

Letters, reports, &c., / by E. R. Cook... and the chemist on the subject of the treatment of the sewage in the sewers by manganate of soda.

Contributors

London. Metropolitan Board of Works.

Cook, E. R.

London School of Hygiene and Tropical Medicine

Publication/Creation

[London] : [publisher not identified], 1888.

Persistent URL

<https://wellcomecollection.org/works/hcefejdp>

Provider

London School of Hygiene and Tropical Medicine

License and attribution

This material has been provided by This material has been provided by London School of Hygiene & Tropical Medicine Library & Archives Service. The original may be consulted at London School of Hygiene & Tropical Medicine Library & Archives Service. where the originals may be consulted. This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.

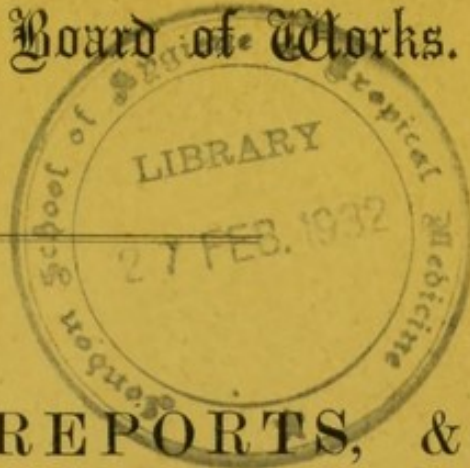
**wellcome
collection**

Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

With dr. 3425- P.12127

am8w

SH
London, Metropolitan Board of Works. 8



LETTERS, REPORTS, &c.,

BY

E. R. COOK, ESQ., AND THE CHEMIST,

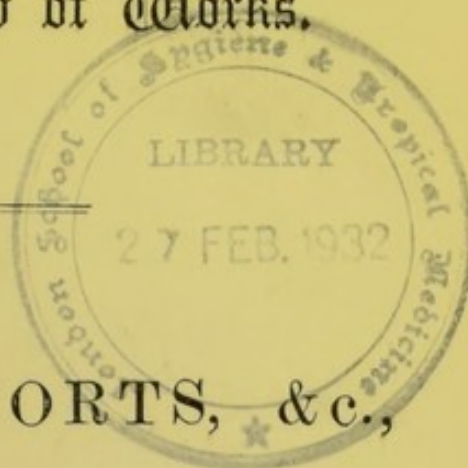
ON THE

SUBJECT OF THE TREATMENT OF THE SEWAGE IN THE
SEWERS BY MANGANATE OF SODA.

*(Ordered by the Works and General Purposes Committee to be printed
25th June, 1888.)*



Metropolitan Board of Works.



LETTERS, REPORTS, &c.,

BY

E. R. COOK, ESQ., AND THE CHEMIST,

ON THE

SUBJECT OF THE TREATMENT OF THE SEWAGE IN THE
SEWERS BY MANGANATE OF SODA.

*(Ordered by the Works and General Purposes Committee to be printed
25th June, 1888.)*

THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

REPORT OF THE PHYSICS DEPARTMENT

FOR THE YEAR 1900-1901

BY THE PHYSICS DEPARTMENT

CHICAGO, ILL., 1901

Metropolitan Board of Works.

Letter from Mr. Cook addressed to the Chairman, the Deputy-Chairman and Members of the Works and General Purposes Committee.

GENTLEMEN,

Although for some time, owing to conversations with several scientific friends, I have had misgivings as to the value of the manganate process as a whole, I do not at present propose to deal in any way with the process at the outfalls, but to confine myself entirely to the question of the wisdom of pouring manganate into the sewers.

It was not till I saw the Report of the Chemist, dated 4th October, upon the letter from the Home Secretary, complaining of the state of the Thames, that I realized the importance of endeavouring to settle whether beneficial results, at all commensurate with the expense, were obtained by attempting to disinfect the sewage in the sewers. The fact that £33,325 was expended between the 17th May and the 30th September on chemicals alone—without taking account of the cost of labour, gas, sheds, apparatus, &c.—makes it a matter of the most serious moment to ascertain—

- I. Whether that outlay diminishes the expenditure at the Outfalls.
- II. Whether any considerable advantage is obtained by it in preventing nuisances from the Sewers in the Metropolis.

Before acquainting myself with the statistics connected with the subject, and only from my general knowledge of the nature and action of permanganic acid, I had formed a strong opinion that, having regard to the small quantity of

manganate used per gallon—viz., two grains to 70,000 grains of sewage—the use of manganate in the sewers was practically useless and the expenditure lost.

Since stating this to the Committee on 25th October last, I have, by a series of experiments, most completely confirmed this opinion; and I propose now to state, as shortly as possible, the considerations and facts which have led me to that conclusion.

And, first, it is important to understand the action of permanganic acid.

Manganate of soda ($\text{Na}_2 \text{Mn O}_4$) contains 2 atoms of Oxygen in a state combination so slight that in the presence of oxydizable matter they are set free and combine with the elements of that matter, and it is of the first importance to remember that when once these atoms of oxygen have been used by oxydizable matter, the manganate is wholly and completely impotent for further service. Though I believe some chemists allege that the precipitated oxide of manganese exercises a further oxydizing process by absorbing and then parting with oxygen, I, personally, believe that neither the soda, the manganese, nor the oxygen when once combined, exercises any further influence—either in combining with other organic matter or in preventing decomposition in the same way that antiseptics do. So that, at the instant of combination of the oxygen with the organic matter with which it unites, the beneficial use of the permanganate ceases once and for ever.

The next consideration of importance is that permanganic acid gives up its oxygen to matter which is *not* putrescent as well as to that which is.

In fact, the Official Reports on the London Water Supply show that a gallon of the companies' water, pure and simple, would have consumed the Oxygen of 2 grains of Manganate seven years ago, and that at the present time the quantity it will deprive of oxygen is actually a little over one grain.

Again ten pounds, which is the weight of a gallon of water or sewage, of gelatine will deoxydise and render impotent 7,550 grains of commercial manganate in one minute.

10,350 grains, or $1\frac{1}{2}$ lbs. in 5 minutes,

17,900 „ „ $2\frac{1}{2}$ „ „ 3 hours.

Ten pounds of white of egg (containing about 12 per cent. albumen) decomposes—

6,250 grains, or $14\frac{1}{4}$ ozs., in 5 minutes.

12,500 „ „ 1 lb. 12 oz., in 3 hours.

Again—and this is of still greater practical importance—

fresh urine instantaneously renders impotent large quantities of manganate.

From experiments made with a sample taken from a mixture of the urine of 6 men, I find that—

1 gallon of urine destroys	870 grains	in 1 minute,
„ „ „	1,155	„ „ 2 minutes,
„ „ „	1,470	„ „ 15 „
„ „ „	1,720	„ „ 1 hour,
„ „ „	2,284	„ „ 3 hours.

Now, let us get some notion of the quantity of urine in London sewage—

The population of the Metropolis may be taken at 4,000,000. The average quantity of urine passed by an adult male in 24 hours is $1\frac{1}{2}$ litres—so if we take 1 litre ($1\frac{3}{4}$ pints) for the population per head we shall be well within the mark, especially as we reckon nothing for the urine of animals, which, of course, passes into the sewers.

This gives 7,000,000 pints, or 875,000 gallons in the sewers per diem. That is to say, taking the daily average quantity of sewage at 150,000,000 gallons, each gallon contains $\frac{875}{150,000}$ or $\frac{7}{1,200}$ of a gallon of urine.

So that, if 1 gallon of urine neutralizes 870 grains of manganate in 1 minute, the urine in a gallon of sewage will neutralize

$$\frac{7 \times 870}{1,200} = 5 \text{ grains in 1 minute,}$$

or $\frac{7 \times 1155}{1,200} = 6.7 \text{ „ „ 5 minutes.}$

Thus we see that one ingredient of sewage is alone capable of destroying nearly three times the quantity of manganate used in the sewers in *one minute*.

It was important next to find out what is the neutralizing power of London sewage, and to do this I obtained samples from Abbey Mills on ten days (see table):—

Sewage taken.	Smell.	Appearance.	Thickness in m.m. which obscured the print of Chemical Journal.	Grains dry insoluble matter in Gallon.	Grains per Gallon of 20 % Na_2MnO_4 absorbed per Gall. in time stated.		
					1 m.	5 m.	3 hours.
Oct. 28	Strong	Black	10	38			
" 29	Stinks	Light	15	53	35	39	72
Nov. 1	Strong	Thick dark	8	81	41	54	100
" 2	Slight	Light	12	36	39	39	76
" 3	"	"	22	18	21	27	50
" 4	"	Darkish	10	61	25	34	64
" 5	Trace	Light	—	8	20	22	38
" 6	Tarry or Gas	Thick	5	154			
" 12	Gas or Carbolic	"	9	87	31	44	80
" 15	Carbolic	Light	14	35	27	37	72
MEAN			12	57 = '081%	30	37	69

From this it will be seen that the average neutralization of manganate was—

30 grains per gallon in 1 minute,
 37 " " " 5 minutes,
 69 " " " 3 hours,

that is to say, 150 millions of gallons will in one minute neutralize 287 tons of manganate, the average quantity used by the Board being only 18.2 tons for that quantity.

The next question is, how much manganate will deodorize sewage? This I found a very difficult question to decide, for the sewage at Abbey Mills varied very much in condition, some days being almost inodorous, and on others smelling bad; but it took 8 grains per gallon to destroy the smell of a mixture of 10 daily samples.

While the following history of one sample will show that the deodorizing is of a temporary nature only, as might be expected from the fact that manganate oxydizes, but does not prevent putrefaction.

Sewage of the 29th October, 1886.

25th November, 11 a.m.—15 grains per gallon required to destroy smell.

26th November, 11 a.m.—20 grains per gallon more required to destroy smell.

26th November, 3.30 p.m.—(Or in $4\frac{1}{2}$ hours) it smelt again decidedly.

26th November, 6.30 p.m.—(Or in $7\frac{1}{2}$ hours) it smelt bad.

29th ,, 11 a.m.—Smelt very bad, and took 35 grains per gallon more to destroy the smell.

29th November, 6.30 p.m.—(Or in $7\frac{1}{2}$ hours) smell was bad again.

And now let us see how the above facts help us to answer the two questions I proposed.

I. Whether the outlay in the Sewers diminishes the expenditure at the Outfalls.

I find that 2,474 tons of manganate were used in 136 days or 18.2 tons on an average per day. $18.2 \text{ tons} = 285,376,000$ grains, which is as nearly as may be, but not quite, 2 grains to a gallon in 150 million gallons.

This was poured into the main sewers and in a tiny current, compared with the large stream of sewage flowing in them. Now, considering that one gallon of sewage will neutralize 30 grains in one minute, and that the urine in one gallon by itself will neutralize 5 grains in the same time, it is evident that the sewage with which the deodorants first come into contact must in a few seconds render them impotent, and that a large, indeed the largest, portion of the sewage cannot come within touch of the permanganate. So that for all practical purposes, if 2 grains per gallon do any good at all at the outfalls, they will be equally needed whether the sewage has the insignificant quantity added in the sewers or not.

Doubtless the gaseous matter in the sewage is the first to be influenced by the oxygen, but as that is dissolved equally in the whole flow of the sewage, and as it is impossible that such an insignificant quantity as 2 grains per gallon can, while in an active condition, come into contact with the largest portion of the sewage, we cannot expect that the

sewage, as a whole, should be deprived of its smell. I have shown that it is not, as 5 grains per gallon is the minimum quantity which I found did deodorize a sample which had a distinctly offensive smell.

Every atom of oxygen will of course oxydize its atom of organic matter, but many atoms will be absorbed by innocuous organic matter ; and I, therefore, come unhesitatingly to the conclusion that—

The outlay for disinfectants in the sewers does not diminish the outlay at the outfalls.

II. Is any considerable advantage obtained by it in preventing nuisances from the Sewers in the Metropolis ?

That some smell is destroyed every one must admit—but is the advantage obtained at all commensurate with the expense ? or could not better results be obtained at a far less cost ?

In order to judge of this, it is necessary for a moment to consider the origin of Sewer gas, and, if I am correctly informed, the smell from the sewers does not so much arise from the running fresh sewage as from gases evolved from deposits, and especially from the brick walls of the sewers, which are constantly being wetted with the sewage and then exposed to air and moisture in a warm temperature. It must also be remembered that the gases arising from this latter source escape, not into the sewage, but into the air of the sewers.

Now, it is obvious, from what I have shown, that the treatment under discussion cannot affect the deposits, as the liquid alone is many times more than enough to neutralize all the oxygen of the manganate. Nor can it affect the gases in the sewer, as it is run into the sewage and cannot affect the air.

Thus we see that whatever little good the manganate does, it cannot and does not affect the chief sources of production of sewer gases.

One must also compare other methods of destroying Sewer gases, and judge what would be the result if a similar large expenditure were made upon these methods.

A careful perusal of the Reports of the Engineer, and of the Special Purposes Committee, will show that at least two methods of dealing with sewer gases have been successful, but that perusal will also show that till lately the Board has been alarmed at the expenditure of sums of money on these

methods which are absolutely infinitesimal compared with the enormous outlay which has been quietly allowed for the manganate process.

In a report of SIR JOSEPH BAZALGETTE, dated 30th June, 1869, after showing that the capital cost of fitting up the Ventilating Shafts of all the Sewers of the Board with Charcoal deodorizers would be £22,000, and that the Annual Expenditure would be £1,000, he proceeds to say:—

“ Of the efficacy of Charcoal as a means of deodor-
 “ ising and disinfecting the Sewage Gases, Dr.
 “ MILLER has said there can be no question ; and in
 “ my report dated 19th December, 1866, upon the
 “ subject, it is stated that the experiments which had
 “ then been made, appeared to have given results
 “ sufficiently favourable to warrant my recommending
 “ that, prior to the introduction of Charcoal Ventila-
 “ tors to any great extent, they should be conducted
 “ upon a larger scale than theretofore, and upon a
 “ District to be separated from the surrounding area.
 “ The Board did not, however, adopt the recommen-
 “ dation, and thus the Charcoal has been used in
 “ cases only where complaint has been made of
 “ offensive smells emitted by any particular ventilators
 “ and not upon any general system.”

In a report by the Clerk, dated 21st July, 1876 :—

“ During the same year the subject of the scheme to
 “ be adopted for effecting the ventilation of the main
 “ sewers of the Metropolis engaged the attention of
 “ the Board, and the whole question was referred to
 “ the Main Drainage Committee, with authority to
 “ obtain such professional assistance as they might
 “ find necessary.”

“ In pursuance of the foregoing instructions, the
 “ Committee devoted considerable time and attention
 “ to the subject, and in the following year they recom-
 “ mended the Board to offer a premium of 250 guineas
 “ for the best plan for the ventilation of sewers, so as
 “ to prevent the issue of offensive and poisonous gases
 “ therefrom ; but on the motion being put to the vote,
 “ the Board came to no resolution thereon.”

And further, in the same Report—

“ In the same year (1870) the Engineer, in a Report
 “ presented to the Ventilation of Sewers Committee,

“ described certain experiments in which he had been
 “ engaged upon the deodorization of the foul effluvia
 “ from the sewers by means of sulphurous acid.
 “ The Board, upon the recommendation of the Com-
 “ mittee, authorized an extended trial of this agent
 “ to be made, in order to ascertain its efficacy and
 “ cost, at an expense not exceeding £100, by the
 “ Engineer in conjunction with Mr. KEATES, the
 “ Board’s Consulting Chemist. [In August of the
 “ following year (1871) the Engineer reported that
 “ the further experiments made, in pursuance of the
 “ resolution of the Board, in the sewer along Camden
 “ Road, for neutralizing the effluvium by means of
 “ acid, had been attended with success, whilst the
 “ cost had been but trifling.”

“ The Board were of opinion under these circum-
 “ stances that the experiments might, with propriety,
 “ be extended where necessary, and they authorized
 “ the Engineer to continue the use of the acid for the
 “ purpose.”

Both these plans, instead of wasting the deodorizing agent, as the manganate process does, upon the sewage in the sewers, that is to say, upon matter which is doing no injury, deal with the noxious gases when they alone become dangerous, viz. when they are leaving the sewers and coming into dangerous proximity to mankind; and I cannot but believe that had the Engineer been authorized to spend a proportionately very small sum on one or other, or both, of these means of rendering sewer gases harmless, much greater results would have been obtained than we now get at such a large cost.

I hope to append a statement showing the money actually expended on these processes.

In conclusion, I am convinced that no results at all commensurate with the expenditure can be looked for from pouring so small a quantity of these chemicals into the sewage. That they neutralize *some* offensive matter cannot be denied, just as the use of an old parish engine would undoubtably exercise *some* influence on a great fire. The effect of its stream, however, would be so overwhelmed by the great mass of burning matter, that it would make little difference whether it was worked or not. Such is, I believe, the case in this instance; and as the working costs some £40,000 per annum, it would seem to me only prudent to put a stop to it, and to seek some way of obtaining better results at a less cost.

The experiments have been made in the Laboratory, at the EAST LONDON SOAP WORKS, by my direction, and under the immediate and constant personal superintendence of my brother-in-law, Mr. SAMUEL HALL, F.C.S.

They have, for convenience sake, been conducted with permanganate of potash, and the results translated into the equivalent quantities of commercial manganate, 20 % strength, as required by the Board's Specifications, and they have been made at the ordinary temperature, and without the addition of acid during the time of action.

The Samples of Sewage experimented with have been taken in cold weather, and the results, therefore, are more favourable than would have been the case had they been taken in Summer. The Returns made by the Engineer and Chemist show that the average daily flow of the Sewage, from May to September, was practically 175,000,000 gallons, instead of 150,000,000, the figures assumed by me. This decreases the proportion per gallon of manganate used.

I have the honour to remain, GENTLEMEN,

Yours faithfully,

EDWD. RIDER COOK.

Bow, 18th December, 1886.

Report by the Chemist in reply to Mr. Cook's Letter.

CHEMICAL AND GAS DEPARTMENT,

SPRING GARDENS, S.W.,

January 17th, 1887.

While fully acknowledging the care and accuracy with which Mr. Cook's experiments have been made, I submit that the conclusions based thereon are misleading and beside the facts, in consequence of a misapprehension on his part as to the object in view in the deodorisation of the sewage within the Metropolis, and also for the following reasons, viz.:—

1st. That the strength of the manganate used has been under-estimated by nearly one-third, viz., 20 per cent. instead of its actual strength of 26 per cent; the former figure having been adopted merely as a basis of calculation.

2nd. Although Mr. Cook's statement as to the quantity of oxygen yielded by the theoretical unit of manganate of soda is true, he overlooks the effect due to the presence of the sulphuric acid, which is twofold, as follows:—

(a) It acts, not only by setting free the oxygen from the manganate, but also by liberating oxygen from some of the bin-oxide of manganese existing in the crude sample in other forms than as manganate. The practical result being that by the action of the acid the oxidising effect is always in excess of the theoretical quantity.

(b) It acts independently of the manganate or in the manner set out in *a*, as the quantity used in excess of that required to neutralise the alkaline manganate combines with the ammoniacal compounds in the sewage, and thus prevents their evolution as one of the constituents of sewer gas.

As much misconception exists with regard to the method of treating the sewage by oxidising agents, Mr. Cook has done good service in opening a discussion on the subject.

The ultimate object to be firmly held in view in the treatment of sewage, whether in the sewers or at the outfalls, is its *destruction*. For this reason the employment of a preservative agent cannot be too strongly condemned, whether that agent be carbolic acid, sulphurous acid, or any other of the numerous antiseptics proposed.

Before proceeding further on this point it will be well to glance at the course taken by the sewage matters in their transition from an offensive to a permanently harmless condition. The latest researches on the decomposition of organic matter have clearly demonstrated that this change is brought about by the agency of living organisms, and not by direct combination with the atmospheric oxygen. It is true that the atmosphere is the source of the oxygen actually used, but it is brought into combination with the organic matters by means of the life processes of minute organisms, just as the food of human beings is in great part oxidised by the agency of their digestive, assimilative and respiratory systems. If the food presented to the organisms in the river is in a fresh and wholesome form, its disappearance will take place without nuisance. On the contrary, if the food is in a foul and unwholesome condition, and the supply of atmospheric oxygen deficient in consequence of the defective aëration of the water, the organisms which before disposed of the sewage matters without trouble are unable to live, and their place

is taken by a different set whose life processes do not require oxygen, and, instead of the evolution of harmless carbonic acid and water as the resultant, sulphuretted hydrogen and other noxious vapours are evolved, and a nuisance created. To illustrate this let such a condition of things be imagined as would result from supplying the inhabitants of London with foul putrescent matters, and a materially reduced quantity of atmosphere in place of fresh meat and vegetables, and abundance of fresh air. The result would be precisely analogous to the condition of the river water at its worst. The inhabitants would die and their bodies go to increase the general pollution.

These considerations, which result from ascertained facts, teach us that the proper method of treating sewage is to destroy or neutralise those matters which are actually putrescent at the time, and to leave those which are fit food for a harmless class of organisms, such as the "Aerobians" of Pasteur, viz., those which live in the presence of air. But while we destroy the objectionable matters we must be careful to add nothing to hurt the friendly organisms. Therefore I have advised the Board to use a harmless substance, which in destroying the objectionable matters for the time being is itself destroyed, and so prevented from doing more than is actually required.

Mr. Cook has shown that, even after making all allowances for quality of manganate, &c., the destruction of the sewage matters by direct chemical means is financially impossible. In this I entirely agree with him. But while it is neither possible nor desirable to oxidise the whole of the sewage, for the reasons I have already given, considerable benefit may be derived from the neutralisation of those immediately objectionable matters which are the cause of nuisance. If this nuisance is abated there can be little question as to the value of the result; and if at the same time the abatement is effected by even only partially destroying the cause, that value must be greatly enhanced. Fresh sewage is composed in great part of matters which are for the time being unobjectionable, the proportion of actually putrescent substances being exceedingly small. It is evident that in order to destroy these, only a small proportion of the total quantity of chemicals required to oxidise the whole of the sewage will be necessary. To destroy the cause of an unpleasant odour in a room it is not necessary to destroy the room itself. Mr. Cook refers to the parish engine: I might remind the Committee that a small quantity of water pro-

perly applied at the outbreak of a fire is of far more importance than volumes pumped by many steam engines at a later period. It is true that the odour of the sewage will return eventually if it is specially kept; but the object is to destroy the odour only for such time as the sewage remains in the sewer, viz., a few hours.

The peculiar property of permanganic acid is that it exerts a selective action, first attacking the most easily oxidised substances, which, in the case of sewage are the putrescent ones, and then, in inverse order of their stability, the remainder.

Mr. Cook further contends that the quantity of manganate required to effect *complete* deodorisation is in excess of the quantity employed. The experiments upon which he bases this statement are described in his letter as having been made on a mixture of ten daily samples. Such an experiment is of little value as affording the slightest indication of the work necessary in deodorising sewage only one or two hours old. Again, the experiments quoted to show that the deodorising is of a temporary nature only were made on sewage nearly one month old, which must evidently have been in a totally different condition to that of fresh sewage, so that the quantities of chemicals required in such a case are altogether misleading.

The contention of Mr. Cook that the smell arises from deposits on the walls of the sewers, and is therefore unaffected by the manganate, is not borne out by actual observations of my own, and is shown to be erroneous by the disappearance of the odours in what were, before the deodorising operations, exceptionally foul sewers.

Complete deodorisation of a sample of sewage, when critically examined in a closed vessel, such as a bottle, is a different thing to such deodorisation as is necessary for the prevention of nuisance from a sewer grating. It is proverbial that laboratory experiments on sewage are apt to be misleading, and particularly so when applied to deodorisation.

During a considerable portion of the last summer the quantity mentioned by Mr. Cook as being necessary, viz., 8 grains per gallon, was actually employed on the whole of the system, one-half being used in the sewers. The *average* naturally reduces this figure, as during the cool and wet weather the quantities were materially reduced. The effect of the treatment as carried out must be judged by the results, and I submit that the outside evidence already

before the Board affords ample indication of the benefits derived by the public.

In order that the Committee might be further informed on this point, I requested the Engineer to obtain for the purpose of this Report, the results of the personal experience on the officers of his department having charge of the operations, as to the practical outcome of the work done during the past year, and I submit the following reports from them on the subject :—

Mr. Lovick reports :—

“ There has been, during the time that the deodorising operations were in hand, a marked cessation of smell from the sewers, and this at a period (of hot weather) when the complaints are the greatest. Last year Mr. Dunch, the Surveyor of the Limehouse Board, asked me how it was that the smells had ceased to come from certain sewers in his District which had previously been a constant source of complaint, when I informed him of our deodorising operations, and which no doubt had been the cause of this improvement.”

Mr. G. Attwood, Inspector of flushers for the Western Division of the Northern District, reports—

“ The deodorising operations carried on last summer had a beneficial effect on the smells of the sewers. I might state that on several occasions after heavy rains I found a great improvement from smells in the relief sewers, also there were a very few complaints from the public.”

Mr. R. Tuck, Clerk of the Works for the Northern Division of the Northern District, reports—

“ During the period when the deodorising operations were being carried on in my district last summer, we found a great effect on the smells from sewers and ventilators, and I had very few complaints compared with what I had previously.”

Mr. R. Fernley, Inspector of Flushers for the North-Eastern Division of the Northern District, reports—

“ So far as my part of the district is concerned I know that while the deodorising was going on, I had no complaints of smell from air-shafts and gullies on the line of sewers through which the chemicals passed.

"I have questioned the flushers, and they say that the
"smell in the sewers was not so bad."

Mr. T. Anthony, Inspector of Flushers for the Eastern District of the Northern Division, reports—

"During the deodorising in the summer of 1886
"I had no complaints about the ventilators on the
"several lines of the Board's sewers through which the
"chemicals passed, viz.: the Low Level Sewer, Rat-
"cliffe Highway Sewer, Pennington Street Sewer (one
"of the worst in the district), Waterloo Place, Com-
"mercial Road, Ropemaker Fields, and Millwall. In
"former years, before the deodorising was carried on,
"the above sewers were a constant source of complaint."

Mr. B. Croft, Superintendent of the Western Pumping Station, Pimlico, reports:—

"In answer to your question as to the practical
"results of the deodorising operations at this Station I
"have to state that when using the manganate of soda
"mixed with sulphuric acid there was scarcely any
"smell either in the engine-room or at the gratings, and
"the brasses on the engines did not tarnish as when
"the deodorisers were not in use; but when using the
"manganate of soda alone it did not answer so well,
"even when using half as much more."

Mr. W. Jeffree, Superintendent of the Deptford Pumping Station, reports:—

"Our practical knowledge of deodorization of the
"sewage is that all the nasty smells were taken away,
"and the filth-hoist men, engine-drivers, stokers, and
"all the staffs were much benefited. We tested the
"smells three or four miles below our works, and found
"the sewer free from bad smells. I am confident there
"will be no disease found where the deodorization is
"carried on. Our men working over the sewer had no
"disease during the summer (4 men working by day and
"4 by night), but enjoyed the best of health."

Mr. F. E. Houghton, Superintendent of the Crossness Outfall Works, reports:—

"The beneficial results of the treatment of the
"London sewage during the past summer with man-
"ganate of soda and sulphuric acid have been of the
"greatest advantage to the river in the neighbourhood
"of the outfalls. I have no hesitation in saying, living

“ as I do on the banks of the river, that if the sewage
 “ had not been deodorized during the past summer, the
 “ river would not have been fit for navigation.”

The following series of special observations were made under my direction during the summer of 1885, in connection with the stations then established.

Western Pumping Station, Pimlico.

Since this deodorizing station has been in operation the smell in the engine-room and outside has almost disappeared. Complaints at Grosvenor Road Station have ceased. Since the deodorizing, the brass-work in the engine-room does not become tarnished. Samples taken along the line of sewer for a distance of one mile and a half, at intervals of 250 yards. No perceptible smell, except at the extreme end, although the samples were taken at ten o'clock in the morning.

Francis Street, Westminster.

Samples were taken along the sewer for a distance of one and a half mile. No very perceptible smell of sewage. Strong smells of brewery products. Complaints of bad smells from surface ventilators have ceased since the erection of station.

Deptford Pumping Station.

Since the deodorizing station has been in operation the smell in engine-house and outside has almost entirely ceased, and a decided improvement has taken place, no complaints having come to hand with regard to smells from surface ventilators.

Bedford Park, Turnham Green.

The sewage here runs through an open brook for a distance of 300 yards. The brook is situated at the boundary of Bedford Park Estate, on the road to Acton. The smell above the deodorizing station is at times most offensive, but at no time is there the least smell below the station, and samples taken from the brook were free from any perceptible sewage smell. A large number of the inhabitants have taken great interest in the work, and are anxious that it should be carried on.

Willesden.

This is a very foul sewer. A sample taken just above the deodorising station smelt very strongly of sewage. Further samples were taken below the station for a distance of $2\frac{1}{2}$ miles at intervals of 500 yards. Along the whole line the smell of sewage was scarcely perceptible, and even at the point ($2\frac{1}{2}$ miles distant from the station) at which the sewer empties itself into a main sewer, the sample taken smelt only very slightly of sewage.

York-road Pumping Station, Battersea.

A sample taken from the Sewer immediately above this deodorizing station had a distinct smell of sewage. 200 yards below no sewage smell was perceptible, but a strong oily smell. At a distance of nearly two miles from the station a sample was taken, when only a slight smell of sewage was perceptible. The Superintendent remarked that since the deodorizing, there had been no smell of sewer gas either in the engine house or in his house, which is attached to the former. Complaints from the neighbourhood were formerly frequent, but have of late ceased.

Effra Pumping Station, Vauxhall.

This station is situated about two miles below the York Road Pumping Station on the same sewer. At a distance of one and a half mile below this station a sample did not smell perceptibly of sewage, but evolved a strong smell of brewing products. At a distance of two and a half miles a sample taken smelt slightly of sewage, but was in no way offensive.

Bayswater Road.

This is a particularly offensive sewer. Samples taken before and after deodorization went to show that the effect of deodorization is traceable for a distance of about two miles.

Baker's Row, Whitechapel.

Complaints were of frequent occurrence before the erection of this station, especially near the New Shadwell Fish Market, distant about two miles from the station. Complaints seem now to have ceased, and the improvement in the neighbourhood of the Market has been several times remarked on by the inhabitants. Samples taken below the station for

a distance of two miles show a distinct improvement in the sewage, as regards smell, compared with samples taken above.

Tower Hill.

Samples taken below this station for a distance of one and a half mile, and compared with samples taken above the station, showed a distinct improvement. At a distant of one mile from the station the smell of sewage was slight, and at one and a half mile the smell was not nearly so offensive as in the sample taken above the station.

Lonsdale Square, Hoxton, and Holloway Road Stations.

Similar experience to that at Tower Hill. Mr. Fernley, Inspector of Flushers, reported on the 7th October, 1885: "I have not heard any complaint of bad smells from the air shafts lately, and from what I hear there appears to be some improvement at Cannon Street and Lower Shadwell."

I therefore submit to the Committee that, on both theoretical and practical grounds, the application of manganate of soda and sulphuric acid to the sewage both in the Metropolis and at the outfalls, has been well advised; and that the removal of an admitted evil from the sewers under the Board's control, at a cost of two and a half pence per head of the population, has been effected in a manner at once beneficial to the ratepayer in his own district, as well as to the condition of the river generally.

If the Committee is of opinion that the deodorization of the sewage should be continued, either in the Metropolis or at the outfalls, I would suggest that no time be lost in inviting tenders for the supply of the chemicals required, viz., about 4,000 tons of manganate of soda and 1,500 tons of sulphuric acid.

(Signed) W. J. DIBDEN,
Chemist.

Statement made by Mr. Cook at a Meeting of the Works and General Purposes Committee, held on the 31st January, 1887, in reply to the Chemist's report:—

Mr. Edward Rider Cook said:—I suppose the Members of the Board expect I should make some few remarks upon Mr. Dibdin's report upon the letter which I had the honour

of submitting to this Committee. I wish to say in the first place that there was not the slightest intention on my part, in bringing this matter before the Board, to adopt a line of criticism. The view I took of the matter was this: I thought the Board was making a mistake. I was anxious that the Board should discontinue that mistake, but I did not wish in any way to criticise the officer of the Board upon whose recommendation the mistake was made. When I first gave my mind to the matter, I determined positively to hold that attitude; and the only reason why I adopted the expedient of putting my remarks in a concise form in print, was to give fair play to the officer, so that he might have an opportunity of reporting upon written remarks rather than upon remarks which were made in debate. I find myself to-day in somewhat a difficult position. I find that if I am to continue placing my views before the Board, I am inevitably driven into the attitude of criticism. I find that I must either criticise (I hope in a fair, generous, and kind spirit) the action of our Chemist, or I must let the matter drop altogether. I do not conceive that it would be my duty, as a Member of this Board, to let the matter drop. Having expressed strong views upon it, I feel that I must criticise (however unwillingly, and I may say with something like pain) the report of the Chemist upon my letter in a way from which I should like very much indeed to be relieved. I hope I have never been a coward; all my life I have tried to do what is right. If Mr. Dibdin will accept my assurance, and if the Board will accept my assurance, that I have no personal feeling in the matter, but that anything I may say is said only from a sense of public duty, I shall feel my task is considerably lightened.

And now, Sir, every Member of the Board has had my letter, and every Member of the Board has also had the report of Mr. Dibdin; and, if I may judge from what happened when that report was read last week, or the week before, there were some Members of the Board who were saying to themselves quietly, "Well, Cook's completely smashed." (Laughter.) I had some little hope, I must confess, as the report was read, that the facts of the case, the scientific facts of the case, which I ventured to lay before the Committee, having been admitted by the Chemist to be accurate, Members would have concurred in the deductions I had drawn, whether they possessed scientific knowledge or not. I am placed in a position of great difficulty, because there is no controversy about the chemistry of the matter,

but the controversy is upon my ability to make deductions therefrom, and upon an alleged misapprehension on my part.

The report consists of two parts. The first part is the chemical and physical part. The second part consists of a number of reports from officers of our own Board, tending to show that this system of deodorizing the sewage in the sewers has been successful. Now I cannot help feeling that had Mr. Dibdin felt confident about this latter part of his report namely, the reports of our officers, he would have contented himself with saying, "The problem *solvitur ambulando*. What is the use of questioning the science of the matter? The proof is that the thing is done, and there is no need to go into the science at all." Therefore when I find Mr. Dibdin does not content himself with that, but goes into the scientific question, I am obliged to believe that he thinks with me that reports of this character, coming from colleagues of an officer of a great Board like this, are always reports which have to be looked at with a certain amount of care. I wish particularly to guard myself against saying one word offensive to anyone. We all know when evidence comes from one side, we always wish there was some evidence from the other side to be compared with it. Reports from colleagues of a public officer always need to be confronted with reports from somebody else, or to be closely examined. Anybody acquainted with evidence in Police Courts or Courts of Law knows very well that there is a tendency, even in the minds of men actuated by high motives, to stick to their colleagues. This is an admitted principle in human nature, and it must continue as long as human nature is what it is.

I go further than that. I say with reference to these particular reports, there are some of them which I must ask the Board to look at, remembering that there are sometimes things which are *post hoc* but not *propter hoc*. There are two particular allusions in this report to which I should like to draw the attention of the Committee from that point of view. One is the allusion to Mr. Dunch. Now I am sorry that with such an apparent abundant mass of material to choose from, it should have been thought necessary to bring the Shadwell Fish Market and Mr. Dunch, Surveyor of that Market, into the report; but as they happen to be brought in, they afford me an opportunity of illustrating what I mean. When I first had to do with Shadwell Market, there was an extremely offensive ventilator in Lower Shadwell. It was in

the main sewer, over a point where the sewage from a much higher neighbourhood fell into that sewer. The sewage did not come in slowly, but came in with a rush, and stirred up the whole of the sewage in the main sewer. Exactly at that point there was a ventilator, and this rush of sewage caused an exceedingly disagreeable smell. My attention as Chairman of the Fish Market was called to it, and Mr. Dunch's attention also was called to it. We made representations here, and the result of it was that the ventilator was closed, and a ventilator in another position established. Of course, that being the case, there have been no complaints from the Shadwell Fish Market, or from the neighbourhood of the Fish Market, or from Mr. Dunch, of that particular ventilator. It is all very well to say the complaints ceased because of the deodorizing. I venture to think they ceased because the ventilator was done away with and not because of the deodorizing. I merely instance that as an illustration that because a thing happens *after*, it does not always happen *because of* a certain action.

I wish to go another step with reference to these reports, and to say, we must thin them down very considerably by eliminating, as regards any effect upon our minds, such reports as those of Mr. Croft, Mr. Houghton, and Mr. Jeffree, with reference to the stations where the deodorizing material was put in. There is no doubt that at the particular place where this deodorizing matter is used there is a diminution of smell. I have never said *no* good was done by the deodorizing; I have only said what good was done was very small in proportion to the expenditure. It may be well understood that it is perfectly consistent with this contention of mine, that at the points where the chemicals are put in, there should be a marked improvement. Therefore these particular officers, who refer to the stations where the stuff is poured in and say they find no smell, may be perfectly accurate and true in their remarks, and yet I may be accurate and right in my contention. I will not say anything more about these reports. I have referred to them as illustrating a general principle of evidence;—that what is *post hoc* is not always *propter hoc*;—and that some reports refer to the place where the deodorizing agent is put in, and it is only natural to expect that at these places there should be freedom from smell.

I now come to the chemical part of the Report. Here I wish to thank Mr. Dibdin for acknowledging the care and accuracy with which my experiments have been made. It

is no duty of mine to make experiments of this kind. I did it with a view to the public interest. I did it in the midst of a great many other engagements, and under circumstances of difficulty, without being able to engage gentlemen, as I might have wished, at the public expense, to help in these experiments. I am therefore exceedingly pleased to find Mr. Dibdin admits, as far as the scientific part of the thing goes, that I have been accurate, and have only placed that which is true before the Board.

Now I come to the question of my "misapprehension of the object in view in the deodorization of the Sewage within the Metropolis." I confess that that sentence rather puzzles me. I should think everyone was able to comprehend that the object of deodorization was to deodorize. That was the apprehension I had formed of it. I do not quite see how the "following reasons" show that I had misapprehended in any way the object of deodorization.

I may here say that I believe the mistake which the Board has made consists in having rather hastily changed its mind. Mr. Dibdin, Dr. Dupré, Dr. Odling, and Sir Frederick Abel, all gave evidence before the Select Committee that the Sewage of the Metropolis might safely go into the river, and do no harm whatever. They all made a mistake there; the very gentlemen *who are said to be* now urging the Board to this elaborate and expensive method of deodorization. Well, if they made a mistake before the Royal Commission, it is possible that they have made another mistake now. But there is a great difference in the results of the two mistakes: when they gave evidence before the Royal Commission they made a mistake which saved the pockets of the ratepayers. Now, I contend, they have made another mistake; only in this case they dip tremendously into the pockets of the ratepayers.

My view being that they have made a mistake, I looked rather carefully at Mr. Dibdin's answer, to see if I could trace in it the evidence of hurry, and of acting upon impulse, rather than with that calm, scientific spirit that ought to pervade the mind of every scientific man. I am bound to say that throughout the whole of the scientific part of his answer, I see the evidence of hurry and of imperfect information. He accuses me of misapprehension. I think if he had read my letter more carefully, he would not have done so. But he goes into reasons. And the reasons why he thinks I have made a mistake are: firstly, that I estimate the strength of the manganate at 20 per cent., instead of

its actual strength of 26 per cent. I will not dilate on the fact that as the specification of the Board provided it should be of the strength of 20 per cent., I naturally concluded the manganate supplied was of that strength. It appears the stuff supplied has been, not 26 per cent., as Mr. Dibden states, but 25 per cent. I am confirmed in that contention by this reason—that the contractor, when he entered into the contract, was bound to provide manganate of a strength over 20 per cent., up to 25 per cent.; but if at any time he provided manganate of a strength over 25 per cent., he was to make a deduction in weight, because if the Board got over 25 per cent. of manganate, it was contended they did not need so much as if it were of a strength of only 20 per cent. I was speaking to the contractor, or rather he was speaking to me, on 'change on Friday last. I said to him, "What about this 26 per cent.?" He said, "If you look at the papers, you will see the first thousand tons averaged a little over 25 per cent.; but there was a clause in the contract that if the whole came over 25 per cent. the quantity was to be reduced, so we naturally took care that the second part should be under 25 per cent." That may be right or not, but it differs from Mr. Dibdin's statement that the actual strength was 26 per cent. I wish to remark that Mr. Dibden has evidently not done me quite justice in his first contention. If you will look at my letter, page 7, you will find that in the last sentence I used these words, "The returns made by the Engineer and Chemist show that the average daily flow of sewage, from May to September, was practically 175,000,000 gallons, instead of 150,000,000, the figures assumed by me. This decreases the proportion per gallon of manganate used." It was 174,897,000 gallons, or something like that: practically 175,000,000 gallons. If you will take manganate of 26 per cent, upon 175,000,000 gallons and compare it with manganate of 20 per cent. upon 150,000,000 gallons, which is the basis I assumed throughout my letter, you will find it works out (I went into the question with some little care) that the quantity used equals 1.84 grains per gallon of 20 per cent. manganate; so that the assumption I made in my letter, that we were using two grains to the gallon, is proved to have been a favourable one to the Chemist rather than unfavourable. And yet he overlooks that fact in his answer to my letter, and says that I have made a mistake in the strength of the manganate,

because it was 26 per cent. used instead of 20 per cent. The fact is as I have already stated, that when I said two grains per gallon were used, that was over the mark and is so in spite of Mr. Dibdin's correction. Then Mr. Dibdin goes on to say, "Although Mr. Cook's statement as to the quantity of oxygen yielded by the theoretical unit of manganate of soda is true, he overlooks the effect due to the presence of the sulphuric acid." Mr. Dibdin here accuses me, I venture, to say, of overlooking one of the most important features in the whole thing; and I should not have been worthy to stand up here and speak of the matter as a chemist, if I had been guilty of what Mr. Dibdin assumes. But I have not been guilty of anything of the kind. I have since carefully verified what I knew before, that Mr. Dibdin's assumptions (*a*) and (*b*), under the second head, are both of them absolutely imaginative and illusory. He says I overlooked the effect of the sulphuric acid, which acts, "not only by setting free the oxygen from the manganate, but also by liberating oxygen from some of the bin-oxide of manganese existing in the crude sample in other forms than as manganate. The practical result being that by the action of the acid, the oxidizing effect is always in excess of the theoretical quantity." That would be so if Mr. Dibdin had an excess of acid. I am assuming that the acid used is OV, the oil of vitriol of commerce 140° , and that one-third of the weight is used. If Mr. Dibdin, or any other Chemist, will look at the commercial manganate as supplied, and the effect of adding one-third of the weight, he will find that one-third of the weight of the acid will not neutralise the manganate. This commercial manganate is made by combining caustic soda with oxide of manganese, which makes a very imperfect compound, because the finished article contains only 20 to 25 per cent. of manganate. What becomes of the other 75 per cent.? The other 75 per cent. consists of uncombined caustic soda and uncombined manganese. If Mr. Dibdin will do me the favour to try the experiment, he will find that it not only requires one-third weight of acid, but it takes absolutely two-thirds of the weight of the manganate before you can neutralise the caustic soda. Now caustic soda is one of the strongest alkalies we have, and for any one to tell me that if you put sulphuric acid into the presence of caustic soda, this caustic soda will not neutralise the acid, is to tell me that which I cannot believe. This morning I took (in order to verify the facts once more, and to be quite sure of them) a weight of manganate, the commer-

cial manganate of 24 per cent. as supplied to this Board, and I added two-thirds of the weight of sulphuric acid, and the solution was only then just neutral. But the quantity used by the Board is one-third of the weight. What becomes of the alleged excess of sulphuric acid? Why there is no excess, Sir. I am astonished that Mr. Dibden, in putting an answer to my criticisms in print, overlooks (to use his own expression) such a very important fact as that it takes acid equal to two-thirds of the manganate to neutralise the caustic soda. This is very important. It seems to me that Mr. Dibdin has been handling his sulphuric acid very much like the managers of theatres do an army. They march the soldiers across the stage, take them off and bring them back again behind the scenes, and then march them over the stage a second time. Chemistry will not admit of such procedure, though stage management may. Again, if there is not any free acid, I should like to know how it combines with the ammoniacal compounds in the sewage. Perhaps Mr. Dibden will tell me how it takes place.

I come now to the paragraph at the bottom of page 3 of the Report. Mr. Dibden says: "The ultimate object to be firmly held in view in the treatment of sewage, whether in the sewers or at the outfalls, is its destruction." As far as I am able to understand the next paragraph—I have read it carefully over and over again, and confess I have not been able to understand it thoroughly—but as far as I am able to understand it, Mr. Dibden is dealing with the ultimate destruction of sewage in the rivers, when it comes to be diluted with water. The question I am discussing is the dealing with sewage in the sewers, and not dealing with it in the rivers. I confess I do not see the pertinence of a great deal that follows. I do not understand the analogy of what is said about the food in towns, or what we have to do in this present discussion with the organisms in the river. I dare say it is very true, but it is one of those theories, this germ theory, which is very much in the clouds. If you were to meet with fifty physicists, scientific men, they would have fifty different views on the action of these germs. So far as the question I am dealing with now is concerned, not the deodorizing at the outfalls but in the sewers, this theory has nothing whatever to do with the question.

I come to page 5. Mr. Dibden says: "The peculiar property of permanganic acid is that it exerts a selective action, first attacking the most easily oxidized substances which in the case of sewage are the putrescent ones, and then, in

"inverse order of their stability, the remainder." That is a statement of which I should like to see some proof. Mr. Dibden complains that some of my statements are based on an average of ten experiments. I must remind the Board that, at the present moment, we have, as a Board, gone into this tremendous expenditure without having any experiment at all before us. We have Mr. Dibden's recommendation to do certain things; we suppose he has made some experiments. In patent matters, and some commercial matters, a chemist has a right to keep his experiments to himself. But it is not good form for a scientific man, holding a high position, ever to make a recommendation without showing in detail the experiments which induced him to make it. If you look at the Journal of the Society of Chemical Industry, or the Journal of the Society of Arts, you will find that a man who recommends a course as a proper chemical course substantiates his position by saying, "I have obtained the following results," and there are the tables of experiments which justify his conclusions. (Hear, hear.) It is all very fine for Mr. Dibden to say, "Mr. Cook only produces ten experiments." I want to know what experiments he has laid before the Board to justify it in the expenditure it has incurred.

With reference to selective action, how does he know there is a selective action? It is very well for him to say so, but where is the proof? I may say it does not do so. How are we to prove which is right or which is wrong? I do not see how Mr. Dibden can prove I am wrong, and he is right. I venture to say this, that permanganic acid (as I showed you by experiment on this table) is destroyed by the first oxydizable matter with which it comes in contact. I showed you a bottle full of sewage, and I put in the Board's quantity of manganate, and you could see with your own eyes that before that which I poured in slowly at the top had got down one-third of the depth of the bottle, the pink colour was destroyed, the influence of the permanganic acid was at an end. I want to know what becomes of the two-thirds of the sewage at the bottom of the bottle. How does the permanganate exercise any selective influence on that? I may be foolish, but I fail to see how it can. You know, Sir James, that in war it is very desirable to pick off the officers of a regiment, and it would be just as sensible, to my mind, to say that if a volley were fired into a regiment of soldiers, the bullets which found the bodies of privates in their way, should exercise a selective action, and dodge the bodies of the privates, and run round them, and find their way into the bodies of the

officers (Laughter.) I do not understand selective action. I do not see any reason why we should believe there is any. There is no reason in the world why these atoms of oxygen, coming in contact with urine, should not be destroyed by the urine, as well as run round the urine, to get at the atoms of sulphuretted hydrogen or something else. But Mr. Dibdin says they do so. It is a pure assumption. I want some proof of it before I vote for spending £40,000 per annum.

I also wish to point out the sentence at the bottom of page 5 of the Report. It says: "The contention of Mr. Cook that the smell arises from deposits on the walls of the sewers, and is therefore unaffected by the manganate, is not borne out by actual observations of my own, and is shown to be erroneous by the disappearance of the odours in what were, before the deodorizing operations, exceptionally foul sewers." Now, I do not wish to be very critical, but if you will read my letter you will see it is not *my* contention. I said: "I am informed." Well, Sir Joseph Bazalgette, ever since I have been at this Board, has always contended that if you will keep your sewers clean by flushing, you would do more to prevent nuisances than in any other way.

Passing that over, I should like just to refer to a speech made the other night (Wednesday, December 1st, 1886), at the Society of Arts, by Dr. Carpenter, who is no mean authority on this matter. He said, "One of the points which all sanitarians ought to aim at was to get the sewage out of the towns as rapidly as possible, and not to allow sewers to exist that were sewers of deposit. He was bound to say that that was not the condition in which sewers were in the majority of instances. The point that they should first direct attention to was that the sewers ought to be kept as clean as back kitchens were, and there was no reason why they should not be. If they were properly constructed, and all the arrangements in connection with them were carried out in a proper manner, there would be none of those difficulties which were connected with putridity." There has been a very interesting discussion going on at the Society of Arts, on a Paper read by Dr. Tidy, I should recommend every Member of this Board who wishes to be informed on this question to read that discussion. I think you will find what I have stated is perfectly true, that the bulk of the smell which comes out of sewers arises either from deposits, or from the dirty walls of sewers.

Sir Robert Rawlinson, and other speakers, all agree that fresh sewage is not unpleasant. I think you will find such is the case.

On page 6 of the report Mr. Dibdin says, "During a considerable portion of the last summer the quantity mentioned by Mr. Cook as being necessary, viz., 8 grains per gallon, was actually employed on the whole of the system, one-half being used in the sewers." This is not quite a fair statement of what I said. It is a pity in this contention, where we seek to get at the truth, to make any misrepresentation. What I stated will be found on page 5 of my letter, viz., that "5 grains per gallon is the minimum quantity which I found did deodorise a sample which had a distinctly offensive smell." I have found some samples take more than that; but it is not fair, when I say a minimum of 5 grains, to say the quantity mentioned as necessary is 8 grains. It is not dealing with the matter in a way to get at the truth.

I do not think I need go further into the details of this report. But I wish just to supplement what I have said by one other matter. A great many members of the Board are under a very serious delusion as to the cost of this manganate. They imagine they are getting a chemical at £11 a ton, or £10, which is of the same kind as that first employed by this Board at a very high price. The first experiments were made with permanganate, and we did pay a long price. But before you come to the cost of the real manganate, you must remember you are only dealing with a substance containing from 20 to 25 per cent. of strength, so that the efficient chemical you put in the sewers costs you £50 a ton. In moving this chemical you have to move five times the weight of the efficient chemical you employ. And then (what to my mind is of infinitely more serious importance) there is the fact that in putting one pound of the deodorizer into the sewer, you are putting four pounds of rubbish into the sewer which you do not want there. Out of that four pounds, one-third of the whole original weight is insoluble matter. For the manganate we buy contains from 33 to 34 per cent. of insoluble oxide of manganese. I calculated it on Saturday, when I was thinking over this question, and found that in putting 2,474 tons of manganate into our sewers, we put in 825 tons of one of the heaviest solid matters I know, because the oxide of manganese precipitates out of nearly anything. If you go on in this way you will

find the sewers, in the neighbourhood where you pour this mixture in, filled with a hard, solid, black deposit, which will cost you a great deal of money to get away, and which will be a harbour for putrefaction and decomposition. This is of great importance. It is a side matter which may not have occurred to Mr. Dibdin, but it is important for us to look to. Sir Joseph Bazalgette will agree with me that if you object to the Commissioners of Sewers sweeping road detritus down the sewers, surely you must object to have the sewers blocked up with solid oxide of manganese. For these reasons, I say, the pouring of this stuff into the sewers is a great mistake. I think I have given the Board sufficient *prima facie* evidence of it. I do not think Mr. Dibdin's report is in the slightest degree conclusive. It is characterized by a looseness of observation, and a want of care in investigating the facts he lays before us. I am not content, on Mr. Dibdin's authority only, to be a party to continuing this extravagant expenditure, which I believe is practically waste of money. I am not going to take any further action. The position which I have taken is an extremely invidious one, but having had a chemical education, and obtained some slight position in the chemical world in my time, I felt it to be my duty to do what I have done. If in the course of my remarks I have said a word that is painful to Mr. Dibdin or any other officer, I beg you to believe that I have not spoken from any feeling of ill-will but from a simple desire to do what is right to this Board. (Applause.)

**Report by the Chemist, in reply to the Statement made
by Mr. E. Rider Cook to the Works and General
Purposes Committee on the 31st January, 1887.**

CHEMICAL AND GAS DEPARTMENT,

SPRING GARDENS, S.W.,

February 14th, 1887.

The first point in Mr. Cook's speech is his rejection of the three Reports on matters of fact by Messrs. Houghton, Jeffree, and Croft, and remarks upon a statement by Mr. Dunch to Mr. Lovick.

With reference to the latter I have again referred to Mr.

Lovick, who is my authority on the matter, and he informs me that—

“The works to the sewer at Shadwell were for the purpose of the market, and could not have had the effect of taking the smells away from the District. The mere stopping up of a ventilating shaft would have the effect of intensifying the smells at other points. His inquiry could not have been the result of the stopping of a single ventilator, as it was a general inquiry, and obviously arose from our general work of deodorizing upon the sewers running through his District.”

It is obvious that Mr. Dunch, being acquainted with the circumstances of this particular ventilator, would not have asked Mr. Lovick the cause of the disappearance of a nuisance which he had himself assisted in stopping.

Mr. Cook has asked for evidence of the effect of the manganate on the sewers, and when I give him proofs, which consist of careful observations made under my direction at the commencement of our operations, some 18 months before he intimated his objection to the system, and also give independent testimony by trusted Officers of the Board unconnected with my Department, he ignores the first and discredits the latter.

Mr. Cook also leaves out of consideration the Report made by Dr. Dupré, F.R.S., in October, 1885. The Committee will remember that when the River in that year was bad, I asked and obtained the sanction of the Committee to consult that gentleman, or whoever might be preferred, in order that there should be no mistake as to the advisability of continuing the manganate process. Accordingly Dr. Dupré was retained, and after inspecting the whole of the operations during the summer he reported thereon. His opinion as to the value of the method of deodorizing in the sewers is clearly expressed in that report by the following passage—

“It is extremely probable that, had the system of deodorizing the sewage at various points within the sewers of the Metropolis been then established, even this temporary evil would not have occurred ;” and further on, “Many men who one would have expected to have known better have spoken or written against the process of deodorizing carried on at Barking and Crossness, on the assumption apparently that it was to be a permanent scheme, and on the calculation that the amount of deodorant added could deal only with a small fraction of the sewage. The first point I have already disposed of, and with regard to the second, it

“ only necessary to say that it is not necessary to add an
 “ amount of manganate which by itself would be sufficient
 “ to destroy completely the organic matters in the sewage.
 “ All that is really necessary is to add so much and no more,
 “ so that the River itself can deal with the remainder.”

It was by the strong and often-repeated expressions of approval of Dr. Dupré and other chemists of the process of deodorizing in the sewers, that I was strengthened in my own views on the matter in 1884 and 1885 ; and the reasons now advanced for those views were founded many years back, and subsequently strengthened and established during the course of lengthy observations of the River water in conjunction with Dr. Sorby and others. These views have been independently adopted and worked out by men following a similar path in other directions, and are given in the journals of our public societies and elsewhere.

Mr. Cook is of opinion that I am now acting imprudently, because he thinks a mistake was made in the evidence given before the Royal Commission. This is such an important question that I must ask the permission of the Committee to place a few facts before them. It seems to be assumed because the River has been in an unsatisfactory condition for limited periods during the past three summers, that the evidence given by the chemical, as well as other advisers of the Board, was erroneous. I venture to state to the Committee that the evidence given by its advisers before the Commission was evidence of fact. The fact that a serious alteration has taken place in the condition of the water during the summer months of the last three years, is in itself evidence that the conditions have changed. The published returns of the Registrar-General shew that the reason of this change is due to deficient rainfall, in addition to the ever-increasing flow of sewage. The rainfall during the months of June, July and August, in the ten years ending 1886, was as follows :—

1877	...	...	...	5·84 inches.
1878	...	...	...	10·26 ”
1879	...	...	...	13·18 ”
1880	...	...	...	6·74 ”
1881	...	...	...	7·80 ”
1882	...	...	...	6·04 ”
1883	...	...	...	4·13 ”
1884	...	...	...	4·65 ”
1885	...	...	...	3·49 ”
1886	...	...	...	4·05 ”

As the evidence was prepared up to the spring of 1883, the Committee will see that the conditions under which that evidence was given have totally changed. After inspecting the River during the summer of 1883, the Royal Commission reported—"That it does not appear that hitherto the sewage discharged has had any seriously prejudicial effect on the general healthiness of the neighbouring districts. But that there is evidence of certain evil effects of a minor kind on the health of persons employed on the River, and that there may reasonably be anxiety on the subject for the future;" which was a very differently worded conclusion to that drawn by the same Commission after they had inspected the River in 1884, a year in which the rainfall was 17.76 inches, as against 25.16 to 31.65 inches in the six years previous to the evidence laid before them.

As Mr. Cook maintains that the quantity of manganate added to each gallon of sewage in the sewers was less than 2 grains, it will be necessary for me to enter upon a little further detail. As the Committee is aware, the main-drainage system on the north side of the Thames is divided into three main sewers, viz., the High, Middle and Low levels. The number of deodorizing stations upon the High Level Sewer, last year, was only two, those upon the Middle level system numbered six, and 10 were upon the Low Level system. In order to know the average quantity of manganate put into the sewers in grains to the gallon, it is necessary to know the quantity of sewage flowing past each station. This was one of the first points I endeavoured to ascertain; but I was met with the objection on the part of the Engineers, that the flow was very variable, and to obtain anything like definite information considerable difficulty and expense would be involved. I, therefore, had to fall back on the system of putting in enough to thoroughly kill the smell. The rate of flow in the High and Middle Level Sewers is unknown; but as the whole of the sewage on the Low level west of Pimlico is pumped at Grosvenor-road, we are able to get at some approximation of the average in this case. In July last about 6,326 lbs. of manganate of soda were put into the sewage per day at the stations on the Low Level System, West of Pimlico, at which stations about 18 millions of gallons were pumped. The average quantity so added would thus be 2.46 grains to each gallon. At the same time 12,915 lbs. of manganate were added at all the stations on the Low Level system. The flow as pumped at Abbey Mills unfortunately affords no guide to the quantity of sewage

passing these stations, in consequence of the enormous influx of River water by various channels, and I am informed by Mr. Lovick that an estimate of sewage actually treated founded on the quantity of water pumped would be useless.

On the South side about one-half of the sewage is pumped at Deptford. On the line of sewers which flow by direct gravitation to Crossness, only two stations were placed. On the lines of sewers which run to Deptford six stations were situated. In July last the daily quantity of manganate added at the latter was about 16,535 lbs., and the sewage pumped (including a large quantity of River water admitted to the sewers for the purpose of flushing) was $39\frac{1}{2}$ million gallons, or an average of 2.9 grains per gallon. In like manner the quantity of manganate added daily during August last was 2.57 grains per gallon, in the Low Level system, West of Pimlico on the North side, and 2.8 grains per gallon on the Low Level system, on the South side.

I submit that this is a truer way of averaging the quantities added than that adopted by Mr. Cook. It must be remembered, however, that even this system of averaging is wrong, as the quantities put in were added at certain points, and the work done there was complete, and the thoroughly deodorized liquid sent forward to dilute and sweeten the sewage received by it further on; the process being somewhat analogous for the purpose of deodorization to what would have happened had the sewage flowing past the deodorizing station been suddenly diverted, and a dilute solution of a deodorizing liquid turned on in its place.

The Committee will remember that the reason for these deodorizing stations being opened was that some control might be obtained over the storm-overflows during hot weather. This was a point very strongly dwelt upon at the time I was giving evidence before the Royal Commission on the second part of their inquiry; and when I subsequently mentioned the proposed establishment of such stations to Dr. Williamson, he strongly supported the idea. Finding that the first stations opened were so efficient in reducing a long-standing evil, in connection with the sewer ventilators, I recommended the establishment of further points of treatment, and those stations were accordingly opened by the instructions of the Committee. I simply refer to these historical facts in order to show that we have not acted hurriedly and without information.

Mr. Cook takes exception to my statement respecting the action of the acid on the ammoniacal matters of the sewage.

My strict instructions were that in all cases sufficient acid was to be added to the solution of the manganate to render it distinctly acid, and proper means were provided for testing this. On every inspection of the stations by myself or my assistants it was found that the liquid running into the sewers was distinctly acid, except on some occasions when in consequence of the difficulty experienced in getting the deliveries made with sufficient rapidity, the acid had to be reduced and in some cases altogether stopped, as mentioned in Mr. Croft's report. This difficulty was met with chiefly on the North side of the River, in which district most of the chemicals were used. On the South side, in consequence of the smaller quantity required, the same difficulty was not experienced, and in many cases the acid employed was equal to more than half the weight of the manganate. The later deliveries of manganate of soda were far more alkaline than the original samples on which the estimate of acid equal to one-third the weight of the manganate was founded.

This question was one of the many practical difficulties I had to contend with, the Contractors having been repeatedly requested to hasten on the supplies as fast as possible. The intention and instructions were to add acid in excess, whatever might be the quantity required, and these instructions were carried out as far as the circumstances would permit.

Mr. Cook objects to my putting forward the reasons which induced the chemical advisers of the Board to recommend a system of deodorizing by means of an oxidizing agent, instead of employing antiseptics.

I submit that the subject must be dealt with as a whole, and not piecemeal, that what is done in one part of the system must be part and parcel of what is done in another.

Mr. Cook does not understand the advantage of treating the sewage in the sewers, while he believes in adopting precisely the same system at the outfalls. I cannot follow him in this reasoning. I submit that if a certain amount of work has to be done, it matters not whether we accomplish that work in one part of a sewer or another, and that if the stink of the sewage is to be removed at all, it is advisable to achieve that end while it is a cause of nuisance within as well as without the Metropolis.

Mr. Cook takes exception to my statement regarding the "selective action" exerted by permanganic acid, and asks why I do not quote authorities, or give my experiments. In reply, I would point to the first elementary text-book on

Chemistry that may come to hand, and to the whole foundation of chemical facts, whether contained in the records of one Society or another. I might multiply instances innumerable; but it will be sufficient to illustrate the case if I take three or four only, of both a simple and complex character. Baryta will instantaneously combine with hydrochloric acid to form chloride of barium. It will also combine with sulphuric acid to form sulphate of barium; but if it is presented to a mixture of these two acids the whole of the sulphuric acid will be first attacked and neutralised by the baryta before a fraction will enter into combination with the hydrochloric acid, which must stand by until the sulphuric acid is satisfied. Again, oxalic acid, sulphuretted hydrogen and proto-sulphate of iron are all equally and rapidly attacked by the oxygen of permanganic acid, but if permanganic acid be gradually added to the mixture of these substances, the first to be attacked is the iron, which is converted into a higher state of oxidation; that being accomplished the sulphuretted hydrogen next succumbs, and finally the oxalic acid. Mr. Cook says that sulphuretted hydrogen is not attacked at a greater rate than, and in preference to, the matters in urine. I find that this is exactly what does take place. A small quantity of urinary matter is attacked before the last faint traces of the sulphur compound are neutralised; but the great bulk of this objectionable gas is primarily disposed of before any material quantity of oxygen is taken by the effete organic matters of the urine. The experiments made by Mr. Cook demonstrate the same thing. He took a sample of sewage, and added sufficient permanganate to destroy the smell. On the smell returning, he again destroyed it, and repeated the process from time to time. Now if the smell disappeared, the substances in an odoriferous condition must have been destroyed, and this was done by a quantity of manganate totally inadequate to oxidise the whole of the organic matter present.

Mr. Cook states that "a great many Members of the Board" are under a very serious delusion as to the cost of the "manganate," and to prove his statement says that we are paying £11 per ton for a substance containing only from 20 to 25 per cent. of the strength of the substance purchased by the Board as a high price. I am sure Mr. Cook will be the first to admit that in this he has made a serious mistake. When the Board first decided to use permanganic acid, the substance then employed for the purpose, viz., permanganate

of potash was inquired for, when instead of hundreds of tons we were offered a few hundred weights. I then went to the only maker of manganate of soda in England, Mr. Condry, and he charged £40 per ton for a substance inferior to that which we are now getting at less than one-fourth the price. The actual comparison of cost of oxygen available from manganate and permanganate is best shown by the following:—

1 ton of oxygen obtained from permanganate of potash, at £140 per ton	 =	£560
1 ton of oxygen obtained from permanganate of potash, at £80 per ton (very inferior quality)	=	320
1 ton of oxygen, 20 per cent. manganate of soda, at £40 per ton (Condry's first price)	 =	1,000
1 ton of oxygen, 25 per cent. manganate of soda, at £12 10s. per ton, as at present used	=	250

The comparison must be made, however, between the manganate of soda at first obtained and that now purchased, as only practically useless quantities of permanganate of potash have been at any time obtainable.

The objection to the use of manganate on account of the admission of insoluble oxide of manganese is unimportant. The 825 tons of solid material in a very fine state of division were put in during a period of about 5 months, or six tons per day at 26 different places, or only a few ounces per minute at each place. The quantity is absolutely infinitesimal in comparison with the heavy matters introduced into the sewers during only a single moderate shower. I am informed by the Engineers that no difficulty whatever has been experienced from this cause.

Mr. Cook objects to continuing the process on my authority only. I have already shown that under the order of your Committee one of the most distinguished scientific chemists of the day has reported in favour of the plan. Dr. Dupré, F.R.S., amongst other appointments holds the post of chemist to the Medical Department of the Local Government Board, and is therefore presumably a competent judge on such matters. I have previously stated that the plan was approved by Dr. Williamson, the chief chemical member of the recent Royal Commission, and by Sir Frederick Abel and Dr. Odling.

As a further proof of the beneficial effect of the *general system* of the deodorization of the sewage adopted by the Board, I submit the following extract from the Annual Report

for 1886 of Dr. Studdert, the Medical Officer of Health to the Erith Local Board.

“The free use of disinfectants and various other precautionary measures adopted by the authorities at the outfall, had a marked effect on the state of the River, and so far as Erith has to be considered, little was left to be complained of, from a sanitary point of view.”

W. J. DIBDIN,
Chemist.



