

Yorkshire Section.

Meeting held at Bradford on Monday, Jan. 20, 1908.

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THE ANALYSIS OF TURPENTINE OILS.

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Light hydrocarbons appear to be almost the sole adulterants used for commercial turpentines. Pine oils and pinolins, by-products obtained in the manufacture of rosin oil, are as powerful solvents of oils and resins as the best turpentine. As these are largely composed of volatile terpenes, their use for ordinary commercial purposes can scarcely be condemned; for pharmaceutical use their presence in turpentine is objectionable, as they act more powerfully on the skin and cause considerable inflammation. As Valenta has stated, mere shaking of the oil with half its volume of a solution of 6 per cent. of iodine in carbon tetrachloride and subsequent heating in a water bath for one minute will give a dark green colour if pinolins are present.

Polarimetry.—On account of the presence of varying amounts of levo and dextro-rotatory pinenes in pure turpentines, polarimetric methods are of very little service.

Refractive index.—We find that the Abbé refractometer and, within a certain range, Zeiss's butyrosrefractometer give invaluable aid in the analysis of turpentines. Pure turpentines from various sources give refractive indices of 1.470 to 1.473 at 15½° C., while hydrocarbon adulterants yield figures varying from 1.41 to 1.46 at 15½° C.

Specific gravity.—The specific gravity furnishes an indication almost as valuable as the refractive index; but it is not as easily applicable to very small amounts of liquid.

Specific refractivity.—There is no special advantage in using the Lorentz and Lorenz formula $\frac{n^2 - 1}{n^2 + 2}d$ over

that of Gladstone and Dale, $\frac{n-1}{d}$, for the specific ref activity factor. (n =refractive index and d =sp. gravity.) Compared with turpentine the lighter hydrocarbons show both lower densities and refractivities, on this account the division of the latter by the former diminishes the difference between the specific refractivities of these two classes of bodies; hence we do not find the specific refractivities of service in the analysis of commercial turpentines.

We obtain:—

—	Specific gravity at 15½° C.	Refractive index at 15½° C.	Specific refractivity.	
			Gladstone formula.	Lorentz formula.
Pure turpentine (average) ..	0.86436	1.47334	0.5476	0.3190
Petroleum ..	0.80192	1.44474	0.5547	0.2824

We have before us two adulterants, A and V, and mixtures of these with a pure turpentine:—

	Specific gravity at 15½° C.	Refractive index at 15½° C.	Specific refractivity.
A. Petrol	0.7447	1.4174	0.5605
V. Petroleum	0.82114	1.4505	0.5559
10 per cent. "A" plus 90 per cent. turpentine	0.85237	1.46775	0.5488
27.75 per cent. "V" plus 72.25 per cent. turpentine	0.85237	1.46885	0.5500

It is therefore evident that while these two physical factors enable us to discover the fact, they do not enable us to find the amount of hydrocarbon adulterant with any degree of accuracy. To deal satisfactorily with such mixtures it is necessary to resort to fractionation.

Fractional distillation.—We have tried different forms of apparatus and have got good results with Young's rod and disc still-heads, while the Glinsky form has proved troublesome. By using a flask of about 500 c.c. capacity, and with a side tube, for 100 c.c. of the turpentine we obtain sufficiently good results for ordinary work. The large empty space and even the thermometer stem, fixed a little below the opening into the side tube, serve to condense portions with higher boiling points. Any residue boiling at over 200° C. should be transferred to a very small flask with side tube for final fractionation. We have tried distillation in a current of dry carbon dioxide but have obtained no advantage. The vapours which rise in the ordinary course of procedure speedily and completely drive off all air, and no appreciable amount of oxidation can occur.

The following table shows our results from the distillation of American "Daylight petroleum":—

Temp. ° C.	Volume per cent.	Sp. gr. at 15½° C.	Refractivity at 15½° C.		n-1 d.
			Abbé.	Butyrosrefr.	
126.7—137.8	2.6	0.7147	1.4174	under 0	0.5605
—149.1	7.2	0.7502	1.419	"	0.5585
—154.6	3.6	0.7548	1.4211	"	0.5579
—161.0	3.4	0.7580	1.4229	2.0	0.5579
—165.4	3.0	0.7618	1.4255	4½	0.5584
—171.1	2.8	0.7652	1.4276	6½	0.5587
—176.7	2.4	0.77135	1.42866	8½	0.5579
—182.2	2.4	0.77236	1.4308	11½	0.5577
—187.8	2.72	0.7704	1.4333	14½	0.5579
—193.3	3.0	0.7818	1.4363	18½	0.5570
—198.9	2.0	0.78504	1.4380	20½	0.5578
—204.5	2.8	0.7872	1.4392	22	0.5578
—210.0	2.0	0.79236	1.4414	25	0.5570
—215.6	2.64	0.79599	1.4431	27½	0.5566
—221.1	2.2	0.79851	1.4441	28.6	0.5560
—226.7	3.8	0.8008	1.4450	31	0.5572
—232.2	1.72	0.80655	1.4483	34½	0.5556
—237.8	2.64	0.80856	1.4495	36	0.5556
—243.3	3.76	0.81188	1.4514	38½	0.5512
—248.0	0.4	not estimated.	1.4538	42	—
—254.4	1.4	0.82063	1.4550	45	0.5555
—260.0	2.0	0.82114	1.4565	46	0.5559
Over 260 C.	38.72	0.83044	1.4655	50½	0.5605

An American turpentine oil similarly distilled gave the following figures:—

Temp. ° C.	Volume per cent.	Sp. gr. at 15½° C.	Abbé.	Butyrosrefr.	n-1 d.
157—160	74.4	0.8651	1.4719	69	0.5453
—165.5	10.6	0.8663	1.4739	72½	0.5470
—171.1	2.8	0.8690	1.4765	77	0.5482
—176.7	0.96	—	1.4777	79	—
—182.2	0.40	—	1.4797	82½	—
Over 182° C.	1.84	—	1.5036	—	—
Itself	—	0.86844	1.4728	71	0.5438

The turpentine oil only commenced to distil at 157° C., and between this point and 171° C., 96.8 per cent. had passed over into the receiver.

90 parts by volume of the turpentine were mixed with 10 parts by volume of the petroleum and the mixture was fractionally distilled:—

Temp. ° C.	Volume per cent.	Sp. gr. at 15½° C.	Abbé.	Butyrosrefr.	n-1 d.
126.1—140.1	0.24	0.8101	1.4307	18.3	0.5198
—154.6	0.28	0.8506	1.4545	43	0.5352
—161	30.00	0.8590	1.4685	64	0.5453
—165.4	47.00	0.8629	1.4704	67	0.5452
—171.1	8.88	0.8632	1.4717	69	0.5464
—176.7	3.88	0.8636	1.4726	70½	0.5471
—182.2	2.00	0.8654	1.4726	70½	0.5460
—187.8	1.32	0.8649	1.4723	70	0.5460
—193.3	0.80	0.8647	1.4721	69½	0.5458
—198.9	1.72	0.8639	1.4719	69½	0.5462
Over 198.9	3.28	0.8626	1.4873	66	0.5458
Itself	—	0.8626	1.4873	68	0.5458

It requires little more than a superficial glance to see that the sample is shown by the results of distillation

to be adulterated with hydrocarbons. 1.472 is the lowest refractivity for a distillate from genuine turpentine, whereas over 80 per cent. of the distillate had to come over before this figure was reached in the case of the above mixture. The distillates from the petroleum, the turpentine, and the mixture may be briefly summarised:—

	Percentage distilling under 171.1° C.	Sp. gr. at 15½° C.	Abbé.	Butyro refr.	n—1 d.
Turpentine	96.8	0.8660	1.4725	70.1	0.5451
Petroleum.	22.6	0.7551	1.4216	below 0	0.5584
Mixture ..	87.8	—	1.4698	66.1	—

Our calculations in regard to this adulterated article are complex, and are based on the following factors:—

Distillates at °C.	Refractive indices at 15½° C.			Percentages found.		
	Petroleum.	Turpentine.	Mixture.	Distillates.		Petrol in sample.
				Turps.	Petrol.	
126—154.	1.418	1.472	1.4403	41.5	58.5	0.31
—161	1.423	1.472	1.4685	03.0	7.0	2.10
—165	1.4255	1.474	1.4704	02.6	7.4	3.53
—171	1.4270	1.4765	1.4717	00.0	10.0	0.80
—198.0	1.4334	1.4780	1.4720	87.0	13.0	1.27
Over 198.0° C.	1.46	1.40	1.4873	01.0	0.0	0.30
				Total 8.40		

A curious feature is noticeable in the distillates from 154° to 198.0°:—approximately 10 per cent. of these on the average consists of petroleum. The loss or error of 1.6 per cent. is inconsiderable when the difficulties of the case are remembered.

Samples of petroleum and turpentine differing from the ones used in the mixture just described were mixed in the proportions of 10 per cent. and 90 per cent. respectively. In order to test the method suggested by Vèzes (this J., 1903, 1106), we obtained the distillates in fractions of one-fifth. 100 c.c. of the sample on fractionation gave:—

Volume per cent.	Temp. °C.	Refractive index at 15½° C.	Dis-persion.
a few drops	16—40.11		30.0
2.0	46.1—148.0	1.46321	30.7
5.0	148.0—155.6		
5.0	155.6—156.0		
8.0	156.0—157.2		
B. 20.0	157.2—158.3	1.46935	30.7
C. 20.0	158.3—158.8	1.47041	1.4705
D. 20.0	158.8—165.5	1.47115	30.3
E. 10.0	165.5—182.2	1.47180	1.4752
10.0 residue over	182.2	1.47875	

Vèzes bases his method on the differences of the refractive indices of the distillates obtained in fifths.

Let D represent this difference and Dd the difference between the refractivities of E and C:—D=(E minus C) (5th and 3rd distillates). X=percentage of foreign substances. D=0.0032+0.0037x.

Naturally A to C are scarcely affected, while C to E are considerably influenced by resin or rosin oil. The gasoline class of adulterants will naturally affect A and B Petroleum, while affecting all the distillates, will most strongly influence E. With the differences from A to C, Vèzes asserts that the quantity of each adulterant may

be found from $\delta - \frac{0.0007}{x} = P$, where δ is the observed difference C and A, and x is a factor dependent upon the nature of the adulterant used.

Substance.	x.
Petroleum	0.0002
"White spirit"	0.0080
Light petroleum	0.0025
Benzene	-0.0000
Carbon bisulphide	-0.0046

According to Vèzes, unadulterated turpentine gives for x, nil to 0.001, whilst also the value for D is not greater than 0.0125, and the initial boiling point is not lower than 150° C. To test this method we tried to distil turpentine and petroleum in fifths, but we were not surprised to find ourselves confronted with certain difficulties. 5½ per cent. of residue was left by the turpentine, and we could see that at 200° C. and over, this did not distil, but began to decompose. We were only able to distil 36 per cent. of the petroleum under 205° C. (400° F.) and it appeared that a higher temperature only served to slowly split up the residual hydrocarbons. 100 c.c. of the turpentine gave us:—

	C.c. per cent.	At °C.	Refractive Index at 15½° C.	Differences.
nil.	16	-155.5	
20.0	155.5	-157.0	1.47054
20.0	157.0	-158.0	1.47108
20.0	158.0	-160.0	1.47147
20.0	160.0	-162.0	1.47203
14.0	162.0	-165.5	1.47322
0.0 residue over	165.5		1.48046

Instead of a difference of 0 to 0.001 for (C—D), we find a difference of 0.00093: showing a close agreement. The petroleum (100 c.c.) gave:—

	C.c. per cent.	At °C.	Refractive index at 15½° C.
10.0	120.6	-155.5
10.0	155.5	-162.7
10.0	162.7	-182.2
0.0	182.2	-205.0
0.0 residue over	205.0	

The first 20 per cent. deducted from the second 10 per cent. showed a difference in the refractive index of 0.01212. This figure is in strange disagreement with Vèzes' 0.0002. As gasoline is more amenable to this kind of treatment we obtained the following figures:—

	C.c. per cent.	At °C.	Refractive index at 15° C.	Differences.
20.0	21.1	-37.8	1.36271
20.0	37.8	-40.1	
20.0	40.1	-54.5	1.36393
20.0	54.5	-69.4	1.37053
14.0	69.4	-93.3	1.37925
0.0 residue over	93.3		1.39333

The gasoline itself had a refractive index of 1.37604.

Here the differences are so variable that no definite factor is calculable. (C—A)=0.00782 with the gasoline, 0.00093 with turpentine, and 0.02749 with 10 per cent. of gasoline in turpentine. Such results are quite impossible for calculation purposes.

The use of solvents.—The British Pharmacopœia says that oil of turpentine "is soluble in its own volume of glacial acetic acid"; but it omits all reference to temperature. On a cold day glacial acetic acid will dissolve only half as much turpentine as on a warm summer's day; moreover such strong acid, and within a range of 10° C., would fail to detect a large adulteration with petroleum. The most useful strength of acetic acid is represented by a mixture of 99 volumes of the glacial acid with one volume of water. In spite of apparently useful results obtained under certain conditions, we have been obliged to abandon the method on account of its unreliability, even in cases where the turpentine has been made to contain as much as 20 per cent. of petroleum.

The use of acetic acid as a solvent for oils and fats is well known in the application of the Valenta test, which, however, gives results as temperatures demarcating clearness from turbidity. As with fatty oils, so with

turpentine, the temperature has an enormous influence upon the solubility in acetic acid. A mixture of 5 c.c. of the turpentine with 3 c.c. of a mixture of 99 vols. of glacial acetic acid and one vol. of water, giving a clear solution at temperatures above 36° C., was heated in a stoppered vial for 2 hours at 99° C.

	Pure turps.	10 per cent. petrol.	Differences.
Turbid at °C.	20½	35	5½
Clear at °C.	30	35½	5½

A mere fraction of a degree made all the difference between turbidity and clearness. As a qualitative method the Valenta test under strict conditions may be of some service.

Alcohol.—Mixtures of alcohol with small amounts of water when shaken with adulterated turpentine give separations no more satisfactory than those obtained with acetic acid.

Chemical methods.

Iodine absorption.—A. McGill compares the Hanus and Hübl methods of obtaining the iodine value in regard to turpentine and their adulterants (this J. 1907, 847). We agree with McGill that the Hübl is preferable to the Hanus method for this class of compounds. However, the circumstances governing the method are not thoroughly understood, and the variations in the same sample are so large that the method is somewhat unreliable for calculation. Nevertheless, as the iodine value (Hübl) of pure turpentine is approximately 370 per cent., while that of petroleum may vary from nil to 20 per cent., it is evident that the test is of some service in turpentine analysis. In conjunction with physical data the iodine number is of great value.

Thermal values.—The action of bromine upon turpentine is so violent that one must use some solvent that is miscible with turpentine and petroleum in order to dilute the bromine. 4 per cent. of bromine by volume (about 12 per cent. by weight) was dissolved in carbon tetrachloride. 2 c.c. of the oil were mixed with 2 c.c. of this solution, and the following elevations of temperature were noted :—

Turpentine.	Petrol.	°C.
100	—	26.7
90	10	23.3
80	20	23.1
50	50	22.5

The differences are too small to be of value.

As petroleum gave variable thermal values, we sought for some reagent which would exert no action whatever on saturated hydrocarbons, and even upon such olefines as are usually found in these liquids, while at the same time it should produce an appreciable amount of heat constantly with terpenes. We thought we had found such a substance in antimony trichloride. A thermometer with a specially small and spherical mercury bulb was used. The mixture of the powdered salt with a fluid presented difficulties, and we did not get uniform results until we used a platinum tube charged with mercury as a protecting and conducting medium for heat to the thermometer bulb. 1 gm. of finely powdered antimony trichloride is rapidly weighed and introduced into a stout glass tube (of these tubes a large number ought to be obtained exactly identical in all possible respects). The platinum tube containing mercury and having a delicate thermometer immersed, is then introduced, and by means of a twisting action, the antimony trichloride is caused to form a thin layer in the lower parts of the glass tube. After a few moments the temperature is noted (the whole being packed in a beaker with some non-conducting material). A quantity of the turpentine to be examined is obtained at the same temperature, 2 c.c. are rapidly added, and the increase of temperature noted, a twisting action being maintained during the

whole of the experiment to facilitate the action. The increase in temperature in degrees C. is what we designate as the "antimony trichloride value." Tested in this manner petroleum give absolutely no value, whereas a pure turpentine gave 47.3 in four consecutive occasions. Unfortunately for the utility of the test, we have met with an undoubtedly genuine turpentine which gave an antimony trichloride value of only 22.8. Moreover this turpentine gave the same iodine absorption as a sample having an antimony trichloride value of 47.2. It is evident that a turpentine may contain bodies reactive to Hübl's iodine reagent and not to antimony trichloride. A ratio of from 100 to 104 in the iodine absorption cannot account for a ratio of 100 to 207.3 for the antimony trichloride value.

A table showing the influence of the addition of petroleum to turpentine upon the antimony trichloride value is here given :—

Per cent. petroleum.	Sp. gr. at 15½° C.	Refraction.		Antimony trichloride value. °C.
		Abbé.	Butyro.	
nil	0.807095	1.4728	71	47.4
2.5	0.86796	1.4710	69½	46.0
5.0	0.86608	1.4710	68	44.4
10.0	0.86252	1.4697	66	42.1
15.0	0.85932	1.4685	64	39.4
20.0	0.855428	1.46725	62	35.8
25.0	0.8521	1.4650	60	32.5
30.0	0.84502	1.4646	58	28.4
35.0	0.84544	1.4633	56	26.3
40.0	0.841896	1.4619	54	23.9
45.0	0.83832	1.4608	52.3	22.3
50.0	0.8350	1.4595	50.3	18.8
55.0	0.83156	1.4582	48.3	16.1
60.0	0.82842	1.4572	46.0	13.6
65.0	0.8250	1.4550	45	13.3
70.0	0.82128	1.4545	43	12.5
75.0	0.81706	1.4533	41.3	10.0
80.0	0.81484	1.4520	39.5	8.0
85.0	0.81136	1.4510	38	6.4
90.0	0.80908	1.4495	36.1	4.2
95.0	0.80504	1.4483	34.3	2.05
100.0	0.80110	1.4469	32.0	nil.

We have worked out a correction for variations in the temperature with regard to the refractivity of turpentine, petroleum, and mixtures for the Abbé refractometer :— One degree C. increase in temperature over 15½° C. decreases the refractive index by 0.00048 for turpentine, 0.00043 for petroleum, and 0.00045 for mixtures of equal parts.

Polymerisation.—Several methods have been suggested for the conversion of terpenes into their polymers while leaving hydrocarbons unaffected. Strong sulphuric acid appeared to give desirable results; but after close investigation we found that : (1) Pasty masses of polymers holding hydrocarbons in solution were formed. (2) It was impossible to make even a reasonably good separation of any hydrocarbons which have escaped chemical action.

We cannot endorse the results obtained by J. M. McCandless (J. Amer. Chem. Soc., 1904, 981—985), who re-purifies by fuming sulphuric acid and steam distillation until the turpentine is eliminated; this point being determined by refractometry.

How the fractional distillation combined with refractometry works out will be evident from the following examples :—

A mixture of turpentine with 10 per cent. of petroleum.

Temp. °C.	Volume. per cent.	Sp. gr. at 15½° C.	Refr. index at 15½° C.	Hübl iodine value.	Antimony trichloride value.
147-150	0.84	0.85053	1.4636	277.6	—
-160	52.40	0.8618	1.46824	318.9	44.0
-170	34.00	0.8646	1.47074	331.3	46.00
-180	3.00	0.8581	1.47154	280.9	37.8
-190	1.80	0.8558	1.46948	222.5	33.4
-200	1.04	0.8532	1.46788	180.3	23.4
-220	1.00	0.84982	1.46578	11.0	13.3
Residue	5.32	0.88408	1.48228	63.0*	1.3

* High figure due to resinoids.

A mixture of turpentine with 50 per cent. of petroleum.

Temp. °C.	Volume per cent.	Sp. gr. at 151° C.	Refr. Index at 151° C.	Hübl iodine value.	Antimony trichloride value.
130-150	2.28	0.8208	1.449575	200.0	23.0
-160	21.36	0.8376	1.456875	247.3	27.2
-170	26.44	0.8494	1.463175	291.3	31.4
-180	14.40	0.8496	1.464275	318.9	29.7
-190	4.40	0.8456	1.463075	214.5	24.3
-200	2.02	0.84007	1.46170	153.4	16.0
-220	3.20	0.83338	1.4590	78.58	4.0
-230	2.40	0.82985	1.4381	35.43	nil.
Residue	22.60	0.8556	1.4714	116.8	nil.

The composition of the turpentine following was unknown to the analyst. 100 c.c. on distillation gave:—

	C.c. per cent.	At ° C.	Refractometry at 151° C.
(a) ...	20.0	155—159	1.46385
(b) ...	10.0	—163	1.46638
(c) ...	25.0	—166	1.46671
(d) ...	10.0	—168	1.46746
(e) ...	10.0	—177	1.46744
(f) ...	10.8	—191	1.46580
(g) ...	1.0	—200	1.46452
*Residue	11.0	over 200	1.46594

* Residue, minus 1.0 c.c. for turpentine non-volatile residue plus 14.23, gave a total of 24.23 per cent. petroleum. The actual amount present was 24.00 per cent.

Calculating, we get from turpentine to 177° C. at 1.472 and petroleum to 177° C. at 1.43. Above 177° C. turpentine at 1.473 and petroleum at 1.44, *e.g.*, distillate (a):— x = per cent. turpentine, y = per cent. petroleum. (1) $x + y = 100$. (2) $1.472x + 1.43y = 1.46385 \times 100$, hence $x = 80.5$ per cent. of turpentine and $y = 19.5$ per cent. of petroleum.

Distillate.	Petroleum.	
	Per cent.	On sample.
(a)	19.5	3.90
(b)	13.5	1.35
(c)	12.5	3.12
(d)	15.0	1.50
(e)	21.0	2.10
(f)	14.8	1.60
(g)	57.0	0.57
		14.23

DISCUSSION.

Mr. F. W. BRANSON asked if it would not be advantageous to use a double-walled vacuum tube in place of the platinum tube in the antimony trichloride test, in order to secure greater accuracy. The fractionation test would often reveal what nothing else would. By means of the polarimeter he had detected turpentine in rosemary oil, but when the instrument was in the hands of the adulterator the latter could avoid detection.

Mr. T. FAIRLEY said that as turpentine was liable to oxidation the boiling point must vary within certain limits. In old turpentine a large proportion of substances of high boiling point was present. He asked if antimony pentachloride would not be better than the trichloride for the heat test, since as a liquid it could be more readily mixed. It would probably be necessary to reduce its violent action, as in the case of bromine, by the addition of some solvent. He believed Mr. Archbutt used bromine in carbon tetrachloride solution and found he could get useful results by limiting to a definite period of time—about half an hour. Where large quantities of the commodity were used it was necessary to have some means of detecting variations in quality. In heat tests the method of mixing was of importance. For instance, by rubbing together vigorously many oils in a large mortar with concentrated sulphuric acid the sulphonic derivative was obtained with very little darkening, without evolution of sulphur dioxide, and the temperature did not rise as in the case where the oil was oxidised and much sulphur dioxide evolved.

Mr. G. W. SLATTER said he thought the fractionation test was the most valuable. The antimony trichloride test, judging from the results obtained in the paper, appeared to be useless. He thought the addition of liquids when other than petroleum would add to the difficulty of testing turpentine substitutes.

Mr. H. G. BENNETT was rather surprised that Mr. Richardson preferred the Hübl method to the Hanus method for determining iodine values. In his experience temperature affected very slightly determinations made by the latter method. The use of bromine and tetrachloride apparently depended on a time factor and would therefore probably yield a method more empirical than could be desired.

Dr. L. L. LLOYD said the antimony trichloride test might be affected by the position of the double bond in the structural formula for turpentine. There would be a difference between the double bond in the nucleus and that in the side chain. Turpentines from different sources contained different terpenes and therefore the method would have to be tested with pure terpenes. He did not think the nitric acid test was a convenient one, and it was necessary to dilute the terpene before testing.

Mr. J. H. WRIGHT asked if the terpenes were not a case of isomerism. He had tested twice distilled turpentine by the polymerisation process and could never get more than 19 per cent. from mixtures which he had made up containing 20 per cent. of turpentine. He did not see how any one process could be used alone, but taking the specific gravity, Hübl's iodine absorption, and refractive indices for comparison seemed to be the only way of arriving at the truth.

Mr. RICHARDSON, in reply, said he had thought of a double walled vacuum tube in the antimony trichloride test, but it was scarcely worth while, since the iodine values of two turpentines might be the same whilst the antimony trichloride test gave entirely different numbers for each. With regard to the method used for obtaining the iodine value, McGill said that Hübl's method was preferable for turpentine, and he found it worked well for the class of adulterant used. Young's still-head was the best for fractional distillation. It was simple and easily cleaned, but an ordinary distilling flask was good enough for rough work. He had tried the nitric acid process and did not recommend it. He had got over the difficulty of fumes by dissolving the turpentine in glacial acetic acid and pouring it down a funnel into a special apparatus, but could not get good results. The nitric acid oxidised both the turpentine and petroleum, and nitroterpenes were formed which dissolved some of the petrol. He had only been able to get 8 or 9 per cent. from mixtures containing 20 per cent. of petroleum. He did not recommend the polymerisation process with sulphuric acid, since the polymerised bodies appeared to dissolve unpolymerised bodies. The terpenes were isomerides and possibly some of these compounds had peculiar characteristics depending on the nature of their side chains. If other liquids were added to turpentine the difficulty of detection would depend on their nature. Such an addition as that of methylated spirit or wood naphtha would be easily removed by water and use of a centrifuge.

Obituary.

JOHN EVANS.

PRESIDENT SOCIETY OF CHEMICAL INDUSTRY,
1892-1893.

Sir JOHN EVANS, K.C.B., F.R.S., was born in 1823, at Britwell Court, Buckinghamshire. He was educated by his father, the Rev. Dr. Arthur Benoni Evans, sometime headmaster of the Grammar School, at Market Bosworth, in Leicestershire. Later he was sent to Germany to study the language as a preparation for his business career. As a result of this varied training, he became an accomplished classical scholar, distinguished antiquary, and an eminent man of science, but he was not destined for an academic career. Through the family connections of his mother, John