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XVIII. *An Essay on Bleaching; with the Description of a new Method of Bleaching by Steam, according to the Processes of C. CHAPTAL; and on its Application to the Arts.*
By R. O'REILLY, of the Academy of Bologna, Member of the *Lycæum of the Arts, &c.*

THE art of bleaching is one of those connected with the first ideas of civilization. The theory on which it is founded was entirely unknown to the antients; but the Egyptians were acquainted with the deterfive quality of some kinds of clay, and the effect produced by the atmosphere, moisture, and light, on the stuffs exposed to their action.

Health and cleanliness rendered it necessary to devise quicker means than these; and the property of soap and leys of adhes were therefore soon discovered.

In the present age, the arts, following science with close steps, have taken advantage of processes and deterfive menstrua, the existence of which was before unknown: these discoveries have succeeded each other with such rapidity, that the last six years have effected a complete revolution in the art of bleaching.

This art divides itself very naturally into two quite distinct branches, which we shall avoid confounding. One of them comprehends the bleaching of animal substances; the other, that of vegetable matters. We shall treat of these subjects separately, as well as of the different menstrua and deterfive substances generally employed.

Bleaching of Animal Substances.

The substances produced by the animal kingdom, which are more particularly employed as vestments, differ essentially from those of the vegetable kingdom. It is on a knowledge of the most striking traits, which form the line of demarcation between the two kingdoms, that the art of bleaching is founded.

Vegetables serve as nourishment to the animals and insects the spoils of which we employ. Animalized by their organs they acquire other properties. *Azote*, in particular, seems to be their most distinguishing character: it is scarcely found in vegetable substances. To this principle we may add the existence of sulphur and phosphorus, which form so many

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sources for those pestilential exhalations with which the decomposition of animal matters, by putrid fermentation, is always accompanied.

The affinity of aggregation of these substances, or that law of adhesion which keeps their molecu^{læ} together, is weaker than in the vegetable kingdom; for this reason they are so easily dissolved and destroyed by acids and alkalies, and hence the readiness with which aëriform fluids are produced.

The bleaching of animal substances requires the concurrence of alkalies, soap, ammonia, and sulphurous acid. We shall here confine ourselves to an examination of wool and silk, as the animal substances most generally employed, and which it is of importance that manufacturers should be acquainted with the method of bleaching in the most æconomical and most expeditious manner.

Of Wool.

Wool is a kind of hair with which the bodies of several animals are covered. It is composed of filaments or tubes filled with an oily or medullary substance. The sides of these tubes are perforated with a multitude of small pores, which communicate with the longitudinal tube. By chemical analysis wool gives a great deal of oil and carbonate of ammonia: caustic alkaline leys destroy it entirely; and it is to the facility with which it dissolves in alkalies that we are indebted for the noble discovery, made by C. Chaptal, of the *soap of wool*. Wool experiences no change in boiling water: this observation is of great importance, in regard to the art of which we are now treating; it alters very little when preserved in a place well aired; acids have very little action on it; when exposed to a strong heat it enters into fusion. All these facts united prove that wool is a semi-oleaginous substance. The grease with which it is covered when on the body of the animal, and from which it is freed by scouring, serves to confirm this assertion.

An examination of these chemical facts is necessary for understanding the principles which ought to direct the artist in the bleaching of this substance. The little action which acids have upon wool, and its unalterability in water, even when aided by caloric, render it necessary to have recourse to alkaline or saponaceous leys; but its solubility in these salts shows that great prudence and caution must be employed. In regard to acids, none have been hitherto used but the sulphurous acid obtained in the gaseous state by combustion.

Of

Of the Bleaching of Wool.

In the preliminary operations to which wool is subjected, it is customary to leave a little of its grease to secure it from insects. Wool is often freed from the grease by the farmers when they wish to sell it at a high price; but in the subsequent manipulations it is greased or oiled before it is combed, spun, &c.; and as this fat matter attracts dust, it dirties and thickens the stuffs. The first kind of bleaching to which wool is subjected, is to free it from these impurities. This operation is called *scouring*. In manufactories it is generally performed by means of an ammoniacal ley, formed of five measures of river water and one of stale urine; the wool is immersed for about twenty minutes in a bath of this mixture heated to fifty-six degrees; it is then taken out, suffered to drain, and then rinsed in running water: this manipulation softens the wool, and gives it the first degree of whiteness; it is repeated a second, and even a third time, after which the wool is fit to be employed. In some places scouring is performed with water slightly impregnated with soap; and, indeed, for valuable articles this process is preferable, but it is too expensive for articles of less value.

Fulling the cloth adds still to the whiteness, and if a new degree be necessary it must be procured by the action of the sulphurous acid; that is to say, of the fumes of sulphur in a state of combustion, or that acid vapour condensed and combined with water.

Sulphuring is generally performed in an arched or very close chamber, constructed in such a manner that the articles to be exposed to the action of the sulphur can be suspended on poles. The chamber being filled, a certain quantity of sulphur is put in a state of combustion on flat dishes having a large surface with very little depth: the entrance is speedily shut, and all the interstices around the door are carefully stopped to prevent the access of the atmospheric air. The acid generated by the combustion of the sulphur penetrates the stuffs, attacks the colouring matter, destroys it, and effects the bleaching. The stuffs are left in the stove some time after the deflagration has ceased. This time varies from six to twenty-four hours. They are then taken out, and made to pass through a slight washing with soap, to remove the roughness they have acquired by the action of the acid, and to give them the necessary softness.

A simple description of this process shows how imperfect it is. At first the acid of the sulphur acts only on the surfaces, and does not penetrate them. This aerial immersion

is not sufficient; the gas cannot introduce itself to a sufficient depth into the stuffs, and the superficies only is whitened. By taking advantage of the intimate knowledge which we have of the nature of this acid, we have discovered a process much simpler, more æconomical, and more agreeable to the principles of science.

The sulphurous acid, or that acid generated by the imperfect combustion of sulphur, differs from the sulphuric acid (oil of vitriol) by its containing less of the acidifying principle, and by being, as we may say, the mean term between sulphur and the sulphuric acid. As we are desirous that our work should be understood in manufactories, we shall speak only very briefly of the chemical properties of the sulphurous acid, and shall proceed to the method of preparing it.

Sulphurous acid gas unites very easily with water, and in this combination it may be employed for bleaching wool and silk. The sulphurous acid in this state of liquidity may be prepared by making it traverse water in an apparatus nearly similar to that used for preparing oxygenated muriatic acid. The most æconomical method of obtaining it is, to decompose sulphuric acid (oil of vitriol) by the mixture of any combustible matter capable of taking from it a part of its oxygen. In exact experiments of the laboratory, where the chemist is desirous of having great purity, it is obtained by means of metallic substances, and particularly by mercury; but for the purpose of which we are treating, where great æconomy is required, we would recommend the most common substances. We shall therefore give the following process:

Take chopped straw, or sawdust, and introduce it into a matras; pour over it sulphuric acid, applying at the same time heat, and there will be disengaged sulphurous acid gas (vapour of sulphur), which may be combined with water in the following apparatus, and by the following method:

Place long necked matrasses on a furnace, and make them communicate with a tubulated flask into which a little water has been put to absorb the small portion of sulphuric acid (oil of vitriol) that may pass without being decomposed through this first reservoir. Care must be taken to apply a small safety-tube, one of the extremities of which must be immersed some lines in the water, to guard against absorption. A tube with a double bending conducts the acid into flasks or other vessels, where it must at length combine with the water.

We would propose using, instead of the tubulated flask, a cylinder of lead, or of fir, or any white wood, hooped with
varnished

varnished iron (to prevent rusting) of a pretty considerable height, terminating at top with a Wolf's bottle, the bottom of which must be taken out, and which is to be placed in a collar formed in the leaden cylinder; care being taken to cement it with a luting of wax to render it impermeable to fluids. This capital of glass will enable the operator to see the quantity of air bubbles disengaged from the surface of the water, and thus to appreciate the progress of the saturation, while the weight of this narrow and high column of water pressing on the bubbles of sulphurous acid gas, in proportion as it is disengaged from the extremity of the tube at the bottom of the cylinder, will facilitate its combination with the water, and accelerate its solution in that fluid. That nothing may be lost, two or three of these cylinders can be united in the same way as is done with a series of Wolf's bottles. A cock adapted to the bottom of each cylinder will facilitate the discharge into the immersing tubs.

The apparatus which we would employ for the immersion of woollen and silk stuffs in leys of sulphurous acid are perfectly similar to that which we shall describe hereafter for immersion in oxygenated muriatic acid, and which we have constructed according to the principles of Rupp*. It was by reasoning upon his apparatus with C. Widmer, of Jouy, that we conceived the design of the present one, which is now making at the manufactory of Essone. Let us suppose an oblong box, divided in the middle by a partition, and on each side of it a large reel, on one of which the stuff is rolled up: in each angle are placed rollers, over which the stuff is conveyed before it passes the partition, and traverses a like number of rollers, which conduct it to the other reel. The object of this disposition is to cause the stuffs to pass through the bleaching ley, and to expose to its action the greatest surface possible.

To turn these reels, an axis or column of glass passing through a collar of leather is employed. One of the extremities of this axis, which is square, is inserted into the axis of the reel, while the other is adapted to a handle, which gives it a rotary motion. By this disposition there is no need for employing any metallic substance internally. To prevent the dispersion of the gas, the covering of this apparatus is furnished with a border which fits exactly into the box, and of which an inch, at least, ought to be immersed into the de-terfive liquor.

* For an account of Mr. Rupp's process and apparatus here alluded to, see *Manchester Transactions*, vol. v.; or *Philosophical Magazine*, vol. ii.
—EDIT.

For bleaching woollen stuffs we propose the following method:—The stuffs are first to be scoured by a slightly alkaline ley in the proportion of a pound of potash to 50 pounds of wool; the ley must be heated to the temperature of 30 degrees: the old process, by means of stale urine, already mentioned, may be also employed. Urine is preferred, because it holds in solution only a small quantity of salt incapable of hurting the wool. When the grease is dissolved, and the wool has been perfectly rinsed, it is to be washed in warm soapy water: this part of the scouring process is performed sometimes in the fulling-mill, sometimes with beaters, and sometimes by treading in the tub. In all these cases the stuffs must be freed from grease by repeated washings before they are sulphured. If a very bright whiteness be required, it will be proper to expose them to heat a second, and even a third time, always in water a little soapy, made with two ounces of that substance for each pound of wool. It will be better to repeat this operation, turning the stuff for half an hour at each immersion with a stick, than to run the risk, by too strong a ley, of injuring the quality of the wool. After the stuff has been carefully rinsed it is carried to the tubs to be immersed in liquid sulphurous acid, or sulphur water, as the workmen term it: the pieces are rolled upon the reels, and are drawn through the sulphurous acid by turning them until it is observed that the whiteness is sufficiently bright. They are then taken out, and left to drain on a bench covered with cloth, lest they should be stained in consequence of the decomposition of the wood by the sulphurous acid: they are next washed in river water, and Spanish white is employed if it should be judged necessary. This operation is performed by passing the pieces through a tub of clear water in which about eight pounds of Spanish white have been diluted. To obtain a fine whiteness, the stuffs, in general, are twice sulphured. According to our process, one immersion and reeling for two or three hours is sufficient. Azuring or blueing is performed by throwing into the Spanish-white liquor a solution of one part of Prussian blue to four hundred parts of water, shaking the cloth in the liquid and reeling it rapidly.

The operation is terminated by a slight washing with soap, to give softness and pliability to the stuffs. The final operations of drying, stretching, pressing, &c. are foreign to the processes which are the object of this essay.

Before venturing thus to recommend the use of the liquid sulphurous acid, we made a great many experiments on spun wool and woollen stuffs, and always with the most complete success.

Of

Of Silk.

Silk is a diaphanous matter spun by a caterpillar, and formed of a substance contained in its body, which becomes hard in the air. This insect inhabits warm climates, being indigenous in Asia: it was naturalized in Europe about the time of the downfall of the Roman empire.

The filaments prepared by the filkworm are rolled up in a cod or ball. In the state in which we find it, it is covered with a yellow varnish, which destroys its brilliancy and renders it rough. Silk by chemical analysis gives carbonate of ammonia and oil; water at a boiling heat produces no effect upon it; alcohol makes it experience no change, but concentrated alkaline leys attack and dissolve it.

To give splendour to silk, it must be freed from its varnish. This covering is soluble in alkaline leys. Silk is scoured by means of soap, which ought always to be chosen of a good quality for fear of staining it, and sometimes with diluted muriatic acid. Silk by being scoured with soap loses a fourth of its weight. The matter disengaged from it is exceedingly fetid: if a skain of silk be not washed in abundance of water after being scoured, it will become hot in a few days, putrid fermentation will take place, and small white worms will be produced, which will devour the glutinous and saponaceous matter that remains in the silk. The liquor in which it is boiled putrefies, and becomes useless. Macquer has very properly observed, that if the yellow varnish can be precipitated to the bottom of the soapy liquor before putrefaction takes place, the soap may be recovered, and the dyer will thus make a considerable saving.

Even when the best soap is used, it is generally suspected that it injures the whiteness of the silk. The splendour of the Chinese silks is brighter than that of the European, and the Chinese employ no soap in their operations. We remember that the Academy of Sciences proposed a prize for a method of scouring without soap, which was gained by Rigaud, who performed it by a slight alkaline solution. Colomb even dissolved the varnish of silk in water, notwithstanding the opinion entertained of its insolubility in that liquid. He exposed the raw silk for nine hours to ebullition, and freed it from the varnish with the loss of a fourth of its weight.

Notwithstanding the whiteness which silk acquires by these different operations, it must be carried to a higher degree of splendour by exposing it to the action of sulphurous

acid gas in a close chamber, or by immerfing it in that acid in a liquid ftate.

Of the Bleaching of Silk.

To obtain the complete bleaching of filk it is fubjected to feveral operations. The firft tends to deprive it of the gum and colouring matter which externally cover its filaments; the fecond, to give it a juft degree of whitenefs: fometimes the fcouring is feveral times repeated; it is then baked, blued, and fulphured.

It is freed from the gum by a ley of foap and foft water, in the proportion of from twenty-five to thirty pounds of the fineft kind of foap for a hundred pounds of filk. The boiler is then expofed to the action of the fire, and the heat is fo far kept down by a little cold ley, as to maintain, as uniformly as poffible, the temperature of about 90 degrees of Fahrenheit. The filk is turned, to expofe all the parts of the fkains to the action of the bath. The fkains are then twifted on the wringer to free them from the ley. They are put into bags of coarfe cloth in packets of about twenty-five pounds.

The baking, as the workmen term it, though a boiling, is performed by throwing all thefe bags into a kettle of frefh ley compofed as the preceding, making it boil for two or three hours, and ftirring it often with a batton left the filk fhould adhere to the bottom: it is then taken from the bags, after which it is opened and fpread out. When the fkains have been fuffered to drain they are again wrung, and then rinfed in a ftream of water. When they have been well wafhed and beat in the running water, they are examined, to fee whether there be any fpoats not diffolved which may render it neceffary to repeat the operation.

To give it whitenefs, a foapy ley is prepared of four ounces of foap for each pound of filk, diluted with water till it form a good lather when well ftirred and beaten. The fame heat is maintained as in the preceding operations, and never that of boiling water; the filk is preffed for half an hour at leaft, and after being turned for another half hour it is removed; and, not unfrequently, it is *baked* before it is fubjected to the operation of fulphuring.

This *white baking* is performed in a ley fimilar to that above defcribed, and in bags like thofe employed for boiling the filk in its raw ftate. This baking finifhes the bleaching with foap. The filk being taken from the bags is wrung, and rinfed in running water. If an azured white be required, it is made to pals through blue; after being azured, and
when

when the filk is dry, it is then sulphured, and the bleaching is complete.

All these processes are exceedingly destructive: those which I am about to propose will make a total change in the method of bleaching filk. I have already mentioned the prize granted by the Academy to Rigaud for scouring by means of a slightly alkaline ley, and the success obtained by the abbé Colomb in having succeeded to dissolve the varnish of filk by the action of boiling water at a very high temperature: these incontestable facts furnish more than the necessary proofs of the goodness of our method.

Take a solution of caustic soda, so weak as to mark only a fourth of a degree at most of the areometer for salts, and fill with it the boiler of the apparatus for bleaching with steam. Charge the frames with skains of raw filk, and place them in the apparatus until it is full; then close the door, and make the solution boil. Having continued the ebullition for twelve hours, slacken the fire, and open the door of the apparatus. The heat of the steam, which is always above 250 degrees, will have been sufficient to free the filk from the gum and to scour it. Wash the skains in warm water, and, having wrung them, place them again on the frames in the apparatus, to undergo a second boiling. Then wash them several times in water, and immerse them in water somewhat soapy to give them a little softness.

The last degree of bleaching is effected by making the skains to pass through sulphurous acid, making use of the process and apparatus before recommended for bleaching wool, and which supplies here the place of sulphuring. The incalculable advantage of this process in comparison of any other, consists chiefly in the possibility of following its operations progressively, and without running the risk of injuring the quality of the filk by too violent leys.

Of the Bleaching of Vegetable Matters.

The characters and properties of vegetable substances are widely different from those we have described. As organic matters, they contain oxygen, hydrogen, and carbon; but azote, which acts so important a part in the animal kingdom, is rarely found in them, and much less phosphorus and sulphur.

The substances found in the interior of plants are, like those observed in the interior of organized bodies, the result of vegetable secretion. The nourishment of vegetables is derived from the bosom of the earth, and this combination of principles

ciples, absorbed by the roots, with the juices assimilated in their vascular vessels, produces new compounds.

The destruction of plants exhibits phenomena which have very little resemblance to those exhibited by the dissolution of animal bodies; but the last result is always the natural destruction of the combination of their constituent principles, the union of hydrogen and oxygen forms water, and the combination of oxygen and carbon forms carbonic acid. It is on these principles and modifications, applied to the treatment of vegetable matters, that the art of destroying colour is founded; it is a decomposition begun and checked in proper time, or the destruction of some principles in order to preserve others.

To bleach vegetable substances requires the concurrence of several menstrua or deterfive substances; such as soda, oxygenated muriates, calcareous sulphuret, and soap. There are several processes for depriving hemp, flax, and cotton, of their colour, which may be classed in the following order:

1st, Bleaching in the open air, with the assistance of alkali and soap.

2d, Bleaching by water alone.

3d, Bleaching by the oxygenated muriatic acid, substituted for the action of the atmospheric air; and this method is divided into four distinct processes: the first consists in employing the oxygenated muriatic acid alone; in the second, potash is mixed with this acid to condense the gaseous vapour and destroy its suffocating odour; for the third, oxygenated muriates dissolved in water are employed; and in the fourth, sulphuret of lime is united with this acid.

4th, Bleaching by the steam of alkalino-caustic water, where the air and solutions of oxygenated muriates coincide alternately with the action of the steam.

Of Hemp and Flax.

If hemp and flax be examined immediately after they are pulled, we observe an union of fibres cemented together, which form filaments; these fibres are moistened by the sap, and the stalks, formed of bundles of filaments, are enveloped in a semi-ligneous substance, and covered with a very thin bark. The sap of textile plants differs from those of ligneous plants; it approaches near to extractive matter; it is neither saponaceous, nor resinous, nor aqueous, but it possesses something of all these properties: it is soluble in water like the sap of wood, it precipitates itself in flakes by the action of oxygenated muriatic acid, but these two kinds of sap are distinguished by

by one very striking character: that of trees almost always contains tanning principle, or gallic acid; that of textile plants never possesses any. The sap, therefore, is nothing else than real vegetable chyle; a nutritive juice, composed of water, mucilage, and sugar, with some portions of carbon, phosphorus, and lime.

These preliminary observations are indispensably necessary for comprehending the theory of the operations to which hemp and flax are subjected. Deprive these plants of their sap as soon as they are pulled, decompose the extracto-mucilaginous matter, which occasions the aggregation of their filaments, and you will have performed the first operation, which is called *watering*. The hemp or flax, tied up in bundles, is immersed in stagnant or spring water, in which the bundles are pressed down by means of stones. Well water and brackish water must be carefully avoided, as well as that which flows over gypseous soil. Such water accelerates putrefaction, and hurts the quality of the hemp and flax. This is perfectly agreeable to the principles of chemistry; it is thus that a little salt accelerates animal putrefaction, while a great deal tends to prevent it. The portion of saline substances taken up by the water hastens corruption by extending the putrid fermentation, which ought to operate only on the juices, even to the filaments, which it blackens and spoils.

The fibres of flax are separated by letting them remain in stagnant water until the mucilaginous membranes which connect them are destroyed by putrefaction. During its immersion their sap is decomposed and dissolved, the bark separates from the ligneous body, and the fibres are insulated. Some days are sufficient for the process of watering.

To ascertain the period of watering, which always varies according to the kind of plants, the degree of their maturity, and the nature of the sap, a handful of the flax is taken from the pond, and broken and rubbed between the fingers: if the stalks are still green, but brittle, and break with the least effort, the bundles must be taken out: a longer immersion might extend the decomposition even to the fibrous texture. The putrescence decomposes the water; there is formed carbonated hydrogen pestilentially foetid; the fishes die, and the air becomes infected. In countries where a great deal of hemp and flax are cultivated, there are laws which forbid these substances from being watered in rivers and other streams.

The hemp and flax, when taken from the water, are spread out on the grass to dry. During the fermentation and decomposition

composition which thence result, there is a speedy combination of oxygen and carbon. Exposure on the grass facilitates the escape of the carbonic acid into the atmosphere. The plants become of a whitish gray colour, which is called a *flaxen gray*.

It is known that a ley very slightly alkaline may be substituted with advantage for this long and noxious operation: it is therefore certain that a chamber of from 20 to 30 feet in length, into which the steam of alkalino-caustic water of the strength of *one-fourth* of a degree only is introduced, will be sufficient to produce the same effect as watering, on an immense quantity of hemp and flax suspended on basket-work, in less time and with less expense than are required for the different manipulations of watering. The losses occasioned by the negligence of workmen, who, by suffering the hemp and flax to macerate too long, give time to the decomposition to reach the filaments, which renders them brittle and occasions a considerable waste, will also be avoided. In our process the artist can follow every moment the progress of his operation, and stop it at the favourable period.

Hemp and flax, after being watered, must be dried in a kiln or stove. A fibrous skeleton which exhibits a number of small tubes, the interior of which is composed of a fibrous tissue, and the exterior of a ligneous, will then be obtained: one of these must be preserved, and the other rejected. This is the object of the subsequent operations of beating, heckling, &c.

The ligneous tissue, or this bark, as the workmen call it, is thrown away as useless, and a certain portion of the fibres of the hemp and flax, which still adheres to it, is thus lost, notwithstanding the care of the workmen during these different manipulations.

In the neighbourhood of mills, where the operations of beating, heckling, &c. are performed, I have seen heaps of that substance thrown away: it cannot be converted into manure, on account of the long time required for its decomposition; and I have often lamented the loss of a matter so valuable, and which might so easily be employed for some useful purpose. By macerating it in water, and subjecting it to the other operations of a paper manufactory, it may be converted into pulp proper for the fabrication of every kind of paper*: it might even be previously bleached, or bleached in the state of pulp, by the different processes which are the

* In Britain this substance is often so made use of.—EDIT.

object of this essay. The price of rags is already high enough, besides their scarcity; and Belgium, the ci-devant Brittany, Auvergne, Alsace, &c. are every year covered with heaps of this substance, which the paper-makers might procure at a very low price, and which would afford a rich mine to be worked by the industrious artist.

Hemp and linen cloth, when they come from the hands of the weaver, are charged with flour paste called *dressing*, employed by the manufacturers to aid the tension of the threads during the weaving: some manufacturers immerse their cloth in tubs, or expose them in running water, or boil them, to free them from this substance. These are bad methods, which betray absolute ignorance of the proper principles. The best is to immerse the cloth from forty-eight to fifty hours in a tub filled with soft water, at the temperature of from 60° to 75° : the kind of fermentation which ensues is sufficient to decompose the paste, and is never strong enough to attack the filaments of the thread: the cloth is then to be rinsed in running water, by the help of a fluted cylinder, which entirely frees it from that amylaceous substance.

This operation gives to cloth a first degree of bleaching, which arises merely from the destruction of a part of the colouring matter during the fermentation, which opens the threads of the cloth, slackens and softens their tissue, and swells their fibres: it may be seen that it has reached its proper term by observing all these phenomena, and when the colour of the cloth is uniform throughout.

After the cloth has been completely rinsed in running water with the cylinder, it remains of a grayish white colour: the tint which opposes its perfect whiteness arises from extracto-resinous matter which remains combined with the filaments, and from which they must be freed. This is the operation properly called bleaching, whatever may be the operation employed for accomplishing it. These different processes will be described in the course of this work.

Of the colouring Matter of Hemp and Flax.

Before we proceed to a description of the different processes for bleaching, it is of importance that we should say a few words respecting the colouring matter of flax. This subject has been fully treated of by the celebrated Kirwan, from whose experiments it is abundantly proved that the colouring matter extracted by the action of alkalies is a peculiar resin, which differs from pure resin by being insoluble in essential oils, and in having some resemblance to licks. Having procured some of this substance, by separating it from what

the workmen call *dead ley*, by saturating the alkali with acids, and in that manner obtaining it in the form of a greenish precipitate, which he carefully washed, he made the following experiments to determine the action of alkalies upon it:

Eight grains of it were digested in a solution of crystallized soda saturated at the temperature of 60° of Fahrenheit: the solution instantly assumed a dark brown colour. Two measures of this solution, weighing each 275 grains, were not entirely dissolved by this substance; but two measures of a solution of potash dissolved the whole of it.

One measure of caustic soda, the specific gravity of which was 1.053, dissolved almost the whole of it, leaving only a white residuum.

One measure of caustic potash, the specific gravity of which was 1.030, dissolved the whole of it.

One measure of an alkaline sulphuret, the specific gravity of which was 1.170, dissolved the whole matter.

One measure of ammonia dissolved also a portion of this substance.

Though these experiments were sufficient to satisfy Kirwan's doubts, he thought it necessary to repeat them with the saline substances usually employed in bleaching as well as with soap.

He dissolved, therefore, an ounce of common soda, and as much Dantzic potash, each in six ounces of distilled water: eight grains of the green matter were put into a measure of an ounce of each solution, and then digested for three hours and a half in a heat equal to 180° of Fahr. The dissolving power of the Dantzic potash was superior to that of the soda; for, an ounce of the solution of soda was still required, and half an ounce only of the solution of potash, to dissolve the whole of the substance.

An ounce of white soap was dissolved in 18 ounces of distilled water. The solution was turbid, and it could not be rendered transparent but by heating it almost to the point of ebullition, and then the operation was difficult; for when the liquor, by chance, began to boil, it was thrown to the distance of more than three feet from the matras. Three ounces of this solution were required to dissolve eight grains of the colouring matter.

In order to compare the respective strength of these solutions, it must be observed, that an ounce of the soda of the shops contains only 114 grains of pure soda: suppose the solution to have been made in six ounces of water, each ounce of water will contain 19 grains of pure alkali, while

an ounce of the like solution of Dantzic potash will contain 50 grains.

The deterfive force of lime was tried without success; three ounces of water, saturated with lime, produced scarcely any effect on the colouring matter: these three ounces contain at most three grains of pure lime.

Description of Apparatus.

Fig. 1. (Plate II.) the new apparatus proposed by the author for preparing liquid fulphurous acid, and which may serve also for distilling oxygenated muriatic acid. A, a section of the furnace, which is a sand bath, and contains three flasks (as may be seen in the horizontal section fig. 2). Each flask is furnished with a bent tube *a*, for pouring in the sulphuric acid; and from it the liberated gas passes by the tube *b* into the receiver B, which is made of lead. This receiver has five necks (vide fig. 2.): three of them receive the tubes connected with the three flasks, one receives a safety-tube *c*, intended to prevent absorption, and the 5th the bent tube *d*, which connects it with the series of tall Wols C, D, &c.

Fig. 3. shows the way in which it is proposed to alter Mr. Rupp's apparatus. The stuff is made to pass over rollers in the corners, &c. of the box in going from one reel to another, and the axes come through leather collars in the side instead of the top of the box. The engraving represents a vertical section.

Fig. 4, a boiler and steaming chamber. A, the boiler, charged with stale urine, rendered caustic by the addition of quicklime*. The ammonia thus disengaged passes through the tube B into the chamber C, which is furnished with reels and rollers for winding the stuff, and thus exposing it to the action of the vapour. At the corner *a*, the uncondensed vapour can pass into the worm-tub D to be condensed, and returned to the boiler by the tube *b c*. Or it may be received into the tub E by shutting the cock at *c*, and opening the cock *n*. The opening into the chamber, *i.e.* the door, is on the top, and shuts air-tight. With this apparatus, vapour or steam of any kind may be employed for the purpose of bleaching.

[To be continued.]

* For this method of applying ammonia to the purposes of bleaching, the world is indebted to Mr. Crooks, of Edinburgh, who, a considerable time ago, took out a patent for it for England. The same gentleman having, along with Mr. Turnbull, improved the process, and extended the principle to the use of fixed alkalies also, assisted by the action of the steam of boiling water, patents have since been taken out in their joint names for England, Scotland, and Ireland. Of this invention we gave an account in our ninth volume.—EDIT.

Fig. 2.