CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.—Second Series.—Chemical Methods.

XLX.—Method of Determining the Shade of Paints.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

EXPLANATORY.

Perhaps no characteristic of paints gives more trouble, both to the manufacturer and to the consumer, than the shade. To the uninitiated, red paint is red, green paint, green, and blue, blue; but the person who attempts to make a sample of paint which shall match any given color, be it red or green or blue or any other color, either with or without a name, soon finds that there may be hundreds of shades of what is commonly known as one color, and that only one of these is an exact match for the color he has in hand. Oxide of iron, as is well known, is commonly said to be red in color, but the number of shades of the red of this pigment are almost as numerous as the different sources from which it is obtained. Each mine of this material used as a pigment apparently has its own shade, and each batch of artificially made oxide of iron, so far as our experience goes, differs more or less in shade from every other batch. The truth of this statement may be very easily verified by obtaining samples of the various colcothars, crocus martis and cheaper grades of Indian and Venetian reds in the market, most or all of which are artificially prepared, and compare them for shade by the method described below. The results obtained, we are confident, will fully justify the statement made at the beginning of this article.

The method of producing the shades desired in pigments is twofold; first, by varying the conditions under which the pigments are produced in the manner known to color makers; and, second, by means of mixtures. The latter is obviously the method that must be used by the color grinder, and the painter or consumer. But in order that the color maker, the color grinder or the painter may know what he is doing, or when he has secured the desired result, it is obvious that he must have some method of determining shades. Furthermore it is well-known that large amounts of paints are used by railroads for a definite purpose, such as painting freight cars or passenger cars, or for buildings and fences along the line. These paints have definite shades, established after considerable care and study. They are, many of them, bought on definite specifications, and always in successive shipments, and from different manufacturers. There must, therefore, be some method conscientiously used of determining the shades of these various shipments, or the utmost confusion and mixture of colors will result. It is the object of the present article to describe such a method.

Several ways have been suggested and employed with more or less success in determining the shade of paints. They are all based, at least so far as our experience goes, on comparison of the sample in hand, with some other sample which represents the shade desired. This comparison has been made in three ways:

I. Since the end desired, viz., that the painted work when finished shall be of the required shade, perhaps the most natural and most universally employed method of determining shade, has been to have previously prepared a small board or other surface painted with the standard or desired shade, and compare this with a similar one painted with the material whose shade is in question. The comparison is usually made by placing the two boards side by side and examining them at different angles and in different lights. This method has been very largely used, and was for a long time, perhaps, the only one in general use. It has the advantage mentioned above of enabling the judgment in regard to the paint in question to be based on the finished work, and this is unquestionably a very strong point in its favor, but the disadvantages of this method are also very great, so much as to render it almost impracticable for testing successive shipments. These disadvantages may be briefly enumerated as follows: *First.* Paint when it is freshly applied does not always have the same shade that it dees when the same paint is dried, owing, perhaps, to change of position of some of the constituents of the pigment during drying, and possibly to chemical changes between the oil and pigment during the same operation. Both these phenomena are known to occur during the drying of paint, and both are known to affect the shade. Moreover, differences in surface, viz., the glossy surface due to the liquid, or the more or less dead surface due to dried paint, have an influence on the shade, so that it is clear that unreliable results will be given by comparing a freshly painted surface with the standard dried sample. If this method of determining shade is used, therefore, it is evident that the paint to be tested must be allowed to dry before comparing with the standard, or some of the standard must be freshly mixed each time, and the comparison made on the undried paints. The former requires far too much time for successful use in testing shipments, and the latter is laborious and moreover sacrifices the strong point of this method, viz., a judgment obtained from the finished work. It should be stated that in common use the standard is prepared once for all, and is kept, sometimes without exposure to the light, but more commonly hanging on the wall in the shop. This leads us to the *second* objection to this method, viz., the standard changes with time. The change in paints which results from exposure to the light, the air and to the action of water is far too well known to require especial comment, and while it is quite possible to exclude the action of water on the standard board, and by proper and reasonable protection to diminish the action of light, it is still, we believe, impossible to prevent any paint, and especially those containing organic coloring matter, from slowly fading. A *third* objection to this method, at least if the dried standard is used, is that the various ingredients used in mixing the paint affect the shade. This is especially true of the japan drier, which, as is well known, is dark in color, and also by its action on linseed oil changes that to a dark color. In order to make a fair comparison, therefore, with the dried standard, it would be essential to use the same amount of the same japan, since japans differ widely in their composition, as was used in preparing the standard board. It needs no extended comment to make clear how difficult this would be. *Fourth,* and finally, this method does not give very sharp results, that is, does not enable fine distinctions in shade to be made. Inequalities and irregularities in the surfaces, the difficulty of getting the light to strike the two samples at exactly the same angle, and especially the absence of any sharp line of demarkation between the two, all conspire to render the indications obtained by this method general, rather than sufficiently definite to enable the operator to do justice to both producer and consumer in his tests.

II. A second method of determining shade, which has been tried somewhat, is by means of the Lovibond tintometer. This instrument may be briefly described as a flat wooden tube, open at both ends, about 14 inches long and 3 inches broad and an inch and a half thick. At one end a partition divides the tube lengthwise for a short distance. At one side of the partition are arrangements for holding small colored glasses, and on the other side, arrangements for holding the sample to be examined. The instrument is used by placing the material to be examined so that the light will pass through or from it on one side of the partition to the eye looking into the other end of the tube, and then placing a pure white surface on the other side of the partition, so that light from it will pass to the other eye. Now a series of colored glasses of varying colors and strengths being introduced between the white surface and the eye, it is possible under favorable conditions to get the same color that the sample to be examined shows. The glasses being numbered and marked according to a previously arranged nomenclature, it is possible to, in reality, make an analysis of the color which is being worked on. It is obvious that as applied to determining the shade of paints, it is only necessary to make an analysis of the standard sample, and then see if the successive shipments give the same analysis. Our experience with this instrument has not been very large, but we have experimented with it enough to find as follows: *First.* The

Digitized by Google

source from which the light comes, makes considerable difference in the analysis. It is recommended to use the instrument in a "perpendicular light from a dull gray sky." But such light is not always available, while the testing of shipments must go on, whether good light is available or not. This difficulty, therefore, is quite a serious one. *Second.* Different operators are not able to make the same analysis, all other conditions, being as far as possible, the same. Indeed, the same operator, using one eye at a time to make an analysis, will not get the same results with both eyes. It is obvious that this difficulty, might lead to serious trouble, if the analysis by test of the consumer, led to the rejection of a shipment, while the analysis by the expert of the shipper showed that the material passed test. *Third.* The analysis of the standard even under favorable conditions is slow and laborious, and while, with sufficient time and care, close results and fine distinctions can be made, it would be quite out of the question to make an analysis of the standard and of sample from shipment each time the instrument was used. This procedure would probably eliminate the two difficulties mentioned above to a greater or less extent, but such a procedure would require more time than could be given for determining shade. We are far from saying that such modifications and fixing of conditions cannot be introduced into the tintometer as would make it entirely a practicable instrument for determining shades, but our studies have not yet led us to such results.

III. The third method of determining shades which we have had experience with is described below:

OPERATION.

Have the pigment representing the standard shade in the dry condition, that is unmixed with oil or any other menstruum. Then if the material to be tested is in the dry condition likewise, weigh into an agate mortar a gram of the standard, and add as much pure fresh raw linseed oil as will form with the pigment a stiff paste. Rub with the pestle until the paste will stand a previously decided upon test for fine grinding. A satisfactory method of testing fineness of grinding is described under the heading, "Method of Determining the Fineness of Grinding of Freight Car and Passenger Car Colors," published in the June number of this journal. Mix the same amount of the material to be tested with the same amount of oil used with the standard, and rub with the pestle to a condition as to fine grinding at which it is desired to know the shade. Now, with a spatula or glass rod, transfer a little hillock of each of the samples of paste to a small piece of clean glass, placing them near each other. Lay on top of the two hillocks a thin cover glass, such as are used by microscopists, and press it down until the two samples unite. If they are of exactly the same shade, there will be no line of demarkation between the two. If they differ in shade, this line will be more or less clearly marked. If the material to be tested is in the paste form, or mixed with any menstruum whatever, it is essential to mix the standard pigment with the same amount and the same kind of menstruum as is characteristic of the material to be tested before the comparison is made. Also the fineness of grinding of the standard must be that previously determined upon, otherwise the operation is in all respects the same as that described for dry pigments.

APPARATUS AND REAGENTS.

An agate mortar is best for preparing the samples for testing. but a porcelain mortar or other means of mixing the oil and pigment and bringing the paste to the proper fineness can be used.

Strips of ordinary glass may be used to put the hillocks of paste upon, but for the cover it is essential to have the glass thin and as free as possible from color, since the color of the glass affects the shade. What are known in the market as "microscope slide cover glasses," about three-quarters of an inch in diameter and as thin as possible, work very nicely.

In regard to menstruum, pure raw linseed oil, not too old and fatty, and of clear amber color, is best. Oil that is discolored from any cause should not be used.

CALCULATIONS.

Obviously no calculations are required by this method.

NOTES AND PRECAUTIONS.

It will be observed that this method is simply a comparison of the material to be tested with a previously decided on standard, under certain definite conditions.

The shade of paints is affected quite considerably by the fineness of the particles of the pigment, and also, apparently, by the intimacy of the mixture of the pigment with the menstruum. The shade of some pigments, notably scarlet lead chromate, is very perceptibly changed, or, indeed, almost destroyed, by fine grinding; other pigments develop their most desirable shades only when finely ground, and all pigments, so far as our experience goes, vary their shades more or less according to the fineness of the grinding. It is obvious, therefore, that some standard of fine grading must be established before a standard of shade can be decided on. The pigments of paints to be compared with the standard may or may not be brought to the same fineness as the standard, according to the information desired from the test.

The shade of pigments is often so completely changed by mixing with some menstruum that no satisfactory results can apparently be obtained by comparing dry pigments. A very good illustration of this may be secured by comparing white lead and sulphate of lime or gypsum, both dry and ground in oil.

With some pigments a change in shade occurs during the first 12 hours, after mixing with the oil, so that if the standard is mixed and the comparison made immediately the same result will not be obtained as if the standard is allowed to stand 12 hours after mixing. As the principal use of the test is to see whether successive shipments of ground material have the standard shade, it is essential with these pigments to mix the standard and allow it to stand at least 12 hours before making the test. We are unable to explain the change in shade of the standard which results from standing. The change is beyond doubt.

The pigment representing the standard shade should be kept in a place free from moisture, and, as previously stated, should not be mixed with the menstruum until needed for use. All attempts to keep a standard shade in any other way have, so far as our experience goes, resulted in failure, while with many pigments this method gives entirely satisfactory results. It is possible that some pigments, even in the dry condition, will slowly change in color; many, if not all, certainly will if mixed with oil or other menstruum and exposed more or less to light and air.

The principal use of this method being, as previously stated, to test shipments of material bought in the paste form, and on definite specifications as to proportions of pigment and liquid and as to fineness of grinding, a very large number of tests can be made in a day. In describing the method an attempt has been made to give it a little more general application.

It may be urged as a defect of the method that it tests the material at a point in its history so far away from the finished work that really the consumer is hardly fairly dealt with. But as has already been shown the materials which the consumer adds to the paint to enable it to be spread, change the shade, and it certainly cannot be fair to hold the manufacturer responsible for what the consumer does to change the shade. Moreover, when testing shipments, as is seen, the test is applied at that point in the transaction where the material passes out of the control of the producer and into the hands of the consumer, a very fitting place, it would seem, to apply all tests and decide all questions affecting the material.

It will be observed by those who make tests in the manner described above, that the material to be tested either is the same shade as the standard, or it is not, and there is no means of accurately telling how near any given material is to the standard shade, nor without experiment to say what to do to the material under test to bring it to the standard shade. In other words, since commercial materials are rarely in any respect exactly what is aimed at, and since with all materials small variations from the requirements of the specifications are allowed, it may seem that a method so rigid as this one would be inapplicable. It was hoped that the tintometer would enable this difficulty to be met by making it possible to say how much any material might vary

Digitized by Google

from standard shade and still be acceptable. As already stated, this has not yet been found to be possible. In actual practice what is done is to accept shipments that come very close to the standard and reject those farther away. The method described above is extremely delicate, but after a little experience is obtained in its use it is not difficult to use it in such a way as to do no injustice.

Mill Heating from the Hot Well.

In a paper read before the New England Cotton Manufacturers' Association, Mr. George W. Weeks described a novel method of heating employed in one of the buildings of the Lancaster Mills, Clinton, Mass. The building is 116 feet × 109 feet × 74 feet high, with about 60 per cent. of the wall area occupied by window openings, none of which were supplied with double windows. The heat for warming the building is obtained from the water discharged from the hot well of the compound engine that furnishes the power, while the air heated is put in motion by the flywheel of the same engine. The system has been in use four winters. Mr. Weeks says:

After consulting with Mr. H. S. Robinson it was decided to put in on trial his system of heating air by means of water from the hot well of engine and add thereto a small engine and blower for use nights and Sundays when the large engine was not running.

The ordinary Corliss flywheel would force sufficient air for this purpose without alteration (we find the air pressure in one of our Corliss wheel pits to be equal to 1¼ inches of water), but the wheel of the Wright engine used in the mill being made with arms so shaped as to pass through the air with the least resistance, we found it necessary to add "wings" to them. This wheel is 16 feet in diameter and runs at a belt speed of 4,000 feet per minute. After the wings were attached we obtained a movement of 8,000 cubic feet of air per minute through the flues and mill with an expenditure of three horse-power, as shown by the indicator.

The air is taken mostly from the basement, where it enters from out-of-doors and largely from the connecting boiler-house.

The heater is situated in the air duct leading to the flue, and consists of eight sections, each 42 inches high by 28 inches wide, with 204 ¼-inch pipes, each 90 inches long. These sections are connected by pipe with the hot well, and so arranged that the end covers and diaphragm causes the hot water to flow by gravity through half of the pipes in one direction and return through the other half, and then continue through the other sections in the same manner, and discharging where the air enters, so that the air is always coming in contact with hotter water.

Small pipes were used in order to obtain the largest amount of heating surface in a given space, but as we find we have more heating surface than is needed, it would have been better perhaps to have used larger and fewer pipes so as to offer less resistance to the passage of the air.

With water from hot well at 115 degrees Fahr., we heat the air to 100 degrees Fahr. In one test air was taken directly from out of doors at a temperature of 26 degrees and sent to the mill at 107 degrees, with water taken from hot well at 123¼ degrees and discharged from heater at 97¼ degrees. We find in practice that the air is heated to within about 10 degrees of the water used.

As stated before, we put in a small engine, fan and blower to heat the mill before the large engine was started, and to heat it also nights and Sundays during the winter. It would have been cheaper to have put in steam pipes in the old way, and if one does not object to pipes the expense of the extra engine and blower may be saved.

While heating the mill in December, before the large engine was started, we ran the fan engine, exhausting the steam in the same heater. After the large engine started we drove the fan by belt from this engine, and while the walls were still wet, the mill having just been completed, we forced 12,000 feet of air per minute into it, this being sufficient to heat it while in that condition. This required 8.81 horse power, as shown by indicator on engine. As soon as the "wings" were put on the arms of the flywheel we started the air from that, and, as stated before, we heated the mill with 8,000 cubic feet of air per minute, as the looms were nearly all then in operation, and we found that to be sufficient. It took 3 horse power only to furnish this air from the flywheel.

We did not rig up to run the "blower" at a speed to force 8,000 feet per minute, but judging what it would take from the 12,000 feet, it would doubtless require 5¾ horse power to force 8,000 feet, or nearly double that required by the flywheel.

We find that it requires about double the heating surface to heat with water that it does to heat with steam, but as water heaters have to sustain no pressure, they can be furnished for a very little more than steam heaters made in the usual way.

Hot or cold water can be showered into the duct in the usual way when desired. When the weather becomes warm enough, so that no heat is required in the mill, the water from the condenser is turned off, and the engine flywheel continues to force the same amount of air through it for ventilating and cooling, and for this latter purpose we can turn cold water through the pipes in the same manner as water from the hot well.

During the time this plant has been used, it has required no repairs and has demonstrated that it will heat and ventilate the mill during the running hours with no expenditure for steam or power beyond the three horse-power added to the engine as stated; that 100 degrees temperature is sufficient to satisfactorily heat the mill, and that the air can be heated to this temperature, with water from the hot well with no loss of power, and our experiments tend to show that it is more economical (when the uptakes are built into the walls) to send a larger amount of air at a lower rather than a smaller amount at a higher temperature. Air heated to 97$\frac{7}{10}$ degrees at heater is delivered to the fourth story at 94¼ degrees, showing a loss of only 3$\frac{6}{10}$ degrees, while air at 124 degrees at the heater was delivered at the fourth story at only 113, showing a loss of 11 degrees.

The Freight-Car Repair Shops of the Southern Pacific at Sacramento.

The Sacramento *Weekly Union* has been publishing an entertaining series of shop notes relating to the car shops of the Southern Pacific at Sacramento, and the last one gives the following facts regarding the freight-car repair shops:

"The shop itself is located at the extreme northern part of the works, and extends from a point at about Third street to the river front. It is the largest and most important of its kind on the Pacific system.

"All cars requiring heavy repairs or rebuilding are sent here, where they undergo a thorough inspection, and, if it be found advisable, are again placed in serviceable condition. If, on the other hand, they be found unfit for further service, owing to age and decay, or from being in a badly damaged condition, the car is torn to pieces, the trucks laid aside for future use on another car, the ironwork assorted and the woodwork otherwise disposed of, usually being used for fuel.

"In this shop are repaired and rebuilt about 700 cars monthly, or 8,400 during the year. The amount of material used monthly is estimated at about 60 carloads, which includes lumber for the floors, roofs and sheathing, timber for the sills and bolsters, and the ironwork used in the construction and repair of cars.

"Many of the cars turned out are painted all over, and in such cases the old tedious process of brush work is relegated to a back seat, and the labor performed by means of an air machine. A vessel, not unlike an ordinary sprinkling can in appearance, though considerably smaller, is so arranged that the air, which is procured from pipes distributed throughout the shops by a system of pipes, is forced under heavy pressure into an opening in the nozzle of the paint tank, which has been filled with paint, thereby forming a vacuum and drawing out the paint through a small valve with great force, so that it reaches the car in the form of a fine spray, penetrating the wood, thus turning out a clear, even and satisfactory piece of work.

"Some idea can be realized of the rapidity by which this little 'pneumatic gun' does its duties, when a flat-car can be given a coat in about five minutes and a box-car in 25 minutes, when handled by one who understands how to manipulate it. The car is then numbered, lettered and stenciled, and is again ready for the road.

"Almost all work done at this shop is conducted under the 'piece rate system,' which has proven to be entirely satisfactory both with the employees and the company, as the rates are always fixed so that the mechanic need do but a fair day's work for a correspondingly fair day's pay.

"As previously stated, a large amount of work is done at this shop, as everyone will understand, when it is considered that each month about 650 sills and 500 draft timbers are used, 120 floors laid, 70 roofs and about 350 California couplers applied.

Digitized by Google