

THE PROBLEM OF SMOKE ABATEMENT*

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I do not propose to attempt a discussion of the problem of smoke abatement from the engineering standpoint, but rather from the standpoint of a layman who would create a greater public spirit of cooperation with the engineer in the move for smoke prevention. This can be done only by educating the public to the facts that smoke is dangerous and costly and that the evil of atmospheric pollution can be greatly reduced.

"We are what suns and winds and waters make us,
The mountains are our sponsors, and the rills
Fashion and win their nurseling with their smiles."

This Landor calls "climate and culture." Culture is impossible without prosperity, and prosperity, if it be at the expense of health, is a stigma, especially if the victim of ill-health be not the perpetrator of its causes. We are dependent upon "suns and winds and waters" for good health. If the waters we drink are laden with germs and poisons we become ill. When this fact was recognized, science was ready to contribute its part toward solving the problem of water purification. This, however, was not sufficient. The public had to be convinced.

So it is with the problem of atmospheric pollution. Dust and soot are known to be detrimental to health. They irritate mucous membranes; they promote the development of germs and pathogenic bacteria; they cut off sunlight, long recognized as our best natural disinfectant and stimulant. The engineer knows how to cope with the problem of atmospheric pollution. He knows that the public must cooperate if real results are to be obtained.

We are inclined to look upon the problem purely as one of engineering. The engineering phase appears to be the least troublesome part of the problem. Engineers can serve as efficient officers to direct the fight, but they need a great army—the public—to win. To be successful this army must have the firm conviction that a polluted atmosphere, first, is dangerous and expensive, and second, that it is not an unavoidable condition arising from the necessary activities of civilization. When the public fully recognizes these facts, *smoke will go*. The problem of smoke abatement, then, is a problem of public education. It is a psychological problem.

It may be of interest to know that in England, Edward I in 1306 issued a proclamation prohibiting the burning of soft coal because of the noxious gases and smoke resulting therefrom. Today, coal is a basic raw material for civilization. Thousands of volumes in our libraries attest the truth of this conclusion. Wealth, measured by the millions on top of millions are created around smoke stacks, too

*Read before the Tennessee Academy of Science at its Knoxville meeting, April 20, 1928.

many of which are belching forth a destructive breath. "What's a smoke stack for, anyway," someone has asked, "if it is not to smoke?" In the march of civilization our enthusiasm for material production has partially eclipsed the greater problem of health and happiness.

"Ill fares the land to hastening ills a prey
Where wealth accumulates and men decay."

We measure the prosperity of a city by the number of its smoke stacks, paying too little attention to the question whether the products which escape into the air are harmful or whether they can be reduced. Recently, there appeared in a local newspaper a picture of a typical stack, bountifully emitting smoke, through which was written the word "prosperity." The time is coming when such a display of smoke will be labeled "destruction."

Some of the ways in which smoke is destructive, and some justification for the assertion that it can be reduced enormously may now be pointed out. Manifestly, the evidence can be stated here but incompletely. The important thing is to create a stronger public sentiment against atmospheric pollution. We will get just so much smoke abatement as the public demands. Our demands for better conditions of living are determined by our knowledge of what factors contribute to human welfare on the one hand, and by our ability to control these factors on the other.

It is because of great advances in industry and the centralization of the population in industrial centers that the smoke problem has become so important in our day. Considerably more than a half billion tons of coal are mined annually in the United States, and about five-sixths of it is soft coal, high in volatile matter. It is estimated that from ten to fifteen per cent is used for heating dwellings. The Federal Government, recognizing the importance of studying the problem of combustion of coal and the smoke nuisance, has carried out a number of surveys. These government surveys on the conditions of different cities with respect to smoke have been discontinued, but they have been of inestimable value in creating greater public interest in the problems and in pointing the way to improvements. Today all of our larger industrial centers have some kind of smoke ordinance. This, however, does not mean that they are accomplishing the results they may be expected to accomplish in the future.

Various angles of the smoke problem have been studied in recent years and much valuable information has been published. The role of leadership has been taken by the Mellon Institute of Industrial Research. Ample evidence that smoke is destructive is found in these publications.

First, we may consider its effect on *health*. No consideration can be more important than this. The plea which Dr. Russell Wallace¹ makes for England may be appropriately made for America. I quote from his book, "Man's Place in the Universe": "The huge and ever-increasing cities, the vast manufacturing towns belching forth smoke and poisonous gases, with the crowded dwellings

where millions are forced to live under the most terrible unsanitary conditions, are witnesses to a criminal apathy, an incredible recklessness and inhumanity. Yet this is the one great and primary essential of a peoples' health and well-being, to which everything should for the time be subordinate. This is the gospel that should be preached in season and out of season till the nation listens and is convinced. Let this be our claim. Pure air and pure water for every inhabitant of the British Isles. Remember we claim to be a people of high civilization, of advanced science, of great humanity, and of enormous wealth."

Dust and smoke shut out sunlight. This effect is greatly magnified by the formation of fog, twenty-five per cent of which in cities may be attributed to dust and smoke. Chemical actions that are promoted by sunlight have been shown to be reduced at least twenty-five per cent in large cities. The United States Public Health Service in New York City found an average loss of daylight at the lower end of Manhattan Island to be forty-two per cent at eight A.M. and eighteen per cent at noon for January, 1927. For June the losses were thirty-three per cent at eight A.M. and six per cent at noon. The figures are for clear days only, foggy days showing much greater losses. Of special significance is the fact that ultraviolet rays which are so necessary to good health are reduced to a much greater extent than the other rays. As an energizing agent for the human organism, augmenting its functional efficiency, and in innumerable other ways, sunshine is indispensable. The average city dweller gets too little at best. The Italian proverb that "all diseases come in the dark and are cured in the sun" is worth remembering.

Again, the solid particles of dust and soot irritate the sensitive membranes of the eyes, nose, throat, lungs, and gastro-intestinal tract. The sticky, tarry matter and poisonous acid substances in smoke greatly increase the magnitude of these irritations.

Furthermore, dust and soot serve as carriers of germs and pathogenic bacteria so that infections of the irritated membranes are more likely to occur.

From statistical and experimental studies, Ascher² draws the following conclusions:

(1) The mortality due to acute lung diseases is certainly increasing, especially among children and old people. The cause of this increase, which is greatest in industrial centers, is attributed to smoke in the air. Since 1875 the mortality from such diseases has increased as much as six hundred per cent.

(2) Within industrial districts the mortality is found to vary directly with smoke development, being highest where the smoke nuisance is greatest.

(3) The mortality from acute lung diseases among miners is one hundred and thirty-five per cent higher than among the other population of the same age.

(4) The course of tuberculosis is hastened by smoke-laden atmospheres.

Dr. Wilhelm, director of the Department of Hygiene at the University of Tennessee, states that many students coming to Knoxville from rural sections develop throat and nose infection a few weeks after arriving in the fall. He attributes these infections to atmospheric conditions. The number of throat, nose, and eye specialists per capita in our industrial cities is probably greater than in other cities, according to one on the staff of the Knoxville Health Center. Figures are available, but computations appear not to have been made. It is my personal guess that the harmful effects of smoke upon health increase not in simple arithmetical proportion to the amount of smoke, but enormously, perhaps, almost according to a geometrical proportion.

The value of life, health, and happiness cannot be measured in dollars. Aside from this, however, we all know that economic losses from ill health are great. In an address before the joint meeting of the Virginia Section, American Chemical Society, and the Woman's Club in Richmond, on October 21, 1927, Dr. Charles H. Herty of the Chemical Foundation stated that in the United States the total annual losses involved as the result of illness reach the staggering figure of fifteen billion dollars. As he points out, this is more than two-thirds of the twenty-two billion dollars required annually to feed the nation. What part of the total losses are attributable to polluted atmospheres, no one can say, but surely the time has come for more intensive studies of preventive measures.

There are also certain destructive *mental* effects of smoke. They are not strictly separable from health considerations. Dispositions and conduct appear to be affected by smoke. Irritability, malcontent and fatigue are known to be influenced by atmospheric conditions. Wallin³ points out that dark clouds have a depressing, devitalizing effect; that they may reduce working efficiency, give rise to disquietude, restlessness, and forebodings in the insane; and that they may increase drunkenness.

Fogs, in addition to augmenting the death rate by increasing the prevalence of disease, are believed to decrease the accuracy of mental work. City fogs are denser, more persistent, and more dangerous than country fogs because of the solid matter associated with them.

Tests in the business section of Pittsburgh, before effective measures of smoke abatement were introduced, showed that the limit of visibility was only one-tenth that in the open country. This must have been intensely depressing.

The possibilities of high *esthetic* development are greatly reduced by smoke. The development of art is handicapped. Architecture, statuary and paintings become inartistic in appearance. All forms of exterior and interior artistic effects in color, brick, stone, or metal are spoiled by discoloration or corrosion. The natural terrestrial panorama of art is obliterated. Smoke and dust befall

our persons and wearing apparel and may foster habits of indifference.⁴

Finally, the destructive *economic* effects of smoke should be mentioned. Considered solely from the economic standpoint, smoke is expensive. Classifications of the costs are somewhat arbitrary, but we may mention the following:

(1) Loss of fuel through incomplete combustion. Soft coal contains on the average a little more than one-third volatile matter. A ton may yield twelve thousand cubic feet of gas and one hundred and twenty pounds of tar. Smoke is the result of incomplete combustion. Improper firing or faulty furnace or boiler design whereby not enough air is admitted or the volatilized products are chilled before they burn, result in direct waste of fuel, the magnitude of which may be far greater than any but the engineer realizes.

(2) Cost of laundry and dry cleaning, including curtains, draperies, rugs, etc., in addition to wearing apparel.

(3) Cost of cleaning and renewing wall paper, cleaning windows, skylights, wood, metal, and stone work.

(4) Cost of renewing sheet metal work due to corrosion.

(5) Cost of extra painting.

(6) Cost of artificial lighting.

(7) Loss due to damaged merchandise (Miller's, Knoxville, estimate their monthly loss from this source at one thousand dollars.

(8) Cost of extra precautions.

Every item of this summary, which is perhaps far from complete, represents a loss of thousands of dollars. After our survey of the soot-fall in Knoxville for the year 1927 was completed, a rough estimate of the annual cost of smoke to the city was placed at one million seven hundred and fifty thousand dollars. More recently, Mr. John E. Hunter, nationally known combustion engineer who has been employed by the city of Knoxville to initiate its program of smoke abatement, has stated that the annual cost is perhaps two million dollars. When the results of our survey appeared in the papers in January, a wealthy citizen of Knoxville wrote me that our figures were "perfectly ridiculous." This assertion shows the need of educating the public to the facts.

Our attention may now be turned to the question whether smoke can be eliminated. This is largely an engineering problem, but as has been pointed out already, the engineer is bound to have the cooperation of the public to get results. The public conscience must be aroused. We have no moral or legal right to stifle the other man's breath and damage his property through the wanton practice of unnecessarily polluting the atmosphere. That smoke can be reduced and reduced economically is attested to by the results obtained where active campaigns have been launched.

It is easier to reduce smoke from some sources than from others. Mr. Hunter places the sources of smoke in any city in five classes in the order of their importance as follows:

- (1) High pressure industrial and commercial boiler plants.
- (2) Low pressure heating plants of large capacity.
- (3) Railroad locomotives.
- (4) Industrial processes such as brick kilns, foundries, etc.
- (5) House heating furnaces.

In attacking the smoke problem, naturally the high pressure boiler plants are studied first. These are the most conspicuous offenders and their corrections have important psychological effects. In Asheville, North Carolina, it is reported that ninety per cent of the smoke from large plants was eliminated in six months. Smoke from railroad locomotives has been reduced eighty per cent. The interesting thing is that changes in boiler designs for prevention of smoke pay for themselves by saving fuel. One obstacle has been that many of our boilers were built in the east and designed for the use of hard coal. Changes in the boilers so as to regulate the proper amount of air at the right place and to prevent cooling the gases before combustion is complete are purely engineering problems. Methods of correct firing, however, must be learned by the public. Much of the heating value of coal that is thrown on top of a fire may be wasted through distillation and incomplete combustion. By carefully following the engineer's instructions the smoke nuisance can be reduced below the danger line. Numerous bulletins giving instructions for firing have been prepared. The best of these should be placed in every household. The problem of house heating furnaces is the most difficult to solve, and unfortunately, the smoke they produce contains more tarry matter and is more harmful than that produced by other types. One solution would be to use coke.

In conclusion, the attitude of the public will determine largely the extent of smoke prevention in any city. It will determine whether throat, nasal and sinus infections shall increase or decrease; whether the ravages of tuberculosis shall be checked; whether merchants and mills shall continue to lose millions in waste and labor, caused by soot and smoke; whether housewives shall continue to change curtains every two weeks; whether linens, fine clothes and other things shall continue to be soiled except when kept in cedar chests; whether, in a word, life shall be made better, brighter and happier. Our consciousness should be awakened to the realization that atmospheric pollution, no less than pollution of the water we drink, is contrary to our theory of government, and contrary to our sense of right and justice to our fellowman.

¹Wallace, Russell A. *Man's Place in the Universe*. Doubleday, Page. New York. 1903.

²Ascher, of Koenigsberg, Germany, made extensive investigations of the effect of smoke on health.

³Wallin, J. E. W. *Psychological Aspects of the Problem of Atmospheric Smoke Pollution*. Mellon Institute. *Smoke Investigation*. Bulletin No. 3. 1-46. 1913.

⁴Klotz, O. and White, W. C. *Papers on the influence of Smoke on Health*. Mellon Institute. *Smoke Investigation*. Bulletin No. 9. 1-173. 1914.