two pie dishes lined with crust; beat the whites with three tablespoonfuls of powdered sugar to a stiff froth, and spread over the top when nearly done; return to the oven to color a pale brown.

LEMON PUDDING.—Beat a cupful of butter to a cream, adding gradually the yelks of ten eggs, two whole eggs and the juice and grated rind of three lemons, one cupful of finely chopped almonds, one cupful of sugar, and lastly the whites of the eggs whipped stiff; line a large dish with rich crust, pour in the mixture and bake one hour, or bake in two one-quart pudding dishes.

ANOTHER.—A quarter of a pound of stale sponge cake crumbled into bits, the juice of four lemons, the grated rind of two, one and a half cupfuls of sugar, a pint of cream, the yelks of six eggs and whites of three. Bake in two pudding dishes lined with crust for half an hour.

LEMON SIRUP.—This is an article to make when lemons are twenty-five for twenty-five cents. Grate the rind of sixteen large lemons, over eight pounds of granulated sugar; add the juice and two quarts of boiling water; stir until the sugar is dissolved; strain through a fine flannel bag and cork up in pint bottles.

LEMON PIE.—Beat the yelks of three eggs to a cream, add the grated peel and juice of one fine large lemon; put half a tablespoonful of butter over the fire in a small saucepan, and when melted add the yelks and lemon juice; stir to a creamy thickness; remove from the fire, and when cold mix with one cupful of sugar and a beaten egg; line a plate with crust, brush over with the white of an egg, sprinkle with fine crumbs, put in the mixture, cover with a thin crust and bake in a medium oven. This is a delicious pie if rightly made.

LEMON CREAM CAKE.—Stir together half a cupful of butter and one of sugar; add the juice and grated rind of one lemon; then three whites of eggs whipped to a froth alternately, with one and a half cupfuls of flour sifted, with a teaspoonful of baking powder and half a cupful of milk. Bake this in two jelly tins. For the filling, boil three-fourths of a cupful of milk with two tablespoonfuls of sugar; dissolve a tablespoonful of cornstarch in two tablespoonfuls of cold milk, stir into the boiling milk and cook for ten minutes in a double boiler; add a generous lump of butter, the juice and grated rind of a lemon and the yelks of three eggs; stir until it thickens, and remove from the fire. When cakes and filling are cold, spread this between the layers.

LEMON ESSENCE.—When one is using lemons plentifully, an excellent essence may be made at the slightest cost. Put the grated rind of a dozen lemons into a pint of alcohol, add a teaspoonful of lemon oil, bottle and cork tightly and set in a warm place; shake every day for two weeks, when it will be ready for use.

LEMON BISCUIT.—Beat the yelks of nine eggs with the weight of the eggs in powdered sugar; add the juice of two lemons and the grated rind of one; then, a little at a time, the weight of the eggs in sifted flour, and lastly the whipped whites. Bake in small gem pans.

Receipts might be multiplied indefinitely. Lemon juice is superior to vinegar for making a mayonnaise. Iced tea in summer with a slice of lemon is a most refreshing drink, and will prevent the loss of sleep that is sometimes caused by a too intemperate use of tea taken in the ordinary way.

If the hands be rubbed with a cut lemon every time after washing, particularly when one is engaged in any work which stains them, they will keep white and soft.

To keep lemons, cover them with fresh, cold water, and change every week. They ripen and become more juicy, and may be kept in this way for several months. —*Alice Chittenden, in the Country Gentleman.*

EFFECTS OF SULPHUR ON CLARIFICATION.*

By Prof. J. T. CRAWLEY.

THERE is probably no question connected with sugar manufacture about which there is such a diversity of opinion as the use of sulphur, notwithstanding the fact that it has been used and studied so extensively. In looking over the literature of the subject, one is struck with the divergence of conclusions reached by chemists and manufacturers from experiments, both in the laboratory and in the sugar house; indeed, we may often find almost identical results reached by two different experimenters, while conclusions drawn are diametrically opposed. The chief advantages claimed for sulphur are three—namely: (1) it decolorizes; (2) it clarifies; (3) it prevents fermentation; although some have heralded it as a panacea against all accidents and misfortunes to which sugar products are liable.

1. SULPHUR AS A DECOLORIZER.

Sulphur is used very extensively in the arts as a decolorizing agent, and it accomplishes this effect both by uniting with the coloring matter to form colorless compounds and by taking away oxygen from coloring matters, thus reducing them to colorless compounds.

When this latter action takes place, the sulphurous acid is oxidized to sulphuric acid. The hydrogen that is thus set free unites with the coloring matters and reduces them to compounds less colored.

As sulphuric acid is a stable body this decolorizing effect is apt to be permanent, provided the compounds be not oxidized again. If, on the other hand, sulphurous acid acts by combining with the coloring matter, accidents may break up this combination, when the color will reappear. In fact, it is usually the case that sulphur acts but temporarily, as we shall see upon further study of our subject.

Where sulphur is used in sugar manufacture, the chief aim is the decoloration of the juice, sirup or other product, and therefore this is the most important part of the subject. The use of sulphur is almost as old as the sugar industry itself, and we find its use recommended by such men as Walkoff and others—men who, it might be said, are founders of the sugar industry. Sulphur can be added both in the form of sulphites of soda, lime, etc., or in the form of free sulphurous acid, and the decoloration is much better when added to acidity.

* A paper read before the regular meeting of the Louisiana Sugar Chemists' Association, held at Donaldsonville, La., June 10, 1893.

L. Battut (*Bull. de l'Association des Chimistes*, 1894, p. 132) cites an experiment which shows this fact very well. Fifty cubic centimeters of a 5 per cent. solution of SO_2 was added to a liter of juice. A voluminous precipitate was produced which settled easily, leaving the supernatant liquid clear and almost colorless. Milk of lime was then added to neutrality, there was a new precipitation of coloring matter by the lime, but the juice became more colored, showing that the compounds originally produced with SO_2 had been at least in part broken up and the coloring matter reappeared.

It seems that when sulphurous acid is added to juice a precipitate of coloring and nitrogenous matters is formed, but that it redissolves when the juice inclines to alkalinity. To test this question further, Battut made the following experiment:

Two liters juice were treated separately by SO_2, and the precipitates formed separated from the liquid. One of these was heated for twenty minutes with 50 c. c. of a twenty per cent. milk of lime and 300 c. c. of the filtered juice. After treatment with milk of lime and carbonatation, the precipitate was separated and the juice analyzed. In the second case the precipitate formed by SO_2 was separated, and the remaining juice limed, carbonated, filtered and analyzed. It was found that when a filtration intervened between sulphuring and liming a juice of higher purity resulted. Battut, in an excellent memoir on this subject (*Bull. de l'Association des Chimistes*, 1890, p. 176), compared the decoloration produced by SO_2, and other acids, such as muriatic, sulphuric, etc.

Samples of beet juice were made acid with equivalent quantities of sulphurous, muriatic and sulphuric acids, and the resulting solution compared as to color as follows:

Sulphurous acid	1
Muriatic	2
Sulphuric	2½
Original color of juice	3½

Thus it is seen that the color of the original juice was destroyed to a considerable extent by the two latter acids and almost entirely by sulphurous acid. From several experiments of like import the author concludes:

The decolorizing effect of sulphurous acid comes both from its acidity and from its reducing action.

It is a matter of common observation in sugar manufacture that acid juices, no matter what their acidity is due to, are lighter colored than alkaline juices, and also make brighter sugar. In attempting to isolate the acids contained in sugar cane I have been struck with the difference in color between different solutions containing acids together with coloring matters. In neutralizing these solutions with ammonia or milk of lime they often were of a perfectly black color, but this color was changed to a light amber on acidifying with any of the common mineral acids.

Part of the effect of SO_2 then is due to the fact that it is an acid, but from the above experiments we see that there is a further decoloration due to the peculiar properties of this acid. The great danger in the use of sulphurous acid lies in its destructive effect on sugar when used in excessive quantities. If juices made acid with SO_2 be heated before liming a great inversion will result, and if these same juices remain in contact with the air, sulphuric acid is formed from the oxidation of the sulphurous acid both by the air and the organic matter contained in the cane juices.

There is a considerable diversity of opinion as to the point where sulphurous acid should be employed, but theory would suggest that it should be applied at a point as near to the crystallization of the sugar as possible. When it is applied to the juice, and these juices are limed either to neutrality or alkalinity afterward, its effects are, to a considerable extent, destroyed, and it will be found that the coloring matters will gradually reappear during the concentration in the triple effect and in the vacuum pan. Again, if sirup or masse cuite be diluted until it has the same density as the original juice it will have a deeper color than the juice, thus showing that coloring matter has been developed during the concentration. It would seem then that the sulphur should be applied after all the coloring matter has appeared, so that it would have its greatest effect.

In Seyfert's process as recommended by him in 1869, the SO_2 was drawn into the vacuum pan during the evaporation to masse cuite, the vacuum in the apparatus serving to draw the gas into the solution. This, however, gives considerable trouble, inasmuch as there is no way of judging of the alkalinity or acidity of the solution, and it disturbs the pressure in the vacuum pan. For these and other reasons this process has been generally abandoned, and many prefer to sulphur the sirup as it comes from the last of the triple effect.

2. SULPHUR AS A CLARIFIER.

As was said in the beginning of this paper, SO_2 on being added to raw juice produces a precipitate, which is composed in part of nitrogenous substances contained in the juice; and therefore the use of SO_2 should raise the purity. When applied to sirup also a precipitate is formed, which in beet factories is allowed to settle, or is filtered off. The general opinion, however, seems to be that the acid is not very valuable as a clarifier, and were this the only good result from its use it would scarcely repay the cost and labor expended in its application.

3 SULPHUROUS ACID AS A PREVENTIVE OF FERMENTATION.

The antiseptic properties of sulphurous acid and sulphites have long been known, but it does not seem that sugar manufacturers have given due credit to this agent in the sugar houses. They are accustomed to look upon the decolorizing effect as the only good to be attained, and neglect to observe if juices treated with sulphur keep better than do those which have not been so treated. A great many experiments have been performed, which go to prove absolutely that this agent tends to prevent sugar products from fermentation. It is well known that juice from unsound canes—canes that have lain in the rain for a long time, or have been bruised, or that have been frozen—are specially liable to fermentation, and I would suggest that a great saving would result from a judicious application of sulphurous acid to the juices. Toward the end of the season, when a great many canes are injured by windrowing, freezing, rains, etc., it is seen that the yield of sugar per ton decreases very greatly, due in part to fermentation; and by this time, unless special care has been taken in keeping the sugar house and all apparatus clean, there is an accumulation of bacteria, the deadly enemy of sugar, giving rise to a number of different kinds of fermentation. Sulphurous acid would commend itself in the treatment of these juices in that it is a destroyer of bacteria.

Following are some experiments and results obtained by M. Battut in the memoir referred to above. Juices of second carbonatation were taken. To No. 1, SO_2 was added; No. 2, 1 gramme caustic potash per liter; No. 3, nothing added.

These solutions were left 136 hours at the ordinary temperature, and submitted to analysis with the following results. Sucrose at beginning of experiment=12·37 per cent.

	1 SO_2	2 K_2O	3 Nothing.
Sucrose	12·08	11·98	7·39
Loss of sucrose after 156 hours	0·29	0·39	4·98

Like experiments at a temperature of 40 deg. C. showed a much greater loss of sugar in alkaline juices.

From these and other experiments the author concludes that the sulphurous acid added to the cold juices retards notably the fermentation; when it is added to acidity, the preservation is complete; added to hot juice (40 deg. C.), its antiseptic properties are equally apparent, even when not added to neutrality, but when added to acidity the preservation from fermentation is complete, but there is inversion of sugar.

Following are conclusions reached by Dr. Stubbs from carefully conducted experiments, both in the sugar house and in the laboratory (see Bulletin No. 10, Louisiana Sugar Experiment Station):

"Sulphur is burnt and converted into sulphur dioxide, one part uniting with two parts of the oxygen of the air to form a gas which has an irritating odor, but with bleaching and antiseptic powers. Pure water dissolves under ordinary pressure 43·5 times its own volume of this gas. Cane juice under the same conditions absorbs 33. A solution of this gas exposed to the air absorbs oxygen and is gradually converted into sulphuric acid.

"In Louisiana this gas is forced by machinery into the cane juice as it comes from the mill. Laboratory experiments indicate that one ounce of sulphur suffices for the perfect clarification of 300 gallons of juice. Yet in daily practice this is greatly exceeded. Sulphured juices should be handled with great care and skill, since this gas is an acid, which in itself has the power of inverting sucrose, and further, is easily converted into sulphuric acid, a most energetic destroyer of sugar. Sulphured juices should, therefore, be worked as early as possible, and never heated before being limed. It is a good practice to run a small quantity of lime water into the juice at the mill before sulphuring to unite with and render insoluble any sulphuric acid formed in the combustion of sulphur and which has escaped the wash water. Sulphur acts upon the juice in three ways.

"1. It temporarily arrests fermentation.

"2. It temporarily decolorizes.

"3. It assists in rendering coagulable a portion of the albuminoids.

"Against these good offices are to be placed the constant danger of inverting sugar, the decreased yields, the difficulty of cooking its sirups without filtration, the difficulty of preserving sugar made by its use and the formation of sulphates and sulphites in the juice, which interfere with the crystallization of sugar and the deposition of scale upon the apparatus in which the juices are cooked, due to the formation of double sulphates. The last objection is especially troublesome where neutral juices are worked. Sulphur has been used in sugar manufacture from the raw juice to the masse cuite in the pan, and in all forms, from the pure gas and its solution in water to every one of its salts."

In conclusion I would say that the opinion of those in a position to speak authoritatively is: (1) That sulphurous acid carefully used is of considerable assistance in brightening sugar products and in arresting fermentation; this latter effect being particularly seen toward the end of the campaign, when the products are specially liable to fermentation. (2) That sulphurous acid should be used carefully and always under the supervision of a technical director, who is able to keep it under control and decide when the good effects are greater than its evil effects.

PINE NEEDLE OIL.*

By J. BERTRAM and H. WALBAUM.

UNDER the general name of pine needle oil ("Fichtennadelole") are comprised the volatile oils of the needles and young shoots of various conifers belonging to the genera *Pinus*, *Picea*, *Abies*, and *Larix*. Our knowledge of the chemistry of these oils is still very imperfect; with some few exceptions there have been no complete investigations of them, and it has hitherto been customary to consider only certain of their physical characters, such as specific gravity, optical rotation, boiling point, and the detection of particular terpenes. For distinguishing between the needle oils and turpentine oils the odor has been the chief criterion, and only in a few instances determination of the rotatory power offered the means of ascertaining the presence of considerable amounts of lævolimonene in some kinds of pine needle oil.

Under these circumstances it is not remarkable that the material met with in commerce as pine needle oil has often been nothing more than turpentine oil to which a pine needle oil odor has been communicated by distillation over coniferous needles or by admixture of some true pine needle oil. A practical examination of genuine pine needle oil was, therefore, desirable, and, operating upon material of unquestionable origin, the authors have determined the physical characters and constituents of several of these oils, so far as the present state of science will allow.

It has been ascertained that in almost all kinds of

* Abstracted from *Archiv. der Pharm.*, 231, 270-306.—*Pharm. Jour.*