better results but apparently far short of the true amount. It would seem therefore that a large amount of chemical investigation is a necessity before digitalis can be properly standardized by chemical analysis alone, and a vast field of chemical research lies before us.

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THE MANUFACTURE OF COAL TAR AND COAL TAR PRODUCTS.*

GEORGE MCDERMAND.

About ten years ago the Denver Gas and Electric Light Company saw the possibilities of manufacturing and selling coal tar products in Colorado and the Western States. A plant was erected and roofing and paving materials manufactured. In a few years the sales were so great, with the demand for the products steadily increasing, it became imperative that a larger plant be constructed. The result was that a modern up-to-date tar plant with a large capacity and equipped to go more thoroughly into the manufacture of these compounds was erected. The amount of tar worked up into salable material by this plant is 100,000 gallons per month.

Coal tar is obtained during the process of gas manufacture. It is collected from the hydraulic mains and gas condensers, and after passing through a separator to relieve it of ammonia liquor, is stored in large wells until used in the manufacture of tar products.

Coal tar mixed with tar oils is extensively used as a paint for iron work and is used on the bottom of ships to keep them free from barnacles. It is also used for painting roofs, wooden buildings, fence posts, etc. Tar paint is an excellent wood preservative, as it contains a large amount of creosote. Paints that are composed of coal tar are very durable owing to the fact that tar is non-corrosive and free from oxidation.

Coal tar without water content is used in manufacturing tarred felt. Modern saturating machines convert the dry felt into uniform rolls of tarred felt. The roll of dry felt is placed on a spindle at the end of the saturating machine; it is run down into a saturating tank about five feet and is kept in the tar by an idler; after coming from the tar it is run between two rolls, where the surplus tar is pressed out, from which it is wound on a spindle until the roll becomes approximately fifty pounds. It is then taken off and seasoned in a warehouse, which takes about a week, before being wrapped and labeled.

* Read before the Denver Branch.

Four grades of tarred felt are manufactured at this plant. The heavy grade, No. 1, weighs twenty pounds to the square; the next heaviest is No. 2, weighing seventeen pounds; the medium grade, No. 25, weighs fifteen pounds; and the lightest, No. 22, thirteen pounds to the square.

The distillation of coal tar is carried on in stills with a capacity of about 5,000 gallons each. During the distillation the following fractions are made:

The oil collected up to 110° C is first light oil.
The oil collected from 110° C to 210° C is second light oil.
The oil collected from 210° C to 240° C is carbolic oil.
The oil collected from 240° C to 270° C is creosote.
The oil collected from 270° C to 360° C is anthracene oil.

In our plant the highest temperature reached is 270° C., as this produces a pitch which is the most universally used in this territory for roofing and paving purposes. On especial occasions, we make a harder grade of pitch for sealing dry cell batteries. The distillation as carried on here is as follows: The first and second light oils are run in one fraction. The carbolic and creosote oils in another. Only two fractions are made. The oils are then redistilled, which will be explained later.

The pitch is graded by suspending a cubic half-inch of pitch on a wire in a beaker of water one inch from the bottom, and thermometer is suspended with the bulb on a level with the center of the cube. The temperature is brought up five degrees per minute with a Bunsen burner. When the cube melts and just touches the bottom of the beaker, the temperature registered on the thermometer is the melting point of the pitch.

The grades of pitch made by this company are bituminous cement, road binder, waterproofing cement work, winter and summer roofing, expansion joints, block paving, and cement for dry cells. Three grades of dust laying tar are also made.

The gravel roof, which is laid of coal tar pitch and tarred felt, has become the most universally used roof on substantial buildings throughout the whole country; it is practically without competition. The United States Government specifies the gravel roof on all Federal buildings. The gravel roof has proven so successful, after many years' use, owing to its being waterproof, fireproof, elastic, and its long life, being suitable to all climates. The demand for material for gravel roofs has become so great that tar plants dispose of great quantities of their coal tar in manufacturing this material. In building a gravel roof, contractors first lay a ply of dry felt or building paper, which is followed by from four to six plies of tar paper, each ply being mopped sufficiently with coal tar pitch so that in no place does tar paper touch tar paper. When these plies of paper are laid, the surface is mopped over with pitch, and for protection, gravel is evenly spread on top of the hot pitch. These gravel roofs last approximately twenty-five years without repair.

The light oils obtained during the distillation of coal tar contain carbon bisulphide, benzol, toluol, xylol, coal tar naptha, and burning oil. It is used in paints as a general solvent.

The creosote oil contains carbolic acid, napthalene, ortho, meta and para cresol. This oil is used as a wood preservative, disinfectant, spray, sheep and cattle dip;

it is also used in shingle stains, iron and wood preserving paints. Large drug and paint houses in San Francisco, Seattle, and Portland use it in carload lots.

Napthalene is found in all the fractions, to a certain extent.

Benzol is used as a varnish remover, in paints, and for dissolving resins. It is the source of a great many products. Many colors are produced from benzol.

Nitro-Benzol, known as oil of bitter almonds, and under the name of oil of mirbane, is used to perfume soap. It is prepared by adding a mixture of nitric and sulphuric acids very slowly, to benzol, keeping the temperature low; after the acid is all added, it is washed several times with water; then purified by distillation. It has the formula of $C_6H_5NO_2$.

Aniline—$C_6H_5(NH_2)$, is prepared from nitrobenzene by a mixture of iron filings and hydrochloric acid, when the chlorides of iron and aniline is formed. The aniline is liberated by an alkali and is separated by distillation.

Aniline is a colorless liquid possessing a peculiar odor. When an aqueous solution of an alkaline hypochlorite is added, a violet coloration is produced.

When nitrous acid is allowed to react on aniline nitrate, diazobenzene nitrate is formed. This compound is a colorless crystalline substance which explodes on percussion or when heated. These salts when boiled with water decompose. Nitrogen is liberated and the group HO replacing N_2 forms phenol.

Aniline yellow is produced by the action of nitrogen trioxide in an excess of aniline, and heated in the presence of a salt of aniline. A great many more colors may be produced.

Benzylamine is obtained by the action of ammonia on benzylchloride. It is a true amine and gives rise to corresponding secondary and tertiary amines.

Benzyl alcohol $C_6H_5CH_2(OH)$ is obtained by the action of alcoholic potash on nitro benzol. Oxidizing agents convert it into the aldehyde C_7H_6O, and lastly, into benzoic acid.

Quinol, or hydroquinone, is prepared by dry distillation of quinic acid and by the moderate oxidation of aniline.

Acetanilide is formed when aniline is boiled with acetic acid or its anhydride.

Phenol: The creosote here contains about 23 per cent carbolic acid and 35 per cent of the three cresols. This creosote is used to a large extent as a disinfectant and sheep and cattle dip, the creosote being suspended in a rosin soap.

Our commercial cresol contains about 34 per cent carbolic acid and 66 per cent of the three cresols. It is known to tar distillers as carbolic oil No. 1 and No. 2, according to the number of times it has been distilled. Disinfectant manufactures know it under the name of cresylic acid.

The creosote is distilled in an especially constructed still, the fraction between 170° C. and 210° C. is collected and redistilled.

Cresylic acid rapidly becomes discolored in the light. It is used as an insecticide and germicide and suspended in a neutral linseed oil soap as a sheep dip, having twice the strength of the creosote dips.

Carbolic acid is produced by agitating the carbolic oil with a 10 per cent solution of caustic soda, neutralizing the sodium in the sodium phenate with a 10 per cent solution of sulphuric acid. The phenol is then separated from the water and distilled, the portion distilling within a few degrees of 182° C. is subjected to a

freezing mixture when crystals of phenol form. This process in some cases is repeated several times.

Salicylic acid is produced by dissolving phenol in caustic soda, then passing carbon dioxide into the dry salt which is slowly heated up to 180° C. Salicylic acid on being heated breaks up into phenol and CO_2.

Phenolphthalein is formed by heating phenol with phthalic anhydride and sulphuric acid.

Phthalic acid is produced by the oxidiation of napthalene and crystallizes from hot water in large prisms. It is decomposed on distillation into phthalic anhydride and water.

Picric acid is formed when phenol is acted upon by nitric acid.

Napthalene moth balls are produced by distilling crude napthalene with 5 per cent sulphuric acid; the purified napthalene is then formed into balls.

Alpha and Beta napthol are used in preparation of colors; thus, the sodium compound of a dinitronaphthol is known as napthalene yellow.

By the action of concentrated sulphuric acid, napthalene yields two isomeric sulphonic acids of the formula $C_{10}H_7SO_3H$.

Between the temperature of 80° C. and 100° C., the alpha modification is produced, while at 160° C. to 170° C., beta napthalene-mono-sulphonic acid predominates. On diluting the solution with water and saturating it with lead carbonate and filtering from the insoluble lead sulphate and excess of lead carbonate, the lead salts of the two sulphonic acids are obtained in solution. They are then concentrated and crystallized, forming napthalene-sulphonate; when this is fused with caustic potash, a substitution of OH for SO_3 occurs, forming the variety of naphthol corresponding to the sulphonate employed. When this fused mass is dissolved in water and filtered, the solution is treated with hydrochloric acid, when the naphthol is precipitated. There are other ways of obtaining napthol.

Beta napthol refluxed with wood alcohol produces a perfume with the scent of cassia blossoms, and when refluxed with grain alcohol, produces the scent of orange blossoms.

LEGALIZED ADULTERATION OF FOODS AND DRUGS.*

CHARLES M. FORD.

It would be too much to expect that the Federal and state laws for regulating the manufacture and sale of foods and drugs could, in the short period of their existence, have accomplished all that was hoped for, by the champions of so fundamental and far-reaching a reform.

It was not possible, and is not now, to provide in the letter of the law for the detection and punishment of every form of adulteration and misbranding; although in the past five years we have learned how, in several important ways, to amend the Federal Act.

Even when amended in accordance with all the views of wise, vigilant and honest exponents of pure drugs and healthful foods, it would be still general in

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