ing about 4,000,000 gallons of sewage in a day, the three together being therefore capable of dealing with 12,000,000 gallons per day. Each set of pumps can be worked separately, one of them being sufficient for dry weather, a second set being brought into use in wet weather, while the third is held in reserve in case of accident to either of the others. Space is provided for the accommodation of two more similar sets of pumps and engines, if in future they should be required. Steam is supplied for all the machinery by three Galloway boilers, each 18 ft. long by 6 ft. 6 in. in diameter, set on Livet's system, any one of which will supply sufficient steam for doing the fine weather work, the other two being available when wanted. Weigh-bridge, trucks and a steam crane for unloading coals and chemicals at the dock and wharf and conveying them into the buildings are all provided.

When the sewage rises to a certain height in the sewers and the pump chamber, the fact is communicated by an automatic arrangement of electric bells to the foreman's residence and to the engine room and attention called thereto, thus avoiding any chance of overcharging the sewers. The strained sewage flows continuously into the pump chamber, where it receives a small dose of milk of lime from the vats in one of the chemical mixing rooms. It is then pumped to the surface, the operation of pumping also serving to thoroughly mix the sewage and the milk of lime together. The partially treated sewage then flows from the delivery pipes of the pumps by a covered channel into the inlet channel for treated sewage. At the head of the channel is a close iron bar strainer which removes any large matter that may have passed the first strainer. On its way to the channel the sewage passes through the second chemical mixing room, where it receives a dose of a solution of sulphate of alumina, carbon and iron, and is thoroughly mixed therewith by an agitator placed in the angle of the chemical room. This channel is supported on arches to raise it to the required level to command the whole of the precipitating tanks. Starting from the mixing room it is carried on three arches to the tanks. Here it turns right and left, extending the entire width of the eleven tanks. Between the inlet channel for treated sewage and each tank there is, however, a second inlet channel which communicates with the first by means of valves, which can be opened as required. When one of these valves is opened the inlet channel of one tank is allowed to fill up with treated sewage to the level of a weir forming the outer side of the channel. The sewage then flows over this weir until the tank is filled or the valve is closed. A 15 in. scour valve enables the inlet channel to be completely emptied when desired. The treated sewage channel is covered with tiles set on cement slabs, carried by H beams, spaced 3 ft. apart.

The treated sewage is admitted continuously into one or more of the precipitation tanks, as required. As the tanks fill precipitation takes place, the precipitate rapidly falling to the bottom, while the effluent water, now deprived of the whole of its polluting matter in suspension, and nearly all of that in solution, flows continuously over weirs at the other end of the tanks. This effluent water is sufficiently pure to be discharged direct into the river, and can be passed thereto by the only outlet provided at the northeast corner of the works.

The effluent water is, however, raised to a higher degree of purity, whenever required, by filtration through filter beds constructed of layers of various sized gravel, sand and carbon; the surfaces being covered with a thin layer of agricultural earth sown with grass. The precipitation tanks are emptied of their entire contents once a day, and when a tank has to be emptied, it is shut off from the inlet channel for treated sewage by valves and allowed a short time for repose. The water is then drawn off from the tank by a floating pipe, the upper portion of the water, owing to the levels, being discharged on to the high-level filter beds and the lower portion on to the low-level filter beds by the pipe shown in section. Two 10 in. sluice valves enable the flow to be directed into either pipe. There are valves between the channels and the filters. The discharge from both filter beds will flow into the Thames by gravity, except for a short time at spring tides, when the river is also filled with land water. It may be necessary at such a time to pump it, and for this purpose there are provided a pair of large Worthington steam pumps.

The floors of the filters are laid practically level, and the effluent finds its way through a number of drainage pipes into the delivery channel for effluent water. This channel can be shut off from the river and connected to the sump from which the filter pumps draw.

The precipitate (commonly termed "sludge") at the bottom of a tank averages from 2 in. to 3 in. deep, being nearly all or 90 per cent. water. The water drawn off from the tanks and passed away to the filters or to the river direct is not, however, lowered quite down to the precipitate or sludge; the water immediately overlying the sludge, for a depth of 6 in. or 7 in., being retained with the sludge. The bottoms of the tanks slope at 1 in 60, so as to form channels, and the sludge and water last mentioned run together, aided by sweeping, into a covered sludge passage passing along the upper ends of the tanks behind the inlet for treated sewage. Thence the matter passes into the sludge chamber beneath the press-house.

In this sludge chamber precipitation still rapidly takes place, and the water which rises to the top of the sludge is drawn off by a floating pipe. It is not, however, allowed to pass to the filter beds or to the river, but flows back again into the pump chamber, mixes with the sewage and is treated over again. The quantity of water thus dealt with is comparatively very small. The sludge, having thus been deprived of some of its water, and brought into a favorable condition for pressing, is lifted by pumps into iron receivers placed in the press-house.

These receivers each contain a charge for one press. In these it is limed, that is, a certain small quantity of lime is added to it so as to facilitate the operation of pressing, and it is forced by rams into the presses. The water pressed out of it (again a comparatively small quantity) passes to the pump chamber and mixes with the sewage to be treated over again, and the solid "sludge cakes," measuring 3 ft. square by 1½ in. in thickness, are removed from the presses.

This work is done by three of Messrs. Johnson and Hutchinson's 36 in. square sludge presses, each containing thirty plates and chambers. They are provided with all requisite sludge pumps, forcing rams, liming and skimming apparatus. The various parts of this sludge-pressing machinery are provided in duplicate in case of accident. Sludge in this pressed condition occasions no nuisance whatever, and may be stacked and stored without creating even an annoyance. For agricultural purposes it has a manurial value rather higher than that of the best farmyard manure. The quantity that will be produced from the present population will be about 10 tons daily, and considering the very great demand for manure of all kinds by the market gardens surrounding the locality, there will be no difficulty in disposing of it. Pressed sewage "sludge cake," which contains about 50 per cent. of water, is exceedingly suitable for making up and raising low-lying land, and the Board will be able to utilize much of it for improving their own property.

The entire cost of the works, including the sewers, will amount to between £115,000 and £120,000, the exact outlay being not yet ascertained. The annual cost of carrying on the work, including pumping the sewage, is estimated at £3,480, and this, together with the repayment of capital and interest, will not, it is expected, exceed a rate of 7½d. in the pound for the entire cost.

The contractors who have completed the sewers are Messrs. Nowell & Robson, of London, and the pumping station and precipitation works have been completed by Mr. William Webster, also of London. The contractor who commenced the works was Mr. C. Dickinson. The pumps, engines, boilers and mixing machinery have been supplied and erected by Messrs. James Simpson & Co., of Pimlico. The pressing plant and machinery have been supplied and erected by Messrs. S. H. Johnson & Co., of Stratford, E.

The engineer-in-chief was Mr. J. C. Melliss. Mr. James McKie filled the post of resident engineer, and Mr. W. Fairley has been appointed to the management of the works.

THE "SLEEPING SICKNESS" OF WEST AFRICA.

DR. H. GRATTAN GUINNESS, of London, has recently visited the Congo Free State, and writes home to Dr. Patrick Manson concerning the "sleeping sickness," as it is termed among the negroes living along the river Congo. He had an opportunity to investigate the symptoms of twelve or more typical cases. He examined the blood in each of these cases, and found that filariae were present in all. The most intelligent and brightest members of their tribe or village are frequently among the first to be taken down. Active workers become lazy, or, more properly speaking, indisposed to labor, in consequence of the approaching hebetude peculiar to this disease, and then grow physically feeble. They rapidly deteriorate mentally, and frequently there are developed a stubbornness and perversity which weary out their friends. This is especially true of those who refuse to admit that they have been smitten with the malady, though it is all too evident to others. Insidious somnolent symptoms commonly first attract the attention, but perhaps more frequently there is observed a change of countenance, a lack-luster state of the eyes and skin, a puffiness of the cheeks, and a loss of brightness or keenness of perception and attention.

The maniacal form of the disease is quite rare. At a village called Banza Manteka there have been a hundred deaths among the natives by this disease, and in only four of the cases was there a maniacal history. One of these may have been a case of febrile delirium, as death was believed to have occurred from high fever and neglect; the three other victims probably were starved to death.

Thus far the foreigners, whether white or colored, have been exempt from the disease. Dr. Guinness did not find that the disease was known in the towns nearest to the coast. The greatest known prevalence is reported from a village about one hundred and fifty miles up the river Congo. One case only of sleeping sickness has been seen and studied on English soil, and that was the case of a person who died recently at the London Hospital, a patient of Dr. Stephen Mackenzie's. He was a young negro from the middle Congo, who, recognizing the nature and almost certainly fatal issue of his malady, traveled upward of six thousand miles to offer himself, and his body after death, for the benefit of science and of his suffering fellow tribesmen, his hope being that the English physicians might be enabled to study out the etiology and prophylaxis of this hitherto incurable disease. Dr. Mackenzie has reported to the Clinical Society of London the fact of the occurrence of the *Filaria sanguinis hominis* in the case of this heroic young man, but beyond that item of information no particular advantage has thus far been reaped from his long journey. To this discovery of the filaria Dr. Mackenzie attached very little importance, and in this opinion he was supported by Dr. Patrick Manson, whose authority is exceptionally high in such a matter, and who expressed the belief that the association of filarial infection with the morbid somnolence was non-essential and fortuitous. Whether this opinion will be persisted in when the findings of Dr. Guinness, above referred to, come to be weighed, remains to be seen.

Professor Ludwig Mauthner, of Vienna, has called attention to the reported frequency of ptosis as a symptom of sleeping sickness. Ptosis was present in the London Hospital case, and thus confirms the following theory of Mauthner's, as well as the casual statement of Dr. Junker, the African explorer, that this symptom is an important one, and is held by the African doctors to be a marked prognostic of the onset of lethargy. Mauthner's designation of the malady is "a chronic endemic morbid somnolence of the negro," and his interpretation of its causation is that it is an inflammatory process affecting cerebral motor areas. In this view, it is a *poliomyelitis superior*, an inflammation of the central gray cavities of the third ventricle, the gray matter of the walls of the aqueduct of Sylvius, and the floor of the fourth ventricle, these being correlative to the apathy, depression, muscular enfeeblement, and lethargy, while an extension of the process of inflammation to the nuclei of the efferent cranial nerves would give rise to the focal symptom

of ocular paralysis, inclusive of ptosis. In the absence of an ascertained pathological lesion different from the foregoing, Mauthner's explanation constitutes the most reasonable hypothesis that has hitherto been presented. The endemic nature of the disease is accepted by Hirsch, Corre, Manson, and some others, but that it is not malarial in origin seems to be demonstrated by the fact that, while the Europeans living in the region where this sickness occurs contract the malarial fevers which are abundantly prevalent in the Congo valley, the blacks only are subject to the lethargy. The London Hospital patient gave no history of malarial infection, and an examination of the blood for the *Plasmodium malariae* had a negative result. Dr. Manson is inclined to the belief that the disease will be found to be a food disease. The traveler Stanley has suggested that the uncooked manioc is the cause of much sickness and death among the natives.—*N. Y. Med. Jour.*

THE MANUFACTURE OF NITRO-CELLULOSE.

By Dr. J. B. LITTLEWOOD.

GUN-COTTON is obtained by the action of nitric acid, in the presence of sulphuric acid, upon the purest cellulose—cotton fiber—and is a substitution product. According to the treatment followed—the strength of the acids, etc.—are obtained mono-, di-, tri-, tetra-, penta-, and hexa-nitro compounds. These are termed soluble and insoluble, according to their solubility in alcoholic ether. The equation illustrating the reaction has been written for tri-nitro-cellulose:

A number of these substitution products are known; the soluble varieties being used for collodion; the insoluble as explosive agents, generally the tri-nitro.

The process consists essentially in exposing the dried cotton for a sufficient length of time to the action of a mixture of nitric acid (sp. gr. 1.45 to 1.50) with sulphuric acid (1.84 to 1.85), and in then thoroughly washing the fiber to remove all free acid adhering thereto.

The fiber has been submitted in all forms, from the carded mass or hank to the finest impalpable powder. This powder has been obtained by both chemical and mechanical means—by cuprammonium and by grinding. The reasons for comminution of the cotton are that when the cotton is subjected to the action of the acids in its natural state and length of fiber, the line of least resistance seems to be by way of the inside of the tubes constituting the fiber of the cotton, into which they are taken in part by capillary attraction, subject to change themselves as they progress, and to increased resistance from any oil or gum, etc., in their progress, and therefore to modified action, the result of which is slower and slower, and otherwise more and more imperfect chemical change. It may also be that the power of capillary attraction is balanced in the tubes by air contained therein sufficiently to prevent the acids from taking effect.

It has also been customary to wash the cotton in alkaline baths, rinse and dry before steeping in the acid mixture, and whatever alkali was not neutralized would effect the nitration.

The cotton fiber has for its protection a glazed surface, as if it were enameled by nature. It is tubular and cellular in structure, and contains a natural lubricating semi-fluid substance, composed of characteristic oil or gum, or water, or other material, or a combination thereof. Both the glaze and the lubricating substance, as well as the fineness of the fiber, vary with the soil, climate, and other accidents of growth. Where cotton waste is obtainable, this is cleansed for the purpose of conversion, and unless carefully treated, there is liability of variable nitration of material thus obtained. Where yarns and hanks are employed it has been found that the twisting of the fiber and the disposition in the yarn form caused a resistance to the penetration and to the action of the acids, with the result that parts of the fibers were not acted upon, or acted upon imperfectly.

The same difficulty has been observed where paper has been expressly prepared from cotton fiber for conversion. In this last case the fiber is, of course, modified by the chemical and mechanical treatment which it has undergone in the preliminary preparation of the paper; but if the adherent oil or gum or glaze has been attacked, or if all have been removed by subsequent washing, etc., which is very difficult, if not impossible, the character itself seems to have been altered to such an extent that the cellulose product of the paper process is not uniform, or always otherwise satisfactory.

Fiber has been treated with sulphuric acid prior to nitration, and in this way the material has the character of vegetable parchment imparted to it before it is subjected to the bath of mixed acids. The fiber is washed and dried in this case before nitration.

Where wood is used as the form of cellulose it is necessary to comminute or disintegrate it, and by boiling in presence of alkali under pressure to remove sap, resin, and salts; then washing in a poacher with pure water; beating, straining, and drying. This fibrous pulp is submitted to the usual bath of nitric acid at 1.40 to 1.50 (one part) with sulphuric acid at 1.80 to 1.84 (two parts). The fiber is kept in this bath of cooled acids twenty-four to thirty hours, with occasional agitation, squeezed, and thoroughly washed, steeped in alkali; again washed and dried.

The washing is performed at Newport by repeated passage through a wringer, which is so mounted that the water pressed out is led away, the squeezed gun-cotton falling into fresh water, and in this way a more thorough purification is obtained, in a shorter time, than by the ordinary method of very long exposure to the action of running water.

The Abel method of washing included the use of a pumping engine or beater, where the fiber was submitted to a revolving wheel carrying projections which passed between stationary projections on the bottom of the tub, and thus became fully torn, and from this beater the pulp passed to a washer (poacher), where the pulp was stirred for a long time with large quantities of water. The revolution of the wheel in this tub prevented deposit in any part of the tub.

At Stowmarket an artificial cascade is made by leading a stream of water along a trough, and allowing it to fall from a height into the washer. The gun-cotton

is thrown on the falling stream and immediately carried deep down into the vessel, the agitation being further promoted by the workmen. In this way the cotton comes in contact with such a large quantity of water that the rise in temperature is inappreciable, and the pyroxyline almost altogether free from acids. But, to perfect the washing, the pyroxyline is passed through the centrifugal machine and then thrown into tanks, where it is subjected to the action of water for one to three weeks, and is afterward boiled in large vats below 212° F. These washings may be followed by the addition, or use in them, of alkaline material.

Oxidants may be added to the fiber before drying, and it may be pressed into the form of slabs, cylinders, or pellets.

Unmixed with salts, it may be stored in this wet condition, and is then the safest of all explosive agents. It is not liable to be fired by a spark or flame, nor is affected by blows, friction, or other rough handling. The only care necessary is that the cakes be not frozen. The proportions of acids used vary from one of nitric with three of sulphuric to one to two (as at Le Bouchet). Abel's method (British) and that in use at Newport are alike in using one to three. At the torpedo station either raw or carded cotton is used. It is first steeped in a weak solution of carbonate of soda, to remove the resin from the raw cotton, or the oil from the carded, then washed and carefully dried. The acids are the strongest nitric and sulphuric. A large quantity of the mixed acids is placed in the leaden pan, and into this a small quantity of the dried cotton is immersed. When thoroughly saturated, the cotton is lifted upon a reticulated shelf over the pan to drain. It is then pressed, placed in an earthen jar, and when this is half full of the dipped cotton, fresh acid is poured upon it until the cotton is covered. It is then set where the temperature may be kept reduced for forty-eight hours. The greater part of the conversion takes place at the dipping, but that it may be complete it is necessary that the contact with the acids should continue for the time stated. When the cotton is removed from the first bath, a quantity of fresh acid equal to that removed with the cotton is added before a fresh batch is treated.

At the end of the time stated the cotton from the jars is passed through rubber or leaden wringers.

Where equal parts of the concentrated acids were used, the acids from the first batch were used once again, the time of immersion being extended. In other cases the spent acids are restored in bulk by the addition of a suitable quantity of a nitrate and sulphuric acid, thus employing the acidulous mixture continuously in the conversion of successive batches of material. In this case, by using a nitrate the base of which forms, when introduced into the bath, an insoluble compound, the bath becomes clarified by subsidence of the precipitant. In other cases the spent acid is treated to free it from flocculent matter, after which it is restored by means of fresh acids, and so utilized. The proportions of cotton to acid vary from 1 to 6 up to larger baths. At Waltham Abbey the cotton in 1 lb. quantities is dipped into a 12 gallon pan of the mixed acids.

The same acids have been used again for treatment of successive batches without strengthening, except the addition of such a quantity of acid as may be required to properly cover the fiber. Again, the spent acid has been analyzed to ascertain its condition, and an amount of fresh acids mixed therewith sufficient to restore it for use. Spent acids are in some cases used for the first dipping, followed by a bath of the concentrated acid in usual proportions to fully complete the nitration. Nitration has also been effected by addition of a part only of the acid required for conversion; allowing reaction, and passing the material into additional quantity of the acid required to complete. It has also been effected by immersion of the cotton in a series of tanks, beginning with that having the weakest acid, and following until the fiber has been fully nitrated. As soon as the acid of the first vat falls below the required strength it is replaced by fresh, full-strength acid. This is operated by having the vats on a turn-table, passing the acids pressed out back to the vat from which they were taken. In this way all the suitable properties of the acid are utilized, the weakest acids becoming weaker by the partial conversion of the cotton which they effect, while the last immersions of each charge of cotton are in the strongest acid. This latter plan was to render available all the valuable properties of the acids, and enable the use of such acids until they have become entirely spent, in lieu of the usual way of treating the cotton by repeated immersion in the same acids, or by successive immersions in different receptacles, where the weakened but not entirely spent acid is thrown away.

Earlier the spent acids were used only for the manufacture of the weaker kinds of powder, to economize the cost of manufacture.

A CRYSTALLINE ALBUMINOID FROM OATS.

THE albuminoids which may be extracted from the oat kernel by various solvents are many, and their distinguishing characteristics are few; different solubility and different coagulation temperatures being about the only data for pronouncing them different substances.

In a long paper upon the albuminoids by Mr. T. B. Osborne, it is stated that by using a 10 per cent. solution of sodium chloride at 60° to 70°, Mr. Osborne has extracted an albuminoid which stands by itself among all others, for it can be crystallized.

The ground oats are treated with a 10 per cent. solution of sodium chloride, strained through a hair sieve to remove the husks, and heated to 60° for a hour. This extract is then filtered as rapidly as possible, and after decanting from a deposit which separates out on cooling, is saturated with ammonium sulphate; the precipitate is filtered off and added to the deposit formed on cooling. The substance thus obtained is treated with three liters of 10 per cent. sodium chloride solution at 65°, and filtered as quickly as possible on a hot water funnel, the filtrate being received in a vessel itself standing in a water bath at 70°. This liquid is allowed to cool very slowly, and when cool is decanted from the dense deposit that adheres firmly to the bottom and sides of the beaker. The said deposit is washed, first, with 50 per cent. alcohol, until the washings contain no more chloride, then with absolute

alcohol, and finally with ether; drying over sulphuric acid completes the preparation. By this method the author obtained 8.5 grains from 5 lb. of oats.

The new albuminoid is a dense, snow-white powder when washed and dried, but, while wet, as deposited, it consists entirely of spheroids about 0.01 mm. diameter. It dissolves to an opalescent solution in cold distilled water, and is precipitated again on addition of a little sodium chloride, but redissolves on further addition of this salt. It dissolves to a perfectly clear solution in hot distilled water, and is partially deposited on cooling. It melts when treated with hot dilute alcohol, and remains suspended in the solution in transparent droplets, which dissolve on addition of a little salt and acetic acid; the solution sets to a transparent, bulky jelly on cooling.

The separation of this substance in spheroids naturally suggested to the author the possibility of crystallizing it, and his attempts to do so proved successful, perfectly formed octahedral crystals, which were pronounced by an expert to be isometric, being obtained. The procedure was as follows:

The albuminoid was dissolved in cold distilled water and sodium chloride was very cautiously added until a copious precipitate resulted. On immersing the test-tube in warm water, the precipitate dissolved to a perfectly clear solution, which was allowed to cool slowly in a bath containing about four liters of water at 60°. After a day the deposit was examined under the microscope, and found to consist entirely of crystals.

Inasmuch as the above method of obtaining the crystals is open to some objection on account of the use of salt, with its accompanying impurities, the author saturated distilled water at 60° with the albuminoid, and allowed the solution, surrounded by a large volume of warm water, to cool slowly: an abundant deposit of octahedral crystals was obtained, but they were not quite so perfectly developed as those just described.

Analyses of this substance in the form of spheroids show that its composition is very similar to that of the other albuminoids, among which it ranks with those that contain most nitrogen, 17.8 per cent. Its ash is 0.19 per cent.

Such is the discovery which Mr. Osborne announces he is following up. Emil Fischer has shown us how to make heat producers; we cannot be satisfied until we can make flesh formers.—*Chem. Tr. Jour.*

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