Chemistry in Indiana at the State's Sesquicentennial

M. G. Mellon, Purdue University

In presenting the historical status of any science, such as chemistry, there are two broad aspects to consider. The first aspect concerns the subject as a science, which involves primarily its position in educational institutions. The second aspect concerns any practical applications, which, in this case, means chemical industry.

For a sesquicentennial program there arises the question whether to present a broad perspective of the subject, going back as far as feasible toward 1816, or to emphasize the present, that is, the current status of chemistry. For reasons stated later, most attention is centered on the place Indiana occupies in 1966 in chemical education and on the position it has achieved in industrial chemistry at this time. Because both chemical science and chemical industry are so important in 1966, each is considered separately.

I. Education

According to Noll (15), the first professorship in chemistry in this country was established just two centuries ago, i.e., in 1767, at King's College. Two years later chemistry was offered at the University of Pennsylvania. A half-century was to pass before Indiana achieved statehood. The territory had no colleges at this time.

The next half-century marked the founding of a number of colleges in Indiana (17). Also it was the time of the struggle to have at least some courses in science incorporated in what had been classical curricula. According to Browne's report (1), the significant developments in chemical education during the five decades prior to 1870 occurred east of the Appalachian Mountains.

Then followed the half-century which involved the slow development of chemistry in the small and simply equipped institutions in the new state. Many interesting facts for this period are presented in four historical papers to which reference may be made for details. On reading these publications one has the feeling that the whole subject of the evolution of the teaching of science in the state merits reexamination by a trained science historian.

As 1916 was the centennial of Indiana's statehood, a part of the program of the general session of the fall meeting of the Academy was devoted to a century of science in Indiana. H. W. Wiley, famed graduate of Hanover College and first professor of chemistry at Purdue University, represented chemistry. He spoke on the subject, "The early history of chemistry in Indiana" (18). It should be noted that, at this time, he had been away from the state for a third of a cenutry, and that his professional experience in the state covered only about a decade. On going to Purdue in 1874, he stated, "I immediately fitted up a laboratory where large numbers of students could be accommodated. As I remember, we had working desks for about 25 or 30."

Another paper, entitled "The development of chemical science in Indiana," by J. H. Ransom of the Purdue staff (16), was included in the *Proceedings* for 1916. It was listed by title only on the program because of having been presented before the Indiana Section of the American Chemical Society in Indianapolis. Ransom noted the disagreement on how chemistry (and probably other sciences) should be taught. In the earliest years there seems to have been no work in a laboratory, perhaps because there were none available. One wonders if the current aversion of some young teachers to undergraduate laboratory assignments is an emulation of the practice of the early mid-19th century. Wiley obviously believed in having students do laboratory work. In fact, he thought that, as far as possible, they should have to discover things for themselves rather than to be told.

In 1931 R. E. Lyons (13), Head of the Department of Chemistry at Indiana University for many years, published a paper, "The history of chemistry at Indiana University, 1829-1931." Constituting the entire March issue for 1931 of the *Indiana University News-Letter*, it is the best historical resume known to the writer for any of the state's colleges. There are many details on buildings, students, staff, and publications. This report has been supplemented and up-dated by Day (8).

As a part of the program in 1935 for the semicentennial of the founding of the Academy, Test and Allen (17), also of the Purdue staff, presented "A review of a century of chemical education in Indiana." They consulted many sources and discussed the beginning of the teaching of chemistry in various colleges for which information could be located. Tabular data for 24 institutions include the college enrollments and the credits in the chemistry courses then being offered. In addition, other data cover the staff, enrollments in general chemistry, number of degrees awarded, and accommodations for general chemistry and advanced courses.

These papers reveal something of the difficulties encountered to establish courses in chemistry and to obtain and equip laboratories in which to teach the subject. The names of many men, a number of whom later became noted in chemistry, are mentioned.

The earliest courses might have been taught by a chemist, but more likely by someone whose primary interest and training were in some other area. Thus, at DePauw University in 1839, a Methodist preacher-president, the Rev. Mathew Simpson, taught chemistry. As a graduate of a similar Methodist college, the writer wonders what the content of this course might have been. In 1858, at Butler University, R. T. Brown became professor of botany, chemistry, geology, meterology, natural philosophy, natural science, physiology, and zoology. H. W. Wiley's first appointment, at Butler University in 1868, was as professor of Latin and Greek. Such men must have been among the giants to whom Edington paid tribute (9). The first full-time appointments in chemistry seem to have been in 1874, with T. C. Van Nuys (M.D.) at Indiana University and H. W. Wiley (M.D.) at Purdue University.

There has not been much change in the list of colleges which provided Test and Allen's data in 1935 (17). A recent publication (3)

contains information on the 32 accredited institutions listed in Table I. Included are data compiled from a questionnaire sent to each of these colleges. Vacancies in the table indicate that there were no replies. The number of graduates achieving doctoral degrees is for the period 1920-61 (9).

TABLE 1

Data on accredited colleges

Institution	Number on staff[a]	Enrollment[b] 1965-66		Average number of degrees awarded, 1961-66				Graduates awarded doctorates
		Underg.	Grad.	B.S.	M.S.	Ph.D.	Ch.E.	
Anderson Coll.	2	60		10				
Ball State Univ.	11	1328	196	13	5			6
Butler Univ.	4	495	60	5	2			23
Concordia Sr. Coll.								9
DePauw Univ.	7	300	8	13	2			102
Earlham Coll.	6	250		15				16
Evansville Coll.	4	330		25				15
Franklin Coll.	2	60		6				9
Goshen Coll.	3	250		5				7
Hanover Coll.	3	250		13				15
Huntington Coll.	1	50		10				
Indiana Cent. Coll.	1+	185						2
Indiana Inst. Tech.	6+	30		5			5	
Ind. State Univ.	11	1100	20	18	2			7
Indiana Univ.	36	2188	424	65	4	16		152
Manchester Coll.	4	260		13				40
Marian Coll.	2	190		8				
Marion Coll.	1	656		3				
Oakland City Coll.	1	27						1
Purdue Univ.	53	6115	1266	43	27	37	92[c]	170
Rose Polytechnic Inst.	6	525		4			13	4
Saint Francis Coll.	1	33		5				
Saint Joseph's Coll.								1
Saint Mary-of-the Woods Coll.								
Saint Mary's Coll.	6	126		5				3
Saint Meinrad Coll.	1	53						
Taylor Univ.	4	127		5				3
Tri-State Coll.	11[d]	97					22	
Univ. of Notre Dame	30	1500	85	15	28	17	28	131
Valparaiso Univ.	8	600		12				17
Vincennes Univ.	5	350						
Wabash Coll.	5	350		10				58

[a] Includes part-time members, but not teaching assistants.
[b] Enrollment in all courses.
[c] M.S., 20; Ph.D., 6.
[d] Chemistry and chemical engineering.

For some years the American Chemical Society has had a Committee on Professional Training to recommend standards for curricula for students majoring in chemistry or chemical engineering. An annual

report lists the institutions having approved curricula, adequate facilities, and competent staff. Table 2 lists 10 Indiana institutions included in the report for 1965 which have achieved this status, together with the number of degrees awarded that year (19).

TABLE 2

Degrees awarded by ACS approved institutions

Institution	Degrees awarded		
	B.S.	M.S.	Ph.D.
CHEMISTRY			
	(333)[a]	(198)[a]	(135)[a]
Butler University	3		
DePauw University	8	5	
Earlham College	5		
Evansville College	4		
Indiana University	23	6	15
Purdue University[b]	28	28	35
University of Notre Dame	21	40	30
Valparaiso University	3		
Wabash College	6		
CHEMICAL ENGINEERING			
	(106)[a]	(90)[a]	(66)[a]
Purdue University	123	20	3
Rose Polytechnic Institute	15	1	
University of Notre Dame	25	6	3

[a] Total number of institutions listed.
[b] Data for Department of Biochemistry are not included.

Such recognition reflects a commendable trend in the courses available, the facilities for teaching, and the number and training of the staffs.

Just as important in recent decades is the rather general change in emphasis on the content of courses. Teachers are becoming less concerned with "what" and more with "why" and "how" of chemical phenomena. Sodium chloride crystals are white (normally) and the structure is face-centered cubic. Why is this so; *i.e.*, what are the interpretations of these facts? May there be a danger of going too far in this direction, at least for certain types of students? For example, will a class of freshman girls in home economics be thrilled by a dull lecturer who finally demonstrates (from his notes) that the angle between the two hydrogens in the water molecule is 105°? Even if they are, to what wisdom will this knowledge lead in later life?

Teachers' Colleges. For many years Indiana maintained two institutions whose primary purpose was the preparation of teachers for secondary schools. These were Ball State Teachers' College and Indiana State Teachers' College. They gradually evolved into institutions with four-year curricula, and the names were changed to Ball State University and Indiana State University. As such, along with Indiana and Purdue, they are now part of the state university system, and they have the usual chemistry offerings of an arts college.

Extension Centers. A system of junior colleges, so familiar in some states, has not developed in Indiana. Instead, Indiana and Purdue Universities have established a number of extension centers, now designated as regional campuses. Purdue's are at Fort Wayne, Hammond, Indianapolis, and Michigan City. Shortly, the one at Michigan City will be moved to a new campus some ten miles to the south and will be known as the North Central Regional Campus. Indiana's centers are at E. Chicago, Fort Wayne, Gary, Indianapolis, Jeffersonville, Kokomo, Richmond, South Bend-Mishawaka, and Vincennes. In 1965 the two centers in Fort Wayne were combined in a new building and now operate as a combined Indiana-Purdue campus. Each university is responsible for specific areas of study.

The extension system has been fostered because each of the two universities supervises the work of its centers, including the selection of the teaching staffs. Thus, a member of the Department of Chemistry at Purdue visits the Purdue centers each month. He attempts to coordinate the various courses and to maintain them on a level with the corresponding ones at Purdue.

These extension centers seem destined to expand to full four-year institutions. In fact, the Hammond Purdue center and the Fort Wayne Purdue-Indiana center may soon be offering four years of chemistry.

Graduate Work. Table 2 shows that, in chemistry, only four of the nine institutions awarded any M.S. degrees, and only three granted Ph.D. degrees in 1965. All three of the institutions offering chemical engineering curricula awarded one or more M.S. degrees, and two gave Ph.D. degrees.

The first advanced degree at Purdue was A.C. (Analytical Chemist), awarded to W. A. Fankboner in 1887. At Indiana University it was an A.M. degree, awarded to R. E. Lyons in 1890. From this meager beginning graduate work developed slowly through the next four decades. Graduate schools were established at Indiana in 1904, at Purdue in 1928, and at Notre Dame in 1944. The first Ph.D. degrees in chemistry were awarded at Notre Dame in 1912, at Indiana in 1922, and at Purdue in 1930.

These decades marked a period of struggle to establish the programs on a sound basis, as graduate schools do not rapidly achieve quality. Competent staffs had to be secured, adequate laboratory and library facilities provided, students of ability recruited, and a graduate atmosphere developed.

In 1920 Purdue had an all-Ph.D. permanent staff in chemistry, and most of the permanent staffs of Indiana and Notre Dame had the

doctorate degree; but essentially the teaching programs at all three institutions comprised undergraduate courses. Some research was being done, but relatively it was undistinguished. There were bright spots, of course, such as the work of Father Nieuwland at Notre Dame.

Institutions with well-known graduate schools provided strong competition. A half-dozen of these were in the east but probably more serious were neighboring institutions, such as Chicago, Illinois, Michigan, Ohio State, and Wisconsin. In general, they had better known staffs and more nearly adequate laboratories, equipment, libraries, and other facilities. Because of these advantages, it seems likely that they secured many of the more promising students.

Four decades later Indiana's "Big-Three" institutions occupy a much improved relative standing. All three have relatively new laboratories, well equipped with instruments for modern research. The libraries are reasonably well stocked. The programs of research, some of which are outstanding, cover many areas of chemistry.

The staffs include a commendable number of individuals with established reputations in their specialties. Through the years various kinds of national recognition have come to many men, but only the following have been elected to the National Academy of Sciences: F. D. Rossini at Notre Dame, and A. K. Balls and H. C. Brown at Purdue. No institution has had a winner of the Nobel prize from its staff.

A composite viewpoint is presented in a recent publication (2) which rates 96 institutions in chemistry and 56 in chemical engineering. The relative ratings are on the basis of quality of the graduate faculty and the effectiveness of the graduate program.

a. **Quality of Faculty.** Arranged on the basis of relative standing, the first six institutions are listed as "Distinguished," and the next 22 as "Strong." In this total group of 28, Purdue is tied in chemistry for 17th place with the Ohio State University, and Indiana is 20th. The next 19 departments, listed as "Good," include Notre Dame.

In chemical engineering, Purdue appears among the 11 departments rated "Good."

b. **Effectiveness of Graduate Program.** In this listing, the first nine institutions are rated as "Extremely attractive," and the next 14 as "Attractive." In the total of 23, Indiana ranks 18th in chemistry and Purdue 22nd. Notre Dame is among the next 37, rated as "Acceptable +."

In chemical engineering, Purdue is among the 22 departments rated as "Acceptable +."

According to the report, these ratings were made on the basis of replies to questionnaires sent to more than 4,000 deans, heads of departments, and others well-known in the respective fields. Whatever limitations such an evaluation has, it seems clear that the published results do indicate what the evaluators thought of the institutions listed. For Indiana's institutions to rise from what the situation was in 1920 to the positions listed is a real accomplishment, when one considers the competition encountered. To rise further in the listing is the challenge of the future.

Interesting data on the production of doctorates in chemistry are contained in a publication which covers the period 1920-1962 (10). Tables 3, 4, and 5 are based on this report.

TABLE 3

Leading states in the production of doctorates in Chemistry

Rank	State	Number of doctorates
1	New York	3034
2	Illinois	2845
3	California	1754
4	Massachusetts	1684
5	Pennsylvania	1533
6	Ohio	1439
7	**Indiana**	**1335**
8	Wisconsin	1223
9	Iowa	1039

(Number for all states—23,696)

The distribution, by decades, of the 1335 doctorates in chemistry for Indiana follows: 21 for 1920-29; 150 for 1930-39; 357 for 1940-49; 666 for 1950-59; and 141 for 1960-61. Table 4 shows, by 5-year periods, the production of the "Big-Three" institutions.

TABLE 4

Distribution of doctorates in Chemistry by periods in Indiana's "Big-Three" institutions

Period	Indiana	Notre Dame	Purdue
1920-24	4		
1925-29	11		
1930-34	15	78[a]	13
1935-39	30		47
1940-44	43		98
1945-49	28	33	129
1950-54	49	78	218
1955-59	45	82	193
1960-61	22	28	91
Total	247	299	789

a Number from 1920 to 1944.

The nation's top institutions granting doctorates are shown in Table 5. For the period covered, Indiana University granted 247 degrees and the University of Notre Dame 299.

TABLE 5

First ten institutions granting doctorates in Chemistry

Rank	Institution	Number of doctorates
1	University of Illinois	1564
2	University of Wisconsin	1061
3	Ohio State University	954
4	Columbia University	913
5	Massachusetts Institute of Tech.	888
6	**Purdue University**	789
7	University of California	776
8	University of Chicago	741
9	Cornell University	625
10	Harvard University	590

II. Chemical Industry

The early history of Indiana reveals little on the industrial applications of chemistry. Chemical industry, in the modern sense of the term, did not exist.

From the geological report of 1871, Ransom (16) quotes, "Chemistry as a science was almost unknown in its practical applications 15 or 20 years ago." Yet earlier developments in states to the east must have reached Indiana. For example, someone must have leached wood ashes for crude alkali to make soap from waste fats; somewhere contaminated ethanol must have been distilled for a beverage; and in some way impure iron was refined from an Indiana ore.

To locate and present all such items, and to follow their development was too much of a historical assignment for the writer to undertake. Instead, he chose to confine discussion very largely to the last third of the sesquicentennial period, when relevant data became more readily available. It would be interesting to know where and when peppermint oil was first distilled in Indiana, but more important now is the current position of the industry. Some industries, such as the production of iron from its ore, arose, reached a peak, and then disappeared because of the exhaustion of raw material. In this case, there never was any large deposit of iron ore in Indiana.

Of special interest to the writer is the emphasis on chemical analysis in the 19th century in the historical papers cited. Much early work was done on clays, sands, ores, coal, soils, fertilizers, foods, and other materials. In a way, this may be taken as the most consistent and definite evidence of the development of applied chemistry, for chemical analysis is the measuring means of chemical industry and very largely of chemical research (14).

Sources on industrial activities often are not entirely satisfactory in that they may not differentiate between the production and the application of an item. Thus, the large plant of the Aluminum Company of America in Lafayette does not produce aluminum. It extrudes the

metal, mostly as alloys, to make a great variety of structural forms. Many pharmaceutical firms package and sell Epsom salts, but very likely the stock material is obtained from some chemical firm.

The *U. S. Census of Manufactures* is perhaps the most important source of data. For over a century these reports were decennial, but now they are quinquennial. Of course, they are always late in appearing. Lisack's compilation (12) bears a date later than 1963, but the information may have come at least partly from this census.

Currently the census reports do not include detailed data, such as the production of anesthetic diethyl ether, by states. Such information was available, at least for selected items, in the 1920 and 1930 *Census of Manufactures*. Lisack's data are for Indiana.

With all these limitations, some data are included in the hope that they may have later historical interest.

Lisack's report on manpower requirements supports the need for establishing a curriculum to train chemical technicians. The following data, including Tables 6, 7, and 8, together with comments, are adapted from his report.

The total employment for 1963 in the chemical and allied products industry in Indiana averaged 24,300 people. This was four per cent of the total manufacturing employment for the state. Although Hoosiers account for only 2.8 per cent of the nation's employment in this industry, they make up nearly 11 per cent of the nation's employment in the drugs sub-group. Nationwide, 13 per cent of the workers in the chemicals and allied products industry are in the drugs sub-group, but in Indiana this proportion has been about 50 per cent since 1959.

Firms in this industry in Indiana totaled 190 in March, 1964. Table 6 shows the data for several sub-groups.

TABLE 6

Data for the Chemical and allied products industry

Subgroup	Number of firms	Percentage of employment
Industrial inorganic and organic chemicals	28	15
Plastics and other synthetic products	5	6
Drugs	26	50
Soap, detergents, and allied products	30	15
Paints, varnishes, and allied products	29	6
Agricultural chemicals	49	6
Miscellaneous chemical products	23	2
Total	190	100

Firms with more than 500 employees comprised only six per cent of the total, while those with fewer than 50 comprised 70 per cent.

Data on the geographical distribution of these firms are shown in Table 7.

TABLE 7

Location of chemical firms

County	Number of firms	Number of employees
Marion	42	ca. 8750
Lake	21	ca. 3400
Vigo	8	> 1500
Elkhart	6	> 1500
Vanderburgh	5	> 1500
Clark	4	> 1500
St. Joseph	7	< 1500
Allen	6	< 1500
Kosciusko	5	< 1500
Laporte	4	< 1500
All others	3 or less	< 1500

The first six counties have more than 80 per cent of the total employment, with Marion County far ahead.

Although Indiana is not one of the large producers of chemical products, Table 8 lists some of the important firms which are represented by one or more plants in the state (11).

TABLE 8

Important chemical firms having plants in Indiana

Firm	City
Allied Chemical and Dye Corp.	Beech Grove
American Cyanamid Co.	Michigan City
Charles Pfizer and Co.	Terre Haute
Colgate-Palmolive Co.	Jeffersonville
Commercial Solvents Corp.	Terre Haute
Dow Chemical Co.	
Pitman-Moore Division	Indianapolis; Zionsville
E. I. du Pont de Nemours and Co.	East Chicago; Fortville
Eli Lilly and Co.	Indianapolis; Greenfield; Lafayette
International Minerals and	
Chemical Corp.	Middletown
Lever Brothers Co.	Hammond
Mead Johnson and Co.	Evansville
Miles Laboratories	Elkhart
Olin Mathieson Chemical Corp.	Peru; Warren Co.
Philadelphia Quartz Co.	Anderson
Reilly Tar and Chemical Corp.	Indianapolis
Stauffer Chemical Co.	Hammond
Union Carbide Corp.	
Chemicals Division	Whiting
Linde Air Products Co.	East Chicago

The production of sulfuric acid is often taken as a general index of industrial chemical activity. The data for this product give Indiana a relatively low rating. Thus, in 1958 (6) the state produced about three per cent of the nation's total acid. Only four plants were reported, compared with 216 for the nation.

The situation is better as a whole for industrial organic and inorganic chemicals. In terms of the number of employees in the industry, the state ranks 12th for organic chemicals and 13th for inorganic chemicals. The U. S. census employment data (4) for 1963 are shown in Table 9.

TABLE 9

Employment for organic chemical industry

Rank of state	Number of employees	Number of plants	State
1	19,324	42	Texas
2	13,786	82	New Jersey
3	10,222	11	West Virginia
4	6,166	11	Michigan
5	5,777	44	New York
6	3,660	10	Tennessee
7	2,627	22	Illinois
8	2,281	36	California
9	2,028	22	Pennsylvania
10	1,970	9	Kentucky
11	1,890	32	Ohio
12	**1,364**	**6**	**Indiana**
13	1,009	12	Massachusetts
14	372	5	Alabama
15	236	9	North Carolina
16	213	6	Wisconsin
17	146	5	Rhode Island

Probably Indiana makes its best showing in the drug industry, which may be attributed largely to Eli Lilly and Company. Incidentally, this company was not founded until May 10, 1876. The census statistics for 1963, shown in Tables 10 and 11 rank the state third in number of employees for pharmaceutical preparations and first in the value of shipments for vitamins, nutrients, and hematinic preparations for human use (5).

TABLE 10

Employees in pharmaceutical preparations industry

Rank	Number of employees	Number of plants	State
1	17,079	174	New York
2	14,362	91	New Jersey
3	**10,507**	**23**	**Indiana**
4	8,040	76	Illinois
5	2,704	52	Missouri
6	2,702	48	Ohio
7	2,536	104	California
8	943	39	Texas
9	725	18	Maryland
10	529	5	Nebraska
11	268	9	Georgia
12	194	7	Oregon

TABLE 11

Value of Shipments for vitamin, nutrient, and hematinic preparations for human use

Rank	Value	State
1	**63,597**[a]	**Indiana**
2	62,395	New York
3	44,923	Illinois
4	44,525	Michigan
5	31,913	New Jersey
6	20,385	California
7	9,010	Missouri
8	2,983	Minnesota
9	1,204	Massachusetts

[a] In thousands of dollars

According to census reports (7), four establishments produced sodium silicate, two each anhydrous ammonia, ammonia solutions, ammonium nitrate, hydrochloric acid, nitric acid, and phosphoric acid, and one each aluminum chloride, aluminum sulfate, potassium pyrophosphate, trisodium phosphate, meta sodium phosphate, tetra sodium phosphate, and tripoly sodium phosphate.

More general, area data for Indiana are shown in Table 12.

TABLE 12

Area statistics for Indiana

Product	Total number of establishments	Number of employees	Value added by manufacture[a]
Entire State			
Chemicals and allied products	255	23,635	630,109
Basic chemicals	36	2,403	69,674
Cleaning and toilet goods	47	3,237	121,835
Paints and allied products	32	1,621	20,555
Agricultural chemicals	52	1,095	12,766
Miscellaneous chemical products	41	994	17,646
Gary-Hammond-E. Chicago Area			
Chemicals and allied products	31	3,195	134,186
Basic chemicals	13	1,175	47,877
Indianapolis Area			
Chemicals and allied products	57	10,462	200,154
Cleaning and toilet goods	15	518	9,987
Paints and allied products	10	711	9,514

[a] In thousands of dollars.

To present a really representative sample of data for all industrial chemical activities is a difficult assignment. The foregoing data for selected products are obviously fragmentary and meager. The general conclusion to be drawn is that the state ranks low in some areas and high in others.

Conclusions

In 150 years chemistry has become firmly established in Indiana and in 1966 its position seems reasonably sound. In educational work the content of courses and methods of teaching are generally being improved and up-dated. Nine of the 32 accredited colleges offer ACS approved curricula for chemistry majors and three for chemical engineering. The "Big-Three" universities have established Indiana in 7th place in the production of doctorates, and the institutions are acquiring quality prestige.

A variety of chemical products is being produced in the state, although in many cases the amounts are not large. Probably pharmaceutical products of various kinds are relatively the most important. If one considers steel and petroleum products as chemical entities, the Gary-Hammond area is very important. As a whole, the position of the state is important, but not outstanding.

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