the time intervals might be accurate to within 1/240 of a second from day to day. For a matter of a few hours during the course of an experiment the time as indicated by such a synchronous device is considerably more accurate. Depending upon the speed of the drum, upon which the time graph is made, the time may be read to something certainly less than 1/280 of a second, possibly quite readily to within 1/600 of a second. This accuracy of timing refers to relative time intervals and not to any accuracy of synchronism with ordinary clocks. The so-called "60 cycle circuit" may actually have been controlled at any frequency other than 60 per second, as was the case in our local circuit, where the frequency was 59.6.

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BACTERIAL FILTERS

IN a previous communication[1] I described experiments in which it was shown that by the use of filters made of basic materials having a positive electric charge, bacteria, viruses and colloids, which pass through a siliceous filter made of materials of negative electric charge, are held back.

I have devised a filter which will remove both positive and negative colloids, *i.e.*, one which may be described as amphoteric.

This is accomplished by adding to the siliceous material in the filter compound a basic material carrying a positive electric charge, one which is comparatively insoluble in water and is not destroyed nor altered by heat sufficient to harden clay.

Such a material is magnesium oxide calcined at 1300° C. By combining equal parts of this material and Florida kaolin in the filter compound and firing at a temperature not exceeding 900° C. an amphoteric filter is produced.

A temperature higher than this must be avoided, since it will bring about a combination of the magnesia and the siliceous material used and the resulting filter will act as do other siliceous filters.

Filters made as described above will remove both acid and basic colloid dyes.

They will remove bacteria which do not pass a siliceous filter, as well as the so-called filterable bacteria.

The bacterio-phage and the virus of Mosaic disease of tobacco do not pass through these filters.

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[1] SCIENCE, Vol. LXV, No. 1672, p. 45, Jan. 14, 1927.

SPECIAL ARTICLES

THE OXIDATIVE DESTRUCTION OF THE AGENT OF THE CHICKEN TUMOR I (ROUS)[1]

FROM the time of the first work on the filterable agent of the Chicken Tumor I (Rous), it has been recognized that candle filtrates rapidly lose their infectivity when incubated at 37°. No adequate explanation for this loss appears to have been put forward, although Gye, in his paper of July, 1925, inclined to the view that it might be oxidative. He stated, however, in several lectures given during his recent visit to America, that this auto-inactivation is prevented, or greatly retarded by low concentrations of HCN, and explained this as being due to a poisoning by the HCN of certain proteolytic enzymes which destroy his hypothetical protein "specific factor." The literature, however, contains no evidence that HCN in minute amounts has any effect, except perhaps one of slight acceleration, on tissue proteases. On the other hand, from the work of Warburg and others it is known that certain types of oxidases are inhibited specifically by this reagent.

It occurred to the writer that if the loss on incubation were oxidative, it should be possible to prevent it by some other means than a poison such as HCN, and a number of experiments have been carried out in which cystein in a dilution of 1–2,000 has been added to freshly prepared filtrates of the Rous tumor, and the tubes promptly sealed with vaseline. This has invariably resulted in delaying the loss of infectiousness over control aerobic tubes by many hours. Similarly prepared tubes kept at 4° C. have retained practically their full original potency for several weeks.

One of the annoying features of work with this virus is the great variability in effective strength of different filtrates. Tumors may be produced by one filtrate with 0.001 cc of Mandler filtrate, while on the following day a filtrate made in exactly the same way may fail to infect in a quantity of 1.0 cc. Since there is no method known for determining the properties of such filtrates except to inject chickens and wait two or three weeks, obviously it has always been necessary to set up complex experiments with filtrates of entirely unknown strength, which has led to tremendous waste of time and material. It is hoped that the method of preservation of filtrates with cysteine at low temperatures may find some application in further experimental work with the tumor.

It may also be stated that the initial variation in potency of filtrates is probably due, in part at least,

[1] From the Department of Bacteriology and Immunology, Harvard University Medical School.

to oxidative destruction during the filtration process. In two experiments in which parallel filtrates were made, one in the usual manner, the other with the addition of 1–500 cystein, and protecting as far as possible from the air with liquid paraffin, the latter type of filtrate in each experiment was very much more active than that made in the ordinary way.

It is therefore pretty clear that oxidation will inactivate filtrates of the Rous tumor, although the significance of this fact for a better understanding of the nature of the filterable agent is still not clear. Neill has shown that certain bacterial toxins and enzymes are subject to a reversible oxidation and reduction and it becomes of considerable importance to know whether this "virus" inactivation may be subject to a similar reactivation by means of reducing substances. Up to the present, no clear-cut evidence for this has been obtained, although there have been some indications that it may occur. Should this prove to be the case, the bearing on the interpretation of Gye's complex experiments is obvious.

It is interesting to speculate on how far this property of the filterable chicken tumor agent may be paralleled by other filterable viruses. A number of these, at any rate, exhibit the same phenomenon of rather rapid loss of infectiousness on incubation, and the question is now being studied in this laboratory.

J. HOWARD MUELLER

VELOCITY OF CADMIUM ATOMS REGULARLY REFLECTED FROM A ROCK SALT CRYSTAL

WE have previously shown that a beam of cadmium atoms incident upon a cleavage face of a rock salt crystal is reflected so that the incident and reflected beams make equal angles with the normal to the crystal surface. At that time we suggested that this phenomenon could be interpreted in terms of the phase waves of de Broglie. The existence of a reflected beam making the same angle with the normal as does the incident beam suggests at once the possibility that we have here a situation in which the phase waves behave as X-rays do in the Bragg type of reflection.

We have now measured the velocity and velocity distribution of such reflected beams for three angles of incidence, 22.5°, 45° and 67.5°, using a rotating sectored disc velocity filter in the reflected beam. We find that within the limits of resolution of our apparatus the reflected beam is "monochromatic," *i.e.*, it contains atoms whose velocities are very nearly the same. The velocity of the atoms in the specularly reflected beam is independent of temperature of the reflecting crystal for temperatures from 200° to 500° C.

The results are given in the table:

ϑ	Velocity observed m./sec.	Velocity calculated m./sec.
22.5°	500	494
45°	530	530
67.5°	600	605

The assumption of de Broglie is that there is associated with a particle of mass M and velocity V a phase wave of wave length $\lambda = \frac{h}{MV}$. We wish now to assume that this equation applies only to the three elementary particles, the photon, electron and proton, and that the wave length associated with an atom whose velocity is V is $\frac{h}{MV}$ where M is the mass of a proton, and not the mass of the atom.

That is to say, we assume that the fundamental periodicity associated with a proton does not change when it combines with other protons to form an atom. We will further assume, following Eckart,[1] that the velocity of phase waves is not the same in a crystal as in free space, so that the form of Bragg law to be used is that used by Davisson and Germer[2] in their work on reflection of electrons by crystals of nickel. That is

$$n\lambda = \frac{nh}{MV} = 2d\ (\mu^2 - \mathrm{Sin}^2\vartheta)^{\frac{1}{2}}$$

If n were greater than one we would find two or more velocities in the reflected beam. With n equal one we have but one arbitrary constant, μ, the refractive index for phase waves. Using the velocity of the atoms reflected at 45° we find $\mu = 1.50$ and putting this value in the equation we get for the velocities to be expected at 22.5° and 67.5° values of 494 and 605 meters per second, as compared with observed values of five hundred and six hundred meters per second, respectively.

A. ELLETT
H. F. OLSON

STAINING REACTIONS OF FERN GAMETES

THE work of Naylor[1] demonstrated that the retention of stains by fixed and sectioned plant tissues varies with the reaction of the liquids used in washing the slides. The dead cytoplasm of such plants as Naylor used (hyacinth, lupine, etc.), retains basic dyes when washed in buffer solutions alkaline to pH 4.6, but loses them when washed in more acid solu-

[1] Eckart, Proc. Nat. Acad. Sci., 13, 460, 1927.

[2] Davisson and Germer, Proc. Nat. Acad. Sci., 14, 317, 1928.

[1] *Amer. Jour. Bot.*, 13: 265–275, 1926.