the instructor after which the student was expected to devise his own methods for solution. The instructor answered specific questions but refused to suggest an outline or general plan of procedure, requiring the student to work out his own methods from the literature. A full discussion and exchange of methods among the students in the laboratory was, however, encouraged. Experience has shown that students attack such problems in a wide variety of ways and frequently with varying results. These are criticized and amended in class discussions at the end of each semester.

PROBLEM I—Given a sample of crude California petroleum, obtain the yield of kerosene oil which complies with the requirements of the state law.

Requirements: An examination of the state law, reference to the literature of petroleum refining and familiarity of the student with the varying effects of the rate of distillation, the design of distilling apparatus, the effects of acid and alkali treatment, the removal of water from oily distillates, and the various forms of oil testing apparatus.

PROBLEM II—Given a sample of coal-gas tar at a local cost of 6 cents per gallon, determine the yield of creosote complying with the specifications of the city of Seattle and the cost per gallon, f. o. b. plant, of the creosote.

Requirements: The specifications of the city for creosote, the distillation of the coal tar, computation of fractions and the derivation of the process of distillation, the analysis of the creosote by the official method, a study of the uses and values of the by-products such as light oil and pitch, the selection of a unit charge for commercial operation, a field study of a Barrett plant, and itemization of costs of production.

PROBLEM III—Prepare a bituminous enamel containing 20–35 per cent carbonaceous matter insoluble and 55–65 per cent ash, with physical properties specified by the United States War Department.

Requirements: A study of the commercial pitches, methods of analysis of bituminous materials and selection of a paint filler.

PROBLEM IV—Determine which one of two commercial boiler compounds shall be selected to prevent scale formation in the University Power Station.

Requirements: Analysis of scale, of feed water and of the boiler compounds; a study of the causes and prevention of scale formation and the application of the data to the given case. A description of the problem has already been published in *THIS JOURNAL*, 8 (1916), 435.

PROBLEM V—Determine the effect of blending Portland cement with Washington tufa.

Requirements: Reference to the literature of blended cement products; testing of cement by standard methods; and a study of cement specifications.

PROBLEM VI—Determine the proportion of cement, sand and gravel in concrete.

Requirements: Method of mechanical analysis; grading of aggregate; specific gravity determinations; chemical analysis of cement; and computations.

PROBLEM VII—Determine the effect of adding lime and sand to a plastic red burning clay.

Requirements: Methods of clay testing; study of range of vitrification; grinding and mixing operations.

PROBLEM VIII—Classify the oil obtained from samples of Philippine nuts.

Requirements: Extraction of oil from nuts; comparison with the known constants of fatty oils; and the relation of constants to uses of the oil.

PROBLEM IX—Determine the yield of rosin in western yellow pine.

Requirements: Methods of sampling; extraction by various solvents; and efficiency of commercial solvents.

PROBLEM X—Determine the efficiency of the recovery of ammonia in the extraction of rosin from Douglas fir.

Requirements: Separation of rosin and humus; Kjeldahl determinations; removal of ammonia from wood; and computations.

PROBLEM XI—Devise a method for the extraction of cedar oil from the destructive distillation of Port Orford cedar and determine the nature and probable uses of the residues of the distillate.

Requirements: Methods of steam distillation and of vacuum distillation; study of literature relating to Port Orford cedar oil; determination of constants of oil; study of wood tars and their uses.

PROBLEM XII—Prepare a rosin paint drier soluble in raw linseed oil.

Requirements: Preparation of metallic resins; methods of paint testing; and commercial requirements of driers.

During the present year similar problems dealing with the study of cactus, wood humus, potash salts, recovery of iodine, cost of manufacture of hypochlorites, etc., have been undertaken. It is apparent that the problems are capable of great diversification, which adds to the interest. The chief objects in view are to throw the student upon his own resources, make him acquainted with chemical literature and force him to make use of the tools of knowledge already in his possession.

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AN UNUSUAL EXPLOSION IN CONNECTION WITH POTASSIUM CHLORATE

By FLOYD E. ROWLAND

Received May 3, 1916

There was nothing unusual about the explosion itself, but the manner in which it occurred is well worth mentioning and bringing to the attention of all who have occasion to use pestles which have wooden handles.

Everyone knows that disaster is sure to follow when potassium chlorate and sulfur are ground together; but to have a perfectly clean mortar and pestle suddenly explode with great violence, when one is grinding an inert substance like pumice stone, makes one pause and wonder why.

A pestle and an 8-inch mortar were thoroughly cleaned and about fifteen pounds of potassium chlorate were ground with no disastrous results. The mortar

and pestle were washed and dried. A few days later some crushed pumice stone was required in the laboratory and the same mortar and pestle were used. A loud explosion resulted. The mortar and pestle were broken into many pieces and thrown violently about the room. One piece passed through a window scarcely shattering the glass. The room was filled with sulfur dioxide and fine particles of sulfur were scattered over the floor and table. An examination of the pieces of the mortar showed no traces of sulfur but quite large quantities of sulfur were found adhering to the fragments of the pestle. The wooden handle of this pestle had been sealed into the ball part with sulfur. Evidently a small amount of the potassium chlorate worked into the crevice with the sulfur and caused it to explode when given a sudden jar.

FRAGMENTS OF BROKEN MORTAR AND PESTLE

An examination of other pestles of the same type showed them to contain as much as 10 to 20 g. of sulfur.

This explosion might have been more disastrous had not the mortar been used at this time for grinding the pumice stone, as, in a few days it would have been used again to pulverize more potassium chlorate, and with the excess chlorate the explosion would have been more violent.

It certainly is not generally known that the handles of these pestles are sealed in with sulfur, for if it were they would never be permitted in the laboratory.

The pestle was of German make and whether or not they still employ sulfur for this purpose is difficult to say. If any companies in this country are using sulfur for this purpose they should substitute in its place some inert cement. Laboratories should bar the use of this type of pestle until the sulfur has been replaced by some safe material.

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A RAPID METHOD FOR COMPARING THE DECOLORIZING EFFICIENCY OF CHARCOALS

By LEONARD WICKENDEN AND JOHN W. HASSLER

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The various methods in general use at the present time for comparing the decolorizing values of charcoals, possess features which render them, for one reason or another, unsatisfactory. In most oil laboratories, direct tests are made with the oil which is to be treated. Such tests are satisfactory as far

as they go, but filtration is slow and small differences in the decolorizing powers of charcoals are difficult to detect, even with the aid of a colorimeter. When the operation is repeated on a manufacturing scale, these small differences become magnified and may mean a considerable difference in the final product. The same argument applies, though perhaps to a lesser degree, to the testing of charcoal on argols solution and on various pharmaceutical products.

The use of an alcoholic solution of caramel, as suggested by Laube, is open to the objection that the solvent is volatile and the solution cannot, therefore, be used at high temperatures. If an aqueous, instead of an alcoholic, solution of caramel be used, trouble is experienced in obtaining clear filtrates, and, moreover, the solution will not keep.

An aqueous solution of an aniline dye gives unreliable results owing to the fact that many charcoals on the market contain appreciable amounts of soluble ash, and the alkalinity of this ash produces color changes which vitiate the results obtained.

A method has been devised in these laboratories, which is very rapid and which enables charcoals to be classified with great ease and accuracy according to their decolorizing efficiency. A solution of Aniline Red, Soudan III (oil soluble), in kerosene is used. The strength of the solution is largely a matter of choice, but we have obtained the most satisfactory results with a 0.025 per cent solution (0.25 g. per liter). One hundred cubic centimeters of this solution are measured into a 150 cc. beaker, 5 g. of the charcoal are added and the beaker placed on a boiling water bath in such a manner that the beaker is entirely enveloped in steam but does not dip into the water. The charcoal is kept in suspension by frequent stirring and at the end of ten minutes the beaker is removed from the water bath and the mixture filtered. The kerosene solution filters very rapidly and comes through clear and bright. Its color is compared with a scale prepared in the following manner:

One hundred cubic centimeters of the kerosene solution of Soudan III are treated with 1 g. of a charcoal of average quality. The solution thus obtained is given the value 10. A second solution, obtained by treatment with 2 g. charcoal, is given the value 20, a third, obtained with 3 g. charcoal is numbered 30, and so on up to 100.

The scale thus obtained is, of course, of a purely arbitrary nature, but it has, none the less, a real meaning. Thus, if, by treating the standard solution with 5 g. of charcoal according to the method above described, a solution is obtained of the same depth of color as that which has been given the value 70, it means that 5 g. of the charcoal under examination will do the same work as 7 g. of the average charcoal, and thus possesses a 40 per cent greater efficiency.

By using a solution of the strength indicated, the difference in color between the solutions forming the scale is sufficiently marked for comparisons to be made without the aid of a colorimeter. In order, however, to make our comparisons easier and more exact, we