Scottish Section.*Meeting held at Glasgow on Tuesday, 25th November, 1913.*

DR. THOMAS EWAN IN THE CHAIR.

NOTES ON NAPHTHALENE IN COAL GAS.BY JAMES MACLEOD, F.I.C. AND JAS. A. RUSSELL
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The data contained in this paper were collected by the authors during last summer (1913) at the Gas Works, Greenock.

Stoppages owing to the deposition of naphthalene in the service pipes, induced the Greenock Corporation to introduce into their works a Livesey washer for the purpose of eliminating naphthalene from the gas. The washer was placed between the purifiers and the station meter so that by the time the gas reached the washer it was freed from its principal impurities (cf. J. of Gaslighting, 1913, 123, 682).

Two oils were experimented with for use in the above washer; of these one was a shale oil (750 naphtha) and the other a coal tar distillation product, "Special solvent for naphthalene."

It is to be pointed out that these costs are based on the complete extraction of the naphthalene from the gas which is of course unnecessary as all that is required is to lower the naphthalene content sufficiently to prevent its deposition in the mains and service pipes.

Freezing experiments. "Special solvent for naphthalene." When a test tube filled with this oil was immersed in melting ice no naphthalene separated. When a sample of this oil saturated with naphthalene was treated in a similar way naphthalene began to separate in a few minutes and in a short time the contents of the test tube became solid.

From "750 naphtha" saturated with naphthalene large crystals of naphthalene separated after several hours' immersion in melting ice.

Taking all things into consideration it appears that the "Special solvent for naphthalene" is more suitable than the "750 naphtha." The following points may be noted:—The special oil is not so volatile and dissolves a larger quantity of naphthalene than the naphtha, and consequently when the special oil is used the work of renewing the oil in the washer is not required so frequently as when naphtha is used. The special oil, being a distillation product of coal tar, has little or no effect on the quality and nature of the tar when run into the tar well, whereas naphtha, being a paraffin product, alters the nature of the tar. There is not much difference in the relative costs of washing the gas per 1000 cub. ft.

	750 Naphtha.	Special oil.	
Colour	Water clear	Reddish	
Sp. gr. at 15° C.	0.750	1.000	
Distillation—Below 100° C.	17 per cent.	23.5 per cent. (1)	(1) Benzene, toluene.
100°—170°	66 per cent.	4.5 per cent.	
170°—185°	12 per cent.	63.5 per cent. (2)	(2) Phenols.
Residue	3 per cent.	6.5 per cent.	
Loss	2 per cent.	2 per cent.	
Naphthalene dissolved by 100 c.c. of oil	11 grains	20 grains	
Sp. gr. of saturated oil	0.780	1.000	
Amount of naphthalene dissolved by	11,573,888	21,043,434	(3) Capacity of washer at works is 1500 galls.
1500 gallons (3)			
Cost of oil per gallon	9d.	18d.	
" " 1500 gallons	13,500d.	27,000d.	
Vol. of gas saturated with naphthalene	70,145,000 c. ft.	127,536,000 c. ft.	(4) According to Schlumberger (this J., 1913, 76)
at 20° C. which can be washed by			coal gas saturated with naphthalene at 20° C.
1500 galls.			and 15° C. contains 16.5 grains and 10.9 grains
Vol. of gas saturated at 15° (4)	106,153,000 c. ft.	103,050,000 c. ft.	per 100 c. ft. respectively.
Cost of washing gas per 1000 c. ft.	0.154 (5)	0.188 (6)	(5) After allowing for oil run into tar well and
when gas is saturated with			sold as tar at 2.22d. per gall. and allowing a
naphthalene at 20° C.			loss of 20 per cent.
Cost when gas is saturated at 15° C.	0.102 (5)	0.125 (6)	(6) Allowing for a loss of 15 per cent. and oil sold
			as tar.

Tests during July, 1913.

Date.	Naphthalene. grs. per 100 c. ft.		Make of gas per ton of coal.	Temp. at condensers.		Temp. of atmosphere.	Vacuum at exhauster.
	Inlet of washer.	Laboratory.		Inlet.	Outlet.		
7—8	13.0	4.3	9,810	122	67	59	12.5
10—11	24.7	5.6	10,923	97	61	59	8.3
11—14	18.1	5.4	11,102	101	63	63	10
14—15	22.0	11.9	10,709	93	62	63	10
15—16	24.7	5.7	10,527	103	65	66	9.6
22—23	14.4	6.1	10,480	123	67	63	12
23—24	18.3	9.1	10,555	122	69	65	13
24—25	21.2	5.5	9,805	117	65	64	10.1
Average	19.7	6.7	10,493	100.7	64.8	62.7	10.7

NOTE.—20 gallons of special oil were added to the naphthalene washer on 9th, 15th, 18th, 24th and 28th.

Tests during August, 1913.

Date.	Naphthalene, grs. per 100 c.f.		Make of gas per ton of coal.	Temp. at condensers.		Temp. of atmosphere.	Vacuum at exhauster.
	Inlet of washer.	Laboratory.		Inlet.	Outlet.		
1—4	16.6	4.9	9,838	123	66	65	12.6
13—15	15.4	5.6	10,161	125	65	62	14
15—18	18.5	5.5	10,133	123	65	64	14
18—19	18.4	10.4	10,446	109	65	63	16
19—20	15.6	7.3	10,400	124	65	60	17
20—21	14.1	8.0	10,420	128	66	64	16.5
21—22	—	10.4	10,696	119	63	63	16.5
22—25	11.2	4.6	10,483	113	63	59	15.7
25—26	11.8	4.5	10,657	106	61	62	10
26—27	—	6.3	10,194	123	65	64	10.2
Average	15.2	6.7	10,352	110	64	62	14.2

NOTE.—30 gallons of oil were added to washer on 1st and 9th, 50 gallons on the 13th, 40 gallons on the 18th, 20 gallons of oil and some naphtha on the morning of the 22nd.

Average results of Tests.

Date.	Naphthalene, grs. per 100 c.f.		Make of gas per ton of coal.	Temp. at condensers.		Temp. of atmosphere.	Vacuum at exhauster.
	Inlet of washer.	Laboratory.		Inlet.	Outlet.		
July	19.7	6.7	10,498	109	64	62	10.7
August	15.2	6.7	10,352	119	64	62	14.2
Average	17.45	6.7	10,425	114	64	62	12.4

The method the authors used for estimating the amount of naphthalene in coal gas is as follows:—The gas was passed at the rate of about 0.7 cub. ft. per hour through a saturated solution of citric acid and then through a ten-bulbed absorption tube containing 2.6 grams of recrystallised picric acid and about 100 c.c. of water and finally through an experimental meter. The experiments were allowed to run overnight. The naphthalene picrate and picric acid in the absorption tube were washed into a 250 c.c. flask and heated to 40° C. on a water bath till all the picric acid had dissolved. After cooling the naphthalene picrate was filtered off and the amount of unused picric acid determined by titration with N/10 sodium hydroxide in 50 c.c. See Coleman and Smith (this Journal, 1900, 19, 128), Dickenson Gair (this J., 1905, 24, 1279), Jorissen and Rutter (this J., 1909, 28, 1179), and Schlumberger (this J., 1913, 32, 76).

Amount of naphthalene required to saturate a gas.

Temperature.	Grains per 100 cubic feet.	
°C.	I.	II.
0	6.0	2.0
5	9.8	3.2
10	14.1	6.7
15	19.0	10.9
20	24.6	16.5
25	30.9	24.7

I. According to Allen (this J., 1900, 19, 200).
II. According to Schlumberger.

If the figures given by Schlumberger are correct then the coal gas entering the naphthalene washer must have been supersaturated with naphthalene on several occasions; if, on the other hand, the figures obtained by Allen are accurate then the gas entering the washer has never been saturated.

On no occasion has the gas leaving the works been saturated with naphthalene. It was observed that on disconnecting the tube from the inlet of the naphthalene washer to the absorption apparatus some crystals of naphthalene had formed. It appears probable that Allen's figures are not quite accurate.

The greatest amount of naphthalene found in the gas entering the washer was 24.7 grains per 100 cubic feet, on July 15—16, and the lowest amount, 11.2 grains per 100 cubic feet, on August 22—25. The figures obtained for the naphthalene at the inlet of the washer during July were greater than those for August. The averages for these months were respectively 19.7 and 15.2 grains per 100 cubic feet.

The amount of naphthalene in the gas depends upon many factors and it is almost impossible to find any relations between the figures given in the tables. The amount of naphthalene depends first of all on the coal used in the retorts. Some coals especially the coking coals, seem to yield a gas rich in naphthalene. As naphthalene is a pyrogenetic substance the amount of it present in the gas will depend upon the temperature at which the coal is carbonized and also upon the time during which the gas remains in contact with the hot coke and walls of the retorts. The amount of free space in the retort has also a marked influence on the amount of naphthalene formed.

The rate at which the gas is cooled in the condensers seems to effect the naphthalene content of the gas. It is to be noted that during July the average cooling of the gas during its passage through the condensers was 44.9° F. and in August 55°, and during these months the amounts of naphthalene were 19.7 and 15.2 respectively. On July 7—8 the cooling amounted to 55° and the amount of naphthalene fell to 13.9 grains per 100 cubic feet. From the 9th to 22nd July the cooling at the condensers was not so efficient and there is an accompanying rise in the amount of naphthalene.

The dependence upon the rate of cooling is not general as is seen in the figures. However, the figures obtained seem to indicate that it would be well to let the gases enter the condensers as hot as possible and cool them there as effectively as possible.

An attempt has been made to correlate the amount of naphthalene in the gas with the vacuum at the exhauster. By keeping the exhaust low it was thought that perhaps less naphthalene would evaporate into the gas; on the other hand a strong exhaust would draw the gases away

from the retort more rapidly and so lessen the time during which the gas is in contact with the hot coke and the walls of the retorts.

One of the coals in use was considered to be the cause of some of the naphthalene trouble. Experiments were carried out in the coal testing plant with this coal with the following results.

The charge of coal consisted of 2 lb. of coal and the time of heating was one hour.

Temp. of retort	840° C.	360° C.	1040° C.
Vol. of gas per ton....	8,133 c. feet.	9,327 c. feet.	11,083 c. feet.
Wt. of coke per ton ..	12.5 cwt.	12.25 cwt.	12.25 cwt.

In none of the above cases was there any indication of naphthalene on passing the gas through a solution containing picric acid in suspension. In these experiments the gas was not long in contact with the hot coke and the cooling was very efficient. Lime was used in the purifying box. No tar was present in the gas on arrival at the holder. This is striking evidence of the elusive character of naphthalene, as naphthalene was generally troublesome when this coal was in use in the works.

The figures given in the tables indicate that there is some relation between the amount of naphthalene in the gas leaving the works and the daily temperature provided account is taken of the efficiency of the washer for any particular day.

Oil has to be added to the washer every few days. The results of the experiments show that the day after the oil has been added to the washer there is a decrease in the amount of naphthalene per 100 cubic feet. Thus on July 14--15 the amount of naphthalene leaving the works was 11.9 grains per 100 cubic feet; on the 15th oil was added to the washer and on the 15th--16th the amount of naphthalene fell to 5.7. Similar results are to be observed on July 24th and 25th.

During the period of the tests in August the amount of gas passed through the washer was 23,172,000 cubic feet. The amount of oil added in the same period was 170 gallons. The average weight of naphthalene extracted by the oil was 8.5 grains per 100 cubic feet. This gives a total quantity of naphthalene extracted of 1,969,620 grains, or 11,586 grains per gallon of oil used. Experiments

showed that the oil was capable of dissolving 14,000 grains per gallon. This extraction works out at an efficiency of 82.7 per cent.

It was meant to carry out experiments on the effect of back pressure or varying seal in the washer on the efficiency of the extraction, but this could not be undertaken although it is hoped to carry out tests at a future date. The naphthalene content of the gas has, as usual with the advent of colder weather, fallen to a very low figure and in any case tests would not have been exactly comparable with those done previously.

FIRST REPORT OF THE COMMITTEE ON THE NOMENCLATURE OF ALLOYS.

See under Class X. of the Journal and Patent Literature, page 318.

Obituary.

CHRISTOPHER CLARK HUTCHINSON.

The death occurred on March 7th from heart failure of Mr. C. C. Hutchinson, K.C., one of the founders of this Society.

Born in 1854, the second son of Mr. William Hutchinson of Burnside, Westmorland, he was educated at the Royal College of Science, Dublin, and soon afterwards became an engineer in partnership with the late Mr. S. H. Johnson. He served as an abstractor for the Society's Journal from 1885 to 1891, on the Publication Committee from 1891 to 1899, and on the Council from 1891 to 1895. He was called to the bar at the Middle Temple in 1896 and took silk in 1910. His experience as an engineer was of great service to him at the Parliamentary Bar, where he soon obtained a large practice. He drafted the Charter of Incorporation and By-laws of this Society.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—8d. each, to the Comptroller of the Patent Office, W. Temple Franks, Esq., Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56, Rue des Francs Bourgeois, Paris (3e.); Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

German.—1 mark each (with full particulars) to Kaiserlich Patentamt, Berlin, Germany.

I.—GENERAL PLANT; MACHINERY.

"Mammoth-pump"; Use of the — in chemical industry. K. Meerbach. *Chem.-Zeit.*, 1914, **38**, 274—275.

MAMMOTH or air-lift pumps are constructed in antimonial lead, stoneware, and ebonite, for lifting acid and alkaline liquids as well as for the transportation of gun-cotton suspended in liquids, and several have been installed for this purpose.—A. S.

Air; Moisture in compressed — [for pneumatic tools]. A. Hofmann. *Eng. and Min. J.*, 1914, **97**, 366—367.

To avoid condensation of the moisture in it, when compressed air is utilised in pneumatic tools it is advantageous first to cool the compressed air, and then to reheat it before it enters the tool.—T. St.

PATENTS.

Cooling, cleansing and drying gases; Apparatus for —. T. R. Wollaston, Manchester. *Eng. Pat.* 2114, Jan. 27, 1913.

THE gas passes downwards through a vertical conical chamber, the wide lower end of which terminates in a fluted comb partially immersed in a liquid seal. The washing liquid is sprayed into the top of the chamber. Owing to the increasing cross-sectional area of the chamber the speed of the gas steadily decreases, whilst that of the liquid particles remains almost constant. The washed gas passes between the teeth of the comb into an enclosing chamber, which may be provided with radial, vertical, fluted metallic strips, having ragged holes punched in them, or with other suitable means for