WOOD DISTILLATION.

By J. J. Sudborough and H. E. Watson.

PART III. The Distillation of some Mysore and Baroda Woods and of certain Waste Products.

With

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A. Mysore and Baroda Woods.

In an earlier paper (Part II) published in this Journal (Vol. II p. 107) the results of the destructive distillation of some 22 species of S. Indian woods were given.

In table I we give the results obtained with 23 other species of Mysore woods. In this table the results are all calculated on parts by weight per 100 parts by weight of moist wood, and in each case the percentage of moisture is given.

In table II the yields are recalculated on the basis of a moisture content of 15 per cent, and with these results are also incorporated those given in table II of Part II, recalculated to a moisture content of 15 per cent, and the whole arranged in alphabetical order.

In table III are given the results obtained by the destructive distillation of certain species of Baroda Woods, and in Table IV the results obtained with these woods are calculated on a basis of 15 per cent. of moisture and are compared with the results from the same species of wood grown in Mysore.

The apparatus and method of procedure was exactly the same as already described and the methods of analyses were the same.

Notes on the results :—

1. Most of the S. Indian woods distilled give lower yields of acetic acid and methyl alcohol than those obtained from the usual European and American hard woods.

This is clearly seen when the values in Table II are compared with those in Table V. This Table is an abstract of

TABLE I.

Destructive Distillation of Mysore Woods.

All figures refer to number of parts by weight obtained from 100 parts by weight of undried wood.

Botanical Name.	Vernacular Name.	Moisture.	Total distillate.	Charcoal.	Gas.	Acetic Acid.	Methyl Alcohol.	Tar.
1. Elaeodendron glaucum [Pers.] ...	Mukarthy ...	4.1	43·8	35·8	20·1	4·29	1.38	9·5
2. Pongamia glabra [Vent.]	Honge ...	5·8	43·7	33·8	22·5	3·86	1·41	8·7
3. Tamarindus indica [Linn.]	Hunse ...	13·4	45·2	32·5	22·3	3·42	1·64	11·0
4. Zizyphus xylopyrus [Willd]	Chetta [b] ...	7·8	46·2	36·0	17·8	3·41	1·21	9·3
5. Bauhinia racemosa [Lam.]	Kanchavala ...	11·0	46·2	39·4	14·4	3·34	1·13	8·9
6. Buchanania latifolia [Roxb.]	Mukki ...	10 0	40·7	36·9	22·4	3·19	1·29	9·4
7. Ixora parviflora [Vahl.]	Gorvi ...	10·3	42·4	34·1	23·5	3·09	1·13	7·7
8. Cassia fistula [Linn.]...	Kakke ...	11·0	42·5	38·8	18·7	3·02	1·41	9·7
9. Zizyphus xylopyrus [Willd.]	Chetta [a] ...	13·9	44·1	37·0	18·9	3·01	1·16	7·9
10. Careya arborea [Roxb.]	Kavalu ...	13·0	45·3	36·9	17·8	2·91	1·24	6·9
11. Gmelina arborea [Linn.]	Shiwane ...	11·0	48·4	31·4	20·2	2·84	1·09	7·7
12. Bridelia retusa [Spreng]	Goje ...	10·7	44·7	37·6	17·7	2·78	1·07	5·9
13. Bassia latifolia [Roxb.]	Hippe ...	9·3	43·7	33·5	22·8	2·76	1·02	6·7
14. Holoptelea integrifolia [Planch.]	Thapasi ...	6·4	37·1	37·0	25·9	2·57	1·16	7·8
15. Vitex altissima [Linn. f.]	Navaladi ...	8·0	38·8	37·0	24·2	2·56	1·21	9·1
16. Mangifera indica [Linn.]	Mavu ...	8·8	41·2	35·1	23·7	2·51	1·52	8·0
17. Diospyros Tupru [Ham.]	Thumare ...	15·8	41·6	35·4	23·0	2·49	1·28	5·7
18. Chloroxylon Swietenia [D. C.]	Huragalu ...	6·3	39·8	34·8	25·4	2·45	1·23	11·2
19. Saccopetalum tomentosum [Hk. f. & T.] ...	Oobaloo ...	7·0	41·6	29·8	28·6	2·40	1·10	6·2
20. Lagerstroemia parviflora [Roxb.] ...	Channangi ...	10·5	46·0	33·6	20·4	2·34	0·76	7·2
21. Holarrhena antidysenterica [Wall.] ...	Kodasiga ...	10·4	44·9	33·4	21·7	2·22	1·13	5·1
22. Albizzia amara [Boiv.]	Chujjlu ...	8·7	39·9	30·3	30·3	2·21	1·17	7·2
23. Acacia Catechu [Willd.]	Tari ...	21·8	39·7	35·7	24·6	2·13	1·01	4·6

Destructive Distillation of Mysore Woods.

All numbers refer to No. of parts by weight calculated on 100 parts of wood by weight containing 15 per cent. moisture.

	Botanical Name.	Vernacular Name.	Moisture in original wood.	Total Distillate.	Charcoal.	Gas.	Acetic acid.	Methyl alcohol.	Tar.
1.	Acacia catechu [Willd.] ...	Tari ...	21·8	34·5	38·8	26·7	2·32	1·10	5·0
2.	Adina cordifolia [Hk. f.] ...	Zettiga ...	19·1	50·9	30·5	18·7	2·67	1·46	8·4
3.	Albizzia amara [Boiv.] ...	Chujjlu ...	8·7	43·7	27·8	28·5	2·06	1·09	6·7
4.	Anogeissus latifolia [Wall.] ...	Dindiga ...	16·8	46·6	34·4	18·9	3·60	1·28	8·2
5.	Anthocephalus cadamba [Miq.] ...	Kadvala ...	16·2	43·2	36·2	23·6	2·57	1·50	7·0
6.	Bassia latifolia [Roxb.] ...	Hippe ...	9·3	47·2	31·4	21·4	2·59	0·96	6·3
7.	Bassia malabarica [Bedd.] ...	Huli Nelli ...	36·0	47·3	34·3	8·4	2·59	1·77	7·0
8.	Bauhinia racemosa [Lam.] ...	Kanchavala ...	11·0	48·6	37·6	13·8	3·19	1·08	8·5
9.	Bridelia retusa [Spreng] ...	Goji ...	10·7	47·0	35·8	16·9	2·65	1·02	5·6
10.	Buchanania latifolia [Roxb.] ...	Murki ...	10·0	44·1	34·8	21·2	3·01	1·22	8·9
11.	Careya arborea [Roxb.] ...	Kawalu ...	13·0	46·6	36·0	17·4	2·84	1·21	6·8
12.	Cassia fistula [Linn.] ...	Kakke ...	11·0	45·1	37·0	17·9	2·88	1·34	9·3
13.	Casuarina equisetifolia [Forst.] [Old]	Casuarina ...	24·0	44·6	31·3	24·0	4·12	1·29	6·9
14.	do [Young]	Do ...	32·4	43·6	32·9	23·4	3·35	1·42	7·7
15.	Chloroxylon Swietenia [D. C.] ...	Huragalu ...	6·3	45·2	31·6	23·0	2·22	1·12	10·2
16.	Dalbergia latifolia [Roxb.] ...	Beete ...	16·1	47·3	34·5	18·1	2·56	1·88	11·1
17.	Dillenia pentagyna [Roxb.] ...	Kanagal ...	16·8	46·2	35·6	18·2	3·18	1·26	7·0
18.	Diospyros Tupru [Ham.] ...	Tumare ...	15·8	41·0	35·7	23·3	2·52	1·30	5·8
19.	Elaeodendron glaucum [Pers.] ...	Mukarthy ...	4·1	50·3	31·7	18·1	3·80	1·22	8·4
20.	Eucalyptus globulus		18·1	47·3	27·2	25·5	3·36	1·39	5·4
21.	Eugenia Jambolana [Lam.] ...	Nerlu ...	21·4	41·1	34·7	24·2	2·70	1·01	5·8
22.	Garuga pinnata [Roxb.] ...	Godda ...	32·0	44·0	36·0	20·0	4·20	1·94	7·1
23.	Gmelina arborea [Linn.] ...	Shiwane ...	11·0	50·7	30·0	19·3	2·71	1·04	7·3
24.	Grewia tiliaefolia [Vahl.] ...	Thadasal ...	17·5	47·7	33·3	19·1	2·72	1·61	7·2
25.	Holarrhena antidysentrica [Wall.] ..	Kodasiga ...	10·4	47·7	31·7	20·6	2·11	1·07	4·8
26	Holoptelea integrifolia [Planch.] ...	Thapasi ...	6·4	42·8	33·6	23·5	2·33	1·05	7·0
27.	Ixora parviflora [Vahl.] ...	Gorvi ...	10·3	45·4	32·3	22·3	2·93	1·07	7·3
28.	Lagerstroemia lanceolata ...	Nandi ...	22·0	42·4	39·2	18·4	2·60	1·16	6·3
29.	Lagerstroemia parviflora [Roxb.] ...	Channangi ...	10·5	48·7	31·9	19·4	2·22	0·72	6·8
30.	Mangifera indica [Linn.] ...	Mavu ...	5·8	45·2	32·7	22·1	2·31	1·42	7·5
31.	Phyllanthus emblica [Linn.] ...	Nelli ...	17·0	48·0	34·3	17·7	3·00	1·29	5·8
32.	Pongamia glabra [Vent.] ...	Honge ...	5·8	49·2	30·5	20·3	3·48	1·27	7·8
33.	Pterocarpus marsupium [Roxb.] ...	Honne ...	26·1	39·3	35·3	25·3	2·76	1·44	6·3
34.	Saccopetalum tomentosum [Hk. f and T.]	Oobaloo ...	7·0	46·6	27·2	26·2	2·19	1·01	5·7
35.	Schleichera trijuga [Willd.] ...	Kendala ...	16·5	48·8	34·0	17·2	2·56	1·61	8·1
36.	Shorea talura [Roxb.]	Jalari ...	18·1	50·1	38·0	11·9	3·05	1·18	6·2
37.	Stereospermum suaveolens [D. c.] ...	Padri ...	15·0	49·8	30·9	19·3	3·06	1·84	10·0
38.	Tamarindus indica [Linn.] ...	Hunse ...	13·4	46·3	31·9	21·9	3·36	1·61	10·8
39.	Tectona grandis [Linn. f.] ...	Teak ...	19·5	51·5	33·0	15·4	2·99	1·42	9·4
40.	Terminalia belerica [Bedd.] ...	Tari ...	12·4	47·5	28·1	24·3	2·62	1·51	6·6
41.	Terminalia paniculata (Roth.] ...	Honnal ...	16·1	44·8	38·3	17·9	2·50	0·91	5·9
42.	Terminalia tomentosa [Bedd.] ...	Matti ...	20·8	39·2	38·8	28·1	2·23	1·13	4·9
43.	Vitex altissima [Linn. f.] ...	Navaladi ...	8·0	43·4	34·2	22·4	2·37	1·12	8·4
44.	Xylia dolabriformis [Benth.] ...	Jambe ...	11·2	42·6	40·2	17·2	2·35	1·12	4·7
45.	Zizyphus xylopyrus [Willd.] ...	Chetta [a] ...	13·9	44·8	36·5	18·7	2·97	1·15	7·8
46.	do. ...	[b] ...	7·8	50·4	33·2	16·4	3·14	1·12	8·6

TABLE III.

Distillation of some Baroda Woods.

All numbers refer to No. of parts by weight obtained from 100 parts of undried wood.

Botanical Name.	Vernacular Name.	Moisture in original wood.	Total Distillate.	Charcoal.	Gas.	Acetic Acid.	Methyl Alcohol.	Tar.
1. Anogeissus latifolia [Wall.]	Dhando ...	13·7	46·5	37·0	16·5	2·84	1·30	6·8
2. Acacia ferruginea [D. C.]		12·5	47·0	35·0	18·0	2·60	1·25	4·4
3. Adina cordifolia [Hk. f.]	Haladnan ...	20·0	50·6	29·7	19·7	2·56	1·37	6·0
4. Terminalia tomentosa [W. and A.] ...	Sadedo ...	11·4	41·2	35·3	23·5	2·55	1·12	4·8
5. Dalbergia latifolia [Roxb.]	Sisam	11·4	46·0	40·0	14·0	2·32	1·46	10·5
6. Stephegyne parvifolia [Korth.]	Kalan	12·2	41·5	31·6	26·9	2·28	1·31	11.9
7. Tectona grandis [Linn. f.]	Sag	12·0	38·2	30·3	31·5	2·27	0·93	7·6
8. Acacia Catechu [Willd.]	Khair	13·6	43·2	39·6	17·2	2·11	1·05	6·0

TABLE IV.

Comparison of Mysore and Baroda woods of same species.

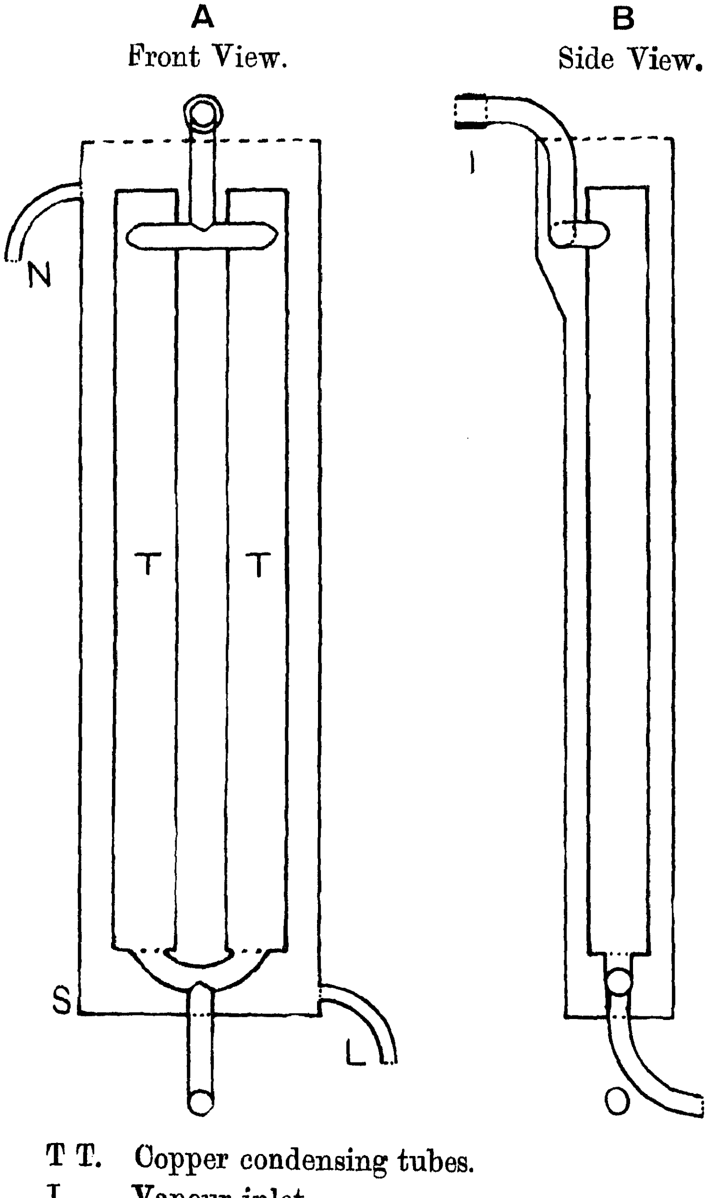
All numbers refer to No. of parts by weight calculated on 100 parts of wood containing 15 per cent. moisture.

1, Acacia catechu [Willd.] Baroda ...		13·6	44·1	39·0	16·9	2·08	1·03	5·9
Do do Mysore ...		21·8	34·5	38·8	26·7	2·32	1·10	5·0
2. Adina cordifolia [Hk. f.] Baroda ...		20·0	47·5	31·6	20·9	2·72	1·46	6·4
Do do Mysore ...		19·1	50·9	30·5	18·7	2·67	1·46	8·4
3· Anogeissus latifolia [Wall.] Baroda ...		13·7	47·3	36·4	16·3	2·80	1·28	6·7
Do do Mysore ...		16·8	46·6	34·4	18·9	3·60	1·28	8·2
4. Dalbergia latifolia [Roxb.] Baroda ...		11·4	48·2	38·4	13·4	2·23	1·40	10·1
Do do Mysore ...		16·1	47·3	34·5	18·1	2·56	1·88	11·1
5 Tectona grandis [Linn. f.] Baroda ...		12·0	40·3	29·3	30·4	2·19	0·90	7·3
Do do Mysore ...		19·5	51·5	33·0	15·4	2·99	1·42	9·4
6. Terminalia tomentosa [W. and A.] Baroda.		11·4	43·6	33·9	22·5	2·45	1·07	4·6
Do do Mysore ...		20·8	39·2	38·8	28·1	2·23	1·13	4·9

FIGURE I.

Pyroligneous acid condenser.

SCALE 2″=1′



T T. Copper condensing tubes.
I. Vapour inlet.
O. Condensed liquor outlet.
L. N. Cooling water inlet and outlet.
S. Iron water jacket.

Table V given in Part II (This Journal *2*, 118) and gives the results for laboratory experimnts and the values are all calculated for woods containing 15 per cent. of moisture.

2. Two woods, *viz. Bridelia retusa* and *Gmelina arborea* (Nos. 9 and 23 in Table II), gave extremely thick tars or emulsions of tar and pyroligneous acid. The result was that the condenser used, *viz.* a Brown's Double Surface Condenser with only a small annular space, became choked and gaseous pressure was developed within the still with the result that leaks at several joints occured. In distilling such woods we found it. advisable to use a different type of condenser, a diagram of which is given in Fig. 1.

3. In Table IV is given a comparison of the results obtained from the same species of wood grown in Mysore and Baroda, and all calculated on a 15 per cent. moisture content.

The results show considerable differences and, as a rule, the yields of acetic acid and methyl alcohol from the Baroda are less than from the corresponding Mysore woods.

TABLE V.

Name of wood.	Source.		Charcoal.	Acetic acid.	Methyl alcohol.	Tar.
Oak,	England	...	30·7	4·60	1·34	12·5
do,	America	...	29·8	4·35	1·13	5·4
do.	Germany	...	34·7	4·08	...	37
do.	England	...	25·6	4·93	1·09	6·6
Beech	America	...	32·6	4·43	1·66	8·4
do.	do	...	35·8	4·98	1·59	8·8
do.	Germany	...	26·7	5·21	...	5·8
Maple	America	...	31·3	4·17	1·72	10·7
do.	do	...	39·6	4·48	1·64	10·1

B. MISCELLANEOUS WOODS AND WASTE PRODUCTS.

Table VI gives the results obtained by distilling such materials as (a) Cocoanut shells (b) Wattle wood (c) Myrobalam kernels (d) Mahua waste (e) Sur-reed (f) Husks of gold mohur pods (g) Bamboo.

(a) *Cocoanut Shells.*

It is well known that on destructive distillation cocoanut shells yield high percentages of acetic acid. In a note in the Bulletin of the Imperial Institute (1916, XIV, 569) it is stated

TABLE VI.

Distillation of Miscellaneous Woods and Waste Products.

All numbers refer to No. of parts by weight obtained from 100 parts by weight of undried wood.

Botanical name.	Name.	Moisture in original wood.	Total distil-late.	Charcoal.	Gas.	Acetic Acid.	Methyl Alcohol.	Tar.
Pinus longifolia (Roxb.)	Chir	6·8	57·7	26·7	15·6	1·59	0·37	33·0
Cocos nncifera	Cocoanut shells	7·6	41·7	38·3	20·0	6·29	1·22	6·3
Acacia decurrens	Wattle	27·1	51·9	28·7	19·4	4·28	1·44	5·3
" ...	Wattle	7·7	49·3	32·0	18·7	5·57	1·31	9·8
Phragmites	Sur Reed	8·5	35·4	39·0	25·6	3.82	0·59	5·5
Terminalia chebula	Kernels of Myrobalams	10·6	41·8	40·7	17·5	4·24	0·80	6.9
Poinciana regia	Gold Mohur husks	9·0	36·0	39·0	25·0	4·06	1.09	6·4
Bassia longifolia	Mahua waste	7·3	22.6	46.0	31·4	0·80	0·47	6·4
	Bamboo	12·8	43-5	36·0	20·5	3·78	1·44	6·9

The above results have been recalculated to a common basis of 15 per cent. moisture

	Chir	6·8	61·5	24·3	14·2	1·45	0·34	30·4
	Cocoanut shells	7·6	46·4	35·2	18·4	5·79	1·12	5·8
	Wattle	27·1	44·0	33.5	22·5	4·99	1.68	6·2
	Wattle	7·7	53·3	29·5	17·2	5·13	1.21	9·0
	Sur Eeeds	8·5	40·0	36·2	23·8	3·55	0·55	5·2
	Kernels of Myrobalams ...	10·6	44·7	387	16·6	4·03	0·76	6-6
	Gold Mohur husks	9.0	40·2	36·4	23·4	3·79	1.02	6·0
	Bamboo	12·8	44·9	35·1	20·0	3·69	1·40	6·7

that experiments made in Ceylon show that the shells distilled in Ceylon yield a pyroligneous acid containing 8—12 per cent. of acetic acid.

A. H. Wells, Phil. J. Sci. A. 1917, XII, 117, gives the following values as the average results of five experiments, using a final temperature of 550°C. The numbers represent parts by weight calculated on 100 parts by weight of moisture free shells :—

Pyroligneous distillate		...	41·3
Settled tar	...	...	6·9
Dissolved tar	...	...	3·2
Gas	...	...	16·2
Charcoal	...	...	32·5
Acetic acid	...	...	6·31
Methyl alcohol	...	...	1·0

In S. W. India where the copra industry is of considerable magnitude the utilisation of the various by-products to tbe best advantage is a problem of some importance. The shells constitute such a by-product. At present they are used as fuel, but the possibility of collecting large quantities of shells, subjecting them to destructive distillation, for the production of glacial acetic acid and methyl alcohol and using the shell-charcoal as fuel is worth consideration.

The quantities of shells available can be gathered from the following figures:—

The average export of copra from West Coast ports is from 26,000 to 30,000 tons per annum.

As a rale 1000 tons of nuts (without husks) produce 192 tons of dry shells and 440 tons of meat from which 266 tons of copra can be obtained. These are the values for Philipine nuts and as West Coast nuts are smaller, *e. g.* 7000 produce one ton of copra, the ratio shell to meat would be higher. It may be assumed, therefore, for rough calculation that the weight of shells is practically equal to the weight of copra.

The amount of shells produced annually is therefore about 25,000 tons which would supply a factory with about 100 tons a day working 250 days in the year.

The chief difficulty would be the collection of sufficient shells to run a factory and the subsequent disposal of the shell charocal. Much of the copra is produced by small manufacturers and the collection of shells would be tedious and the freight charges on bringing the shells to a central distillation factory and also on the distribution of the shell-charcoal might be high.

If it were possible to obtain at one centre some 3,600 tons of shells, this would mean about 12 tons per day. As a ton of shells occupy about the same space as a ton of ordinary wood, one still 45′x6′ would take the daily output.

The yields would be about 1·1 tons of grey acetate of lime and 0·14 ton (= 25 gallons) of methyl alcohol a day.

The advantage such a factory would have over a factory using ordinary S. Indian woods would be the high concentration of the acetic acid in the pyroligneous acid *viz.* about 13 per cent. and hence diminution of costs in redistilling the acid and in evaporating the solutions of acetate of lime. The shells also do not need prolonged drying, as do most green woods. After felling, these contain as much as 40 per cent. of moisture and should, as a rule, be air dried until they contain from 10 to 15 per cent.

As shown in part IV, the distillation of cocoanut shells has the further advantage that the tar obtained can yield crystallised phenol and also a wood cresote, the latter, however, is not quite up to the standard of the United States Pharmacopoeia.

In Table VII results are given for slow and fast distillations. In the slow distillation the time occupied for distilling about 100 lbs. of shells was 6·5 to 7·5 hours and in the rapid distillation about 5·5 hours. The maximum temperatures were respectively 390—420° and 400—500°.

The values do not show very marked agreement, but on the whole the yields of acetic acid and methyl alcohol are rather higher in the slow distillations,

(b) *Wattle Wood.*

Plantations of *Acacia decurrens* exist in the Nilgiris, and a company is utilising the bark for the production of tannin extracts. After removal of the bark large quantities of timber—estimated at about 200,000 tons annually—will be available and several distillations have been conducted in order to determine the yields of acetic acid, methyl alcohol and tar from such wood.

TABLE VII.

Distillation of Cocoanut Shells.

All results are percentages on undried shells.

	Moisture.	Total Distillate.	Charcoal.	Gas.	Acetic Acid.	Methyl Alcohol.	Tat.	Time in hours.
(1) Blow ...	11·3	45·1	35·7	19·2	6·08	1·54	8·48	6·5
(2) fast ...	11·0	46·5	31·6	21·9	6·90	1·40	7·81	5·5
(8) slow ...	10·3	40·6	35·3	24·1	5·15	1·45	7·5	7·25
(4) fast ...	10·0	43·4	32·2	24·4	4·90	1·36	7·84	5·5
(5) fast ...	12·0	43·3	32·5	24·2	4·90	1·40	6·92	5·0
(6) slow ...	11·2	45·2	36·3	18·5	5·83	1·39	7·40	
(7)	11·5	42·8	34·0	23·2	5·00	0·66	8·56	...
(8)	11·6	43·1	33·7	23·2	5·65	0·92	5·36 (settled taly).	...
(9)	11·2	43·9	36·7	19·4	5·62	0·96	7·08	...

TABLE VIII.

Analyses of Samples of Charcoals.

Name.	Moisture.	On dry charcoal. Volatile matter.	Sulphur.	Ash.	Calorific power in calories.	C.	H.
1, Wattle ...	1·5	23·2	0·106	1·62	7560		
1 Pongamia glabra ...	41	31·9	0·063	4·50	6830	77·3	41
8. Holoptelia integrifolia	4'0	24·8	0·105	6·3	6920		
4. Vitex ftlfcJBBima ...	5·0	26·5	0·065	8.6	7240		
5. Elaeodendron latifolia	4·3	31·7	0'082	3·0			
6, Buchanania latifolia,	3·2	30·2	0·021	4·0	6840	76·1	3·6
7, Tectona grandis ...	4-8	23·5	0·053	8·6	7000	76·4	3·7
8. Dalbergia latifolia ...	4·7	28·0	0·074	5·2	7050	77·3	4·8
9. Terminalia tomentosa.	3·2	28·1	0117	9·7	6635		
10. Anogeissus latifolia.	81	32·0	0·070	12·2	6280		
11. Stephegyne parviflora.	4·7	23·4	0·090	3·28	7340		

Small scale experiments have previously been made with S. African Wattle wood (Bull. Imp. Inst., 1916, *14*, 666). The results are given in column 1 of the following table :—

	S. African.	Nilgiri. (a)	Nilgiri. (b)
Acetic acid ...	4·7	4·99	5·13
Methyl alcohol ..	1·2	1·68	1·21
Tar (settled) ..	6·0	6·2	9·0
Charcoal ...	27·0	33·5	29·5

The amount of moisture in the S. African wood is not stated.

The results we have obtained are given side by side with the values for the S. African wood but calculated on a basis of 15 per cent. moisture. Under (a) are given the results for a wood which contained 27 per cent. of moisture when distilled, and under (b) the results with a wood containing only 7·7 per cent. of moisture.

On the whole the values are higher than for the 8. African wood and it is interesting to note the high value for methyl alcohol obtained with a comparatively moist wood *viz.* one containing 27 per cent, of moisture.

The results prove that from the point of view of yields the Nilgiri Wattle wood is one eminently suited for destructive distillation and compares favourable with ordinary European and American hard-woods.

(c) *Myrobalam Kernels.*

At present large quantities of myrobalams (*Terminalia chebula*) are exported for use in the tanning industry, either directly or after conversion into extracts. In order to save freights the question of producing extracts in India and exporting the extracts has been raised. As myrobalams contain 34 per cent. of tannin and many extracts under 50, the saving in freight is not appreciable.

As the kernels are practically free from tannin the separation of these from the flesh before exportation or conversion into extract would be an advantage and we have carried out two experiments with such kernels in order to ascertain their value as materials for destructive distillation.

The numbers given in Table III show a high yield of charcoal, a fairly good yield of acetic acid (4·24 per cent or 4·03 per cent. based on a 15 per cent. moisture content) but only a poor yield of methyl alcohol.

(d) *Gold Mohur Husks.*

After removal of the seeds from the dry pods of the Gold Mohur Tree (*Poincianaregia*) the husks were subjected to destructive distillation. The yields of acetic acid and methyl alcohol were quite good when compared with ordinary S. Indian Woods.

(a) *Mahua Waste.*

In the fermentation of Mahua flowers (*Bassialongifolia*) for the production of alcohol a residue known as Mahua Waste is obtained. Samples of this were dried and briquetted and subjected to destructive distillation. The charcoal blocks obtained were friable as the original briquettes had not been subjected to a sufficiently high pressure.

The yield of by-products indicate that the material is of little or no value from the point of view of destructive distillation.

(f) *Sur-reed.*

The experiments were made with a species of Phragmites obtained from Bombay Presidency.

(g) *Bamboo.*

AH large quantities of bamboo are available in India we carried out a few distillations with old bamboo which had been used for scaffolding purposes and was comparatively dry. The yields of acetic acid and methyl alcohol compare favourably with those from many of the jungle woods examined.

0. CHARCOALS.

Table VIII gives the results of the analyses of a few of the samples of charcoal obtained from different species of wood and in Table IX are collected results taken from a paper (Forest Bulletin No. 1, 1911) by Puran Singh on calorific values and ash contents of certain Indian timbers.

TABLE IX.

Percentages of Ash in some Indian Woods and Charcoals.

Names of trees.	Per cent of ash in wood.	Per cent of ash in charcoal
Acacia catechu	0·78	2·58
Adina cordifolia	1·25	3·12
Anogeissus latifolia	1·76	
Bridelia retusa	1·24	
Buchanania latifolia	2·06	
Cassia fistula...	1·10	
Casuarina equisetifolia	1·28	
Chloryxylon Swietenia ...	1·70	
Dalbergia latifolia		4·53
Eugenia Jambolana		3·08
Garuga pinnata	2·20	
Gmelina arborea	2·51	
Holoptelia integrifolia	1·25	
Lagerstroemia parviflora ...	2·82	2·90
Pterocarpus marsupium ...	0·55	2·75
Tectona grandis	0·80	2·60
Terminalia bellerica	2·28	5·07
Terminalia tomentosa	2·10	
Xylia dolabriformis	2-65	

*Another samples 8·92.

The results are all given for air dried samples and the percentage of moisture in woods was about 11 per cent (10-14·7) and in charcoals about 6 per cent.

The greater number of the species of timbers were grown near Dehra Dun. U. P.