EDITORIALS

CONSERVATION.

In publishing the symposium upon conservation which occupies a large portion of this number of the Journal, a great service is being done. It should be realized that the problem of conservation is largely a chemical one and that the leaders in industrial chemistry have serious responsibility in respect to it.

In reference to many of the materials extracted from the earth there are certain common factors. Most of them have been exploited for thousands of years. However, the drafts upon the reserves of the earth as compared with its total capacity were small until the beginning of the nineteenth century. From the dawn of civilization until that time the amounts of fuels and metals mined had been so inconsiderable that there was no need of thought for the morrow. By the philosophers of any time before the nineteenth century, it might have been asserted that the stores of these substances were so large as compared with the need for them that they would last through the indefinite future.

In the early half of the nineteenth century there appeared a phenomenal increase in the drafts upon the various mineral resources; but still the amounts demanded were not so large as to suggest forethought. Then came the latter half of the century, the age of scientific advance and invention, the industrial and commercial age. Any forecasts as to the future life of the mineral resources which might have been made upon earlier data became worthless; and the closing decade of the nineteenth century and the first decade of the twentieth century show the rate of

exploitation ever accelerated. Indeed in the United States for many substances the output has doubled in ten years or less, including the all-important coal and iron. So far as this is true, it means that the output of the first decade of this century has been more than equal to that of all previous decades.

In this modern era of stable government for great nations, with peace general, war exceptional, instead of war general and peace exceptional; with the development of agriculture, manufacture, and transportation, there has come an enormous increase in population. This increase will continue until the habitable areas of the world are fully occupied. The natural resources must be so handled as to meet the needs of these billions of people through hundreds of thousands, probably millions, of years to come. From the point of view of coming generations, the problem of conservation is the most fundamental and far-reaching of those that are presented to the race.

The conservation movement, following the White House conference in 1908, was taken up with great enthusiasm all over the country, and became almost at once a national policy; but the successful solution of the problem of conservation is one which will require the work of the leaders in applied science through many years to come. Already the popular interest in the movement is waning. Now is the time when the staying powers of those who appreciate its importance is required. It is fortunate for the nation that the industrial and engineering chemists fully appreciate this situation, and are striving not only to keep the conservation movement alive but to push it forward with increasing power.

CHARLES R. VAN HISE.

MINERAL WASTES SYMPOSIUM

CARBON WASTES.

By J. A. HOLMES.

In opening the discussion on the question of waste, it may be proper to say just a word or two on the general question of waste and the possibilities of its reduction.

The Bureau of Mines, created about one and a half years ago, has had set before it two general purposes which illustrate the way that the Federal Government, as a government, is interested in this matter of preventing waste. One of these purposes is to lessen the loss of life, and the other is to lessen the waste of resources in the mining, metallurgical and general mineral industries of the country. Both of these lines of endeavor are essential to the permanent welfare of the nation as a whole.

In discussing problems of this kind under the topics of waste and conservation, we must bear in mind the fact that conservation, which in name though not in reality is a comparatively modern invention, has been

used and abused to such an extent that while it has become more or less popular in the country-at-large, it has also become decidedly unpopular with certain classes of people in this country. I think it is the province of the chemists and mining engineers, more than any other classes of people in the country, to give conservation the basis in practical affairs which it ought to have.

I know that many of us, from the geologic and engineering side, have been trying for years to get along without chemists or with fewer chemists. But we have found this impossible; instead, we have been almost swamped with the constantly increasing need for more chemists. It is therefore eminently proper, it seems to me, to discuss these waste problems with and among chemists.

The topic in this symposium which has been assigned to me, namely "Carbon Wastes," illustrates one or two general principles which also I trust I may be pardoned in calling attention to in opening this dis-

cussion, and that is, what is a real waste may or may not now be a preventable waste in the present state of knowledge or under existing economic conditions. Thus the waste in the utilization of coal; those who are less familiar with the mining industry than you are with the metallurgy, may not be aware of the fact that for every ton of coal brought to the surface in the bituminous or soft coal mines of this country, not less than one-half a ton is left under the ground, and it will not be possible to bring it to the surface in the future at any reasonable cost, if at all. But more shocking still is the fact that in our anthracite coal fields, which are so limited in extent as to be confined to a territory comprising less than four hundred square miles, even with all modern improvements, not more than 50 per cent. of the anthracite coal of the areas mined is being brought to the surface. The remainder of it, now aggregating 80,000,000 tons a year, is being left underground in such condition as to make its future recovery difficult if not impossible.

In the early days of anthracite mining there was brought to the surface an average of between 30 and 40 per cent. of the coal, so that from 60-70 per cent. remained under the ground, which was sufficient to give strength to the roof; and to-day mining engineers are bringing to the surface a part of the coal which was left in the mines 30 or 40 years ago. But as the percentage of coal mined has increased from time to time, the possibility of recovering what is left behind diminishes. It has been estimated that since the beginning of coal mining in the United States, more than 2,000,000,000 tons of anthracite coal and 3,000,000,000 tons of bituminous coal have been left underground in such condition as to make its future recovery doubtful, or impossible.

I know of no other American industry which to-day is in so deplorable an economic condition as is the bituminous coal industry. The operators, unable under existing laws to combine and fix prices of coal or any trade agreements, are adopting what appears to be the only alternative—ruinous competition, which encourages or enforces wasteful and dangerous mining. It seems essential that Federal or joint state legislation be enacted authorizing such reorganization of this great industry as will permit reasonable returns on the money invested and at the same time properly safeguard the public interests. You realize that it is often less expensive per ton for the operator to bring the first half of his coal to the surface than it is for him to bring out the remaining half, because this second half will support the roof while the first half is being removed; but while he removes the second half he must often temporarily support the roof with timbers; this entails additional expense to meet which there is generally neither an accumulated surplus from which to draw, nor a temporary profit from which to meet this extra expense; hence the coal is abandoned. It is only fair to the coal operator that he is not in the mining business for his health, but to make a living by earning a reasonable return on his investment. Therefore, what we may consider a waste may be a

necessary waste under existing economic conditions; a waste, however, that is preventable and should be prevented by improvements in our economic conditions, and necessary legislative requirements.

Therefore, I think it is up to the people of the United States before condemning the coal operator for this waste, to make it profitable and possible for him to mine all the coal and then to see that he does it. I shall not now attempt, with the limited time set apart for this discussion, to inflict you with statistical details. The figures I have given you represent some of the largest preventable losses in carbon. Other large wastes of carbon come in the burning of coal for power and lighting purposes, flue losses, radiation losses, losses in imperfect burning, losses in the engines, and the transformation of steam into mechanical work, or electric light. Many of these losses we cannot see how to avoid now. They may be, for years to come, necessary losses. Both chemists and engineers should do everything in their power, and they are doing much, to reduce these losses and render them preventable. You and I to-day perhaps pay all that we ought to pay for coal laid down at our furnaces, but not enough of that goes back to the mine to repay the operator and the miners for the cost of their labor and other mining expenses. The coal repays to the operator and the laborer together scarcely more than \$1.00 per ton for the responsible and dangerous work of getting out and putting on board the cars most of the bituminous coal in the United States. The operator in Europe gets twice as much per ton out of his coal after getting it on board cars, as does the American operator. I know cases where the profit per ton on European coal at the mine is greater than the total price received for American coal of the same quality on board cars at the mines. Our American operator is right when he says that he cannot prevent this waste, nor can he spend much on safety devices, at the present prices of coal. With facts and justice on his side, he says: "What can we do? We have to earn a living."

Our waste of natural gas is a crime, and thoroughly discreditable to the nation. It is far worse than the waste of coal. The statistics for last year (1910), according to the Geological Survey, showed that some 480,000,000,000 cubic feet of gas were turned into the atmosphere and forever lost. In the above as in other cases, the individual operator finds it easier to save a part, than all, of these resources, yes, cheaper for him to waste a large part of these resources than to save all. In the case of natural gas he says: "I want to get oil, and if I can get the oil cheaper by letting the gas escape, that is the operation I will pursue." And the state and the nation stand by and watch the operation.

In connection with petroleum, we have less losses than in almost any other branch of the American fuel industry. The losses in this branch of the industry, which may be considered in any sense preventable losses, probably do not exceed 10 per cent.; but a loss of 10 per cent. in a great industry like the petroleum industry is a serious matter and worthy of con-

sideration. The waste, if such it be called, in the petroleum industry, is rather that of the misuse of certain products, but that may be passed by for the present.

When the waste products prove injurious in the atmosphere a new factor is brought into place, which aids in developing prohibitory legislation; but prohibitory legislation without the aid of the chemist accomplishes little. If we turn some 4,000 tons of sulphur per day into the atmosphere, as SO_2 , the chemist must discover how that sulphur can be caught and utilized again, or stored until the need for it has developed. If we are now turning more than 100 tons of arsenic into the atmosphere daily, the chemist must show us how we can use this arsenic. The operator says: "You must show me some way in which I can prevent these losses and still make my business pay."

A remedy of one waste may bring about a waste in some other direction. In coal mining, for example, we have been trying to stop the gas explosions, and found that one way to stop them is to pump two or three hundred thousand cubic feet of air through the mine and sweep out these gases; but we found that in doing this the coal dust itself becomes, during the cold weather, more dangerous than the gas, because this very ventilation keeps it dry. Then when we turn exhaust steam through the mine, trying to moisten the coal dust and cause it to settle, and trying to prevent that being explosive, we find we have developed conditions in that mine which in turn are especially favorable to the hookworm and other trouble.

So we can develop along the best lines only by coöperation between the chemists and the engineers, in trying to find out what wastes can be prevented to-day, and how the necessary waste of to-day can be made a preventable waste of to-morrow on a fair, business-like basis.

There are many other examples of extensive and serious carbon waste in this country. Thus, in the coking industry the beehive coke ovens have turned into the atmosphere more than 100,000,000,000 cubic feet of valuable gas which, if properly treated, will yield not only gas but other important carbon by-products.

There is also turned loose into the atmosphere from the blast furnaces of the country enormous quantities of valuable gas. During the past few years there has been considerable progress made in the utilization of this gas for power purposes, but a large portion of it still goes to waste.

So, too, there is a loss of large quantities of carbon growing out of the making of coke by the beehive instead of the by-product process. There are still other important carbon wastes, if time permitted even their mention.

In this discussion I have made no attempt to cover the losses of carbon in the consumption or the waste of forest products, lumber, etc., but in any complete treatment of the subject this, of course, would deserve consideration.

The important proposition before us is, knowing something of the extent of this waste, to find the remedy.

DISCUSSION.

MR. KENT:

I enter this discussion by request of Dr. Holmes. I have been familiar with the work done by him for a great many years, and just want to supplement what he says on the question of wastes of coal in mining operations, by saying something with regard to the wastes of coal after it is mined and is in the market. As he says, 50 per cent. of the coal now mined is wasted in the mines, and then of the 50 per cent. that gets into the market, perhaps 50 per cent. of that coal is wasted by the consumer. I have no statistics on this, but it is a pretty good guess.

In the best boiler practice, we can get nearly 80 per cent. efficiency out of the coal, but such a high efficiency is reached only when we have the aid of the chemist to control the composition of the waste gases. The latest boiler experiments indicate that the condition of maximum efficiency is that the free oxygen in the gases ranges within the narrow limits of 5 and 8 per cent. But we have as yet no gauge or indicator by which the fireman can tell whether the gas is of the proper composition and whether he is firing right or not. He has a steam gauge to tell him the pressure of the steam, but whether he is firing that fire so as to have between 5 and 8 per cent. oxygen, he does not know. So instead of 70-80 per cent. efficiency in boilers, we have in practice only 40-60 per cent.

Now as to steam, we all know that there is a tremendous loss in the steam engine, and in the gas engine too; but there is one feature of loss that is not generally considered; that is, the increase in the use of power which is not really necessary except to satisfy our desire for luxury: for instance, it takes four times as much coal to take a vessel across the Atlantic in four days as it would in eight days. Of course, burning four times the amount of coal, enabling it to cross the Atlantic in four days, may be offset by a saving in the time of passengers and crew, but as far as the coal is concerned, high speed involves a tremendous waste.

There is also a waste here in Washington and in every other city, an immense waste of coal—in the electric lights used purely for advertising purposes.

We are burning up coal at an ever increasing rate and charging the atmosphere with carbon dioxide, which floats around the world until it is absorbed by vegetation. It is hoped that the agricultural chemists some day will be able to devise a process by which they can catch some of that carbon dioxide and put it back into the soil and produce carbon compounds, such as alcohol, which we can use for heat and light and power, and thus diminish the waste of coal.

MR. WHITNEY:

I rise to oppose the suggestion of Mr. Kent that you are wasting too much energy in lighting the great white ways. Owing to recent reductions in costs of producing light, you are nowhere near using your "velvet" in lighting your great white ways to which he referred.

MR. LITTLE:

The paper industry is one which is peculiarly conservative. They are not particularly anxious to be shown. I remember an early experience of mine when, after much trouble, I finally made a contract with a large paper mill. The first thing I did when I went there was to collect samples of all of their waste waters, and determine the amount, proportion and kind of material that was going into the stream. The mill had never paid, though it was well located. One reason for their failure to pay a dividend, as I found, was that 17 per cent. of the product was going down the river. I told the manager about it. Well,

he paid my salary for a year and never allowed me to come into the mill again.

Steps have already been taken to utilize a large quantity of the timber waste for the production of ethyl alcohol. Some of our lay friends have expressed skepticism as to the possibility of getting grain alcohol from wood, but everything becomes clear when we simply tell them that we make it from the grain of the wood.

However, that industry is one which is bound to expand very largely. There is one plant in operation making two thousand gallons per day, and when the new plant comes in it will make from five to seven thousand gallons per day, and probably will be followed by many others of similar proportions.

The paper trade is not the only one that permits itself to indulge in needless waste and even the best intentions sometimes lead to extravagance. There is a story of an automobile concern which was led, by a laudable desire to maintain a dustless testing track, into sprinkling the track with twenty-seven barrels of cylinder oil.

MR. LOEB:

I should like to call attention to a plan which Professor Bone, of England, related to us recently in New York, and which seems to be well adapted toward reducing at least some of the waste of coal. It appears that considerable waste occurs through running dynamos of high capacity continuously at a low duty, merely to be ready for a maximum load at any time. They overcome this in England, especially in Yorkshire and Durham County, by coupling all the electric plants throughout the country in a single wiring system, so that each manufacturer can draw on all the combined dynamos of the region when he needs an excess of power, and transfer his own surplus when his demand is less than his actual capacity; in other words the entire group of plants insure each other against individual overloading and, consequently, need not keep excessively large units in operation. The saving resulting from this system in England is very large, according to Professor Bone.

MR. HERTY:

In connection with the enormous waste of wood in the southern lumber mills, I think it only fair to the southern lumberman to say this: They are fully aware now of the waste that is going on, and I do not suppose you will find any body of men in this country who are more anxious to avert that waste than the very men who are making it. What they are suffering from, however, is the lack of guidance in how to do it, or rational methods of how to avoid it. I have talked with a number of these men in years past, and they are alive, wide-awake, and anxious to know how to do it. That part of it, the educational problem, is finished, so far as arousing interest is concerned.

What is to be avoided in the future is the men who are not scientifically trained, who are promoters of the worst type, who are crippling the work of the real scientific men of the country. I cannot point out to chemists any more resourceful field for work than this. I can assure you that these lumbermen are anxious to know how to help themselves in preventing this form of waste of the carbon of the country.

MR. COMEY:

Speaking of the paper industry: I was in the Adirondacks this summer and saw them cutting up spruce trees 100 feet tall and 2 feet or more in diameter into cordwood to send down to New York to make New York Journals. I think that is about as complete a waste of good material as can be found anywhere. Several thousand cords of that wood were used to make one Sunday edition of the *New York Journal*.

MR. PARR:

I simply want to mention one source of carbon waste which, at first thought, may be a little absurd, but any manufacturer appreciates the very considerable expense attached to the

matter of crating, and when he begins to figure out especially that crating material is rather expensive to recover and put together again, he prefers to make a bonfire of that material rather than store it and utilize it again. A change is gradually coming into vogue in certain forms of cheap material, which will not make it so expensive as with the better grades of material that have been used in crating, but still there is a waste, and it is growing.

MR. BRENNEMAN:

It may surprise many to know that in New York Bay, for a mile or two below the Narrows, I have seen, for many years past, accumulations of driftwood along the shore, sometimes as much as fifty cords of perfectly good wood, which could have been utilized to great advantage as kindling wood in the city if any one would take the trouble to collect and use it. The people along the shore get all the firewood they want from this driftwood, which is composed of lost or discarded timber from vessels, broken piles and lop from the city piers, carpenters' waste, etc. At Seagate, the western end of Coney Island, it used to be burned in large heaps to be rid of it.

MR. CALDWELL:

In connection with what has been said in regard to the waste of lumbermill materials, I may simply state that I visited not long ago a mill which made use of sawmill slabs, also sawdust, in the manufacture of producer gas. While I have no figures to report, I expect it was a very profitable operation, so that people are now becoming more wide awake to the necessity of using these waste materials. I do not think I can illustrate that any better than to relate the fond hope which somebody had the other day. He came into my laboratory with a cubic foot of dried swamp land, which of course contained an immense amount of carbon, and he expressed the hope that it might be used for fuel.

MR. BIRD:

In connection with the subject of carbon waste, a most crying need of conserving carbon is to correct what is going on now so extensively in the neighboring Appalachian mountains; namely, the burning of the forests, depredations by insects, etc. For a future supply of forest products, we must protect the young trees, and bring about a rational system of cutting the older trees.

MR. FRANKFORTER:

I have been interested in the matter of the lumber and wood waste in the lumber mills for a number of years. Actual experiments show that nearly 60 per cent. of the total weight of timber is wasted. Forty per cent. of the tree is the best that the lumber mill can do at the present time. I have seen trees, 8-12 feet in diameter, cut 20 feet above ground in order to avoid the resin which is frequently so abundant as to make the lower part of the tree of little value for lumber. You can imagine what the waste would be in trees of that type. On the Pacific Coast the mills save between 25 and 30 per cent. on the big trees.

MR. ROBERTS:

A rather unusual variety of utilization of a carbon waste product is involved in the proposal to extinguish fires and kill vermin in mines, ships and other enclosed places, by blowing the burnt gases from the furnaces into the burning compartment. The gases first are cleaned and cooled by a shower of water. The basic idea is the subject of an expired patent, but the earlier machinery was crude. An efficient machine for the purpose is covered by a recent patent (Harker, 1909, U. S. No. 915,431). The machine has been thoroughly tried out and approved by the Australian authorities, and the U. S. Public Health and Marine-Hospital Service is now installing one for trial on a quarantine steamer.

MR. HOLMES:

The practice in Belgium and Germany to-day of filling in the mines with sand and other materials known as flushing makes possible not only the taking out of all the coal, but prevents the settling of the surface, and it also prevents explosions and mine fires of which latter, in this country, we have so many. So there are many reasons why that ought to be done, and in European countries the added cost has not exceeded twenty-five cents per ton on the extra coal recovered by this flushing process.

The losses of carbon in many of these ways which have been mentioned, blast furnaces, cupolas, etc., are tremendous.

MR. PARSONS:

There is one point in connection with this question of carbon waste that has not been dwelt upon, and that is, the tremendous waste in carbon and in energy in the beehive coke oven. It has been figured, I believe, by Mr. Parker, of the Geological Survey, that the energy allowed to go to waste in the production of coke in this country alone amounts to one million horsepower per day, which is four times the amount of energy they hope to utilize in Sweden for the fixing of atmospheric nitrogen. They expect in two or three years to have 250,000 horsepower actually at work in fixing the nitrogen of the atmosphere, and there is actually one million horsepower going to waste in the coke industry in this country alone.

I doubt if this audience realizes that by the utilization of the new cup system of gathering turpentine in the South, probably thirteen million dollars has been saved in the turpentine industry.

ZINC LOSSES.

By W. H. BASSETT.

A considerable loss in the brass manufacturing industry arises through the volatilization of the zinc in the process of melting and alloying. This loss owing to want of reliable statistics cannot be even approximately estimated.

The copper losses in most of the more progressive manufacturing establishments are very small. These have not been difficult to take care of, but the zinc losses, on the other hand, have presented a much more difficult problem on account of the volatile nature of the metal.

Zinc melts at about 420° C. and boils at about 930° C. Copper melts at about 1080° C. and, in making brass, has to be sufficiently heated to take the zinc without chilling before it is all added. Brass for working is poured into iron chills, and must be sufficiently hot when cast to give a smooth surface free from cold sets and other flaws. On this account the pouring temperature for high brass is about 1050° C. The melting point of the alloy copper 70 zinc 30 is given by Charpy as 945° C., and that of the alloy 60 copper 40 zinc as 880° C. Two and one brass melts at approximately 920° C., that is, very nearly at the boiling point of zinc. It is consequently evident that, when most of the brasses are sufficiently fluid to pour freely, the zinc is rapidly distilling from them.

The actual loss of zinc, in flue dust and in zinc fumes which pass into the atmosphere in the melting and casting of brass for rolling, amounts to approximately 6 per cent. of the zinc used.

Most commercial brands of zinc carry both lead and cadmium. Either of these elements may run as high as 0.75 per cent. in the common brands used in brass-making. The cadmium in the Western brands average 0.30 per cent. to 0.50 per cent.

The composition of the flue dust from the fires in which brass is melted is interesting as it indicates a much more rapid volatilization of cadmium and lead than of zinc. Samples taken from flues in the casting shops of two different mills gave the following composition:

	"A." Per cent.	"B." Per cent.
Copper oxide.....	2.85	2.50
Iron oxide.....	2.43	...
Zinc oxide.....	32.13	24.74
Cadmium oxide.....	1.56	0.89
Lead oxide.....	0.31	1.92
Per cent. cadmium oxide amounts to 4.9-3.6 per cent., respectively, of the ZnO present.		

In some instances we have found 6 per cent. as much cadmium oxide as zinc oxide. A search for cadmium in sheet brass made from zinc carrying $\frac{1}{2}$ per cent. of that element failed to reveal an amount sufficiently large for determination, indicating that in ordinary practice the cadmium is substantially all volatilized.

Part of the zinc lost by volatilization remains in the fluxes mixed with fine ashes as flue dust and part goes off into the atmosphere. Numerous suggestions have been made for the saving of all of the zinc oxide, but none of these have seemed likely to succeed commercially on account of the expensive plant required and the low value of the recovered material. It is practically impossible to get enough for the flue dust to pay for the transportation charges. Apparently the better grade of material is now lost into the atmosphere, and if this could be recovered the total product might be of higher quality.

One of the reasons for the difficulty in recovering the zinc fume is the great dilution of the flue gases, caused by opening the furnace to add to the charges in the crucibles and to work the material down into the pots. The new idea of separating solids from flue gases by means of an electrical discharge, which has been worked out by Professor Cottrell, appears to be a possible solution of this problem.

It also appears that zinc is decidedly volatile and escapes from its alloys at temperatures considerably below its boiling point. On a number of occasions white deposits, which proved on analysis to be zinc oxide, have been observed on the annealing pans. This occurred when the temperature of the heat treatment had not been above 500° C. during the operation.

It has also been frequently noted that strips of copper or copper colored alloys heated in loose contact with brass became brass colored and, in fact, that the surface of copper would be changed to brass for a depth of 0.2 to 0.3 mm. On account of these observations the following experiment was undertaken: Pieces of hard rolled brass made from 2 parts copper to 1 part zinc 2.5 cm. X 12 cm. X 0.1 cm. were wrapped in thin sheet copper and packed with fine charcoal