

Report on the nuisances arising from gasworks / Metropolitan Association of Medical Officers of Health, Trade Nuisances Committee.

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METROPOLITAN ASSOCIATION

OF

MEDICAL OFFICERS OF HEALTH.

TRADE NUISANCES COMMITTEE.

REPORT ON THE NUISANCES ARISING FROM GASWORKS.

TOWARDS the close of last year the nuisances arising from Gasworks were brought somewhat prominently under public notice. The Committee of the Association appointed to inquire into Trade Nuisances consequently came to the determination of commencing its investigations at this subject. Since the middle of October the works of each of the Metropolitan Companies have been visited by invitation from their managers. The Committee desires to record its sense of the polite attention which in every instance it received from the officers of the several establishments, who took great pains to explain the process, and who pointed out to the Committee with the utmost candour every peculiarity in the works.

The following outline of the process of gas making appears necessary to render intelligible to the members of the Association the nuisances it may occasion. It may be conveniently described under the heads of—1. Distillation, 2. Condensation of impurities, 3. Purification.

The *Distillation* of the coal is effected in retorts of clay or iron variously set, but always arranged in blocks, and so that the heated air from the furnaces passes over and around them, raising them to a bright red heat. Clay retorts are mostly preferred to those of iron. The retorts are elongated and cylindrical, oval or D-shaped, the advantage supposed to be derived from the two latter forms being the more rapid accomplishment of the distillation by the diffusion of the coal over a larger surface. The most important difference in the retorts, however, lies in their length and openings. In some works short retorts closed at the further extremity are used; in others they are of twice the length, pass completely through the block, and are open at both extremities. Economy in building and fuel are the objects attained by the latter arrangement. The length of the single retorts is about 8 feet, that of the continuous retorts about 18 or 20 feet; the diameter of both is about 15 or 16 inches, the oval retorts being a few inches wider in their longest diameter. With scarcely an exception, these blocks are situated in a retort-house, the roof of which is at a considerable height above them. In every instance there are free openings to the atmosphere at the roof. The fuel employed in the furnaces is coke. In two establishments the Committee found that a portion of the tar was also burned, being supplied in a small constant stream, with sufficient air to ensure its combustion. The flues from the furnaces communicate with a tall chimney, from which but little smoke was in any instance observed to issue. The charging of the retorts is effected by the aid of a long scoop, which, being heaped up with coal along its whole length, is raised by three or four men, run into the retort, overturned, and withdrawn. The coal thus left in the retort is then in some instances distributed over its lower surface by means of a kind of rake. A single scoopful, or a scoopful and a few shovelful in addition, suffice to charge the single retorts. The continuous retorts are charged simultaneously at the two extremities. Where the retorts are of large diameter, two charges are introduced at each end, several seconds elapsing between the charges, occupied in refilling the scoop. In this case the charging occupies from sixty seconds to two minutes. Where a single scoopful suffices, a very few seconds accomplish the work. A cover or mouthpiece is then adapted to the extremities of the retorts, some luting being interposed, and the cover is fixed by a clamp and screw. The distillation is continued for five or six hours, and at the end of this period the covers are removed, and the coke raked out, and immediately quenched by throwing water upon it. It is ultimately conveyed to a heap in the yard. The luting is usually made with refuse lime from the purifiers. In only one instance did it appear that fresh lime was used for the purpose. At the Chartered Company's works in the Horseferry-road, Boghead coke is ground, and mixed with clay and soap ashes, to form a luting. The perfection of the luting is of less importance now, in consequence of the universal use of an exhausting engine, which reduces the pressure of the gas generated within the retort to about half an inch. The gas passes from the retort through the liquid in the hydraulic main to the condenser.

For the *condensation of the impurities*, the gas is sent through a series of tubes, mostly arranged vertically in the form of syphons, and exposed to the air. In these the gas becomes

cooled, and deposits ammoniacal liquor and tar, which are collected below, and run off into underground tanks, where they separate, the tar below, the ammoniacal liquor above. These are pumped into covered barges, and thus conveyed from the premises. In some works, however, as already stated, a portion of the tar is burned, and in some, as at the London Gasworks, and at the Surrey Consumers in Rotherhithe, the ammoniacal liquor is converted into sulphate of ammonia. In some works the cooling and condensation are assisted by a stream of water over the outside of the tubes. In the South Metropolitan Works the condensing tubes are arranged horizontally in a tank of water. The condensers at the Phoenix Works (Vauxhall) are constructed with an inner tube containing water. From the condenser the gas usually passes to the exhauster, but in some works, as at the City Gasworks and the Ratcliff, it passes to the exhauster before condensation.

The object of *purification* is the separation of those impurities which have escaped condensation. They consist mainly of a little tarry matter, ammonia, carbonic acid, and sulphuretted hydrogen. The means employed vary in different works. The following are those which the Committee has seen in operation at the works it has visited. In each instance they are named in the order in which the gas passes to them.

1. Cream of lime ; dry hydrate of lime ; oxide of iron.
2. Dry scrubbers, containing brick bats, &c., and "gypsum material;" oxide of iron ; dry hydrate of lime.
3. Dilute sulphuric acid or acid solution of sulphate of ammonia ; cream of lime ; dry hydrate of lime ; oxide of iron.
4. A dry scrubber, containing coke ; solution of muriate of manganese ; dry hydrate of lime ; oxide of iron.
5. Water ; oxide of iron ; dry hydrate of lime.
6. Solution of muriate of manganese ; cream of lime.
7. Oxide of iron (Laming's) ; a scrubber containing coke, over which water trickles.
8. Oxide of iron (Hill's) ; dry hydrate of lime ; a scrubber containing coke, into which a jet of steam is thrown.
9. Dry hydrate of lime ; oxide of iron.
10. A scrubber containing crocks, over which water trickles ; water ; cream of lime.
11. Scrubber containing coke and tan ; scrubber of wet coke ; oxide of iron ; dry hydrate of lime.

It is unnecessary for us to discuss the relative merits of these several methods of purification. We shall content ourselves with pointing out the mode in which some of them are applied, and the effect they produce upon the gas.

a. The water, and the scrubbers, dry and wet, ensure the more complete condensation of the tarry matters, and partially remove carbonic acid, sulphuretted hydrogen, and ammonia. The liquor which proceeds from them is permitted to mix with that furnished by the condensers.

b. Dilute sulphuric acid, or acid sulphate of ammonia, separates ammonia and tarry matters. At the Surrey Consumers Works the liquid when saturated is pumped into a settling tank, where the tar is deposited. The solution is evaporated and crystallised upon the premises. The vats for evaporation are heated by steam.

c. Muriate of manganese. The strength of the solution is about 4 or 6 lbs. of the muriate to a gallon of water, or 28° to 30° of Twaddle's Hygrometer (sp. gr. 1145 to 1150). The solution is placed in a box provided with a central diaphragm or plate, not reaching to the circumference of the box. The gas is introduced by a central tube below the plate, and is thus compelled to traverse some distance in contact with the solution, bubbling up round the edge of the plate so as to reach the upper and vacant part of the box, where it passes out. Two or three such purifiers are used. It goes first to the purifier which has been longest in use, and last to the solution most recently introduced. This process separates ammonia, converting it into hydrochlorate, which is run off under cover to barges for conveyance away. It was stated at the Great Central Works that from one fourth to one fifth of the sulphuretted hydrogen is also thus removed.

d. "Gypsum material;" sulphate of lime. This salt acts upon the gas by a double decomposition ; the lime combines with carbonic acid, while its sulphuric acid unites with the ammonia. Laming's oxide of iron, prepared by precipitation of the sulphate of iron by lime, necessarily contains this salt, and acts in a similar manner upon the gas. In the Chartered Gasworks it is the means relied upon for separation of ammonia.

e. Oxide of iron. The preparation used varies at different works. An oxide prepared by precipitation (as Laming's, previously referred to,) is mostly in use. At the Western Gasworks the oxide is prepared on the premises, by adding some of the ammoniacal liquor to crude green copperas. The oxide is usually mixed with sawdust, with a view to extension of surface and to porosity. It is introduced upon four or five metal screens into air-tight boxes. Where, as at the Chartered Gasworks, the oxide is mainly relied upon for the purification, the gas is made to traverse three such boxes. Where other means are added, one oxide purifier is commonly considered sufficient ; and in some works, where the use of dry lime is conjoined, the upper screens contain dry lime, and the lower, through which the gas first passes, oxide of iron, both being in the same purifier. The

effect of the oxide is to separate sulphuretted hydrogen, a black sulphuret of iron being formed. The oxide is changed at intervals, varying in different works from 36 hours to 10 days. When removed from the purifiers it is "revivified" by exposure to the action of the air, the oxygen of which decomposes the sulphuret, throws down the sulphur, and reconverts the iron into peroxide. It is then damped, and again used. The duration of the exposure necessary for revivification varies, with the age of the oxide and the length of time it has been in the purifier, from 24 hours to 14 days. It resumes each time its red colour. The process of revivification is capable of very frequent repetition. The same oxide may thus be in use for many months; in fact until the sulphur precipitated accumulates in such quantity as to prevent the revivification of the oxide. Dr. R. D. Thomson has found the sulphur reach 45 per cent.

f. Cream of lime; "wet lime." The apparatus used for this mode of purification mostly resembles that described when the muriate of manganese was mentioned. In the Phoenix Works (Vauxhall),—a model of the wet lime process,—the gas is made, by an arrangement of plates and bells within the purifier, to bubble three times through the wet lime contained in one purifier; the lime being prevented from settling by agitation effected by machinery. When the cream of lime is saturated (*viz.*, about once in twenty-four hours,) it is usually run off into pits, where the lime may settle; the plastery matter which deposits being used for luting, sometimes alone, sometimes when mixed, for the sake of an improved consistency, with refuse dry lime. The cream of lime separates carbonic acid, sulphuretted hydrogen, and ammonia.

g. The "dry lime," or hydrate of lime, is exposed on screens in a box to the action of the gas, in the same manner as the oxide of iron. It serves to remove carbonic acid, sulphur, and cyanogen compounds; and, when other effectual means of separating ammonia have not preceded, becomes strongly charged with ammonia. When removed from the purifiers (usually every four or five days) it is commonly placed in a heap in the yard, and used for luting.

There are various sources from which annoyance to a neighbourhood may arise in carrying on the manufacture of gas. Against some of them the Committee considers that remedies might readily be suggested.

1. *Smoke.* It has been remarked above that the amount of smoke from the furnaces is usually very insignificant. That which is here referred to proceeds from the openings at the roof of the retort-house, and at certain periods beclouds the atmosphere to some distance about them. The periods at which this nuisance is at its height are when the retorts are being charged, or the coke withdrawn. The evolution of smoke was noticed by the Committee to be less during the charging of the single than of the continuous retorts. The former are charged usually by a single scoop, and the cover is adapted and the process thus completed in a very few seconds, and before the coals can become sufficiently heated to part with much volatile matter. With the continuous retorts, on the other hand, not only is there a delay arising from the double charging at each end, but if one cover be adapted only a few seconds before the other a quantity of smoke commonly issues from the open extremity, and in the case of cannel gas a blast of ignited gas has been seen by the Committee to extend to the distance of several feet from the open mouth. The Committee suggests that much of this might be avoided if two scoops at each end were used instead of one, both being ready filled before the charging commenced, the mouth-pieces being immediately and simultaneously adapted. The withdrawal of the coke should be effected as quickly as possible, and no time should be lost in quenching it with water. But under the best arrangements a great deal of smoke is necessarily given off, which, with the steam produced by the quenching, should be prevented from becoming a nuisance. Probably a remedy might be found in the closure of the ordinary openings at the roof, and in place of them forming one or more communications, at the upper part of the retort-house, with the chimney or tall shaft which carries off the heated air and smoke from the furnaces. Should there be objections to this plan, doubtless gas-engineers would readily discover an effectual means of overcoming its difficulties.

2. *The use of the refuse lime from the purifiers* in luting the mouth-pieces is another very obvious source of nuisance in most of the retort-houses. As the refuse lime contains sulphur and other noxious compounds, it gives off, when heated, very disagreeable and probably pernicious vapours. The Committee is of opinion that this practice should be discontinued, and that fresh lime, the coke ash luting formerly mentioned as in use at the Chartered Works, or some other equally unobjectionable material, should be employed.

3. *Ammoniacal liquor and tar.* In some works where the pits were uncovered an offensive odour was observed to proceed from this source. The proper remedy is that adopted in the majority, *viz.*, to cover the pits, and to convey these products of condensation without exposure to the barges which are to carry them away.

4. *Revivification of the oxide of iron.* The offensiveness of this process depends upon the evolution of ammonia, which is favoured by a rise in temperature which the oxide undergoes during the process. The Committee observed that this nuisance is less in those works where effectual means of removing ammonia are employed prior to the passage of the gas to the oxide purifiers. Something also seems to depend upon the frequency with which the oxide is revivified. The oxide prepared by lime and sulphate of iron on removal from the purifiers contains also sulphate of ammonia and carbonate of lime, the reaction of which upon one another at the elevated temperature that accompanies the revivification produces further ammoniacal fumes with the

re-formation of sulphate of lime. The separation of ammonia then from the gas by Laming's oxide can only be effected at the expense of contaminating the atmosphere, and the production of nuisance, unless some precautionary measures be conjoined. These measures may consist partly in the careful removal of ammonia from the gas by sulphate of lime, muriate of manganese, &c., prior to its being submitted to the action of the oxide of iron. Mr. Evans, of the Chartered Gasworks (Horseferry Road), however, expressed an opinion to the Committee that the presence of ammonia in moderate quantity in the gas supplied was rather an advantage than the contrary to the consumer, asserting that it had the effect of neutralising the sulphurous acid formed during the combustion of the bisulphuret of carbon which the gas always contains. The presence of ammonia in the gas is also held by some gas-engineers to prevent the deposit of naphthaline in the smaller supply pipes. Other means of obviating the nuisance are the revivification of the oxide at shorter intervals than those adopted at some works, and the interception of the vapour that is given off. An arrangement for the latter object may be seen in operation at the Equitable Works (Pimlico), and at the Chartered (Horseferry Road). The oxide is placed in an open chamber, having a perforated iron floor, and air is drawn downwards through it; the air thus charged with ammoniacal vapour is carried into a chimney, and discharged at such a height as to obviate offence to the neighbourhood, or the ammonia it contains is condensed for commercial purposes. In this process the temperature sometimes rises so high as to cause ignition.

5. *Refuse of the wet lime purifiers.* When the cream of lime from the purifiers is stored in pits dug in the earth, or in tanks open to the atmosphere, the effluvia are most offensive, and commonly extend to a great distance around the works. The carbonic acid of the atmosphere also, acting upon the matter it contains, increases the evolution both of sulphuretted hydrogen and ammonia; and, no doubt, when proper tanks are not constructed, the soil in the neighbourhood also becomes contaminated. A partial remedy for this nuisance is obviously the use of water-tight covered tanks for the reception of the refuse. At the Phoenix Works (Vauxhall) and the London, the nuisance is completely remedied; and the method is deserving of imitation by all those companies which prefer the purification by wet lime. The refuse is received into a close chamber, and the hot air from the furnaces is made to pass beneath it, and then to play over the surface of the refuse in its passage to the chimney; in this way all the volatile matters are removed, and the refuse brought to a plastery consistence adapted for luting purposes.

6. *Refuse from the dry lime purifiers.* The effluvia from a dry lime purifier, when opened, in those instances where no means of separating ammonia, sulphuretted hydrogen, and other noxious products, are previously employed, are most offensive and overpowering. The mere opening and emptying of the purifiers may thus contaminate the atmosphere to a great distance around the works. The Committee is of opinion that the dry lime purification should never be allowed unless some effectual means of previously removing these compounds be in operation. At the Equitable Works (Pimlico) the dry lime from the purifiers possessed but little ammoniacal or offensive odour. When charged with offensive products it should not be exposed to the atmosphere, but conveyed from the works in covered receptacles. At the Western Gasworks (Kensal Green), where only cannel gas is made, the dry lime is distributed in the purifier into three compartments; the gas being sent first to that compartment which contains the lime that has been longest in use. It was stated by the foreman who accompanied the Committee over the works that the carbonic acid of the impure gas decomposes the sulphuret of calcium in this compartment, removing its offensive odour. The Committee had no opportunity of satisfying itself upon this point.

7. *The employment of the crude gas-tar for coating the gas-holders and iron work* was in some instances an obvious source of offensive odour. The Committee feels that something should be done to remedy this evil, and that an attempt should be made to discover some equally effectual preservative for the iron which shall not possess similar disadvantages.

Signed by the Committee,

EDWARD BALLARD, M.D. (Chairman),

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London,

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