

of a micron, that's one 250,000th of an inch, constitute some 95 percent of the total weight of all the particles, those smaller than a 10th of a micron constitute some 95 percent of the total number of all particles. More important, the total surface area of these small particles at least equals the surface area of the larger particles. It is on the surface of such particulate matter that waste gases are absorbed, and the fact is that we know little or nothing about how, what kind, or how much gas is absorbed by these tiny particles. Remember, too, that the smaller the particles the more likely they are to get into our nostrils and lungs, and then discharge their contaminants into our bloodstreams. On the basis of their recent work, some of my associates suspect that these mysterious tiny particles may have played an important role in tragic instances of air poisoning such as those in London and Donora, Pa. Surely, we must learn more about them.

SYSTEMS ANALYSIS AND MANAGEMENT

The experience gained by the aerospace and electric utility industries in recent years has produced a new competence in handling multifaceted problems and optimizing systems. The same kind of approach is now beginning to be applied to water-management problems. These certainly can and will be expanded to include a variety of other situations now affecting our environment.

IMPROVED ENERGY CONVERSION AND ENERGY STORAGE SYSTEMS

The U.S. Public Health Service has pointed out that of the "aerial garbage" dumped into the Nation's atmosphere each year, an estimated 85 million tons come from sources under the general heading of transportation. One possible solution to the problem of the internal-combustion engine is, of course, to keep on improving it, with greater emphasis on more complete combustion and cleaner exhausts. You are familiar with efforts in this direction, although it is generally acknowledged that even with the best of luck it may only be possible to keep the present situation from getting worse. In the long run, I believe we must look toward other ways to convert chemical—or other kinds of energy—into mechanical energy.

You have specifically suggested that I discuss the fuel cell in this context.

As you know, the fuel cell is a device that converts chemical energy directly into electrical energy, without moving parts and with inherently high efficiency, since it does not have the Carnot-cycle limitations which put a ceiling on the efficiency of ordinary heat engines. The fuel cell was invented in England, way back in 1839, but it did not have its first practical application until a year ago this month, in the Gemini V spaceflight.

Of course, the success of fuel cells on four Gemini flights hardly means they are ready for automobiles or trucks. At present costs, fuel cell automobiles are economically out of the question.

However, we should not overlook the pace of recent progress in fuel cell research. For over a hundred years there was only spasmodic interest in fuel cells, and virtually no scientific progress. But in the past decade all this has changed. Now, there are literally thousands of scientists and engineers around the world working on fuel cell tech-