

Mr. WATSON SMITH, in reply to the observations made about the nitrous oxide process, said that it appeared to him to be a matter of logic,—that if only partial fusion, amounting to mere softening, could take place at certain temperatures very high up in the scale, and if no proper fusion took place, then there was no real chemical contact. He could not understand in such a case that a chemical change would entirely occur: it might, however, do so to a certain extent. It appeared to him to be an extremely interesting thing that the aqueous solution of these two salts should decompose at the low temperature referred to. From the dry mixture at 240° nitrous oxide came off somewhat slowly; but if nitrate of ammonia were there it would come off vigorously, tending to explosion. But that was not the case. In point of fact, if nitrate of ammonium were heated by itself at 215°, the evolution was as rapid as from the mixture heated to 240°. With regard to the hydroxylamine reaction suggested by Mr. Cross, he did not think that hydroxylamine itself would resist that temperature. If these things did not exist at the temperature given, he could not see that such a change would take place as one could reasonably show by an equation. It would certainly be a mixture of the elements of the substance; but he did not regard that as the substance itself, especially when one considered Berthelot's investigations on the seven different reactions possible on heating nitrate of ammonium. Referring to Mr. Cresswell's question, he believed that Schürmann had omitted aluminium and magnesium because they did not form sulphides under the same conditions as the other metals which he had included.

The results are as follow:—

JUTE.			
—	I.	II.	Mean.
Carbon	46·18	45·12	45·65
Hydrogen.....	5·83	6·33	6·08
Oxygen	47·99	48·27	48·27

COTTON-WOOL.						
—	A. and C.			B.		
	I.	II.	Mean.	I.	II.	Mean.
Carbon.....	42·66	42·16	42·41	42·73	42·47	42·70
Hydrogen	6·25	6·16	6·20	6·33	6·07	6·20
Oxygen	51·09	51·68	51·39	50·74	51·56	51·10

The jute contained 11·35 per cent. of moisture; samples A and C, 5·34; and sample B, 5·83 per cent. The moisture was estimated by drying over sulphuric acid for four weeks in a vacuum.

Although these bodies cannot be regarded as pure chemical individuals, it is interesting to compare the results of certain definite compounds with the results of their analysis. Those which most nearly approach the above composition are:—

—	C.	H.	O.
Pentosane or xylene (C ₅ H ₈ O ₂) ..	45·45	6·06	48·48
Cellulose (C ₆ H ₁₀ O ₂).....	44·44	6·17	49·38
Grape-sugar, C ₆ H ₁₂ O ₆	40·00	6·66	53·33
Starch (probably) C ₆ H ₁₀ O ₅ ...	43·63	6·26	50·10

These samples were distilled in the manner described in our first paper (this Journal, 1892, p. 395). As before, the gas was collected and analysed; and the distillate was separated into three portions, viz., weak acetic acid, crude methyl alcohol and tar.

The results are as follow:—

THE DESTRUCTIVE DISTILLATION OF WOOD.

BY JNO. C. CHORLEY AND WM. RAMSAY, F.R.S., F.I.C.

LAST May we brought before the Society the results of some experiments on the distillation of wood. We have followed up these researches by investigating the behaviour of compounds which have a greater claim to be considered definite. These are jute and cotton-wool.

The sample of jute was purified by boiling it in a dilute solution of caustic soda; the cotton-wool was of two qualities; the samples A and C consisted of crude wadding, while the sample B was purified wool, and is sold under the name of medicated cotton.

These substances were analysed without having been dried; they were afterwards dried and the analyses calculated on the dry material.

—	Jute.			Cotton-Wool.			
	I.	II.	A1.	A2.	B1.	B2.	C.
Weight in grms.....	71	73	45	60	67	45	50
Charcoal, per cent.....	28·71	32·87	33·33	30·00	31·33	3·44	33·00
Distillate	57·70	43·15	53·33	59·00	43·32	51·11	46·00
Carbon dioxide	Lost	12·33	6·66	9·33	5·22	7·77	11·00
Other gases.....	..	11·65	6·68	10·47	17·13	6·68	10·00
Vol. of gas, cc.	3,000	2,500	2,000	2,700	1,500	1,000	3,500
Vol. of gas from 100 grms.....	4,220	3,420	4,000	4,500	2,240	2,200	7,000
Composition of gas per cent.:							
Carbon monoxide	78·80	85·20	70·02	85·71	51·14	52·46	76·20
Oxygen.....	3·01	1·73	3·60	2·80	8·50	4·73	3·34
Residual gas.....	18·10	12·05	10·42	11·46	37·36	43·11	20·46
Tar, per cent.	14·78	0·85	..	8·33	0·70	13·33	12·09
Acetic acid	0·40	1·40	..	2·44	1·75	2·11	1·31
Methyl spirit .....	..	10·08	..	..	3·04	10·24	7·07

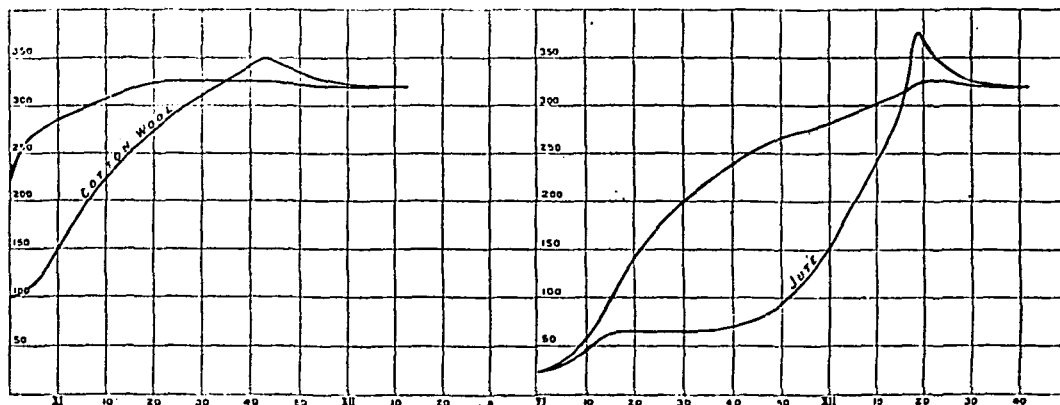
In contrasting these numbers with those obtained in distilling wood, it is to be remarked that the percentage of charcoal is considerably smaller than with such fibres; that of distillate smaller, and that of carbon dioxide larger than with wood. The acetic acid is very much less; and that of the impure mixture counted as methyl-spirit is particularly high, in almost every case.

In comparing jute with cotton wadding and with cotton wool, it appears that the chief difference between them lies in the amount of carbon monoxide which they yield. While jute and impure cotton wool give a gas containing as much

as 70 to 80 per cent. of this constituent, the pure cotton wool yields only a little over 50 per cent., the nitrogen and residual gas being correspondingly increased. We do not think that all of this increase can be accounted for by ascribing it to air present in the retort, though there is no doubt that some may thus be accounted for.

We next pass to the thermal behaviour of the fibres.

The best idea of the changes of temperature distillation is gained by a graphic representation of the temperatures of the bath, contrasted with those of the substance being distilled, time being taken as ordinates.



We give tables, however, showing the actual temperatures in the air-bath (outside temperatures), and of the fibre (inside temperatures), at different intervals of time during distillation, for crude cotton-wool, and for jute; the curves are a graphic representation of these numbers.

Cotton-wool.			Jute.		
Time.	Outside.	Inside.	Time.	Outside.	Inside.
10.50	230	100	11.15	100	63
55	270	115	30	200	63
11.00	285	150	15	255	80
05	295	190	12.00	278	150
20	323	275	03	292	200
25	324	295	10	302	210
30	324	310	15	312	295
35	324	323	17	317	328
40	325	310	18	321	375
43	325	318	19	323	372
45	324	315	20	323	365
50	322	333	25	322	310
55	320	326	1.00	317	320
12.00	319	322	..	..	..
05	319	319	..	..	..
1.15	325	324	..	..	..

With cotton-wool the temperatures are practically equal at 11.35. Eight minutes later the wool is 13° higher than the bath. In 17 minutes the temperatures are again practically equal. The whole rise and fall took place in 25 minutes.

With jute the temperatures may be considered equal at 12.16; at 12.18, the jute had a temperature no less than 54° higher than that of the bath; but the fall of temperature in this case was much more gradual; it was not until 1.00 that the temperatures were practically equalised.

Hence the rise is a very sudden one, occupying only two minutes, and I think that it will be allowed that this approximates to an explosion. Gas was evolved with great rapidity during this sudden rise of temperature, and it is perfectly evident that the exothermic reaction is a violent one.

With purified cotton-wool, there were no signs of an exothermic reaction. The whole operation appeared to be of the nature of an ordinary distillation.

The conclusion is therefore forced upon us that the substance which decomposes in this manner is not cellulose, but some substance which may be removed from woody fibre by solvents. It appears not to be the same substance as the one which yields acetic acid on distillation, for jute, which decomposes with such sudden evolution of heat, gives a minimum percentage of acid. Nor does it appear to accompany the mixture reckoned as methyl spirit in our table, for both jute and pure cotton-wool yield this distillate in considerable quantity.

Oak and beech wood therefore must contain some substances which yield acetic acid on distillation, and which is not (at least not wholly) the cause of the exothermic reaction which accompanies their decomposition. That substance has been removed in the purified wool, which yields a minimum quantity of acid; and with it the body which causes the exothermic reaction has also been removed.

The direction of further research is obvious; but circumstances have prevented the authors of this paper from continuing the investigation; moreover, the problem is in the hands of others. Messrs. Cross and Bevan are working with matters extracted from wood fibre by solvents, and Herr Flint and Tollens are engaged in determining the nature of the decomposition products of fibre (Berichte, 1892, 2916). From the labours of these chemists we may hope soon to obtain a satisfactory idea of the real constitution of different varieties of woods; and we are content to leave the subject in such competent hands, resting satisfied that if our experiments have contributed even a little towards the solution of such a complicated problem.

Only two points remain for mention. One is the striking circumstance that the percentage composition of xylene and jute are the same, viz., (C₈H₈O₄)_n. The other is the fact that products removed from cotton-wool during its purification appear to be the cause of the large amount of carbonic oxide in the gases evolved. For, while jute and impure cotton-wool yield amounts of gas varying from 3,420 to

7,000 cc. per 100 grms., purified wool yields only 2,200 cc. Moreover, the former yields gases consisting mainly of carbonic oxide (76 to 85 per cent.), while the gases from the latter contain little over 50 per cent. It is possible that some clue may be given by these observations to the particular mode of decomposition of the chemical constituents of the fibre.

DISCUSSION.

Mr. A. H. MASON wished to know whether the medicated cotton was pure cotton, as the substance was sometimes rendered impure in the process of manufacture by other combinations.

Mr. C. F. CROSS said that he had been engaged on this subject some years, and knowing that it was to fall into his hands, he had been fortunate in obtaining a gentleman to undertake the prosecution of this question of determining the reactionary agents, and also the variations in the products themselves. As they had been asked to place the subject before the Society at an early date they would endeavour to do so.

Professor RAMSAY said that he believed that what was known as medicated wool was practically pure cellulose, being cotton wool denuded of soda, acetic acid, &c.

Professor FOSTER said it was quite possible to get pure cellulose in the form of cotton wool. He had been surprised at its purity, for it burned clean away and left no acid residue.

The CHAIRMAN said that it was a matter of regret that Professor Ramsay and Mr. Chorley's paper was in a certain sense the final paper on the subject. While he was very glad to hear that Messrs. Cross and Bevan promised a contribution on the same subject, it did seem a pity that Professor Ramsay should drop it, as it seemed to him to provide an ample field for both, from which useful results might have been expected.

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Notices of Papers and Communications for the Meetings to be sent to the Local Secretary.

SESSION 1892-93.

Wednesday, December 7th. — Mr. Hubert L. Terry, F.I.C.
"Critical Notes on the Chemical Technology of India-Rubber."

Meeting held Wednesday, November 2nd, 1892.

MR. HENRY BRUNNER IN THE CHAIR.

CHAIRMAN'S ADDRESS ON ARTIFICIAL MANURES FOR FRUIT CULTURE.

(ABSTRACT.)

THE subject of fruit-growing for profit is one that has during the last few years had increasing attention drawn to it, partly owing to the hope that it may prove a means of bettering the condition of the land cultivator, and partly due to the growing demand for fruit as an article of food. From figures kindly supplied by Sir James Whitehead, Master of the Fruiterers' Company of London, it appears that the total area devoted to fruit culture in this country in 1891 was 268,700 acres. This would represent a value of 9,000,000*l.*, taking 30*l.* per acre as a low average value of the produce. In fruit-growing it may be taken that, roughly, one-fourth of the cost of production is due to the necessary supply of manure, and therefore it is evident that if a large proportion of the natural manure used be replaced by chemical manures, a considerable benefit to the chemical industry of the country will accrue. It appears that to-day the balance of opinion is against the total replacement of natural manures by artificial, but there is no doubt that a large proportion may be so substituted with advantage to the crop and with economy to the cultivator. The author's own experiments made with strawberries show that by employing chemical manures far less potash, phosphoric acid, and nitrogen is required per acre than is the case with ordinary farmyard manure, as owing to their soluble form they penetrate the soil more rapidly and deeply.

The requirement of an acre of land planted with apple trees would amount to about 20 tons of farmyard manure once in three years, whilst the necessary ingredients contained therein would be supplied by the yearly use of 500 lb. of kaimit (at 13.5 per cent. K_2O), 120 lb. of superphosphate (at 16 per cent. soluble P_2O_5), and 360 lb. nitrate of soda, or a total for the three years of 26 cwt. of material. From the above it is evident that in certainty of effect, in convenience of handling, and in distribution over the soil, chemical manures possess distinct advantages. The author does not recommend the complete discarding of farmyard manures, but rather the adoption of some system of rotation of manures such as that recommended by Wagner of Darmstadt for the cultivation of vines, in which farmyard manure is supplied in the first year and supplemented by chemical manures only in the second, third, and fourth years. It has been urged against chemical manures that they render the soil poorer in organic matter, whilst farmyard manure has the reverse effect, but it has been shown by Joulie that the more abundant harvests produced by the use of chemical manures leave a larger proportion of residues in roots and otherwise in the soil, and consequently that there is no impoverishment, but an increase in the quantity of organic matter in the soil.* By the use of chemical manures each ingredient can be adjusted to the requirements of the crops, which is obviously not the case with natural manures, whilst Ville has shown that more than one-third of the nitrogen contained in the latter is lost to the soil on account of the decomposition which the manure must first undergo before it can exercise its action.† The cost of carriage is also favourable to the employment of chemical manures. Superphosphate is the most suitable form of phosphoric acid for the fruit-grower, and it has the further advantage of supplying a considerable quantity of a soluble lime salt necessary for the building

* *Mercure Scientifique*, Supplément du *Moniteur Scientifique* June 1892.

† Ville on "Artificial Manures," trans. by W. Crookes, p. 105.