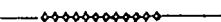


vessels. This was very curious. And again at Woolwich, the oil had been exposed to a tropical temperature, and after prolonged cooling, one does not see why the oil should go back to the original flashing point, because much of this hydrocarbon must have been given off. Of course, if the oil were kept in closed vessels, that would explain it.

Mr. MACMILLAN enquired whether a short exposure to, say, 32° is equivalent to a prolonged exposure to a medium temperature in bringing back the oil to its original flashing point.

Professor ANEL, in reply, said: I am afraid I cannot give a very satisfactory answer to the first enquiry, excepting that it is a fact that when an oil is exposed for some considerable time to a lower pressure or to a higher temperature, in a closed vessel of such construction as to yield sufficiently to external pressure, it has a tendency to flash at a lower temperature when afterwards tested. The tendency of the more volatile portions of these oils, under normal conditions, is to escape as vapour; that tendency is undoubtedly increased when we apply heat, and decreased as the temperature becomes lower. It seems to me that if the oil accumulates heat by preservation of the closed vessels containing it in a warm atmosphere, it is equivalent to rapid exposure to a higher temperature. When an oil, perfectly closed up, is exposed for some considerable time to a higher temperature, the volatile portions have obviously a greater tendency to escape than before, when the oil is afterwards exposed. The fact that time is required to develop the full influence of variation in atmospheric pressure is not, perhaps, at present susceptible of very lucid explanation. With regard to the question whether a short exposure to a very low temperature is equivalent to a prolonged exposure to a medium temperature, so far as the experiments have gone, a short exposure to a low temperature does not appear to have the same effect as a prolonged exposure to a comparatively higher temperature; that is to say, I do not think a very short exposure to 32° would have the same effect as a prolonged exposure to 50° Fahr. in bringing back the oil to its original condition. I speak with some reserve, because the subject is still under investigation.



Read June 6th, 1882.

TURPENTINE, ITS NATURE AND ADULTERATIONS.

BY PROF. HENRY E. ARMSTRONG, PH.D., F.R.S.

IN the course of investigations on the terpenes, camphor and allied compounds, in which I have been engaged during several years past, the opportunity has occurred of gradually collecting a number of data which probably are of sufficient technical value to find a place in *The Journal of the Society of Chemical Industry*.

Thanks to the kindness of my friend Mr. E. Phillips, of Messrs. Ingall, Phillips and Co., I was enabled to examine average samples of most of the cargoes of turpentine landed by his firm during the years 1877 to 1880, and thus to obtain a clear insight into the character of the commercial article. The high price of turpentine during the past few seasons has undoubtedly led dealers here to adulterate it, and it was to be feared that shippers might not uniformly resist temptation; therefore, at the request of the above-mentioned firm, since the beginning of last year, I have regularly tested all cargoes landed at their wharves.

The crude resinous exudation, formerly known as "turpentine," is no longer an article of commerce in this country, the obviously rational course being nowadays adopted of separating it into its constituents, "spirit of turpentine" or "turpentine oil" and rosin. On this account the name "turpentine"—*vulgar* "turps"—is now commonly employed as synonymous with the longer appellation, spirits or oil of turpentine, and it is in this sense that the term is employed in the paper.

The commercial varieties of turpentine mainly consist of hydrocarbons of the formula $C_{10}H_{16}$, of which certainly three distinct classes may be distinguished—viz., *terpenes*, *citrenes* and a third of which *sylvestrene*, the characteristic constituent of Russian turpentine, is the type. Under *terpenes*, I include those varieties which boil at about 156° C.; under *citrenes*, those which boil at about 176° to 178°, such as are the chief constituents of the oils derived from various species of *citrus*.

French Turpentine.—It is generally stated that French turpentine is the produce of a single species of conifer, *Pinus maritima*. It certainly is of remarkably uniform quality, judging from the almost constant rotatory power of samples which I have had occasion to examine at various times, and probably the properties of the terpenes of which the French oil mainly consists are not very different from those of the commercial article. Using any the form of polarimeter which admits of the observation being made in monochromatic light—it is, perhaps, well to note that the Soleil form cannot be employed for the examination of turpentine—and operating with a 200mm. column, the value of α_D is on the average about - 60° to - 61°.

American Turpentine.—American turpentine is said by Hanbury and Flückiger (*Pharmacographia*, 1st ed.) to be chiefly the produce of the swamp pine (*Pinus Australis*), this and the loblolly pine (*Pinus taeda*) being, they say, the most important sources of turpentine.

The following particulars regarding the separation of the hydrocarbon from the crude resinous exudation will probably be of interest. I am indebted for them to Dr. Thomas F. Wood, of Wilmington, N.C.; they were written at the request of Mr. Charles Rice, American editor of the *Pharmacographia*:—

"Turpentine is distilled in copper stills now. Formerly iron stills were used. All crude turpentine is distilled with water. A fifteen-barrel still (barrel weighs 280lbs.) is charged early in the morning. Gentle heat is first applied until the mass is liquified, and a coarse wire skimmer is used to remove the chips, bark, leaves and such other foreign substances as rise to the surface, the temperature meanwhile rising until 316° F. is reached. All the accidental water (that contained in the crude turpentine as it comes from the forest) having been distilled off, a small stream of cold water is now let in, so that the heat is kept at or below 316° F., the boiling point of oil of turpentine. The oil of turpentine and water now come over, and the mixture is caught in a wooden tub. The distiller tests the quality of the flow from time to time in a proof-glass, and the distillation is continued until the proportion of water coming over is nine of water to one of oil of turpentine. At this stage the heat is withdrawn, the still-cap is taken off, and the hot rosin is drawn off by a valvular cock at the side of the still near the bottom. This rosin passes through a strainer before it reaches the vat, to rid it of foreign substances which may not have been previously removed by the skimmer. The yield of oil of turpentine from 'virgin dip' (the first exudation from a newly-boxed tree) is about 5 gallons to the barrel, about 20 per cent. being left in the

rosin,* since the removal of a larger proportion would darken the colour, and consequently depreciate its value. The yield from 'yellow dip' (the runnings of the second and subsequent years) is about four gallons to a barrel. The yield from 'scrapings' (the inspissated gum from the tree facings) is about two to three and a half gallons according to age, and also to the proportion of trash which it contains."

The separation of turpentine by what is practically a steam distillation process, serves to explain the fact which, until I received the above information, had often surprised me, that the commercial article is uniformly free from products of the decomposition of rosin by heat.

Some idea of the importance of the turpentine industry will be gathered by inspection of the following table, representing the number of barrels imported into London since 1872:—

1873	41,195	1878	56,221
1874	57,720	1879	42,960
1875	57,664	1880	59,619
1876	57,371	1881	63,721
1877	49,500	1882	57,189

Probably about two-thirds of the entire quantity sent to this country is landed in London.

In so far as general properties are concerned, there is no practically distinguishable difference, other than in colour, I believe, between various samples of the commercial article, but tested by the polarimeter they vary considerably.

The chief port of shipment is Wilmington, and most of the turpentine from this port, like that from Bordeaux, is of remarkably uniform quality. Thus out of 35 samples, representing in all cases bulks of several hundred barrels, and in a number of cases bulks of from 1,000 to 2,000 or more barrels, no less than 28 samples varied in rotatory power (value of a_D per 200mm.), only within the very narrow limits of $27^{\circ} 6'$ to $28^{\circ} 35'$; four samples had an inferior rotatory power of $24^{\circ} 29'$ to $26^{\circ} 40'$, and only three had a superior rotatory power of respectively $29^{\circ} 31'$, $31^{\circ} 21'$, and $32^{\circ} 38'$.

That shipped from Savannah, on the other hand, is, as a rule, characterised by a relatively low rotatory power, e.g.:—

Ex. 1,569 brls.	$a_D = 22^{\circ} 21'$	Ex. 1,696 brls.	$a_D = 19^{\circ}$
Ex. 1,000 "	$a_D = 24^{\circ} 9'$	Ex. 1,870 "	$a_D = 20^{\circ} 33'$
Ex. 1,383 "	$a_D = 20^{\circ} 22'$	Ex. 1,200 "	$a_D = 21^{\circ} 21'$
Ex. 1,571 "	$a_D = 19^{\circ} 39'$	Ex. 1,595 "	$a_D = 19^{\circ} 12'$

In the case of the last of these shipments I had the opportunity of taking five samples, each representing about one-sixth of the bulk, which gave the following values:— $21^{\circ} 4'$, $21^{\circ} 19'$, $18^{\circ} 13'$, $17^{\circ} 38'$, and $20^{\circ} 6'$. I have not been able to ascertain whether the turpentine shipped from Savannah is the produce of a different tree, or whether the difference in climate between the two districts, of which Wilmington and Savannah are "centres," is the cause of the marked variation from what may be termed the Wilmington type. I trust that the publication of this paper may, as one result, lead to my being favoured with information on this point.

Judging from the opportunities which have presented themselves for examining turpentine shipped from Charleston, the deliveries from this port would appear to comprise turpentines of somewhat high rotatory power, as well as those of the Wilmington and Savannah types:—

Ex. 1,000 brls.	$a_D = 30^{\circ} 21'$	Ex. — brls.	$a_D = 19^{\circ}$
— " "	$a_D = 30^{\circ} 38'$	Ex. 1,874 "	$a_D = 26^{\circ} 42'$
Ex. 250 "	$a_D = 33^{\circ} 33'$	Ex. 1,886 "	$a_D = 29^{\circ} 39'$
Ex. 1,689 "	$a_D = 28^{\circ} 15'$	Ex. 200 "	$a_D = 24^{\circ}$
Ex. 2,179 "	$a_D = 24^{\circ} 15'$		

* The fact that the whole of the hydrocarbon is not removed accounts for the statement sometimes made, that "rosin spirit" is optically active, that made from pure rosin, according to my experiments, being inactive.

Other parts also furnish a somewhat irregular product; the values, however, always lie within those already given, and in the majority of cases belong to the Wilmington type, Brunswick alone exhibiting a marked tendency to furnish a product of the Savannah type.

Commercially, I believe, no distinction is made between the turpentine shipped from various American ports, nor indeed is French turpentine, which is now a comparative rarity in the English market, regarded as having distinctive qualities. My observations on the whole justify this practice: French turpentine is slightly less readily oxidised, absorbing oxygen somewhat less rapidly than American turpentine, but the difference is probably insufficient to make itself felt in practice.

RUSSIAN TURPENTINE.—Commercially this variety is of no importance, as it cannot well be used in paint or varnish making, both on account of its unpleasant odour and of the extreme readiness in comparison with French or American turpentine with which it absorbs oxygen, forming a viscid oil; its vapour appears also to produce far more marked physiological effects than either of the ordinary oils, inciting violent headache in many individuals. It is the produce of *Pinus sylvestris*, but I have not been able to ascertain whether the turpentine is specially collected, or is a mere bye-product. According to one account which I have received, the waste timber is piled into heaps and a fire lighted; the resinous matter which drains away is then collected and the turpentine extracted from it by distillation.

Different samples are remarkably different in their optical character, as the following numbers show:

a_D (per 200mm.) =	$36^{\circ} 29'$	$44^{\circ} 11'$	$40^{\circ} 42'$
	$36^{\circ} 7'$	$41^{\circ} 0'$	$46^{\circ} 45'$
	$34^{\circ} 18'$	$35^{\circ} 28'$	$30^{\circ} 4'$
	$38^{\circ} 58'$	$30^{\circ} 42'$	$37^{\circ} 5'$
	$32^{\circ} 27'$	$35^{\circ} 20'$	$42^{\circ} 10'$
	$31^{\circ} 20'$	$38^{\circ} 6'$	$39^{\circ} 52'$
	$34^{\circ} 8'$	$45^{\circ} 10'$	$36^{\circ} 10'$
	$39^{\circ} 58'$	$38^{\circ} 4'$	

Excepting the first four, all these samples were drawn from single barrels, and were obligingly furnished to me by Mr. Kingzett.

Russian turpentine has been shown by Tilden (*Chem. Soc. Trans.* 1878-80) to consist of a peculiar $C_{10}H_{16}$ hydrocarbon, the so-called *Sylvestrene* of Atterberg (*Ber.* 10, 1202), and of an isomeric substance possessing the character of American turpentine. *Sylvestrene*, according to these authors, has a *specific* rotatory power of (a_D) = $19^{\circ} 5'$ (Atterberg), $19^{\circ} 6'$ (Tilden), that of the associated hydrocarbon being $36^{\circ} 3'$ (Atterberg). In confirmation of the assumption that one of the constituents of Russian turpentine is probably identical with the main constituent of American turpentine, I may mention that I have separated from the latter by fractional distillation a portion having a rotatory power per 200mm. of no less than $39^{\circ} 34'$, and that on several occasions, by submitting American turpentine to air oxidation, and afterwards distilling off the unaltered hydrocarbon by steam, I have obtained products of considerably higher rotatory power than the original oils. I have also examined several samples received from Mr. Kingzett of the hydrocarbon carried over by the air current during the air oxidation of Russian turpentine. In most cases these have been almost free from *sylvestrene*, and have exhibited a higher rotatory power than the original crude turpentine from which they were derived.

The numbers above given fluctuate within wide limits, and are of interest as indicating that the proportions in which the two recognised constituents of Russian turpentine are present probably vary con-

siderably, and also that other perhaps isomeric hydrocarbons are mixed with them; they serve to confirm the idea that American turpentine is also a mixture of isomeric hydrocarbons. I may add that certain observations even lead me to think it not unlikely that the low dextrorotatory power of American turpentine is due to the presence of a levorotatory terpene; this would serve to explain the difference in optical character of products from different localities. The comparative study of American turpentine—and indeed generally of oils containing $C_{10}H_{16}$ hydrocarbons—from this point of view, I think deserves attention; variations in climatic and other conditions may have led to a gradual differentiation both in botanical and physiological character of a single parent stock.

Method of Analysis.—The terms "petroleum spirit" and "petroleum oil" as commercially used do not admit of very precise definition; for the purpose of this paper, I would therefore define petroleum spirit as being that portion of crude petroleum which may be volatilised by means of steam from water boiling at atmospheric pressure, and petroleum oil as being the non-volatile portion. Judged by this definition, commercial spirit and oil are, as a rule, more or less mixtures; the amount of spirit in the best burning oils is, however, small.

The presence of petroleum oil in turpentine is readily detected and the amount estimated by steam distilling. Unless it has been freely exposed to the air for a long time, but a mere trace of viscid matter remains on steam distilling turpentine; on one or two occasions only have I met with samples containing a small amount of rosin, which was left as a solid on distilling off the turpentine by a steam current. Should more than a few tenths of a per cent. of non-volatile matter remain, it is probable that petroleum is present. This usually betrays itself by the more or less marked blue fluorescence of the residue; but should this criterion fail, the behaviour of petroleum and of the non-volatile product of the air oxidation of turpentine on digestion with dilute nitric acid will serve to differentiate them. The latter is readily oxidised and dissolved; the former does not alter much in bulk, but apparently undergoes more or less complete nitration. I have never yet met with a sample containing rosin oil, but it would not be difficult to detect it, as it is oxidised by nitric acid, and behaves in a most characteristic manner when triturated with a paste of slaked lime, forming the well-known grease.

The detection and estimation of petroleum spirit is less readily effected. The method which I employ is based on the different behaviour of turpentine and paraffins with sulphuric acid. The paraffins, it is well known, are almost unaffected, whereas turpentine is polymerised and for the most part converted into substances of high boiling point which do not volatilise in a current of steam. I say for the most part, because, as I have elsewhere stated, a certain amount of cymene and of a paraffinoid hydrocarbon is always produced. Inasmuch as the amount of cymene so produced varies with the strength of the acid and the temperature, being larger the more concentrated the acid and the higher the temperature, it is important always to work under uniform conditions, at as low a temperature as convenient, and to use diluted acid. I employ two strengths of acid, a mixture of 2 vols. acid and 1 vol. water (2:1 acid), and a mixture of 4 vols. acid and 1 vol. water (4:1 acid). The turpentine—500c.c. is a convenient quantity—is placed with about one-fourth to one-third of its bulk of 2:1 acid in a well-stoppered bottle, and the mixture is somewhat cautiously agitated. It soon becomes more or less heated, and as it is important to effect

the polymerisation at a temperature not much above the ordinary atmospheric temperature, the bottle is placed in cold water for a short time. After repeated agitation with the acid, the turpentine is converted into a viscid oil, and when this is the case and no more heat is developed on continued agitation, the contents of the bottle is transferred to a separating funnel, the acid layer is run off and the oil poured into a flask; the latter having been connected with a condenser and a steam-pot—an ordinary tin can answers admirably—all that is volatile is distilled off. The distillate is mixed with about half its bulk of its 4:1 acid, and treated in a precisely similar manner.

The product from this second operation should only consist of a mixture of cymene and the paraffinoid hydrocarbon; in bulk it should not be more than 4 to 5 per cent. of the original hydrocarbon. This is the result of a very large number of estimations; as little as 3 per cent. however has been obtained in experiments conducted with special care. If much more than about 5 per cent. be obtained, it is desirable to repeat the treatment with 4:1 acid.

If, from the result of this treatment, it appears probable that petroleum spirit is present, the product is placed in a well-stoppered bottle, together with several times its volume of concentrated sulphuric acid, heated to 50° to 60°, with which it is violently agitated. This treatment is repeated if desirable, (weak Nordhausen acid being with advantage substituted for the concentrated sulphuric acid) and the residual hydrocarbon is separated, steam distilled, and then measured. The amount thus obtained should not exceed from $\frac{1}{2}$ to 1 per cent. of the original bulk of turpentine. This treatment with concentrated acid affords a check on the previous determination.

If American petroleum spirit be thus treated it suffers comparatively little loss, so that the amount of hydrocarbon above 1 per cent. represents the *minimum* amount of petroleum spirit in the turpentine. The spirit from Scotch petroleum contains a very much higher proportion of hydrocarbons alterable by sulphuric acid, and therefore cannot be satisfactorily estimated.

To confirm the presence of petroleum spirit, the turpentine should be distilled. Petroleum spirit commences to distil at a temperature which may be above or below that at which turpentine boils, according to its quality, but always distils within comparatively wide limits of temperature; turpentine commences to boil near 160°, and almost entirely passes over below 180°.

The presence of rosin spirit also affects the boiling point in a similar manner. Evidence of the presence of this adulterant is also afforded by the increased yield of hydrocarbons on treatment both with 4:1 and concentrated sulphuric acid, as rosin spirit also yields a cymene and paraffinoid hydrocarbon on treatment with 4:1 acid. The cymene from rosin spirit being isomeric with that from turpentine, proof of the presence of rosin spirit can be obtained by the detection of its cymene, but this is a somewhat delicate operation.

Addendum.—The method above described is also available for the analysis of solvent naphtha from coal tar and similar products; it is, in fact, the only method which is capable of affording results which approach exactness. The problem is by no means so simple, however, as the coal tar product itself contains, besides benzene and its homologues, basic bodies, hydrocarbons alterable by diluted sulphuric acid, and paraffins. Until, therefore, a considerable number of genuine samples have been examined, the method is chiefly of value as a qualitative test.

THE DISCUSSION.

Mr. LYTE said: During the time I resided in the south of France, while I was at work setting up a large salt works in the neighbourhood of Dax, I had frequent opportunities of visiting different French turpentine distilleries. The French turpentine is extracted—as Dr. Armstrong has told us—from the *Pin Maritime*, and it is also produced in some places, but in far less quantity, from the *Pin Franc*, which is there said to be identical with the frankincense pine. It used to be made by boiling the gem, as they call it, which is collected from the trees, with water, by bottom heat; but of late years it has been distilled by blowing superheated steam into the gem, mixed with water in the still, so that no fire is actually beneath the still. To this improved mode of manufacture the great homogeneity of the French turpentine mentioned by Dr. Armstrong is probably due, because it is not boiled and heated so irregularly in this way as by the old method, and possibly the varying and irregular temperatures obtained by the old method, still frequently employed in other countries, may give rise to a production of hydrocarbons of variable properties and composition. The turpentine used to be collected on the ground in small pits, scooped out at the foot of the trees, and it was found mixed with large quantities of sand, which lay at the bottom of the still, and caused burning. It is now collected by earthen pots, nailed up against the trees, invented by a man named Hugues, who ought to have made a large fortune by his invention, but who, like many other inventors, died in the poorhouse, a broken-hearted pauper. During the American War this gem rose to an enormous price. It went rapidly from 25 francs, equal to £1, a cask—that is, a cask of gem, containing, I should say, somewhere about 100 to 120 litres—to 300 francs, equal to £12 a cask, so that both the proprietors of the pine forests and the men employed by them, gained such enormous sums of money that they took to idling about all day long in the cafes, not knowing on what to spend their money. I literally saw one man drink eighteen cups of coffee, because, as I was informed, he did not know how else to spend his money, this being to his peasant mind the greatest luxury he knew of. This was but an example of the usual state of things throughout the country. They then took to adulterating the gem with large quantities of water. They poured hot water into the gem, and beat the two together with whisks; they also added sawdust and sand, and managed then to get even up to 35 or 36 per cent. of water, and 8 per cent. to 10 per cent. of sawdust and sand into the gem. The manufacturers only discovered the fraud when they came to distil the gem. The water then separated out as soon as the gem became fused. I devised a small apparatus, still used by them, for making a rough commercial examination of the gem, known under the name of "rytymètre," for separating and estimating these impurities. The adulteration of turpentine is frequently done in France by means of resin oil, as well as by means of petroleum. These adulterations by resin oil and petroleum, more especially the former, have been observed to prevent the drying of paint, with which such adulterated turpentine is mixed, and in point of fact they have a rough-and-ready method of discovering such adulterations by mixing turpentine with drying oil and trying it, observing how it dries when painted on to a surface of wood or iron. If they find it dries imperfectly, they conclude it is adulterated with one of these ingredients. The *Pinus Maritime* is not indigenous to those districts of the south-west of France, while now it so greatly abounds that the pine forests cover the entire country,

and the extraction of the turpentine and resin and the exports of pine timber form the staple industry of the country. Edmond About, in an interesting little work, entitled "Maitre Pierre," describes how this was brought about by the efforts of an intelligent Frenchman during the last century. In view of fixing the blowing sand derived from the Atlantic sea-coast, he tried, first of all, shrubs, and many of those dry, stunted, odoriferous weeds which occur so abundantly on all sandy coasts, but these were finally discarded for the *Pinus Maritime*, as they were found insufficient for the purpose. Previously to this, and even down to not long since, among some of the more unprotected and unplanted "dunes" of the Landes and Gironde, entire cottages and small homesteads would be buried in the sandstorms during a single night. The French pine trees in the Department of the Landes, are only worked when they are 18 to 20 years old. At that time they begin to collect the resin from them, by cutting off the bark and the outer skin of the timber in long vertical strips down the sides of the trees on the S., S.E., or S.W., where the sun strikes, and fixing one of the earthen pots, already alluded to, to catch the resin or gem as it streams out of the wound. They do this for five years in succession, a new vertical incision being made each year, and, at the end of that period, they cut more vertical incisions, this time all round the trees, and hang pots to catch the resin. The fluorescence which Dr. Armstrong alluded to as characteristic of petroleum is also found in resin oil. It is obtained by destructive distillation, either from the commercial qualities of resin itself or from the mixture, with sand or earth, of the resin found round the roots of the trees, or from the resinous scrapings and chips from the trees themselves. It depends rather upon the way in which it is distilled for its fluorescent properties. When it is mixed with lime and distilled it shows no fluorescence, but if the resin oil is distilled without a previous admixture of lime it is liable to take on a fluorescence similar to that of petroleum. Attracted by the singular appearance and intensity of their fluorescence, it struck me that perhaps rosolic acid might be the cause of it, and I tested for it, thinking that possibly some dyestuff might be extracted from it, but I was unable to conclude my experiments, as I could have wished, as the Franco-Prussian War intervened and disturbed me. This resin oil is, however, well worthy of further investigation. They use petroleum in the adulteration of the resin oil itself as well as for adulterating essence of turpentine, so that petroleum, in this case, may be looked upon as a very adulterant of adulterants. Mr. Dive, of Mont de Marsau, was, I believe, one of the earliest makers of resin oil, if not the first who made it industrially; and though the son who succeeded him in the business died some years since, the business is, I believe, still carried on. They not only make the oil itself but they manufacture a kind of soap for lubricating purposes by saturating the acids of the oil with calcium hydrate and mixing the pasty mass so obtained with talc, from the neighbouring Pyrenees, or with powdered graphite. Such grease is considered very valuable as a lubricant for the bearings of heavy machinery.

Mr. Crowder said: I should like to ask Dr. Armstrong whether there is much difference in the value of French and American turpentine, and whether you can tell the difference between them. It seems to me to be a very important matter, and if there is any considerable difference it would be a good thing to have some simple plan of testing them.

Mr. INGLIS said: I cannot say much on the scientific portion of the subject, but when I was in the United States, I visited not only the oil regions

but also the turpentine regions. Dr. Armstrong has spoken of the turpentine of Wilmington, Savannah, Charleston, and New York. New York is simply a port of departure, the turpentine is brought there from Wilmington and Savannah. They are widely apart, Savannah being about 700 miles, and Wilmington about 300 miles, from New York. I do not understand the scientific terms which the Professor used, but it occurs to me that the rotary power (I think he called it) being so much lower in one kind of turpentine than in another was due to the turpentine of low rotary power being from Savannah. The turpentine tree there grows in a very much warmer region than in Wilmington, being so much further south. The mode of producing the virgin sap is by boxing the tree. At something like 2ft. 6in. from the ground, about 12in. wide, and about 6in. deep the tree is cut. That process is commenced in November, and lasts until March. In the course of a week the box fills with a gummy matter. After a week the negroes go round and commence the process of chipping. On each side they chip the tree with a tool like a carpenter's augur, and that starts the flow again. That process goes on from week to week throughout the summer season, until the winter begins to set in. The season varies according to the latitude. In Wilmington it ends in September, in Georgia it goes on until November. In Georgia the tree is served in this way for three years, and, according to the extravagant American mode, it is then deemed exhausted and fit only for the purposes of the saw-mill. In North Carolina I have seen trees chipped as high as this room (18ft. to 20ft.); to do this the chipper is put on the end of a long pole. The turpentine trees are rapidly becoming exhausted in North Carolina, and also in South Carolina, and the industry is going down into Georgia. Turpentine is produced also in the States of Mississippi, Louisiana, and Florida, so that there is yet a vast region to work upon. Had I had a little more time I might have compressed the notes I took. I saw the whole process of collecting the gum by the negroes, and the processes in use at the mill or distillery. The farmers there hire or buy tracts of land of many thousands of acres. A gentleman I visited in Georgia had 8,000 acres, and the pines stood a few feet apart. The whole of the produce of that tract went through one still, and would yield about twelve barrels—under 500 gallons. He was going to bring 4,000 acres more under cultivation. I mention that to shew what vast tracts of land are under cultivation. The produce of all those trees is passed through one little "pot" as they call it there.

The CHAIRMAN said: I need not say that we have all listened with great pleasure to Dr. Armstrong's paper, and that we accord him a very hearty vote of thanks. Many of us have to deal with the question of the adulteration of turpentine, which seems to be carried on to a not inconsiderable extent. Whether or not, adulteration with petroleum of particular gravities, may be of advantage to the painter, it is of importance that, if it is desirable, we should carry out the adulteration ourselves.

Liverpool Section.

Chairman: Mr. E. K. Muspratt, J.P., Seaford Hall, Liverpool.

Committee:

Dr. J. Campbell Brown.	Hudson A. Binney.
J. C. Gamble, J.P.	Dr. Hurter.
H. Tate, Jun.	A. E. Fletcher.
J. F. Allen.	E. V. Bibby.
S. M. Harrison.	G. J. J. Wells.
A. Norman Tate.	W. Douglas Herman.
F. H. Gossage, J.P.	

Hon. Sec.: Dr. A. R. Garrick, Eccleston Park, Prescot.

Meetings of this Section, University College, Ashton Street, Liverpool, on the third Wednesday in the month (except December), at 7-30 p.m.

Notices of papers and communications for the Meetings to be made to Dr. A. R. Garrick, Hon. Liverpool Secretary, Eccleston Park, Prescot.

UNIVERSITY COLLEGE, ASHTON STREET, LIVERPOOL,
Wednesday, November 15, 1882.

E. K. MUSPRATT, ESQ., IN THE CHAIR.

MOND'S SULPHUR RECOVERY.

BY HENRY SCHAEPI, PH.D.

I desire to bring before the society the results of a few experiments, and wish to show in which manner they have proved useful to me in conducting Mond's process on sulphur recovery.

1.—My first experiments relate to the solubility of oxidised vat-waste in different solvents. I had to decide whether a weak solution of chloride of calcium, such as is obtained from the sulphur drainers, could not be used again advantageously for lixiviation, and whether a dilute solution of thiosulphate of calcium, resulting as waste liquors from overblown liquors, could be used for the same purpose as well as or better than water. This question seemed of importance, since the quantity of water used is very large and the charges for it often reach 25 per cent. of the cost of regeneration.

A fresh well-mixed sample of oxidised waste was divided into three portions, weighing one kilogramme each, placed in large basins and treated with 1500c.c. of weak solutions of chloride of calcium, thiosulphate of sodium, and water respectively, the solvent previously heated to 90° C. The mixture was allowed to stand two hours, occasionally stirring. 20c.c. of each solution were then withdrawn and tested with deci-normal iodine solution. The quantity of iodine consumed is sufficient for the comparison, as the thiosulphate of calcium is at once dissolved, and the differences in the results can only be due to a difference of the solubilities of sulphides in the various solvents—

	I.	II.
Aqueous solution	55c.c.	19c.c.
Weak solution of chloride of calcium ..	55c.c.	18c.c.
Weak solution of thiosulphate of sodium (after deducting i.e. 5 iodine corresponding to the thiosulphate of sodium)	55c.c.	53c.c.

According to this, chloride of calcium liquor dissolves just as well as water, and in thiosulphate solution the sulphides are rather more soluble.

There are two objections to the use of weak liquor from the sulphur drainers. (1) It is difficult to avoid an excess of acid, unless the sulphur liquors are decomposed with very great care, and an excess of acid would cause an evolution of sulphuretted hydrogen when the liquor is brought in contact with waste. (2) As the weak solution from the drainers has an initial specific gravity of 4° to 8° Tw., it would, unless kept entirely distinct from vats working with water, render it difficult to judge the composition of the liquor by the strength.

The sulphides, which cannot be recovered by oxidising and lixiviating the waste can easily be extracted by a solution of equivalent parts of common salt and sulphate of magnesia. Equal quantities of oxidised waste were treated for two hours with the same volume of cold water, hot water (80° C.), and with a solution of 240grms. crystal sulphate of magnesia and 117grms. common salt respectively. The total N₂ iodine used for testing 20c.c. of the filtered solution amounted—

For cold water to	95c.c.
For hot water (80 C.)	165c.c.
For magnesia solution to	170c.c.