XX. *On the Uſe of Oxides or Calces of Iron in dying Cotton.* By J. A. CHAPTAL.

FROM THE *ANNALES DE CHIMIE.*

THE oxide of iron has ſo ſtrong an affinity to cotton, that if a cotton thread is dipped in a ſaturated ſolution of iron, in any kind of acid, the thread inſtantly acquires a buff colour, more or leſs deep, according to the ſtrength of the liquor. This affinity may be ſhewn by the following experiment, which is both curious and eaſy to be made. If a ſkein of cotton thread is dipped into a ſolution of green vitriol, rendered turbid by the oxide which remains ſuſpended therein, and the cotton is moved about in the liquor, it will take up every particle of the oxide, and thereby reſtore to the liquor the tranſparency it had loſt; after which, the ſolution, which at firſt had a yellowiſh hue, becomes more or leſs green, according to its ſtrength.

The colour given to the cotton by the oxide of iron, grows darker merely by expoſure to the air; and this colour, which is ſoft and pleaſant when the

the cotton is taken from the bath, becomes harſh and ochrey by the progreſſive oxidation of the metal.

The colour given by the oxide of iron is very permanent: it not only reſiſts air and water; but alkaline leys, or ſoap, give it brilliancy, without ſenſibly diminiſhing its intenſity.

On account of theſe properties, the oxide of iron has become an eſſential ingredient in the art of dying, being conſidered as a colouring principle of the utmoſt value. I have been ſo fortunate as to extend the uſe of this oxide; but ſhall confine myſelf at preſent to ſuch reſults as have been found worthy of a place in the operations of the dyer, and have for ſeveral years been practiſed with ſucceſs in my manufactory.

In order that the oxide of iron may be conveniently applied upon the cotton thread, we muſt begin by making a ſolution of the ſaid oxide; for which purpoſe, acids are the moſt uſeful ſolvents.

In moſt places, dyers make a ſecret of the acid they employ; but it is always either the acetous, the vitriolic, the nitrous, or the marine acid.

Some dyers pretend there is a great difference in the effect of the different acids, but, in general, they give the preference to the acetous.

This preference appears to me to be founded much leſs on the difference of colour produced by

by the different ſalts, than on the different degree of corroſive power which each ſalt exerts upon the cotton. The power of the mineral acids is ſo great, that if the ſtuff is not waſhed when taken out of the bath, it will certainly be corroded; whereas, the ſolutions made in the acetous, or any other vegetable acid, are not attended with this diſadvantage.

Iron appears to be as much oxidated by being diſſolved in one acid as in the other, ſince it produces the ſame ſhade of colour when precipitated; and any acid may be employed, without diſtinction, provided the degree to which the acid is ſaturated, and the nature of the ſalt formed therewith, are ſufficiently known; for the ſubſequent operations may be regulated by the knowledge of theſe circumſtances, ſo as to avoid the inconveniences attending the uſe of ſome of theſe ſalts. This is, in the firſt inſtance, an advantage the man of ſcience has over the common workman, who knows not how to vary his proceſs according to the nature and ſtate of the ſalts he makes uſe of.

I ſhall at preſent only point out what colour may be obtained by means of the oxide of iron; firſt, when employed by itſelf, on ſtuff which has not been previouſly prepared; ſecondly, when employed, in conjunction with madder, on ſtuff which

which has been properly prepared for receiving the Adrianople or Turkey red.

Firſt. If ſulphate of iron, or any other martial ſalt, be diſſolved in water, and cotton be dipped in it, it will, as was before ſaid, acquire a buff colour, more or leſs deep, according to the ſtrength of the ſolution; and the affinity of the cotton to the iron is ſo ſtrong, that it attracts the metal, and takes it in great meaſure from the acid in which it was diſſolved.

Secondly. If iron be precipitated from a pretty ſtrong ſolution, by an alkaline liquor, (of five or ſix degrees, by Baumé's areometer,) a coagulum of a greeniſh-blue colour will be formed; if cotton be macerated therein, it will immediately acquire an irregular and dirty green colour, which, by mere expoſure to the air, will, in a ſhort time, turn to a very deep yellow colour.

By theſe proceſſes, or ſimilar ones, dyers produce what are called ochre or ruſt colours.

But theſe colours are attended with ſeveral inconveniences; firſt, when they are very deep, they corrode or wear the ſtuff; ſecondly, this colour is harſh, and does not mix well with the ſoft colours produced from vegetables.

I endeavoured to remedy theſe inconveniences, and I ſucceeded in the following manner.

I ſoak the cotton in a cold ſolution of green vitriol, (of three degrees of ſtrength,) and, having

ving wrung it carefully, I immediately plunge it into a ley of potaſh, (of two degrees,) upon which I pour a ſaturated ſolution of alum. The colour then grows brighter, and becomes infinitely more fine, more ſoft, and more pleaſant. The vitriol no longer corrodes the ſubſtance of the cotton, and, after it has remained four or five hours in the bath, it may be taken out to be wrung, waſhed, and dried.

In the above manner, by graduating the ſtrength of the ſolutions, we may obtain all the ſhades of colour that can be deſired. This ſimple proceſs, the theory of which muſt be obvious to every chemiſt, produces a colour which is very agreeable, very permanent, and, above all, very œconomical. I employ it with ſucceſs in dying fuſtians, &c. the colour of which is infinitely more permanent than that of the Engliſh ones, having the advantage of reſiſting alkaline leys. The only defect I have found in the colour is, that it turns brown by the action of aſtringents.

I thought, for ſome time, that it might be poſſible to combine this yellow colour with the blue of indigo, ſo as to produce a permanent green, but hitherto I have been diſappointed in my hopes. It appears, from the different trials I have made with this ſubſtance, that there is not a ſufficient affinity between the blue of indigo

and the oxide of iron; for I could never obtain any other than a dirty muddy green, very cloudy and faint.

The oxide of iron, on the contrary, combines very readily with the red of madder, and the combination produces a light violet colour, the uſe of which is as extenſive as it is advantageous in the cotton manufactory.

But, if theſe two colours were to be applied to cotton, without having firſt employed a mordant capable of fixing the latter, the colour would not only remain dull and unpleaſant, from the impoſſibility of brightening it, but it would alſo have the great defect of not being able to reſiſt the alkaline leys. We muſt therefore begin by preparing the cotton as if for receiving the Turkey red; and, when the preparation is carried on as far as the operation of galling, the cotton is to be dipped into a ſolution of iron, more or leſs ſtrong, according to the nature of the violet colour deſired. The cotton is then to be carefully waſhed, twice dipped in a decoction of madder, and afterwards brightened in a ſolution of ſoap.

When a true violet colour, very rich and full, is required, the cotton is not to be put into the ſolution of iron till it has been galled: the iron is then precipitated in the form of a bluiſh oxide, which, when combined with the red colour of the madder, produces a very rich purple colour, more

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or leſs full, according to the ſtrength of the galling, and that of the ſolution of iron. It is, however, very difficult to obtain an uniform colour by this proceſs: indeed, an uniform violet colour is conſidered by the dyers as a maſterpiece; and it is generally ſuppoſed, that this great difficulty, of ſo much conſequence in the art of dying, cannot be overcome without the moſt ſkilful management. Nevertheleſs, I am convinced, that the principal cauſe of the irregularity in this dye is, that the iron depoſited on the cotton becomes oxidated merely by expoſure to the air, which expoſure varies in different parts of the cotton. The threads which are on the outſide of the ſkein, are ſtrongly oxidated; while thoſe on the inſide, not being expoſed to the action of the air, ſuffer no change. It therefore follows, that the inſide of the ſkein acquires a faint colour, while the outer part acquires a very dark violet. The only way to prevent this inconvenience is, to waſh the cotton when it is taken from the ſolution of iron, and to put it into the decoction of madder while yet moiſt. The colour thereby becomes more uniform, and more rich.

The ſolvents of iron, for this colour, are nearly the ſame as for the yellow colour already mentioned.

I ſhall omit every thing reſpecting the manual operations of the proceſs, and ſhall confine myſelf merely to the chemical ones; for which reaſon, I ſhall mention an obſervation which may ſerve as a guide to the workman, in brightening the violet colour upon cotton.

The red of the madder and the oxide of iron, by being depoſited on the cotton, produce a violet colour. This colour inclines to red, or blue, as one or the other of theſe two principles predominate. The dyer knows, by experience, how difficult it is to obtain ſuch a combination as will produce the ſhade of colour he deſires, eſpecially when he wiſhes it to be very full, brilliant, and permanent. It may, however, be obtained, not only by varying the proportions of the two colouring principles, but alſo by varying the proceſs of brightening. It is only neceſſary to be acquainted with the two following circumſtances, *viz.* that barilla deſtroys the iron; and that ſoap, by ſtrong boiling, conſumes the colour of the madder. For this reaſon, the colour may be made to incline to red, or to blue, according as the brightening is performed with one or the other of theſe mordants. Thus, cotton taken from the madder-bath, waſhed, and brightened with a proper quantity of ſoap, will be of a rich violet colour; whereas, by brightening it with barilla, we ſhall obtain only a light violet colour.

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The oxide of iron, when precipitated on any ſtuff, combines very advantageouſly with the fawn colour furniſhed by aſtringents; and, by varying the ſtrength of the mordants, an infinite number of ſhades may be produced. In this caſe, the reſult is rather a ſimple mixture, or juxtapoſition, of the colouring particles on the ſtuff, than a chemical combination or ſolution of principles. We may indeed, by a boiling heat, combine the oxide of iron more intimately with the aſtringent principle: it is then brought into the ſtate of a black oxide, as Berthollet has obſerved.

It is poſſible alſo to turn theſe colours brown, and to give them a variety of ſhades, from a light grey to a deep black, merely by dipping the cottons, impregnated with the aſtringent principle, into a ſolution of iron. The oxide itſelf is then precipitated by the aſtringent principle, which is fixed upon the ſtuff.

A circumſtance which may become of great importance to the art of dying is, that all the moſt uſual vegetable aſtringents afford a yellow colour, which, although it is not very bright, is ſufficiently durable to be advantageouſly employed. This yellow colour in vegetables is capable of being brightened in proportion as the aſtringent principle diminiſhes, and the livelineſs of the colour increaſes in the ſame proportion. It

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is, on this account, difficult to obtain yellow colours which are at the ſame time durable and brilliant; theſe two valuable qualities being in an inverſe ratio to each other. But it is poſſible to mix theſe two colouring principles in ſuch a way as to unite durability to brilliancy. Green oak-bark unites perfectly well with woad or yellow weed, (Reſeda Luteola;) and ſumach unites well with quercitron * bark. From ſuch mixtures, in combination with the oxide of iron, we may produce vegetable colours, the brilliancy of which is equal to their durability.

I ſhall conclude theſe reflections with an obſervation relative to the uſe of aſtringents in dying cotton:

It has been ſuppoſed that, in dying cotton red, the place of galls might be ſupplied by an increaſed quantity of ſumach, alder-bark, or oak-bark. I wiſh this were the caſe, as the high price of galls very much enhances the expence of the colours dyed with them; whereas I could procure ſumach at a low price, as it grows almoſt every where in the dry parts of our ſouthern provinces; but I can affirm, that it is impoſſible to ſupply the place of galls with theſe ſubſtances, in whatever proportion they are employed; the

* A name given by Dr. Bancroft to a ſpecies of American oak.

colour

colour produced from them being always more pale and faint, and leſs permanent. I know that what is here ſaid does not apply to dying wool and ſilk, for which the above ſubſtances are ſucceſsfully employed; and, upon conſidering the cauſe of this difference, it appears to me to ariſe from the nature of the galls. In the firſt place, the acid they contain is different from that of other aſtringents, (as Berthollet has proved,) and facilitates the decompoſition of the ſoap with which the cotton is impregnated; hence, a greater quantity of oil remains fixed in the ſubſtance of the cotton, and is more intimately combined with it. Secondly, galls, being produced by means of inſects, always retain a certain degree of animal nature, which they impart to the cotton, thereby increaſing its affinity to the colouring principle of the madder. The uſe of animal ſubſtances in facilitating this combination is well known; but wool and ſilk being themſelves animal ſubſtances, it is unneceſſary, in operating upon them, to make uſe of galls.

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