security. This clause has proved most ineffective as *no single case of revocation of a patent on this ground has been known*. Therefore, when the abolition of the working clause was discussed, it was suggested to do away also with that clause on the obligation of granting licenses. It was objected that cases might happen where the use of a patented invention by others than the patentee could be necessary *for the public welfare*, for instance, manufacturing certain drugs in case of an epidemic."

This consideration seemed to justify the insertion of the following clause in that new law of 1911:

"If the patentee refuses to grant license to another for using the invention upon the offer of an adequate compensation and security, such grant for using the invention can be allowed (compulsory license), if such granting seems necessary in the public interest. The grant may be limited or subject to special conditions."

This detailed report of the Commission on Economy and Efficiency is supplemented by some specific recommendations as follows:

I. That a new building specially designed, equipped, and furnished be constructed on a suitable site in the city of Washington, for the exclusive use of the United States Patent Office.

II. That the number of officers and employees of the United States Patent Office be increased, and the increases and readjustments of salaries be made as shown in detail in this report involving an increase of 36 in the number of employees and a total increase of \$236,550 in the pay roll.

III. That the Commissioner of Patents be the head of the Patent Office; that his duties be the same as are now prescribed by law, excepting that he be relieved from the consideration of cases on appeal; that he be aided by an assistant commissioner and seven supervising examiners in the administrative work, including control of the methods and procedure of the 43 examining divisions in the allowance and rejection of applications for patents.

IV. That one appeal within the United States Patent Office be eliminated; that the number of members of the board of examiners in chief of the Patent Office be increased from three to five; that all appeals within the office be taken to that board; that its decision be the decision of the Patent Office; that the appeal therefrom be to the Court of Appeals of the District of Columbia, as now allowed from the decisions of the Commissioner of Patents.

V. That the fee for filing an application be increased from \$15 to \$20; that appeal fees be adjusted to the conditions arising from the elimination of one appeal; that a fee of 25 cents be charged for each additional patent, etc., included in one instrument presented for record; that all fees be paid directly to the Patent Office; that refundment of fees paid by mistake be made by the financial clerk and not by warrant from the Treasury.

VI. That the life of a patent be so limited as to expire 19 years from the date of filing the application therefor, excluding the time (not exceeding two years) during which an application may be involved in interference.

VII. That the work of reclassifying patents and digesting of printed publications, and providing facilities for simplifying and making more accurate the search, be recognized by an appropriation for an adequate force to be employed upon such work.

VIII. That the subscription price of the Official Gazette be increased from \$5.00 to \$10.00 and the method of distribution to libraries be changed to reduce the number of copies so distributed.

IX. That all the work of producing the publications of the Patent Office, including copies of patents, be done at the Government Printing Office.

X. That an appropriation be made for the repair of the rooms occupied by the Patent Office and for the installation of suitable lighting and ventilating facilities and for the purchase of new furniture and equipment.

YONKERS, N. Y.

THE PLASTICITY OF CLAY¹

By JOHN STEWART

It is one of the peculiarities of human endeavor that action taken for a certain purpose often results in the accomplishment of an entirely different and unexpected result. *A priori* it would hardly be expected that a study of the organic phosphorus of the soil would have any bearing on the plasticity of clay, but such is the infinite inter-ramification of the facts of nature that they lead to strange results.

So far as the writer is aware, no satisfactory explanation of the cause of the plasticity of clay has ever been advanced. Numerous attempts to explain the phenomenon have been made, but none of the results has met with general acceptance. Hilgard² reviewed some of the most important of these attempts, but indicated by his treatment of the subject that the question was still an open one. Hopkins³ mentions plasticity as a *property of clay*. Thorp,⁴ in his exposition of the chemistry of the ceramic industries, offers no explanation of the cause of the plasticity of clay, although without this property the industry could not exist. Ashley⁵ reviewed the literature of colloids and of clay, and made a study of the absorptive power of some clays for certain dyes. His work was based on the idea that "clay is . . . a mixture of granular matter and a colloid gel," and had for its purpose the development of a method of measuring the plasticity of clay by utilizing the absorptive power of colloids for this purpose. In a later publication, Ashley⁶ discusses plasticity of clay on the same general lines. He says: "The colloid matter of clays may be considered as consisting of complex mineral and organic acids and salts." Bleining⁷ studied the effects of heating clays to temperatures under 400°. He found that the plasticity was decreased and that there was *not* a corresponding change in the absorptive powers of the clay. Acheson,⁸ in 1901, ground clay in a water extract of straw and found that this treatment increased the plasticity. He considered this result to be due to the *organic* matter in the water extract. In 1904 this result was claimed to be due to gallo-tannic acid, and seems⁹ to have been regarded as a *physical* and not a chemical action. Thus the importance of Acheson's observation does not seem to have been recognized by investigators. P. Rohland¹⁰ attributed the plasticity of clay to hydroxides of Si, Al, and Fe. He noted that fuller's earth *absorbs* unsaturated *hydrocarbons*, and he recommended the use of clay to purify factory wastes.

There are some facts relating to the plasticity of clay which have received general recognition and acceptance as being true. First, *pure* clay is *not* plastic. Hilgard¹¹ says: ". . . it is readily mistaken for chalk (and is sometimes used as such), being powdery to the touch and entirely devoid of plasticity" Those engaged in the ceramic industries call the purer clays "lean" on account of their lack of plasticity. Second, *impure* clays are the plastic ones. These are the "fat" clays, so-called by those engaged in the ceramic industries because of their possession of plasticity. Third, it is a common practice in the ceramic industries to mine the clay and allow it to *weather*¹² for months before use. This is said to increase the plasticity. Fourth, *ignition* destroys the plasticity of clay. Attempts to

¹ Paper presented at the Eighth International Congress of Applied Chemistry, New York, September, 1912.

² "Soils," 1906, pp. 57-62.

³ Hopkins' "Soil Fertility and Permanent Agriculture," p. 55.

⁴ "Outlines of Industrial Chemistry," 1909, pp. 191-200.

⁵ U. S. G. S., *Bull.* 388 (1909).

⁶ C. A., 5, 174-5 (1911).

⁷ *Ibid.*, 5, 175 (1911).

⁸ "Some Chemical Problems of To-day," R. K. Duncan, 1911, pp. 118-119.

⁹ U. S. G. S., *Bull.* 388, 12 (1909).

¹⁰ C. A., 4, 503, and other abstracts.

¹¹ "Soils," 1906, p. 59.

¹² Thorp, "Outlines of Industrial Chemistry," 1909, 194. Roscoe and Schorlemmer, "Treatise on Chemistry," [1] 2, 495 (1883), new edition.

all failed. Fifth, a pure clay is a hydrated *aluminum* silicate.

Two other facts¹ which are not as generally recognized as the above may be mentioned here. First, Ries in his work on Michigan clays found examples of lean clays absorbing a greater percentage of water than fat clays absorbed. Second, Grout found that a shale increased largely in plasticity on weathering, but that the combined water remained practically constant. It is also a fact that shale loses its plasticity on being metamorphosed into slate.

During the past year the writer made an observation which is of considerable importance with reference to this subject of plasticity. The observation referred to was made during a study of humus and the organic phosphorus of the soil, in which the writer was engaged during the summer of 1911. This study resulted in some interesting data and conclusions with reference to the organic phosphorus, iron and aluminum compounds of the soil. A paper has been prepared embodying the data and conclusions resulting from the work and not embodied in the present article.

In the study of humus, or the constituents of humus, there is a fundamental difficulty, due to the deflocculation of the clay by the alkali used, which makes it almost impossible to obtain a humus solution free from suspended clay. In searching for a means of overcoming this difficulty the writer added a small quantity of alumina cream, washed free from salts, to a humus solution containing some suspended clay, and filtered the liquid. A perfectly clear humus solution passed through the filter; but the residue on the filter was dark colored, indicating that chemical action had occurred between the humus and the alumina cream. This indicated that this method could not be used for quantitative work, and, consequently, the filtered solution and residue were set aside for several days. The filtered solution was then placed in an evaporating dish to determine if the chemical action of the alumina on the humus had seriously interfered with quantitative results. After being on the water bath a short time a flaky, dark brownish colored solid separated out, leaving the humus solution almost colorless. This solid was gelatinous, and some of it floated on the liquid. As the solution evaporated, these flakes adhered to the sides of the evaporating dish and to the glass stirring rod, sticking almost like glue. The solid was then filtered off and leached with one per cent hydrochloric acid. It proved to be rather difficult to decompose. The acid was used cold at first, then hot acid was tried; and a hot stronger acid was used before a very complete decomposition of the precipitate was obtained. The acid solution gave a heavy precipitate of *aluminum* hydroxide on adding ammonia. There was a residue of organic matter left on the filter which dissolved readily in ammonium hydroxide.

Now taking all these facts into consideration, the writer suggests that the plasticity of clay is due to the presence of an *organic aluminum* compound (or compounds). This will satisfactorily explain all the important, established facts concerning the plasticity of clay. This explains why it is the *impure* and not the *pure* clays which are plastic. This explains why *ignition* destroys plasticity and why levigation fails to restore plasticity to the ignited clay. This explains the heretofore unexplained practice of weathering clay before using it in the ceramic industries. In 1883, Roscoe² and Schorlemmer said: "It . . . is allowed to remain for a considerable length of time in a moist place, when the organic matter contained in the clay undergoes putrefactive decomposition: this seems to increase the plasticity of the mass, but the exact action which takes place under these circumstances is not well understood." This explains why shales lose their plasticity on being metamorphosed into slate. This explains the observations of P. Rohland, mentioned by Ashley,³ to the effect that plasticity

of clay is reduced by all bases and all salts of strong bases with weak acids which hydrolytically split off hydroxyl ions and that neutral salts have no effect on the plasticity; for, the aluminum organic compound observed by the writer is soluble in alkali. This gives a partial explanation of the universal observation that hydrous *aluminum* silicates are sometimes plastic, while similar hydrous silicates of other bases, as serpentine, are not plastic; and, taken in connection with some other facts which readily suggest themselves, makes a complete explanation of the observations.

In all probability, the writer's observation gives at least a partial explanation of the use of fuller's earth for purifying mineral and vegetable oils. The writer suggests also that the heretofore unexplained fact that vegetable oils purified in this way generally have a bitter taste, is due to the formation of an aluminum organic compound which is somewhat soluble in the oil, and to which the bitter taste is due.

It is interesting to recall in this connection an observation made by Th. Schloesing¹ in 1874. After washing a kaolin with dilute acid, he separated it into several fractions by mechanical analysis, using ammoniacal water. Out of five fractions, only one showed any marked plasticity. This was the fraction that was still in suspension after 27 days. Schloesing called this fraction "colloidal clay;" and it was so plastic as to be sticky and adhered strongly to the porcelain dish in which it was dried. In the light of the writer's observation, and considering Schloesing's method of work, it is evident that Schloesing's "colloidal clay" contained a large proportion of an *organic aluminum* compound (or compounds) to which its plastic, sticky properties were due.

In speaking of "colloidal clay," Hilgard² said: "(It) . . . bears more resemblance to glue than to the clay of every-day life. Like glue, too, the dried colloidal clay adheres to the tongue . . . it assumes a highly plastic and adhesive condition, so that it is difficult to handle and almost as sure to soil the operator's hands as so much pitch." Hilgard³ also says: ". . . the several humates (of lime, magnesia, iron), which, when fresh, are colloidal (jelly like) like clay itself, but unlike the latter, when once dried do not resume their plastic form by wetting (Schloesing)." No mention of *aluminum* humates was made by Hilgard in this connection. His treatment of the subject also indicates that up to the time of his writing there had been no suggestion of a possible causal relationship between the plasticity of humates and the plasticity of clay. On the contrary, Hilgard⁴ states: "A similar process," (*viz.*, to that of Johnson and Blake,⁵ who levigated kaolinite in a mortar for a long time in an attempt to produce plasticity) "but continued much longer by the mechanical agencies concerned in soil formation (see Chap. 1), is unquestionably the chief factor⁶ concerned in the formation of natural plastic clays; but whether this is the *only* process by which powdery kaolinite may be transformed into plastic clay is a question not definitely settled."

In view of the observations of the writer and of Schloesing, it is evident that if plastic clays be subjected to treatment for the removal of the humus they will lose their plasticity. These observations point the way for the development of analytical methods for estimating the plasticity of clay; and also point the way for methods of treating clays which are too "lean" (or too "fat") for certain uses in the ceramic industries. Further research along these lines might prove very interesting and also of considerable practical value. It should probably be mentioned in this connection that Ashley⁷ has already indicated

¹ *Compt. rend.*, **79**, 376-380, 473-477 (1874).

² "Soils," **1906**, pp. 61 and 62.

³ "Soils," **1906**, p. 110.

⁴ "Soils," **1906**, p. 60.

⁵ *Am. Jour. Sci.*, [2] **43**, 357.

⁶ These italics are Stewart's.

⁷ *C. A.*, **5**, 174-175 (1911).

¹ U. S. G. S., *Bull.* **388**, 28 (1909).

² *Treatise on Chemistry*, [1] **2**, 495 (1883), new edition.

³ U. S. G. S., *Bull.* **388**, 21 (1909).

some means of improving clays in accordance with these principles; but Ashley's work, in this connection, appears to be based upon the observations of Rohland,¹ for which neither of them apparently had a satisfactory explanation.

While the writer does not doubt that time will prove his explanation of the plasticity of clay to be correct and that these aluminum organic compounds are the only important ones concerned in this phenomenon—he would not be understood as claiming that in some cases other compounds may not contribute to the plasticity of *very impure* clays in a very minor degree. In this connection he would call attention to the fact that the "lime muds" obtained in purifying sugar beet juices are

very plastic. These are composed of granular calcium carbonate and coagulated albuminous substances and *calcium organic* compounds mainly. Limestone is generally impure and there may be also magnesium, iron and aluminum organic compounds in the "lime muds." There can be no doubt that plasticity results from the mixture of a granular substance and a gelatinous substance in due proportion. There are many granular substances and many gelatinous substances; and so the plasticity of different substances is due to different components of the mixtures.

UTAH EXPERIMENT STATION
LOGAN, UTAH

CURRENT INDUSTRIAL NEWS

By W. A. HAMOR

THE TINNING INDUSTRY

The tinning industry from a chemical standpoint is discussed by Hodgson in *The Chemical World*, 2, No. 3, 98. At first tinning was practiced as an auxiliary branch of various handicrafts, such as that of the copper-smith, spur-maker, etc., but its rapid development effected its separation as an individual industry. As early as 1670, an English company was organized to start a tin-plate works at Pontypool, but patent difficulties occasioned their stoppage. In 1720, however, works were started once more at Pontypool, and being followed by others in South Wales, the industry developed so extensively as to become probably the most important seat of this manufacture in the world.

The pickling process has exercised the minds of those engaged in the industry from its inception, and the problems it presents are essentially of a chemical character. The real development of tinning, therefore, runs parallel with that of the production of mineral acids and sheet steel. Pickling was originally performed with organic acids, and Reaumur was the first to recommend dilute sulfuric acid for pickling sheet iron. At the present time, the sheets are very carefully dipped into a mixture of dilute sulfuric and hydrochloric acids, then well washed, dried, and gradually heated to a cherry-red heat in iron boxes placed in furnaces. After remaining several hours in the furnace, the sheets are slowly cooled and smoothed between hard rollers, again rapidly heated with exclusion of air, and dipped into a fermenting mixture of bran and water. A final immersion in dilute sulfuric acid, with subsequent washing and sand scouring, causes the sheets to be ready for the plating process. (This is the Welsh practice, and, while it has been found to be satisfactory, shortly before the development of the tinplate industry in the United States, there were introduced various improvements, principally mechanical, to reduce the labor involved, to cheapen the cost of manufacture, and to lessen the consumption of raw materials. On these points, see W. C. Cronmeyer, German Engineers' Society, Pittsburgh, 1899.—W. A. H.) In the United Kingdom, until government action was taken, lead was added to the fused tin for easier and cheaper tinning, and Newton proposed the addition of bismuth. The usual tinning plant, or stow, consists of five vats: the first and fifth, the "grease-pots," contain tallow or palm oil; the second, the "tinman's pot," is filled with molten tin at 400° C., this being covered with a layer of palm oil to prevent oxidation. The sheets are placed in the grease pot while wet and after 10 minutes are taken to the tinman's pot. Small metallic objects are, however, usually tinned by the blanching process. The well-scrubbed object is placed for several hours in a boiling solution containing tin or alkali stannates, and is then washed with water, rubbed and dried. Electro-tinning has recently made important progress, although as yet no marked commercial success has been attained. A beginning has been

made at Swansea to coat black plates with aluminum by a cold wet electric process.

Among the ideas Thomas (*Chem. Trade J.*, 52, 341) considers worthy of investigation are the following:

- (1) Over and under black pickling, the influence of strength and temperature of the acid solution, and of time.
- (2) Effect of varying temperatures and time of annealing.
- (3) Light and heavy cold rolling.
- (4) Temperature effects in the tinning operations.
- (5) Differences from the tinplate trade point of view between acid Bessemer steel, basic Bessemer steel, acid open-hearth steel, and basic open-hearth steel, and the comparative tin consumption of each kind.

LINSEED OIL

The distribution of the world's linseed shipments has been as follows (*Chem. and Drug.*, 1913, Jan. 25):

Year	World's seed shipments, in tons	Distribution, in tons	
		United Kingdom	The Continent and the United States
1903	1,178,150	385,954	592,196
1904	1,523,426	505,519	1,017,907
1905	1,110,773	345,412	795,361
1906	1,080,883	286,140	794,743
1907	1,368,311	372,537	995,774
1908	1,432,186	382,169	1,050,017
1909	1,293,836	303,237	990,599
1910	1,153,923	236,066	917,857
1911	1,101,690	243,338	858,352
1912	1,127,424	257,294	870,130

The production of linseed for the last ten years is reported as follows in tons:

Year	Argentina	India	U. S. A.	Canada	Russia
1903	937,601	481,367	682,513	21,100	461,314
1904	740,000	571,832	585,013	13,388	471,836
1905	591,912	347,400	711,944	18,342	421,000
1906	825,764	353,400	626,500	25,588	540,500
1907	110,710	425,200	646,275	43,301	550,590
1908	1,048,852	163,200	645,125	79,133	500,339
1909	716,515	297,700	487,817	120,829	558,360
1910	595,000	527,600	317,950	100,974	650,000
1911	572,000	563,600	484,250	196,675	670,000
1912	1,130,000	641,200	701,825	528,505	650,000

Practically the whole of the Argentine exportable surplus will be diverted to Europe, as well as the great bulk of the Indian supplies and a considerable tonnage from Russia.

THE "RHENANIA" STEAM METER

A Dresden firm has placed upon the market a meter which is reported to successfully measure the whole quantity of steam

¹ U. S. G. S., *Bull.* 388, 21 (1909).