## THE TESTING OF CHEMICALS, SUPPLIES IN TEXTILE MILLS AND DYE WORKS, ETC.

### Introduction

In these days of keen competition and narrow margins of profit in all branches of the textile industry, success does not lie so much in the marketing of goods as it does in making or finishing them at the lowest possible cost. Market prices for selling the finished product and for buying the raw material, wage scales, the fixed expenses of operating, etc., are fairly uniform over wide areas, therefore, since general trade conditions are the same for all, the man who makes the most money will be the man who runs his plant with the lowest expenses. Expense may be cut down in various ways, according to various local conditions, but there is one expense that can be lessened solely by careful supervision, and that is the expense, loss rather, of waste; everything wasted is something taken from profits. There are so many ways in which waste can occur in the various textile processes that eternal vigilance is the price of success, carelessness or heedlessness will run up losses from waste to a big figure in a very short time. For instance, there is waste of raw material spoiled in process of manufacture or finishing, waste in the development and utilization of power, light, etc., waste by unskilled operatives, waste by throwing away useful material, waste by purchasing and using inferior raw material, supplies, etc., etc., in endless detail. Material wasted means money wasted, and while the big losses and wastes are usually quickly noted and steps taken to prevent or lessen them, the little losses and small things wasted are overlooked or taken as inevitable. Yet, it is just these seemingly trifling losses, waste, etc., that in the end often make the difference between profit and loss, and cause the thoughtless manufacturer to wonder and worry why his business does not pay.

Any system, method or device that will prevent losses or lessen waste is worth a trial if it is practical and sure in results and does not cost too much. One of the most practical ways to prevent certain losses in the textile industry, especially in its branches of dyeing, bleaching, finishing, etc., is by the practical application of chemistry in systematically testing raw materials and manufactured supplies before purchase and before using them in the various processes. Waste can be prevented also by the systematic testing of dye-baths, solutions of chemicals, etc., while these are in use, so that only the proper additions need be made to keep their strength uniform, and also by testing used baths, dye-liquors, solutions, etc., to ascertain the amount of useful material they still contain, so that this can be saved and further utilized.

Many of the problems of waste and losses in textile industries are to be solved only by the application of engineering or mechanical skill, others can be solved or lessened by training the help or making it to their advantage to be careful—with such problems this article will have nothing to do. Its object will be, first, to point out how savings can be made at many points, by the knowledge and application of the chemical operations of analysis and testing, the many ways and important uses to which these can be put, and then to show how this chemical knowledge can be obtained. The scope of instruction proposed will be referred to later.

It must be remembered that the buyer of chemicals and mill supplies is at the mercy of the seller as to their quality, strength, purity, etc., unless he is able himself to check the seller's statements by testing his purchases. If not employing a chemist or having the services of himself or some other person capable of making the necessary tests, the buyer has only the seller's guarantee or statement to guide him, and if he depends solely on the usual trade guarantee, he may find to his sorrow that it means nothing. Moreover, most dyeing processes are exact chemical reactions, and unless the exact strength of the chemicals used is known, the processes are sure to be based on guess work and the results depend on chance. How can uniformity be secured if a uniform quality and strength of materials be not used each time? Suppose a specially brilliant color be obtained with a certain dye-bath, how can this same color be repeated unless the exact amounts and proportions of its ingredients be known, so that the former conditions can be exactly duplicated?

**The Necessity for Testing Chemicals and Mill Supplies:** While the recently enacted federal and state "pure food and drug laws" protect the consumer against fraud and adulteration in articles used for food or medicine, there is absolutely no safe-guard for the purchaser of industrial chemicals and supplies except the guarantee of the manufacturer, and this is often merely a conventional compliance with trade uses and generally means nothing. The only sure protection against fraud, adulteration, substitution and inferior articles is that supplies be tested or analyzed by, or for the purchaser, except in the sole instance that the manufacturer sells them accompanied by a guaranteed

certificate of chemical analysis or other test. In many industries, everything is bought according to rigid specifications and must correspond to these requirements on chemical analysis before it is accepted, and while it is not always possible for the small dyer or mill owner to follow this system in its entirety, still, he can insure that he is getting what he pays for by insisting on testing the supplies he orders before paying for them. The cost of a single purchase of inferior material or the delivery and use of a mistakenly or fraudulently substituted wrong article, will, in many cases, amount to more than the cost of testing the entire year's supply.

There are many reasons why the materials used in the dye-house or mill should be tested before being used. In the first place, there is an enormous quantity of inferior or adulterated chemicals put on the market every year, as is proved by the published results of a series of tests of chemicals, bought in the open market, recently conducted by the U. S. Department of Agriculture. Many samples of staple chemicals were found to be far below their labelled or required strength or purity, and some of them were actually not at all what they were sold for. The most important chemicals used in the arts and industries were found full of impurities, from careless manufacture or purification, and some were grossly adulterated with cheaper adulterants or inert substitutions of cheaper substances resembling the true article.

The conclusion reached, and published officially, was that the label is no guarantee of the quality, strength, purity, value or even the identity of the so-called industrial chemicals sold in the open market, if these are not accompanied by a certified guarantee from a responsible manufacturer. That there is no standard for industrial chemicals and that the label seldom indicates the strength or purity of the article and is sometimes actually false, are facts which must be borne in mind by every buyer.

Chemicals and mill supplies vary widely in strength and value even if pure, that is, free from foreign substances or other chemicals. Carbonate of soda, for instance may contain ten molecules of water of crystallization or only one molecule of water. At the same price for the two different articles, their value would be very different; in the first case, the purchaser would get only 40% of what he actually wanted, carbonate of soda, the rest of the weight being made up of water, which is no use to him, whereas in the second he would get 85% of useful material. Again, in many processes of dyeing, iron is a very undesirable factor, its presence giving very inferior colors, therefore a lot of bichromate of potash containing iron would be worth far less to the dyer than a lot free from iron, in fact he would not want the first lot at any price. But, how is the purchaser to know these things unless he has his purchases chemically tested, he cannot take the meaningless commercial catchwords of "standard purity," "strictly pure," etc. as a guarantee?

Another reason for testing supplies is to guard against mistakes or the fraudulent substitution of one article for another. There are so many chemicals that look alike and behave alike in some ways that it is very easy to mistake one for the other, unless a chemical test is made.

Take for example epsom salts and zinc sulphate. These two salts look somewhat alike and it requires some experience to distinguish them from one another, unless a chemical test is made; yet if zinc sulphate was used by mistake in place of epsom salts, it would cause great confusion and damage. To prevent any mistake, all chemicals should be properly and carefully labeled and marked and if these markings or labels become destroyed or lost, and there is any doubt as to the chemical, it should be tested to make its identity certain. Moreover, chemicals are often heavily adulterated with useless or deleterious substances and these must be detected for the protection of the purchaser.

In the actual work of the dye-house, bleachery, etc., the ability and means to apply chemical tests at various stages of many processes are very valuable. Many times, failure can be prevented by testing dye-baths or solutions when something seems wrong, learning the cause and taking the necessary steps to correct things. Again, many times, used solutions can be saved for further use, if the amount of the chemicals in them can be known exactly, thus much valuable stuff can be saved that otherwise must be thrown away, for fear that its use would spoil good material. Take the bichromate of potash bath used for mordanting wool—this is often used over and over again by adding fresh bichromate, acid, or water, or all three, but if the strength of the bath is only guessed at, no one can know what quantity of fresh materials to add to it to keep it at the proper strength, consequently there is every prospect of wasting chemicals, by using too much or of spoiling the wool by using too little of one ingredient or another. If the bichromate bath be tested after each batch of wool has gone through it, its exact strength can be easily ascertained and the proper quantity of bichromate, acid or water can be added to it, and it can again be used safely many times.

The mill owner can protect himself from fraud or over-payments by having his lubricating oils, soaps, greases, sizes, paints, etc., etc. tested before buying them, and he can establish standards of strength and purity for all his supplies, that will not only save money in their purchase but will also pay good profits in securing for him uniform results and operating conditions. It will not take long for him to find out just what standards suit his conditions best, and every mill owner of experience knows that uniformity in operating means a good deal of money saved. By

testing articles, he is also protected against the possible presence of harmful materials in what he buys which might damage either machinery or finished goods; grit in greases, excess of alkali in soaps, for examples.

Moreover, uniformity in the goods will obtain and hold the good will of the consumers because they will know that the goods they buy will be always of the same grade and character. There will be no complaint that the last lot of material was not as good as that sent before.

Still another valuable result secured by the ability to test one's supplies is that a person can go into the open market and buy goods that come up to his standards at much lower prices than he would have to pay for trade-marked or guaranteed brands. Rest assured that you will have to pay the manufacturer for the expense of testing and guaranteeing his products, why not do your own testing and save the money for that, as well as the fancy prices charged for articles of guaranteed quality? The very fact that you must pay more for guaranteed quality shows how much inferior stuff is sold.

The value, rather the positive necessity, of chemical analysis of their crude and finished materials has been recognized by every industry, and most large plants have a staff of chemists and completely equipped laboratories, but on the other hand, few small manufacturers think it worth while to follow their example, either from fear of the cost or else from the mistaken idea that their practical experience will carry them through. It would, of course, be out of the question for a small mill or dye-house to employ a high-priced chemist and to fit up an expensive laboratory, but it is practical for some one person connected with it to learn enough chemistry to perform simple tests and for the testing of their various materials purchased or used to be made a regular part of his duties. Such work would neither require much chemical knowledge and training nor the use of expensive apparatus and chemicals; the necessary skill would soon be obtained by practice and a little instruction in the general principles of chemical analysis and the individual tests for various articles. All that is really necessary is a moderate outfit and a few hours' study and the desire to succeed. Of course, this is not said in disparagement of the expert chemist, his work will require all his skill and training, and he cannot be dispensed with in a large plant, but where the mill or dye-works is not large enough to afford such a man, much can be done along the lines mentioned by the owner or manager himself.

The boss dyer is the proper man to do the testing in smaller dyeing establishments which have no chemist, since frequently he may have a knowledge of general chemistry as well as a practical and thorough knowledge of dyestuffs. He is used to chemicals and knows that they require care in handling.

The purpose of this series of articles will be to give only such general information and directions as are necessary for the understanding and application of the tests to be described later, then to give the best and most practical way of testing each substance separately, to ascertain its identity, purity, strength, amount present in a solid mixture or solution, its value for various uses, etc., etc. The work will not go into general chemical analysis any further than is necessary for its application to certain operations or substances, nor will detailed methods requiring complicated or expensive apparatus be given—for such the reader is referred to the standard works on industrial chemistry and analysis. The system followed will be to give just enough detail to make every test described clearly understood, and to enable any person of good intelligence to perform them by carefully following the instructions given. Certain general operations, such as making test-solutions, drying and weighing precipitates, handling chemical apparatus and the use of various appliances, measuring, weighing, etc., will be described as a preliminary, and discussed in sufficient detail to make them clearly understood by the student.

Lists of the necessary apparatus and chemical reagents will be given, as far as practicable, with directions for fitting up a compact and complete laboratory, to assist the reader in ordering his outfit. The space needed for this will be small, the only absolute essential being a supply of running water. If gas is not available, alcohol (grain or wood) can be used in the various operations requiring heat, although gas is by far preferable for use.

The scope of this series of articles can best be described by giving an outline of the work to be undertaken under chapter headings. It will be in three parts, and, as far as possible, the article in each issue will be separate and complete.

PART I.

Fitting up the Laboratory. List of Chemicals and Apparatus Required.

(1) The Principles of Chemical Analysis and their Application, etc. The Metric System.

(2) Volumetric Analysis, or Testing by Standard Solutions. Directions for Making and Testing the Standard Solutions. How to use Them. Indicators, etc.

(3) Gravimetric Analysis or Testing by Weight; Scales, Weighing, etc.

(4) Operations Requiring Heat; Boiling, Drying, Fusing, Igniting, etc.

PART II.

(5) General Methods of Testing. Operations Required, Results to be Secured, etc.

(6) General Methods of Testing Chemicals and Mill Supplies.

(7) General Methods of Testing Dyes, Dye-stuffs, Colors.

(8) General Methods of Testing Fibres and Fabrics.

PART III.

(9) Tests for and Estimation of Chemicals, alphabetically arranged.

(10) Tests for and Valuation of Mill Supplies, alphabetically arranged.

(11) Tests for and Valuation of Dyes, Dye-stuffs and Colors, alphabetically arranged.

(12) Tests for and Valuation of Fibres and Fabrics, alphabetically arranged.

(13) Water Analysis. Tests for Impurities and Estimation of Amount Present.

(14) General Tests for Fuels, Paints, Oils, Various Materials.

It is recommended that *Part I* be carefully studied and preserved for reference, as the skillful and correct performance of the tests, etc., given in *Part III* depends on the thorough understanding and application of the principles and directions there explained. By mastering the general principles of *Part II,* the student will be able to make many tests not mentioned in this article, as they are applicable to any article whose value can be estimated by chemical analysis.

It must be clearly understood that while exact accordance with the general principles of chemical analysis herein stated is necessary, modifications can often be made in the individual tests, or others may be used with equally good results. The various methods and special tests given are by no means the only ones that can be used, but an effort has been made to select and describe those which will give accurate results in the hands of a person not thoroughly versed in chemistry and chemical manipulations, and which are practical both in method and application. As before remarked, this article is not intended for the expert chemist, but rather for those whose knowledge of chemistry is slight, and it is hoped that the instructions given will enable the student to undertake the testing of all the chemicals, mill supplies, dyes, raw materials, etc., commonly used in the textile industries.

**Fitting up the Laboratory:** About the only essentials for a laboratory sufficient for the needs of a small plant are a long work-table, a sink with running water, gas for heating and light, and good light, from a window for the daytime and a good lamp or burner at night. If available, a small room can be set aside for a laboratory, with the advantages of quiet and better facilities for work, but it is not necessary, the table can be set against the wall near a window and shelves built over it. It will be better if a light partition be run up enclosing the table, shelving, etc.

The one absolutely necessary equipment is a sink with running water, without which the work will be severely handicapped and will be sloppy and messy. If no other way be possible, install a fair-sized water tank at the ceiling and run pipes to the sink. The sink will be most conveniently placed if set in the work-table, at about the middle, the upper rim of the sink being brought flush and level with the top of the table. The joints between the sink and the table should be made water tight. Good drain pipes are necessary.

If gas be at hand, run a pipe over the table and fit it with one or two outlets for quarter-inch rubber tubing, for connection with Bunsen burners, etc. If there is no gas connection, alcohol lamps can be used for those operations requiring heat, one style of lamp now made giving as high a degree of heat as does the "blue-flame" gas burner. Either wood alcohol or denatured alcohol is economical.

The table should be strong and solid, with a good thick top, about six feet long and three feet wide, set at a convenient height from the floor. If a hot mixture of paraffin and turpentine be well rubbed into the planed surface of the table until the wood is saturated, the excess wiped off and the surface well polished, the table top will not be affected by acids, etc., spilled on it.

It would be better to cover the top of the table with sheets of asbestos. These can be obtained for a small price and will be better in case of fire which may be caused by accident. It will keep the table in good condition and where the asbestos becomes old and dirty it can be renewed with fresh clean pieces. Moreover, asbestos is better because it is softer than wood and very often hot beakers are picked up and the person who picks them up generally wishes to put them down quickly and these would break if they came in contact with the hard wood.

Several drawers will be found useful for containing apparatus, tools, etc.

The shelving need be only sufficient to hold the bottles of chemicals, test solutions, apparatus, etc. Two or three shelves, about 8 inches wide, placed above the table will be found convenient for holding the bottles mostly used. These shelves should run the full length of the table, the bottom shelf being set about two feet above the table, the other shelves set about 10 inches apart. Other shelves can be put up as needed. A small folding shelf near the table will be found handy for use as a desk.

Of course, other and more elaborate fittings may be put in if desired. If it is wished to fit up a complete laboratory, the entire necessary equipment can be ordered from any one of several firms making this a specialty, and the furniture can be bought, shipped and put up at the mill by its own employees or by hired carpenters.

(*To be continued*)