in larger quantity its color is black. The lead sulphide is readily formed by contact with other sulphides, as, for instance, vermilion, cadmium yellow and ultramarine.

3. Boiled oil, containing lead, is colored brown by exposure to air, owing to the presence of minute quantities of sulphureted hydrogen, which causes the formation of lead sulphide.

The remedy is obvious: no oil should be used which has been boiled with driers containing lead. In other words, oil should be boiled with pure manganese compounds only.

(To be continued.)

IMPROVEMENTS IN THE MANUFACTURE OF NITRIC ACID.

By OSCAR GUTTMANN, Assoc. M. Inst. C. E.

As is known, this system consisted of cooling the nitric gases in long earthenware pipes which are alternately connected on the top by bends and at the bottom by trapped bends, all discharging into a main drain pipe, so that the gases are as little as possible in contact with the condensed acid.

The improvements lately effected relate to the abolition of the trapped bends and to the purification of the acid. Fig. 2 gives a general idea of the improved condensing battery. B B are the pipes for the condensation, C are "chamber pipes," consisting of long earthenware pipes divided into compartments or chambers by partitions between each pair of sockets. These chambers are connected to each other by the small bends, B¹ B¹, so that while the gases pass through the upper bends from one chamber into the other, the condensed acid runs without interruption into the collector, F, without filling the chamber pipes, or bringing the acid too much in contact with the gases. A tee-piece, L, with taps, X X, allows the inlet to the collector to be temporarily closed, and samples drawn. A show glass is provided for controlling the process by the color of the gases passing. A pipe line, F¹, connects the collector with the tower. Those gases which escape condensation in the battery go to the Lunge-Rohrmann tower, H, and the last traces are carried through the receiver, J, into the chimney flue, K.

FIG. 1.—DOUBLE WATER-COOLED CONDENSER.

tion of the nitrous acid also takes water away, the result is that all the acid finally obtained has a strength over 96 per cent. monohydrate. At the same time, even with hard firing, the nitrous acid will not be more than 1 per cent., and as a rule only 0.75 per cent. The consumption of coal is also diminished. In consequence of the high concentration of the acid about 5 per cent. of the theoretical yield is carried into the Lunge-Rohrmann tower, the excellent action of which allows, with proper regulation, nitric acid of 76° Tw. to be recovered from it. Although this form of condensing battery works so well, and is practically indispensable for the denitration of waste acids for the manufacture of arsenic acid and similar processes, where it is essential that the gases should remain in contact with the air as long as possible, it is undoubtedly true that for the ordinary nitric acid factory, especially where weaker acid is chiefly made, its rather large first cost is not always compensated for by the higher concentration and greater purity of the acid produced.

The unique qualities of the earthenware apparatus made by Mr. Rohrmann, such as its power to stand large variations of temperature and its exceptional toughness, have allowed the remodeling of the battery, the chief alteration being the use of a water-jacket to cool the pipes.

Fig. 1 shows a double water-cooled condenser. It is sufficiently large for two retorts of 12 cwt. of nitrate each, and has been working with excellent results in this country for the last three months. It will be seen that the number of pipes is reduced from twenty to five. They are connected at the bottom by one chamber pipe, and at the top by bends. The arrangement of injectors, draw-off and testing taps, the collector,

time for reaction of the air, but it does not exceed 1 per cent. The consumption of cooling water and air is insignificant. Of the former 50 to 60 gallons per hour are wanted for a double condenser, and the air is consumed at the rate of about 60 cubic feet (at 60 lb. pressure) for the whole charge. The time of distillation has also been reduced to between nine and eleven hours. Both the vertical and the chamber pipes remain quite cool; they get, at most, only lukewarm, so that the possibility of cracking is almost excluded. The condensers occupy very little room, the whole space required for a double condenser, including the collector, being only 8 ft. by 3 ft. 2 in. by 14 ft. high. The cost of the condensers has also been reduced to one-half. A condenser for two retorts, complete with injector, collector, frame, wood tank, rubber rings, flanges, etc., costs about £100, so that the total cost per retort for a 12 cwt. charge is only about £50.

Similar good results are obtained with these condensers when making lower grade nitric acid, and if it is desired to produce perfectly white acid it can be easily done by branching off a hot air pipe into the collector and letting a small current of air constantly go through it during the distillation, to drive off the very small remaining traces of nitrous acid.—*Industries*.

SEPARATION OF MICRO-ORGANISMS BY CENTRIFUGAL ACTION.

By M. R. LEZE.

THE micro-organisms comprise chiefly in their constitution substances heavier than water; these are the albumenoid, cellulosic, and mineral substances, which are isolated by incineration. If the living organisms

FIG. 2.—GENERAL VIEW OF CONDENSING BATTERY.

IMPROVEMENTS IN THE MANUFACTURE OF NITRIC ACID.

The injector, D, plays an important part in the process. It is well known that in distilling nitric acid the formation of nitrous acid cannot be avoided, and there will be more of it, the stronger the nitric acid is intended to be. In order to eliminate this nitrous acid the lengthy and costly process of bleaching the nitric acid has in other processes to be resorted to, the acid being heated in a water bath, and the nitrous acid driven off by blowing in air. In this way the strength of the acid decreases and there is a small loss. But it is known that nitrous acid can be converted into nitric acid by means of air and steam, and on this principle is based the new process of purification.

A small heating worm, made of wrought-iron gas pipe, is set in the flue of the retort, and compressed air blown through it. The worm is so dimensioned that the air comes out at a temperature of between 70° C. to 80° C. (158° Fah. to 176° Fah.) The hot air goes into the injector, D, which is placed as near as possible to the retort, in order that the air should come into contact with the gases before part of them had time to condense. Of course the retort gases are—with the manufacture of highly concentrated acid—a mixture of about 90 per cent. nitric acid, 2 to 3 per cent. nitrous acid, and 7 to 8 per cent. of water, all in the form of vapor, and thereby the best state is given for the reaction of the hot air. The transformation of the nitric acid takes place at the expense of a part of the steam, while most of the rest goes to the tower, as explained on previous occasions.

This process has several advantages. The injector produces increased draught on the retort, so that distillation takes place at a lower temperature. In this way less water is evaporated, and as the transforma-

and the pipe lines to the Lunge-Rohrmann tower remain the same as with the other battery. But the pipes are surrounded by a water-tight wooden box, into which cold water enters at the bottom and leaves it near the top. The frame of the box is independent of the pipes, so that they are only subjected to the pressure of the water. The chamber pipe is relieved by the sockets of the vertical pipes resting on a board with corresponding holes, which is fixed at the top of the box. The illustration does not show the way in which the pipes are isolated from the box. Half-inch India rubber rings are slipped over the pipes and pressed down by iron flanges, so that they form a water-tight joint both against the box and the pipes. In fact, even if the pipe should have become slightly oval from shrinkage in burning, the cavity is perfectly filled up, so that no dripping takes place.

The advantages of this condenser are very important. Fully 98 per cent. of the theoretical yield of nitric acid are obtained at a strength of about 96 per cent. monohydrate, and only about 2 per cent. are collected in the tower as acid of 76° Tw. Thus the yield of strong acid has increased over 3 per cent. One would think at first sight that, by condensing so rapidly, less steam would go into the tower, and that the acid produced must be weaker, but this is not the case. The rapid condensation facilitates the work of the injector and causes a stronger draught on the retort, so that the temperature of distillation becomes still lower, and less water is evaporated. As a matter of fact, the coal consumption can be reduced to 2½ cwt., or about 1 lb. for every 3½ lb. of highly concentrated nitric acid. On the other hand, the percentage of nitrous acid is slightly higher, because there is less

float in liquids such as wine, cider, or milk, the specific gravity of which borders closely upon unity, it is because they probably contain small quantities of gas, and the force which impels them to rise or sink in a liquid heavier or lighter than their protoplasmic substance is certainly very feeble, regard being had to the very small dimensions of these bodies in question.

But we may intensify this tendency to separation by submitting vessels containing fermentable liquids and organisms to rapid rotatory movement. We have the centrifugal force at command, and can render it several hundred times greater than the intensity of gravitation.

In the laboratory appliances which we employ, the radius and the speed are: in the "lactocrit" turned by hand, 9 c.m. and 3,600 rotations; in the steam turbine (Burmeister's design), 20 c.m. and 4,000 rotations.

In the former apparatus the recipients submitted to centrifugal force are small tubes, drawn out for a certain length in a conical form, and sealed before the lamp at the point. The second apparatus is continuous, and enables us to whiz indefinitely increasing quantities of the liquid in question.

Rotation clarifies fermenting liquids and determines the formation of a glutinous or gelatinous deposit, either at the points of the small tubes or upon the sides of the turbine. On examining these muddy deposits under the microscope, we perceive that they consist chiefly of a heap of living organisms.

By this method we have separated the organisms from a considerable number of liquids in course of fermentation by submitting to the centrifugal zone musts in course of fermentation, decoction of hay, milk, or its serum, after the separation of the cream or of the curd,