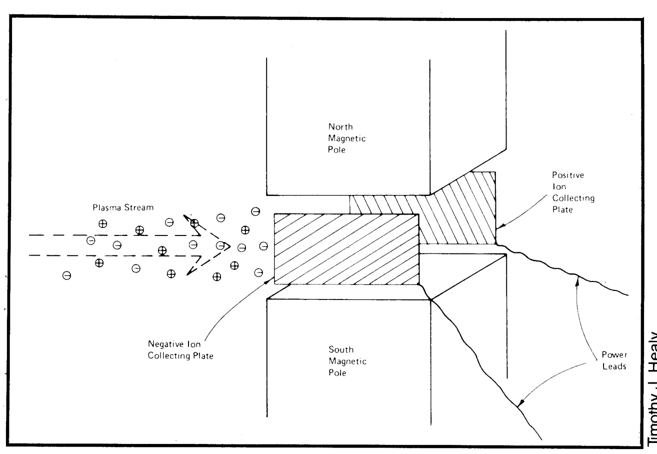
There are other MHD cycles, including those which use conducting liquids in place of the plasma. Their development is not as advanced as open-cycle systems, however.

In theory, MHD can be used as a primary source of power or as a "topping cycle" when combined with conventional combustion or fission power plants. Topping cycles harness heat that is too hot for conventional generating systems.

MHD development has not come easy. Once a world leader in MHD research, the United States mothballed its research program in the early 1960s only to resurrect it a few years later when the vision of unlimited, cheap energy was finally recognized for the myth it is. Now the Soviets lead the United States in most MHD-related technologies, but the progress by both countries is being sped by this cooperative research venture which eliminates costly duplicate research.

George Ruddins of the Department of Energy's MHD program says this joint U.S.-Soviet program is quite a bargain for the U.S. taxpayers. The cost of the superconducting magnet, the only American hardware in U-25B, was about $4 million, compared with the $15 million to $20 million Soviet investment.

How far away is commercial MHD power generation? Perhaps only five or six years, Ruddins says. The Russians are expecting completion of a 500-megawatt (electric) MHD binary-cycle power plant by 1983 or 1984. □



In MHD, ions in a plasma are blown past a magnetic field and deflected to electrodes. This creates an electric current.