being added to the producer gas, forms water producer gas.

In the new form Siemens furnace* the same *modus operandi* is partially carried out; steam is also blown into the producer, and besides this a portion of the products of combustion is led into the producer at a high temperature. As these products of combustion contain steam as well as carbonic acid, both water gas and also carbonic acid producer gas are formed. The sensible heat is here converted into chemical energy by the conversion of steam into water gas ($H_2O + C = H_2 + CO$), and the CO_2 into CO ($CO_2 + C = 2CO$), the result being an increase of the hydrogen and carbonic oxide in the gas made. To produce water gas from steam and hot carbon without any extraneous heat, the steam would have to be introduced at the temperature of 3,230°. To produce carbonic oxide from carbonic acid and heated carbon without any extraneous heat, the carbonic acid would have to be introduced at a temperature of 4,008°. However, the nitrogen contained in the hot products of combustion carries with it a considerable amount of heat, which is available for the above-named processes of conversion. But the introduction of relatively large volumes of nitrogen contained in the products of combustion into the gas producer, and thus going into the heating gas produced, prevents the total utilization of the products of combustion in this manner. Therefore in the new form Siemens furnace not more than half the products of combustion are returned to the gas producer. The theoretical limit of this amount depends upon the temperature of the returned products of combustion, also on their composition, as per table below, assuming that only the theoretical amount of air required for perfect combustion is used and taken with reference to the calorific and other values given above for one liter of producer gas, water producer gas, carbonic acid producer gas, and, for comparison, also water gas.

Weights of products of combustion in grammes in one liter of theoretical heating gas:

Heating Gas.	Products of Combustion in Grammes.		
	CO ₂ .	N.	H ₂ O.
1. Producer gas.....	0.6762	1.6474	
2. Water producer gas from gaseous water at 15°.....	0.806	1.965	0.171
3. Carbonic acid producer gas.....	1.125	1.909	
4. Water gas.....	1.064	3.207	0.504

According to scientific observation these are the highest results which can be attained theoretically for converting sensible heat into chemical energy for water producer gas and carbonic acid producer gas. A comparison of these with the results already obtained in practice would be a guide as to how far the heat in various fuels can be utilized to the best advantage, and so avoid errors in treating fuel.

BACILLI IN BUTTER.

By GRACE C. FRANKLAND.

THE fact that milk affords a particularly suitable medium for the growth and multiplication of most micro-organisms has rightly led to its being regarded as a dangerous vehicle for the propagation of disease. On the Continent the practice of boiling all milk before use, and so destroying any pathogenic microbes which may be present, is almost universal, and recently a number of special pieces of apparatus have been devised for household use, insuring the efficient so-called "pasteurization" of milk. In England, however, but rarely boil our milk, in spite of outbreaks of diphtheria and typhoid fever having been not infrequently traced to a particular milk supply. In a paper by Cnopf on the bacterial contents of milk it is stated that on one occasion out of every thirteen samples of milk supplied to Paris one was found to contain tubercle bacilli, while it is well known that the germs of typhoid, cholera, diphtheria, anthrax, etc., thrive readily in this medium. But although milk has been made the subject of much careful experimental investigation, comparatively little is known of the microbial condition of butter. Heim has shown that cholera bacilli purposely rubbed into butter could be demonstrated after thirty-two days, while typhoid bacilli similarly introduced were found after three weeks, and tubercle bacilli after the lapse of a month, although Gasperini discovered the latter in butter even after 120 days. Quite recently Lafar has published a paper, "Bacteriologische Studien über Butter," in the *Archiv für Hygiene*, in which he has recorded his investigations on the micro-organisms found in Munich butter. These experiments are instructive as exhibiting the fitness of butter to support a large number of bacteria, and thus furnish an interesting supplement to what is already known concerning the longevity of pathogenic microbes in this medium. The samples examined were prepared from fresh cream and were investigated as soon as possible after the butter was made. It was found that the number of microbes differed according as the portion for experiment was taken from the outside or from the interior of the piece of butter. Thus in one instance while one grm. from the center of the pat contained 2,465,555, on the outside in the same quantity as many as 47,250,000 micro-organisms were found. Taking the average of a number of examinations, it was estimated that the interior of a lump of butter possessed from 10 to 20 millions of bacteria in a single grm. Lafar is inclined to regard this as an under rather than an over statement of the number, inasmuch as there are always probably present a certain proportion of microbes which will not develop at the ordinary temperature, or on the gelatine-peptone medium usually employed. He graphically puts it that in some cases it is conceivable that the number of organisms swallowed with a moderately sized slice of bread and butter may exceed that of the whole population of Europe! Lafar found that butter kept in a refrigerator with a temperature of between 0° to +1° C. at first (after five days) showed a marked reduction in the number of bacteria, but that no further diminution took place, although the sample was kept

for a month at this temperature. Samples kept at from 12° to 15° C. exhibited a marked increase in the number of micro-organisms, a rise from 6 to 35 millions being observed in the course of 9 days, while when placed in the incubator (35° C.) after 4 days the bacteria had fallen from 25 to 10 millions, and after 34 days only 5 per cent. of the original number present were discoverable. Experiments were also made to ascertain what was the bacterial effect of adding salt to butter kept in a refrigerator. It was found that although the numbers were thereby considerably reduced, yet, even when as much as 10 per cent. of salt was added, the complete destruction of the bacteria was not accomplished. On examining, however, gelatine plates prepared from these samples, it was ascertained that the organisms present consisted almost entirely of a pure cultivation of one particular microbe, which was apparently entirely unaffected by the addition of salt, and had grown and multiplied to the exclusion of nearly all the other bacteria originally present. When samples similarly salted were placed in the incubator (35° C.) the result was rather different, for while there was more apparent connection between the proportion of salt added and the diminution in the number of bacteria, more varieties of micro-organisms were found on the gelatine plates. But in this case, also, the germicidal effect produced was not proportional to the increase in the amount of salt. Samples of artificial butter were also examined, and were invariably found to be much poorer in bacteria than ordinary butter. Thus, while the smallest number found in one grm. was 747,059, in real butter considerably over two million microbes was the minimum. Two varieties of bacilli have been isolated and described, which were found very constantly present in butter throughout these investigations. They are beautifully illustrated and shown in colored plates as individual organisms and colonies at the end of the paper. Lafar purposes continuing his investigations, and it is to be hoped that the examination of butter for pathogenic micro-organisms, about which so little is known, will form an important feature in any further researches he may undertake.—*Nature*.

GLYCERIN.*

By J. LEWKOWITSCH, Ph.D.

AT the outset, I wish to disclaim any intention on my part of bringing anything new before you. But having been asked to say something about glycerin—with the manufacture of which I am connected—I thought I might perhaps supplement the remarks made last year by Mr. Siebold and several other gentlemen in the discussion following Mr. Siebold's paper.

This will be done mostly from the manufacturer's point of view, as manufacturing processes cannot be supposed to be generally known, and it is not at all unlikely that erroneous opinions may be current among those not conversant with practical processes used in chemical works.

During the last year it has been repeatedly stated that some samples of glycerin destined for pharmaceutical purposes contained arsenic, a fact which was not unknown to manufacturers, but on which for very obvious reasons they did not care to enlighten the consumers. The arsenic in the glycerin owes its existence only to the arsenic contained in the reagents used in the manufacturing process. It has been pointed out by several gentlemen in last year's discussion, that glycerin purified by distillation would not be contaminated by this poisonous substance; although it is but fair to say that Mr. Allen had some doubts about it, still, in the concluding remarks it was distinctly stated that arsenic could be removed by distillation.

This is not so, as the simple fact will show that now all glycerin for pharmaceutical purposes is distilled, nay, even double distilled, glycerin. The times when glycerin was being prepared by other processes of refining have gone by, and a glycerin which had not been purified by steam distillation would be unsalable for pharmaceutical purposes.

But to remove every doubt I prepared the substance formed when arsenious acid is dissolved in glycerin, a substance which has been described by Schiff, and later on by Jackson, who apparently overlooked the earlier publication of Schiff. This substance is the arsenious ether of glycerin, $AsO_3(C_3H_5)_2$. On being heated to 250° C., it decomposes, while arseniureted hydrogen and other volatile arsenious compounds distill over. At the same temperature glycerin distills also over, and it is quite evident, therefore, that any arsenic contained in glycerin will distill along with it. The experiments which I carried out could not show any other result.

Arsenic contained in glycerin cannot be removed by distillation, and to my knowledge there is no process known for completely freeing glycerin from arsenic on a practical scale.

Pure glycerin, free from arsenic, can therefore be obtained from such sources only where reagents not contaminated with arsenic are being used. As it has been suggested last year that glycerin emanating from certain processes ought to be rigorously excluded by the Pharmacopœia, I may be allowed here to very briefly review from our point of view the processes used for manufacturing glycerin. The raw materials are exclusively fats and oils which yield on saponification or hydrolysis the glycerin as a by-product.

Glycerin free from arsenic will be obtained in those processes where the fats are hydrolyzed by means of water, whether it be used in the liquid state, under high pressure, or as superheated steam. The lime saponification, which is yet largely practiced, especially in smaller works, will, as a rule, also yield an arsenic-free glycerin. On the contrary, all glycerin coming from works where the sulphuric acid saponification is practiced will contain arsenic, as the glycerin will extract all the arsenic from the sulphuric acid. There is, however, no doubt that even such glycerin would be pure, as far as arsenic is concerned, if sulphuric acid free from arsenic were used, as it may be prepared from the sulphur obtained by Chance's process.

There is consequently no doubt that there are sources from which one may easily obtain a pure glycerin. With a view to ascertain whether there are in commerce samples of glycerin absolutely free from arsenic—for in many works several processes are simul-

taneously used, and the glycerin will be mixed in the end—I examined ten samples of glycerin coming from ten different works. As I wished to detect smallest traces, I used silver nitrate instead of mercuric bichloride. Three of the samples would have to be rejected, four samples contained very small traces, which might be disregarded, while three only were absolutely free from arsenic.

There is still another process for saponifying fats, and consequently manufacturing glycerin, practiced on a very large scale indeed—that which yields the soap lye glycerin. At last year's conference the glycerin derived from that source was very badly treated, and it was demanded that soap lye glycerin ought to be entirely excluded from pharmacy. Unnecessary precaution!—up to now, at least; for no chemically pure glycerin has been prepared hitherto from soap lees, owing to the difficulties incident to the purification of it.

Being wishful to prove here that soap lye glycerin has a far worse reputation than it—er, or let me say some of it—deserves, I undertook during the last few weeks to prepare chemically pure glycerin from soap lees, not in the laboratory, but on a large scale in the works. I had to use such glycerin as I just had at hand, and as this contained, owing to the impure reagents, some arsenic, I had on starting to expect a glycerin containing traces of arsenic; but this is, from reasons pointed out above, only of secondary importance, as, on repeating the manufacture of it, I shall have to start with purer reagents, and the real difficulties are lying in quite another direction.

Arsenic, although the most objectionable impurity, is, however, not the only one which may be found in "chemically pure" glycerin. As the British Pharmacopœia treats glycerin somewhat cursorily, I may be allowed to point out here one or two tests which will perhaps be found useful.

The glycerin may contain organic impurities, either fatty acids, etc., or so-called polyglycerols, under which name I may summarize all those substances having a higher boiling point than glycerin itself. The way to test for the latter is to gently evaporate a known quantity of glycerin in a platinum dish at a temperature of 160° C. The residue left, from which the ash subsequently found on incineration has to be deducted, will give a fair indication as to the care with which the glycerin has been distilled.

The following table gives the residues for eight "chemically pure" glycerins, arranged according to the quantity of organic residue, to which I have added the analysis of the soap lye glycerin:

	Organic residue. Per cent.	Ash. Per cent.
1.....	0.0243	0.00603
2.....	0.0327	0.0050
3 (a).....	0.0328	0.0140
(b).....	0.0267	0.0102
4.....	0.0360	0.0138
5.....	0.0371	0.0081
6.....	0.0443	0.0066
7.....	0.0738	0.014
8.....	0.0751	0.0154
9.....	0.0931	0.0305

No. 3 represents the figures found for two batches of the soap lye glycerin, which I have shown.

Fatty acids, as, butyric acid, etc., and other organic impurities will be easily detected by testing with ammoniacal silver nitrate at ordinary temperature, which is recommended by the German Pharmacopœia.

It is required of a good glycerin that it should not reduce the silver within fifteen minutes. This test is far more delicate than that in which silver nitrate alone is used, as the manufacturers of cosmetics do, who reject any glycerin which reduces silver nitrate in less than twenty-four hours. I think that the test with ammoniacal silver nitrate is a little too rigorous, as ammoniacal silver nitrate is easily reduced by glycerin at an elevated temperature; in fact, of all the glycerin samples I examined, there were only two (Continental ones) which fairly responded to this test, while all others would have to be rejected. Testing with nitrate of silver alone would perhaps be sufficient to show whether there are any silver nitrate-reducing substances in the glycerin.

Under No. 68 of the blue list an answer is requested to the question how to estimate glycerol in pharmaceutical preparations. I am afraid there is no satisfactory answer to that question, as we are not yet in possession of sufficient quantitative material. Lately, two methods have been proposed for the estimation of glycerol, which seem specially suitable in a great many cases, unhappily not in all. The first method, based on oxidation of glycerol to oxalic acid, can only be of use where no other organic substance is present which might yield oxalic acid. The glycerol in glycerinum aluminis might be thus estimated. The second method—boiling of glycerol with acetic anhydride and sodium acetate—requires highly concentrated solutions, and would, of course, be completely useless when other substances are present which combine with acetic anhydride, as would be the case with, e. g., glycerinum acidi carbolic, or glycerinum acidi gallici and glycerinum acidi tannici. For such preparations it would be required to have a method for completely transforming the glycerol into a weighable substance, e. g., a tribromine derivative.

PHYSICAL PHENOMENA AT LOW TEMPERATURES.

PICTET has experimented on the chemical and physical phenomena observable at very low temperatures. He finds that by means of powerful compressors and aspirators, a mixture of sulphur dioxide and carbon dioxide will give a temperature of -110°, nitrogen monoxide and ethylene about -150°, and air a minimum temperature of -210° to -213°. These low temperatures were measured with a dry hydrogen thermometer, or by alcohol or ether thermometers, verified by the hydrogen thermometer. The author observes that the very long radiant waves emitted at these very low temperatures pass readily through almost all bodies. Thus a vessel at -110° for example will cool with practically the same rapidity whether the layer of cotton enveloping it be 50^{cm} or 10^{cm} or only 2^{cm} in thickness. Moreover, he finds that when chloroform is immersed in nitrogen monoxide at -120°, a ther-

* English patent No. 4,644, of 1889.

* British Pharmaceutical Conference, Leeds.