The third process with Kalle's salt is not properly speaking the printing of indigo, but of a special preparation capable of forming indigo when treated with caustic alkalis. The salt is merely dis­solved and thickened with gum or starch, printed, and then passed direct through a solution of caustic soda, when the indigo is immedi­ately developed. Instead of being passed through the alkali, which is apt to cause the colour to run before it is properly developed, the cloth is more commonly printed with thickened caustic soda, whereby the indigo is equally well produced without any fear of “ running.”

Besides indigo, other vat dye-stuffs, such as indanthrenes, the algol, helindone and ciba colours, thioindigo scarlet, &c., are also printed largely at the present time, yielding colours of hitherto unattained fastness to washing and to light.

(*f*) *Insoluble Azo-Colours.—*These colours do not exist as such, but require to be produced on the fibre itself from their components. They form a range of exceedingly fast colours, including orange, red, pink, maroon, brown, chocolate, blue and black, and are produced by the combination of various diazo-bodies with phenols, the most important of which latter is ß-naphthol (beta-naphthol).

In practice their application is briefly as follows:—The bleached cloth is prepared in a solution of β-naρhthol in caustic soda (naphtholate of . soda), then gently dried and printed with the thickened diazotized amine required to produce the desired shade. The printing colour must be cooled with ice to prevent its decom­position; hence such colours are sometimes known as “ ice colours.”

The two colours most extensively used are para-nitraniline red and *α*-naphthylamine maroon, both of which are bright fast colours, only equalled by turkey red and madder chocolate for general usefulness.

On β-naphthol prepare the following colours may be obtained :—

Red with paranitraniline.

Maroon with α-naphthylamine. Orange with orthonitrotoluidine. Pink with azo pink 2 B. Chocolate with benzidine.

Brown with benzidine and orthonitrotoluidine.

Blue with dianisidine.

Black with dianisidine and benzidine.

Other naphthols and other bases give a still greater variety of shades.

The naphthol prepare requires to be freshly made, and the cloth prepared with it carefully dried, if good results are to be obtained.

Paranitraniline is made up for printing by dissolving in hydro­chloric acid. Nitrite of soda is then added, and, after standing a short time to complete the reaction, the resulting diazo-solution is mixed with thickening, and acetate of soda is then added to neutralize any free mineral acid still remaining, the presence of which would prevent the formation of the colour.

In practice the following formulae have given good results :—

(1) Paranitraniline Red

Prepare the bleached cloth in :—

47 parts ß-naphthol.

3 „ naphthol R.

107 „ caustic soda, 50° Tw.

400 ,, hot water.

10 ,, tartar emetic.

12 ,, tartaric acid.

Make up to 1000 parts with hot water.

The cloth is passed through a trough containing this solution, the excess is squeezed out between two wooden rollers, and the cloth is gently dried and then printed with:—

36 parts paranitraniline C.

100 „ ice.

100 „ hydrochloric acid, 30° Tw.

. 70 „ water.

Mix and add quickly:

Ì24 parts nitrite of soda, 93 per cent.

70 „ water (cold).

And just before printing add further:

100 parts acetate of soda.

100 „ ice in large pieces.

400 „ tragacanth mucilage, 12 per cent.

Print, dry and wash.

A similar prepare without the naphthol R. may be used for α-naphthylamine maroons, the printing colour for which is made up as follows :—

36 parts α-naphthylamine.

93 ,, hydrochloric acid, 30° Tw.

171 „ tragacanth mucilage.

Grind till perfectly smooth in a mill and then add:

100 parts ice.

20 „ nitrite of soda of 93 per cent. strength.

80 „ water.

400 „ starch and tragacanth thickening.

25 „ benzine.

75 ,, acetate of soda.

1000

Print, dry and wash.

Immediately these diazo-colour pastes come in contact with the naphthol-prepared cloth the colour itself is formed and fixed and requires no further treatment except that of washing to remove the naphthol from the unprinted parts of the cloth.

The other bases are diazotized in precisely the same way, the quantities of acid and nitrite of soda being varied according to the molecular weights of each base.

Several processes of printing azo-colours directly, without any previous preparation of the cloth, have been proposed, but they are not in general use as yet ; those which have passed the experi­mental stage are not very successful on the large scale, and have, for the most part, been abandoned.

(g) *Application of Sulphur Dyes.—*Of late years the class of colours known as “ sulphur colours ” have assumed a prominent place in textile-printing. They are really direct dyeing colours, but their special properties entitle them to be classed apart from those usually known under this name.

There are now an enormous number of sulphur-colours on the market under many different names, but, as they are all similar in general properties, it is needless to mention more than one series. The “ thiogen colours ” of Meister, Lucius and Bruning will serve as well as any to exemplify the application of these dye-stuffs in printing. They comprise yellows, golds, browns, violets, blues, greys and blacks, all fairly, and some very, fast to light and soap, and, under proper conditions, easy of application to a variety of styles.

The general recipe for printing is as under:—

30 parts by weight of colouring matter.

50 .. .> ». glycerin.

80 „ ,, ,, water.

( 50 „ „ „ china clay beaten up with

( 50 .> .> .. water.

40 ,, ,, ,, concentrated hydrosulphite N.F., 50 per

cent. solution.

700 „ ,, ,, alkaline British gum thickening.

1000

This paste is printed on unprepared bleached cloth, gently dried and then passed through a rapid steam ager, in from 4 to 7 minutes in dry steam at 212° F. to 220° F. (or twice for 3 minutes), after which the cloth is passed in the open width through the washing and soaping machines, and finally dried up and finished.

The sulphur colours may be used in combination with the azo- colours, on naphthol-prepared cloth, for the production of multi­colour effects, and are eminently adapted also to the production of coloured discharges on paranitraniline red and the direct-dyeing colours.

*(h) Aniline Black.—*Aniline black was discovered and first used by Lightfoot in 1863. It is one of the fastest blacks known, and is equally useful for direct printing by itself, and for working along with printed mordants and discharge pastes. Aniline black is formed by the oxidation of aniline.

As a rule the oxidation of the aniline is brought about by means of sodium chlorate in presence of suitable oxygen carriers such as copper sulphide, vanadium chloride or potassium ferrocyanide. Copper and vanadium blacks are usually developed after printing by being aged in a moderately warm room for a day or two, when they become converted into “ emeraldine,” at which stage they are taken down, and passed through a hot solution of bichromate of potash to complete the oxidation of the aniline. Great care is required in printing these two blacks, as if overdried they take fire and have occasionally caused considerable damage to buildings in consequence. The blacks made with ferrocyanide, on the contrary, may be printed in conjunction with “ steam ” colours, and, after a preliminary passage through a rapid steam agcr, and an ammonia "gassing" box, will withstand the long steaming necessary for alizarine colours.

A copper aniline black may be made as follows :—

Ì15 lb starch.

8 lb British gum or dextrine.

5i gals, water.

4 lb chlorate of soda.

} gal. olive oil.

Boil, cool and add :

'8 lb aniline salt.

3 lb aniline oil.

- 5 lb sulphide of ∞ppcr (precipitate pressed to a 30 per cent, paste).

-I gal. water.