THE WET FILTRATION OF COOLING AIR FOR ELECTRICAL MACHINERY.

THE application of air, cleaned by what is now generally known as wet filtration, to the cooling of electrical machinery is a comparatively recent innovation, and the installations of this type are as yet few in number. Owing to the rapidly increasing number of turbine-driven generators requiring large and constant volumes of ventilating air, engineers are much interested in the method, and are discussing its possibilities. While on the one hand some are favorably disposed towards the new practice, the majority, frankly doubtful, prefer to await the verdict of time in those cases where it is in use before coming to a final decision. As the time is opportune, we reproduce the following remarks on the subject contained in an article by Mr. D. A. Hackett in the Electrical Review, dealing with a few of the technical aspects, with the view of stimulating the discussion of the practice.

The process of wet filtration may be briefly described as the bringing of the air which is to be cleaned into intimate contact with water in the form of a very finely divided spray. The air may thus be said to be actually washed, for as the particles form nuclei for the formation of drops, they are removed from the air current passing through the apparatus, both by their rate of fall being rendered greater and by the interposition, in the path of the spray-laden air, of specially shaped baffles from which the air issues clean and without trace of suspended moisture. In addition to the removal of dust particles, the no less objectionable acids, or acid-forming gases, are removed, being absorbed by the water.

The first question that arises is whether it is possible for the water particles to be carried over from the filter by the moving air. It is simply a matter of installing apparatus capable of dealing with the quantity of air required, and there is little doubt that manufacturers of this class of plant would be able to fulfil guarantees of the absolute absence of every trace of suspended moisture in the discharge from the filter.

The air leaving the apparatus is humid, and the greatest amount of discussion in connection with this subject has been devoted to the possibilities attaching to this condition. The insulation resistance of material is reduced by the presence of moisture in it, and considering only the humidity of the filtered air, it might be unsafe, to say the least, to pass it in its practically saturated condition through a machine. This view may be considered from several aspects. It must be remembered that the climate of this country is such, that electrical machines are frequently subjected (more often of course in winter) to atmospheric conditions approximating to 100 per cent. humidity for long periods. This is the case particularly where the machines are of the type requiring forced ventilation, and it is ordinary practice, where the environment is suitable, that is, where the atmosphere remains clean, to pass the air through machines unfiltered, without damage resulting to the insulation. In foggy weather the air is supersaturated and contains particles of moisture, but there is no record of machines having broken down due to the reduction of the insulation resistance at such times, nor is any provision ever made to reduce the quantity of moisture in the event of a fog or unusually humid atmospheric conditions. Finally, machines are insulated for use under ordinary conditions of surrounding air; in practice manufacturers' tests are specified to be made without any special precautions with regard to humidity, and in very many cases it is even specified that the apparatus under consideration should remain in the shops for some days previous to testing subjected to ordinary atmospheric conditions. It would appear then, that the factor of safety of insulation as applied to electrical machines in general would cover such of these as are ventilated by wet-filtered air.

It might be of interest to examine the effect of the passage of the air to and through the machine, on the air itself. Let it be assumed that the filtered air is saturated, that is, that its humidity is 100 per cent. (actually it does not always reach this, the average condition being more nearly represented by 95 per cent.). The air leaving the filter passes to the machine but before coming into contact with the windings, it has to encounter resistance in the form of ducts and bends, and has also to be forced through the machine by some form of fan. In this process energy is expended, the air temperature is raised, and the humidity thereby reduced. It may seem that this effect is slight, but in the first place it requires a comparatively small amount of energy to raise the temperature of a cubic foot of air through one degree (0.575 watts per cubic foot per minute), and for a given moisture content the humidity of a given weight of air decreases rapidly as its temperature rises.

If air at 19.5 degrees C. and 100 per cent. humidity at normal atmospheric pressure, have its temperature raised one and a half degrees, the humidity drops to 90 per cent. If an actual case be taken, and assuming 65 per cent. as an average figure for the efficiency of the external fan supplying air to the machine, calculation shows that the losses in the fan and ducts produce an increase in temperature of about three degrees before the air comes in contact with the windings. The resulting humidity in this case with 100 per cent. leaving the filter is 79 per cent., which is below the average for winter atmospheric conditions in this climate.

It has also been pointed out that the air around a central station, by reason of the water vapor liberated in various operations, has, as a rule, a large amount of suspended moisture present against which no special precautions are taken.

The effect of the heating of the machine itself must be considered. An examination of the heating curve shows a sharp and immediate rise in temperature after putting on load. This should act in the direction of preventing an undue absorption of moisture by the windings, should the humidity be high. It is also worthy of consideration to note that in a generating station, due to the radiation from steam pipes, engines and generators, the air temperature is higher than the external air, and, as a result, the windings of a machine, when put on load, are already several degrees higher than the cooling air, and therefore initially more likely to resist the condensation of moisture in them. This fact, taken in conjunction with the rapid rise in temperature referred to previously, and the increase in temperature due to work done in moving the air, tends towards the reduction of the percentage of humidity, and therefore to the original condition of the air as regards moisture previous to filtration.

It is claimed that the air is cooled as well as cleaned by the process of wet filtration, and as this tends in the direction of a lower maximum temperature, it is desirable to form some idea as to the amount of the reduction in air temperature and the effect of the increased moisture content on the cooling qualities of the air, that is, practically speaking, on its specific heat. If air be taken at atmospheric conditions of temperature, pressure and hu-