

It is advisable at the outset to become acquainted with the workings of the method, using a good commercial sample of tannic acid, before attempting to determine the tannin in oak bark, tea, or other tannin yielding materials.

UNIVERSITY OF MINNESOTA,
LABORATORY OF THE
COLLEGE OF AGRICULTURE.

THE CHEMICAL INDUSTRY OF THE UNITED STATES.

BY HENRY BOWER.

THE chemical industry of the United States, in common with the other leading branches of manufactures, shows a remarkable increase in the decade between 1880 and 1890, and this is accompanied, in some instances, by results of such magnitude as to become phenomenal.

TOTALS OF PRODUCTIONS OF CHEMICALS IN THE UNITED STATES IN 1890.

	Value.
Alum (94,174,008 lbs.)	\$1,625,210
Coal tar products	687,591
Dyeing and tanning extracts and sumac.....	7,947,841
Gunpowder and explosives (108,735,980 lbs.)....	10,802,131
Fertilizers (1,818,552 tons)	34,038,452
Paints, white and red lead colors, and varnishes	52,434,690
Pharmaceutical preparations.....	16,486,643
Potash and pearlash (4,874,439 lbs.).....	185,247
Sodas (329,369,633 lbs.)	5,384,400
Sulphuric acid.....	6,522,591
Wood alcohol and acetate of lime.....	1,885,469
Chemicals, including all acids, bases, and salts not heretofore enumerated.....	25,140,425
All other products.....	12,903,943
	<u>\$176,044,633</u>

Sulphuric Acid.—The most important of all chemical manufactures is sulphuric acid, which maintains its supremacy over any other known article in promoting the manufacturing interests of the world. The large increase in the number of establishments and in the quantity produced indicates the advance that has been made in general manufactures in the United States during the last decade.

¹ Read before the World's Congress of Chemists, August 25, 1893.

During the year ending June 30, 1890, the following quantities of sulphuric acid were manufactured :

50	B.,	948,129,821	lbs.,	valued at	\$3,299,707
60	B.,	19,078,597	"	"	112,540
66	B.,	328,101,657	"	"	3,110,344

Total value, \$6,522,591

This includes the 50° acid used in the manufacture of fertilizers.

In order to obtain an intelligent comprehension of the extent of the entire sulphuric acid industry, it is advisable to reduce the foregoing figures to one uniform basis, that of 66° Beaumé acid (oil of vitriol). As this contains from ninety-three per cent. to ninety-four per cent. of real monohydrate acid (H_2SO_4), the reduction is made by multiplying the pounds of 50° acid by $\frac{100}{150}$, and the pounds of 60° acid by $\frac{100}{120}$. By so doing we obtain the following results :

Strength, Degrees Beaumé.	Pounds of acid as manufactured.	Equivalent to pounds of 66° acid.	Value
50	948,129,821	632,086,547	\$3,299,707
60	19,078,597	15,898,831	112,540
66	328,101,657	328,101,657	3,110,344
		976,087,035	\$6,522,591

The total quantity of sulphuric acid produced in the United States reduced to a uniform strength of 66° B. is accordingly 976,087,035 pounds, or 488,043 tons of 2,000 pounds each.

Reducing the quantity produced to a uniform strength of 50° B., we have results as follows :

Strength, degrees Beaumé.	Pounds of acid as manu- factured.		Equivalent to pounds of 50° acid.
50	948,129,821	× 1.00	948,129,821
60	19,078,597	× 1.20	22,894,316
66	328,101,657	× 1.50	492,152,485

Total 50° acid manufactured, 1,463,176,622, equal to 731,588 tons.

Supposing all the acid chambers to be running 365 days to the year, we find the amount manufactured in twenty-four hours to be 4,008,703 pounds, or 2,004 tons.

Fertilizers.—From a technical point of view, manufactured

manures become the next in importance to sulphuric acid in the category of chemical productions. The total of 1,818,552 tons of these materials produced during the year ending June 30, 1890, indicates by no inaccurate analogy the extent of the farming interests of the country. When we consider that about 300 pounds of artificial fertilizer are commonly used to the acre, it is seen that 12,123,680 acres were enriched by its use.

The increase in manufacture and consumption over 1880 is 1,091,099 tons, or about 150 per cent. These figures show with distinctness that large areas of our country are becoming unprofitable to farm without the use of these aids to fertilization. The existence of factories in the states of California, Illinois, Indiana, Michigan, Minnesota, and Wisconsin, is indicative of the gradual exhaustion of soil that was virgin in character less than twenty years ago. These facts tend to show that the time is approaching with rapid pace when none of our unmanured soils will yield in remunerative quantity. They prove also that economies are gradually being practiced in the utilization of material that formerly ran to waste.

In this respect the farmer occupies a reversed position to that of the manufacturer of artificial manures. By prodigal wastefulness and culpable ignorance he permits immense quantities of manurial matter to find its way to the sea, while bemoaning his lot and sighing over the yield of virgin lands in comparison with that of his own; whereas the manufacturer, by the aid of chemical skill and mechanical devices, converts refuse matter into valuable merchandise.

The advance in this branch of manufacture should give encouragement to the farmers of the Atlantic slope. When the no distant time arrives for the extinguishment of an agriculture that is based on primordial soil, the lands of these regions will recover their lost value, for observation will show how closely fertility is allied to the production of these manufactured manures, which can be carried on most profitably at those points where supplies of foreign crude material are obtained and where sea-board transportation can be made available.

Soda.—The last decade is rendered memorable to the chemical industry by the permanent establishment of the manufacture

of soda salts in the United States. Hitherto all attempts to produce these articles successfully from common salt have failed. The causes that have led to repeated failure and the consequent loss of large sums of money are to be found in the high cost of labor, the absence of customs duties on bleaching powders, or chloride of lime, and the exceedingly low rates of freight that rule on this class of merchandise.

The Solvay Process Company, of Syracuse, New York, has been founded on the experience and skill of the noted Solvay of Belgium. But, however satisfactory the process may be, it has a defect that enters into the production of many articles in the United States, notably in bleaching, paper-making, and chemical works, inasmuch as all the chlorine of the common salt employed is lost, passing away as valueless chloride of calcium. Consequently the United States still remains dependent upon Great Britain for its supply of so important an article as bleaching powder. A question of the greatest interest centers in this problem, how to overcome this defect in our manufacturing system. The efforts of inventors have for many years been directed toward the solution. Theory has marked out a number of paths, but practice has not yet succeeded in following any of these to a satisfactory result.

It may be added that, in addition to bleaching powders, the important chemicals, alizarin, chlorate of potash, and chlorate of soda, are not found among the salts produced in this country; and that these articles, so essential to the textile interests, are free of customs duty.

Pharmaceutical Preparations.—The United States is preeminent in the manufacture of pharmaceutical preparations, which are produced in consequence of the demand by physicians for more palatable or more compatible material for the *materia medica*. These articles cover a large field; they include pills, lozenges, fluid extracts, and a great variety of elixirs. The title, "elegant pharmacy," conveys a correct idea of the position occupied by the industry. Medicinal substances are associated in the mind with *ad nauseam* doses. The producers of pharmaceutical preparations have succeeded, in most instances, in masking or altogether obliterating the unpleasant properties

of drugs, which marks an advancement of no small moment within the past twenty years, inasmuch as this tends to improved health, greater security from disease, and a consequent reduction of the death rate.

The cost of distilled spirits constitutes the largest outlay in the manufacture of pharmaceutical preparations. A special investigation made by the census office of the United States showed that during the year ending December 31, 1889, 10,976,842 proof gallons of distilled spirits were consumed in the arts, manufactures, and medicine.

Chemicals and Dye-stuffs Used in the Industry of Dyeing and Finishing Textiles.—In 1890 the value of chemicals used in independent dye works, bleacheries, and print works was \$8,407,693. Much of the dyeing and finishing, however, is done by the manufacturers of the fabrics themselves, and the value of the chemicals and dye-stuffs is to be added to the amount named.

There were used by these manufacturers during 1890 the following amounts of chemicals and dye-stuffs:

Woolen mills.....	\$6,453,665
Cotton “ 	4,266,773
Silk “ 	558,532
	<hr/>
	\$11,278,970

Adding this \$11,278,970 to the value of the articles used by the dye works, bleacheries, and print works (\$8,407,693), we obtain as the grand total of chemicals and dye-stuffs used in manufacturing, dyeing, and finishing textiles, the value of \$19,686,663,—nearly twenty millions of dollars.

Compressed Ammonia Gas, or Anhydrous Ammonia.—The use of this article has reached large proportions within the past few years, and it has proved an invaluable aid to the preservation of food, the refrigeration of malt liquors, and the manufacture of ice. The introduction of the use of anhydrous ammonia has given great impetus to the manufacture of the special machinery adapted to its employment in the departments named.

The United States can rightfully claim the inauguration

on a large scale of these processes, which at this time yield profit, convenience, and health to people throughout the world.

Fuel.—Together with the metallurgical operations of smelting, melting, and heating, the chemical industry is a large consumer of fuel, hence great interest attaches to its supply; it is a figure of great importance in computing the costs of these manufactures.

Many fuel-saving devices are to be found in chemical works, and within the past two or three years fuel oil has become of considerable importance. Numerous devices have aided in making it adaptable in an admirable manner to furnace works. The replacement of coal is likely to be quite marked if the relative prices of the two fuels shall remain at the present ratio.

Natural gas also has been utilized in chemical works in localities adjacent to a supply, and its use has proved a great convenience.

Labor and Wages.—The employees of chemical manufacturers range from the lowest order to the highest in the scale, and the wages paid vary in proportion. Many operations partake of the "double shift," or twelve hours, the work being continuous, hence the average paid per hand reaches the high figure of \$580 per year. Eleven dollars and sixty cents per week is the average pay, counting fifty weeks steady employment in the year. A few females and a small number of boys find occupation in this department of manufacture. The men are chiefly of the able-bodied class.

The chemical, in comparison with such great industries as iron and steel, woolen and cotton, takes rank as the fourth among these great manufacturing divisions of the country. It represents a diversity of interests such as center in no other department, and it affords to the United States a source of activity for labor, skill, and capital, that is highly encouraging to those who have pride in the progress of their country.

The chemical industry of the whole world is interested in and relies upon certain tables or ready reference calculations. These aggregations of figures are confusing to a certain extent,

owing to the variation of the bases of calculation. In chemical works in the United States tables will be found in use :

For weights.	For measures.	For specific gravity.	For temperature.
Avoirdupois,	English gallons,	Beaumé scale,	Fahrenheit scale,
Apothecary,	Wine " "	Twaddle " "	Celsius " "
Troy,	Metric, as liters.		Reaumur " "
Metric, as kilo-grams.			Centigrade " "

Growing out of these different guides we have endless difficulties unless the writer on a given subject succinctly states by which of the various standards he is governed.

The scale of Beaumé is rendered confusing at times owing to the difference of the modulus that is accepted.

The transmutation of one thermometric scale into another is daily necessary, while errors are frequently made by the difference in the gallon capacity in cubic inches.

The present is opportune for the discussion of this subject with the view of arriving at some deliberate attempt to produce conformity out of this bedlam of figures. The tower of Babel with its traditional confusion of tongues may be taken as representing the difficulties arising in chemical work and transactions. A committee consisting of representatives from each nation could be appointed whose duty it should be to formulate an international system of figures and tables.

Uniform methods and statements for these basal calculations would inure to the ease of commercial transactions throughout the world.

NOTE ON THE MANUFACTURE OF THE PRUSSIATES.

BY WALTER D. FIELD.

Received October 14, 1893.

IN many branches technical literature is very incomplete. Descriptions of apparatus for the purpose of carrying on technical operations are reproduced in publication after publication. Authors are seemingly forgetful of the fact that the patents of this country represent in a large measure the progress of the various chemical industries.

In the "Fabrikation chemischer Producte aus thierische