Art. LXIII.—*Notes on Refrigeration.* By Professor A. W. Bickerton.

[*Read before the Philosophical Institute of Canterbury, 5th May,* 1881.]

Some weeks ago, Mr. Montgomery, Chairman of our College Board, requested me to give my attention to the means available for producing such a slight reduction of temperature as might render it possible to ship home the butter and cheese that was made in the Banks Peninsula and other grazing districts of Canterbury. He assured me that the question was of considerable importance, as there was a very large quantity of land exceedingly suitable for grazing purposes and not very well adapted for other branches of agriculture, yet the want of a market has hitherto prevented its being fully applied to this object. I was afterwards consulted by Mr. J. L. Coster, Chairman of the New Zealand Shipping Company. I have, therefore, thought it desirable to give a brief statement of the ideas that have suggested themselves in connection with the subject.

Temperature may be reduced by three essentially different modes: 1st, night radiation; 2nd, the expansion of compressed air at ordinary temperature; and 3rd, change of state—that is, solids becoming liquids and liquids becoming gases.

The liquefaction of solids is the basis of all the so-called *freezing* mixtures. The volatilization of liquids divides itself into two branches; the evaporation of water and the ebullition of such liquids as boil at an exceedingly low temperature, such as liquid carbonic acid, sulphurous acid, ammonia, ether, etc. Of these methods those that appear most likely to be useful are night radiation, evaporation of water, expansion of compressed air and freezing mixtures.

It must be understood that the problem to be solved is a very different one to the production of a daily supply of ice, for it is evident that if we could obtain a perfect nonconducting air-tight chamber that once had its temperature lowered, it would remain at that temperature for an indefinite time, and require no further attention unless there were an internal action such as chemical change or friction that would develope heat. There is no substance but allows the passage of more or less heat, but substances differ to an extraordinary extent in this particular. It would be a matter of experiment to discover the most suitable nonconductor, though I think it probable that well-carded wool of good quality would be the best. It would also be a matter for experiment to ascertain how tightly this would have to be packed to be most nonconducting.

Having ascertained the most effective material and the conduction of this material that offers the greatest resistance to the flow of heat, it would be necessary to investigate the temperature and other conditions under which butter and cheese may be kept for a sufficient time to enable their transit to be made. Doubtless, the question of time is a very important one, as it may be found possible to carry them with little trouble in a steamship, whilst the uncertainties of the tropical calms may result in complete failure with a sailing ship. A careful investigation into all these matters would doubtless well repay its expense.

In practically carrying out any method of reducing temperature, we are met with the difficulty that air, when cooled, will generally deposit moisture; yet a most important point in the keeping of cheese is that it should be dry. Therefore, in all our processes we must associate drying the air with its refrigeration. There are two different methods of cooling a chamber, and each of these methods will require a different mode of drying the air. These two modes are either by replacing the air by cooler air or by cooling the air already in the chamber. When fresh air is admitted the drying may be effected by passing the air to the bottom of the chamber down a thin copper tube inside the chamber. It will thus part with its heat to the chamber, becoming warmer and consequently drier. As this tube would be much cooler than the air in the chamber, dew would probably be deposited on the outside. Means should be taken to catch this as it trickled down the tube. This would tend to dry the air inside.

If we adopt the method of cooling the air already in the chamber, this will have to be effected at the top, and all that will be necessary to dry the air inside will be to make arrangements to lead away the dew that will be deposited on the coolers. These two methods are extremely simple, and I believe would prove perfectly satisfactory.

Before it could be determined which would be the best method for producing the refrigeration, careful quantitative experiments would be necessary. In this paper I shall only give the outlines of the modes of applying each of the principles already mentioned, leaving it to experience to decide which is best.

If freezing mixtures be used, it would probably be best that the air already existing in the chamber should be cooled, only introducing fresh air occasionally. To cool the air, holes should be made in the roof and large thin copper pipes closed at the bottom should be fitted into them. The mixture should be placed in another slightly smaller similar vessel and slipped down into the inside of the other upper tubes and stirred *in situ.* The heat required to allow the salts to dissolve would come from the inside of the chamber. The dew that was deposited on these tubes should be caught in receivers fixed on the bottom of the pipes. This action as already stated would tend to keep the air dry. As the air was cooled by contact, it would fall by convection and be replaced by warmer air, In making freezing mixtures it is usual to dissolve in acid, but for this purpose I think water would be best, as the solution might be evaporated and recrystallized. In this way the salt may be used over and over again any number of times. It may be mentioned that as a means of reducing temperature on a considerable scale, it is impossible freezing mixtures could be economized. But during a great part of the journey it would not be difficult to prevent the temperature rising above 60° C., so that if not suitable for a long journey it may be a valuable adjunct.

If expansion of air, evaporation, or night radiation, or any combination of these processes, be used, then it is probable that it would be best to exchange the air inside the chamber by the cooled air, although it is not necessary to do so, as the cooled air may be passed along tubes with thin copper bottoms thus acting in the same way as the freezing mixtures.

In taking advantage of night radiation, a black bulb thermometer should be consulted, and when it stands low air should be passed through a vessel with a thin copper top, the other parts being nonconducting; the copper should be smoked on each side. Arrangements would, of course, have to be made to catch the water precipitated. The air by its own density would pass down its tube to the bottom of the chamber, and it may not be necessary to use any artificial means of propelling the air.

If air expansion be used, then the strong vessel into which the air is compressed having been allowed to cool, the air must be allowed to expand into a separate vessel to precipitate moisture; this may be either a nonconductor outside the chamber, or a conductor placed inside; the latter would probably be the most economical.

Evaporation should be taken advantage of when the wet bulb thermometer is much lower than the dry bulb. Of course a Daniel's Hygrometer would be a superior test; the cooling may take place in copper tubes covered with calico, kept wet by water dripping on it. This method may be used with any of the others already mentioned. The whole of the methods are so extremely simple that any intelligent man would quickly know how to use any one or any combination.

I was told that it was mentioned in a paper that the recent cheese and butter shipment was made under my instructions; but my connection with the experiment was a very simple one. It was proposed to keep the chamber cool by passing ordinary air through it. I explained that this could not possibly reduce the temperature below that of the air of the tropics, and suggested that artificial means of producing cold must be used in addition to ventilation, mentioning the methods spoken of above; but the ship started in a few days, so there was no time to make machinery, and not much time for experiment. I suggested that if the experiment must be thus hurried, whenever the temperature of the air was such as to render ventilation useless it was probable freezing mixtures would be the best to try this time, especially as from experiments I had made I could not recommend cooling by evaporation. This I believe was done. Mr. J. Anderson made some experiments in his boiler-room, and found a small quantity of freezing mixture sufficient to keep an experimental chamber 15 degrees below the temperature of the air of the room. I cannot say I am sanguine of the success of the experiment. The varying ripeness of the cheese and the difference of quality found in butter, even in Christchurch, would I fear prevent a great success, even were the confessionally perfunctory arrangements for cooling found to be sufficient. I believe, with Mr. Bowron, that the factory system, or some other means of guaranteeing uuiformity, is an indispensable feature of any successful scheme of making Europe the market for the butter and cheese of Canterbury.

I may add that I personally know nothing of the time or the temperature at which butter and cheese will keep sweet; but if they will keep good at 63° Fahr., I do not believe it would be a difficult matter to keep the air in a good nonconducting chamber from rising above that temperature during an ordinary voyage.

ART. LXIV.—*On the supposed Paraffin Deposit at Waiapu.*

By WILLIAM SKEY, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 20th August, 1881*].

YOU may be aware that a considerable quantity of a soft, greasy, combustible mineral occurs about ten miles south of Waiapu associated with the petroleum rocks of that district, and forming a rather extensive deposit there, and that the nature and value of this has been, and now is, a subject upon which professional opinion is exceedingly varied. Opinions being in this way, at the suggestion of Dr. Hector I have prepared this paper for the purpose of bringing the whole question before you in a concise manner.

So far back as the year 1872, a sample of this mineral was handed to me by Dr. Heetor, who collected it, and the partial investigation of it which I then made, showed that, except for clay and sand, which was, of course, foreign to the mineral, it was in principal part oxygenated hydrocarbons; among which I considered dopplerite, or a mineral greatly resembling it, was largely represented. I promised a fuller report upon it as soon as I had time to continue my examination, but before I could well do this a sample of an article averred to be "solid paraffin," also from Waiapu, was forwarded to Dr. Hector by the Hon. G. Randall Johnson for analysis. This