lion Btu from 33 cents to 43 cents. Thus, the blending route is even more costly than that predicted for hydrodesulfurization.

(b) *Sulfur-fixation during combustion*

One way to reduce sulfur oxide emissions from combustion processes is to use an additive that ties up the sulfur oxides as a solid alkaline sulfate. Limestone and dolomite have been tested to a limited extent for this purpose because of their availability and low cost. Such additives increase the load of the solids-removal system and could contribute significantly to the fireside deposit and corrosion problem. On the other hand, these materials have a major advantage in that they can be added to the coal and crushed with it and thus can be used with existing boilers with little or no additional equipment. Test work in the United States, Japan, and Germany has shown some success, but results in general are erratic, indicating the need for considerably more research.

(c) *Removal of sulfur oxides from stack gases*

Research has been under way for many years to find acceptable methods for removing sulfur oxides from stack gases. Earliest efforts were devoted to scrubbing the gases with *alkaline aqueous solutions and slurries.* Unfortunately all wet-scrubbing methods suffer from one fundamental disadvantage—unless an exceptionally high level of $SO_2$-removal is achieved, ground level concentrations in the vicinity of the stack base may be little improved, and in some cases even worsened. This can occur since the cold, and therefore relatively heavy, effluent gases tend to descend quickly from the top of the stack, minimizing opportunity for diffusion into the surrounding atmosphere.

Because of the disadvantages with *wet-scrubbing processes,* recent research on $SO_2$ removal has been directed toward techniques operating at increased temperature levels (200–900° F.). They also have the advantage in that a marketable product—sulfur or sulfuric acid—could be produced to help offset the operating costs of the processes. At present, several dry processes are at various stages of development, and may find applicability for powerplant use.

*Interior's sulfur-control research program*

Many methods have been proposed for solving the sulfur oxides problem resulting from fuel combustion, but either the engineering technology is not yet developed or the economics are unfavorable. The Department of the Interior's Bureau of Mines, therefore, within limitations of its budget, is making an all-out effort to bring the most promising methods to an economically acceptable level. Any developments for alleviating an air pollution problem that do not consider the economic and resources aspects of control could have serious impact on the nation's overall economy.

In its work the Bureau is applying the *systems approach* because no one method can be expected to prove best for all conditions. Methods under investigation range all the way from those in which the sulfur is removed from the fuel prior to combustion, through those that remove the sulfur oxides from the products of combustion before discharge to the atmosphere, to development of new and improved combustion systems that provide electric power at much higher efficiencies than those now conventionally used. Supplementary studies have been made to determine the sulfur content of our coal resources and their availability, as well as to develop improved methods for measuring the sulfur content of coal as it moves through a coal cleaning plant.

(*1*) *Pre-combustion removal*

Pyrites, the principal sulfur-containing mineral in coal, occurs as discrete particles that theoretically can be released by fine grinding of the coal. Once the pyrites are released, the problem of separating them from the coal remains. The Bureau is exploring several approaches; a dry-cleaning procedure using a mixture of air and magnetite to effect a specific-gravity separation; froth flotation techniques; and magnetic separation.

(*2*) *Sulfur-fixation*

There is conflicting information in the literature on the effectiveness of limestones (and dolomites) for reacting with the sulfur gases during combustion of coal and fixing them in the ash residue. In some cases, appreciable $SO_2$ removal is reported, and in others, none at all. The difference in results may be caused by a variety of factors not yet fully explored. They include reactivity of the limestone, ratio of limestone to sulfur oxides, temperatures in the furnace, and