CHEMICAL INDUSTRY IN EARLY WISCONSIN¹

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The term “chemical industry” can be used in a variety of ways. In its strictest sense it applies only to those industries participating in the production of chemicals, i.e., salts, acids, bases, solvents, and intermediates. Such products rarely reach the hands of ultimate consumers but are purchased by industrial processors who utilize them for their ability to transform raw materials into those products desired by the ultimate consumer. According to this designation, the smelting of lead for use in lead pipe is not a chemical industry but the production of white lead and red lead for the use of the paint industry is one.

Numerous industries not directly involved in the production of chemicals are nevertheless dependent upon chemical changes for their success. This is true of the smelting of metal ores, the fermentation of carbohydrates to alcoholic beverages, the purification of cellulose in the production of pulp and paper, the bleaching of pulp and of textiles, the dyeing of textiles, the tanning of skins, the curing of cheese, and the production of soap. These industries are generally characterized as the “chemical process industries.”

A related type of industry is the one which produces no chemicals, depends upon no chemical reactions, but uses chemicals essentially unchanged in the fabrication of consumer products such as paints, matches, and pharmaceuticals. This may well be termed the “chemical consuming industry.”

We propose to examine the early development of Wisconsin industry in all of these categories rather than limiting our discussion solely to those industries which are chemical industries only in the strict use of the term. A major reason for using this broad approach lies in the difficulty of separating one activity from another. The paper industry, for example, is quite likely to produce for its own use, such chemicals as chlorine, sodium hydroxide, sulfite, and sulfate. To that extent it is truly a chemical industry. It uses these chemicals in the production of pulp and paper and therefore is a chemical process industry. It uses

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such chemicals as alum, clay, rosin, and casein for the sizing of paper so it is also a chemical consuming industry.

** GEOGRAPHY **

Chemical industry, just as other industry, is influenced in its development by geographic location and the availability of raw materials. The State of Wisconsin fares poorly on both counts. The state's location on the northern edge of central United States gives it an unfavorable position for maximum participation in both national and international chemical commerce. Lake Superior on the north and Lake Michigan on the east form significant water barriers to the movement of people and materials. These water routes would be of greater value if Central Canada were an important user of chemicals or if the St. Lawrence Seaway became a reality. Under the existing circumstances, however, Wisconsin holds no advantage not already possessed in more favorable degree by Michigan, Ohio, and New York.

The prairie states to the west fail to provide either a significant market or an important source of raw materials. To the south there is a market but not one in which Wisconsin has an advantage over other central states. We are forced to conclude that Wisconsin's geographic position is not one naturally to stimulate the growth of a chemical industry.

** RESOURCES **

Chemical industry depends for its success upon the availability of water, fuel, and suitable raw materials. Wisconsin has water abundantly available in good quality for chemical operations. On the other hand, its availability has made it an obvious route for the disposal of processing wastes with the development of a serious pollution problem.

Fuel resources have not been abundant in the state. Wisconsin lacks coal, petroleum, and natural gas, the more obvious industrial fuels. The one natural fuel source was Wisconsin's extensive stand of timber. This was of greater importance as a source of lumber and pulp, however, and could not serve as an important fuel resource. Proximity to Great Lakes shipping has prevented the lack of natural fuel from being a critical one in the development of industry but this has not completely offset the disadvantage of lack of home fuel resources. The state is also sufficiently rugged that the energy of falling water has been effectively harnessed as a source of power, thus offsetting in part the lack of fuel energy.
Minerals desirable for a flourishing chemical industry are sodium chloride, sulfur, and limestone. Salt serves as a source of alkalies, chlorine, and salt cake, as well as a variety of lesser chemicals derived from sodium or chlorine. Sulfur is essential in the production of sulfuric acid, industry’s most important acid. Limestone serves as a source of inexpensive base, as an flux in metal smelting, and in a variety of other chemical processes. Wisconsin has only limestone, which is also abundant in many other states.

Again we are forced to conclude that Wisconsin is not naturally endowed for a thriving chemical industry. We must then expect that developments would be in such directions as would utilize its more obvious resources, or toward the development of specialty items not greatly dependent on available resources. Our study reveals that both directions were followed. In the early days of Wisconsin’s history its chemical industry was based largely upon its most important resource, timber. In time there was a drift toward a chemical industry based on agriculture as the brewing industry developed. Recent times have seen the development of specialty produces such as waxes, flavors, dyes, and pharmaceuticals.

Not only is timber useful for lumber and the various products fabricated therefrom but is also the starting material for the production of such chemicals as charcoal, acetic acid, methyl (wood) alcohol, acetone, and potash. The bark of certain trees, particularly oak and hemlock, is valued as a source of tannins for the conversion of skins into leather. Wood provides the sticks for matches and the cellulose for pulp and paper. Wisconsin’s early chemical industry evolved primarily from these products.

Early production of chemicals was small in scale and primitive in technique. Hand labor was aided only by simple and crude machinery. Operators started and terminated operations on short notice as supply and market conditions fluctuated. As a result, records have been hard to trace. It is only possible to indicate the kind of operations and give a few specific examples.

**POTASH**

Crude potassium carbonate produced from the leachings of wood ashes must have been a household product connected with domestic soap-making in early Wisconsin just as it had been in the Eastern States and in Europe. It was natural, in view of the abundance of hardwood in the state, that production for sale should develop early. The operation can be carried out on a small scale with a minimum of equipment. It requires no skilled labor.
Five separate individuals were engaged in commercial potash production by 1857. They were John Mauel, Ashford; Aaron Goodenough, Neosho; F. Y. Mansfield, Oak Creek; Heber Smith, Watertown; and Henry Furguson, Warren. In 1865 factories were established in Milwaukee by W. Ramaker and G. H. Sorens, both immigrants from Holland. A third Dutch immigrant, John B. Hyink, started a Milwaukee factory five years later. All three producers were flourishing in 1881 when Hyink was using 165 barrels of ashes per day, Sorens had 5 men in his employ, and Ramaker produced a ton of potash every week. In addition to local sales the product was marketed in Boston, New York, and Philadelphia. The Eagle Lye Works was founded in Milwaukee in 1874 for the production of alkalies. In 1883, the firm employed 14 workers, in 1909, it employed 40. Census reports for 1860 reveal that potash was being produced by 31 firms located in 12 counties in the southeastern quarter of the state.

In 1880 nine Wisconsin potash companies were producing more than one and one half million pounds valued at $94,424. This amounted to 41% of total U. S. production. The state was the major producer of alkali in the nation. This supremacy did not last long. Decrease in the timber supply was accompanied by competitive developments in the production of caustic. Foreign potash from sugar beet waste and from the newly developed Stassfurt salt deposits was augmented by soda ash produced cheaply by the old LeBlanc and the new Solvay process. Soon thereafter the electrolytic process for the production of caustic soda provided ample supplies of strong alkali. The demand for Wisconsin potash fell to practically nothing by 1890 though a few individuals continued to produce it for local soap factories.

Wisconsin never became an important producer of the sodium alkalies which are produced from rock salt. The supplies of rock salt in the Ohio–New York basin are near Niagara Falls where cheap electric power makes a particularly favorable situation for production of caustic. The Eagle Lye Company continued to do business in Milwaukee but as a distributor rather than as a pri-

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3 Flower, Frank A., "History of Milwaukee", Western Historical Co., Chicago, 1881, p. 1517.
5 Rowland, W. L., "Report on the Manufacture of Chemical Products and Salt", p. 20–1. A part of the Rept. on the Manufactures of the United States at the 10th Census, 1890, folio pp. 1010–11. Other important producing states were Michigan, New York, Ohio, Maine, Indiana, and Minnesota.
mary producer. It became a part of the Pennsylvania Salt Manufacturing Company in 1926.\(^6\)

**SOAP**

A large amount of Wisconsin potash found its way into soap, but since soap manufacture is such a simple chemical operation it is difficult to trace the development with any accuracy. Soap making was a household operation in the nineteenth century Wisconsin, as it continues to be in some rural households in Wisconsin even today.

In the urban centers, commercial soap manufacture achieved some importance. In Milwaukee, for instance, Flower found four flourishing establishments in 1880.\(^7\) The oldest, that of F. Trenkamp, had been established in 1848. Weekly production had risen from 1000 pounds in the first year to 30,000 pounds in 1880. Frederick Wackerow's factory had been established in 1856 by John Langdon. Gross Brothers, established in 1867, was producing 125,000 pounds per week in 1880. This level of production was exceeded by the youngest firm, that of Ricker, McCullough and Dixon, established in 1873, with a production of 173,000 pounds per week. Most of the soap manufacturers were German immigrants who found in Milwaukee a good source of alkali and, as a result of the rapidly developing meat packing industry, a good source of fats.

**MATCHES**

Milwaukee was the site of the first match factory to be established in the west. Its founder, R. W. Pierce, came from Massachusetts in 1844, bringing the necessary chemical supplies with him. Wood for matchsticks was both abundant and inexpensive in Wisconsin. The first matches were produced in the upper story of a dwelling house. Three employees produced $900 worth of matches during the first year, but Pierce sustained a net loss of $800. Despite the loss, Pierce expanded into a small factory building during the next year. The enterprise grew and "Superior Percussion Matches" found a ready market as far east as Cleveland and as far south as New Orleans. When Pierce sold his interest in 1860, the factory was employing 30 persons. Subsequent owners failed to carry on successful operations and, after changing hands several times, the business was abandoned.\(^8\)

\(^7\) Ref. 3, p. 1226.
\(^8\) See ref. 3, page 1509.
The Diamond Match Company began operations in Oshkosh in 1881. Within four years it was employing 175 people. By 1907, 570 employees were listed. Another factory, operated by the Oshkosh Match Company was in operation by 1885.

Working conditions in these early match factories left much to be desired. This was still the day of the white phosphorus match. Match manufacture was dangerous, not only because of the fire hazard, but because of the poisonous effects of the phosphorus fumes which led to necrosis of the jaw. The Commissioner of Labor and Industry was prompted to speak out in 1886:  

I want to say a few words in regard to the conditions of these match factories generally, but more particularly of the dipping rooms. To ameliorate the condition of the people at work in those rooms would be an act of charity. Imagine being in a closed room, the atmosphere of which is constantly contaminated with the fumes of the chemicals used, especially those of phosphorus, which act directly on the bone, and you have the case as I saw it. Found an attempt had been made to purify the air by the aid of suction fans; but the effort seems to be futile, as the rooms were filled with foul odors, the conducting pipes not being large enough, and the fans lacking the requisite power.

I expostulated to some extent with the proprietors and suggested some changes; but as a matter of course they would entail some expense, I left without expecting to see the changes made. But at whatever cost, the working people should be provided with pure air, which the Creator of all things ordained.

In 1891 it was necessary for the commissioner to order the discharge of four girls under fourteen, but health and safety conditions had markedly improved. The task of dipping matches had been taken over by machines, ventilating fans were in operation, and automatic sprinklers had been installed on all floors.  

It was not until 1913, however, that the white phosphorus match was taxed out of existence in the United States. At that time, the manufacture of this highly poisonous type of match was dropped in favor of the more costly but safer phosphorus sesquisulfide match.

WAX

The processing of wax was initiated in Wisconsin as an outgrowth of the wood industry. The S. C. Johnson Company was

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10 Dobbs, J., ibid, 1892, p. 91 a.
founded in 1886 for the manufacture of parquet flooring. The business took an unexpected turn when builders and homeowners began asking how to keep floors in good condition. Wax was recommended since Samuel Curtis Johnson knew that parquet floors in Europe had stood the wear of centuries with only wax treatment. The company began the sale of floor wax and similar products. By 1898, the dollar sales of wax and allied materials exceeded those of flooring. In 1916, the sale of flooring was discontinued entirely with the company concentrating on wax products and expanding into a world market.11

TANNING

It was natural that Wisconsin should develop a strong tanning industry. The hemlock forests provided an abundant source of tanbark. The lesser oak forests provided an additional source of tanning materials. The growing emphasis on livestock as Wisconsin became transformed from a wheat-growing state to one putting emphasis on diversified agriculture, in particular meat production and dairying, brought about a fortunate proximity of hides and tanning materials.

By 1880, Milwaukee had become an important tanning center with at least eight tanneries in operation. Several of these establishments traced their origins back to midcentury. The Wisconsin Leather Company had its origins in an enterprise started in Cazenovia, New York, in 1809. As the New York supply of tanbark became depleted, action was taken to obtain new supplies to the westward. A tannery was opened in Two Rivers, in the heart of the hemlock12 region of Wisconsin, in 1850. A second tannery was built in the same city in 1861. In 1870, the Milwaukee tannery was opened in order to be near the source of hides from the local meat-packing establishments. In 1880, the company was tanning 175,000 hides, worth about $600,000.

The Pfister and Vogel Leather Company was formed in 1857 through the merger of two small tanneries which had been operating since 1847. In 1880, it was tanning around 100,000 hides. The Kinnickinnic Tannery was established in 1849. The Herman

11 “This Company of Ours”, S. C. Johnson and Co., Racine, 1949, and personal correspondence.

12 See R. H. Zinn in J. G. Glover and W. B. C. Cornell, Eds., “The Development of American Industries”, revised edn., Prentice-Hall, New York, 1941, p. 272-3. However, we are unable to confirm the statement of the author that the use of hemlock bark stems from the researches of Humphrey Davy. Neither Davy’s research paper on tanning materials, Phil. Trans. Royal Soc. (London), 83, 293–73 (1803), or his general remarks on tanning in his lectures, see the “Collected Works” 3, 287, 416 (1839), give any indication that he studied hemlock bark.
Zohrlant Leather Company dated from 1857. Trostel and Gallun was started a year later.\textsuperscript{13} 
Besides these Milwaukee companies, there were tanneries scattered around the state. Manitowoc and Fond du Lac were natural tanning centers due to their proximity to the hemlock forests. The census reports of 1880 indicated 73 producers of tanned leather in the state.\textsuperscript{14} All of these establishments were founded mainly because of the availability of tanning materials. By the time the hemlock bark was exhausted they were well established in a center where hides were easily available. Improvements in transportation no longer made proximity to tan-bark as crucial as had been the case at midcentury.

**PULP AND PAPER**

The first Wisconsin paper was manufactured in Milwaukee by Ludington and Garand in 1848. Within the next two decades paper was also being produced in Appleton (1858), Waterford (1853), Beloit (1855), Whitewater (1857), and Neenah (1865). These mills were not engaging in chemical operations, however. Their source of cellulose was rags (straw in the first Beloit and Whitewater mills) and the process used was like that used by other American manufacturers. The demand for paper was growing and the supply of rags was short so an active exploration for substitutes was in progress.

Wood was an obvious source of cellulose but practical success in the conversion of wood into paper was not achieved until 1840 when Friedrich Gottlob Keller and Henry Voelter, in Germany, developed a successful woodgrinder. Wood was reduced to a pulp by forcing it against a grindstone cooled with water. The process, successfully operated in Europe from 1854, was introduced into the United States in 1867. In 1872, Colonel Henry A. Frambach introduced it into Wisconsin when he built the Eagle Mill on the Fox River at Kaukauna.\textsuperscript{15}

Groundwood pulp did not supplant rag pulp but was added to it as an extender. It did make available a larger paper supply at a time when demands were steadily increasing. The best grades of paper continued to be made of pure rag pulp.

In spite of the popularity of rag paper, the availability of pulpwood in Wisconsin stimulated the growth of the groundwood

\textsuperscript{13} Ref. 3, p. 1438.  
\textsuperscript{14} "Rept. on the Statistics of Manufactures of the U. S.", 1850, p. 191.  
process. By 1882, eighteen such mills were in operation on the lower Fox River at Neenah, Menasha, Appleton, and Kaukauna. As the forests of east-central Wisconsin became depleted, the pulp industry began to spread westward into the valleys of the Wisconsin and Chippewa Rivers. Such names as Kimberley, Clark, Gilbert, and Whiting were rising to prominence in the industry. A number of the mills were established on the water-power sites of flour mills which abandoned operations when Wisconsin lost its wheat-growing status to the more westerly prairie states. Concurrent with this, the development of the roller process for flour milling with necessarily high capital investments forced the demise of local stone-operated flour mills such as those which dotted the lower Fox River. Between 1880 and 1925, flour milling slipped from first place as a source of Wisconsin industrial income to twenty-first. During the same period, pulp and paper manufacture rose from eighteenth place to fourth.16

During this time, the pulp industry was turning toward chemical operations for the purification of wood fiber. The soda process, which began coming into use in England after mid-century, never figured prominently in the Wisconsin industry. The sulfite process, on the other hand, rose to real importance.

The basis for the sulfite process was laid in Philadelphia by Benjamin C. Tilgham soon after the Civil War. He observed that sulfurous acid dissolved the lignin portion of wood, leaving the cellulose fibers available for pulping. His research was developed into a practical process by Swedish and German investigators and placed in operation in the late seventies.

The process was brought into Wisconsin in 1887 by the Atlas Paper Company at Appleton, and the Appleton Pulp and Paper Company at Monico Junction. The superior quality of sulfite paper over that made from groundwood created a ready market for the product and in turn stimulated the expansion of the process. The paper industry in Wisconsin had become a chemical process industry.

**Charcoal and Metal Smelting**

The destructive distillation of wood, more commonly called "charcoal burning", was a simple process commonly carried out where hardwood was abundant. Wisconsin's forests contributed to the production of this form of carbon. The charcoal was prepared largely for local use, partly as fuel, partly in connection with the smelting of metallic ores. Production rose and fell with the rise and fall of the state's mining activities.

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Lead. The galena deposits in the region where the present boundaries of Wisconsin, Illinois, and Iowa join were exploited for their lead ever since the seventeenth century when the French explorers and traders taught the Indians to smelt the ore.\textsuperscript{17} The soft metal with its low melting point quickly assumed importance among the Indians as a source of bullets for the hunting of fur-bearing animals and as an item of trade. Mining operations by white men were carried out only sporadically up to the third decade of the nineteenth century at which time a vigorous mining boom occurred. In 1828 production of the metal was 12,000,000 pounds. Troubles with the Indians caused some fluctuation in mining activities but these troubles were ended in 1832 with the termination of the Black Hawk War. Cornish miners began to enter the region in large numbers from 1835.\textsuperscript{18}

The metal moved out of the region by water, south on the Wisconsin and Mississippi Rivers to St. Louis, north on the Wiscon-
sin and Fox Rivers to Green Bay from where it was shipped eastward on the Great Lakes. Milwaukee became a similar port for the shipment of lead after suitable roads and railroads had been built. Bullets and shot were the main products made from lead although the manufacture of white lead for paint was started in 1841 at Buffalo, New York.19

Shot was even manufactured in Wisconsin following the construction of a shot-tower at Helena.20 Daniel Whitney, a Green Bay merchant, initiated construction of the tower in 1881 on a cliff overlooking Pipe Creek, a tiny tributary of the Wisconsin River. A vertical shaft was dug through the soft sandstone for a depth of 120 feet and connected to the stream bank by a horizontal tunnel 90 feet long. The molten lead, alloyed with a trace of arsenic, was prepared in a melting house at the top of the cliff and poured through a sieve into a wooden enclosure, or tower, which connected to the top of the vertical hole (Fig. 1). The drops of lead fell a total distance of 180 feet, twirling and solidifying as they fell and finally landing in a pit of water at the bottom of the shaft. Here they were collected, removed, sorted, and prepared for shipment. Shot was produced here until the decline of lead mining in the fifties.

The lead mines drew heavily upon nearby forests for the wood used in smelting the ore. The depletion of the mines after a quarter century coincided with the depletion of local wood resources and the discovery of more important lead ores in states to the westward. The miners turned to full-time farming on the cleared lands or, if mining was permanently ingrained in their system, joined the copper boom in the Lake Superior region or the gold rush to California. Some lead continued to be produced in southwestern Wisconsin but it was marginal production. Operations rose and fell with the price of lead. Wisconsin never again became the leading producer it had been in the forties.

Zinc. Interest in the zinc ores associated with the galena of the region did not develop until 1860. Up until that time, the smithsonite (ZnCO₃), called “drybone” by the miners because of its resemblance to partially decayed bones) had been discarded as not worth smelting. In 1860 some 160 tons were successfully smelted. Production of smithsonite and the deeper-lying zinc blende (ZnS, called “blackjack” by the miners) increased rapidly as a zinc boom hit the region. Charcoal did not figure in zinc smelting, however, since coal was shipped in from Illinois or,

more commonly, the zinc ore was shipped by rail to central Illinois for smelting near the coalfields.\textsuperscript{21}

**Copper.** Wisconsin charcoal never played an important role in the smelting of copper, though there were sporadic efforts at production of the metal. Wisconsin copper discoveries always proved to be a part of the glacial drift brought in from the Lake Superior region so Wisconsin never had a copper boom such as hit the Keweenaw Peninsula of Upper Michigan in the forties. Since the Michigan deposits represented native copper, the smelting problem was never more than one of melting the metal to separate it from contaminating rocks. When charcoal was used, it was obtained from nearby forests and used primarily as a fuel rather than as a reducing agent.\textsuperscript{22}

**Iron.** Charcoal needs at midcentury shifted to the eastern part of the state with the development of iron smelting in the Iron Ridge Region and soon thereafter in Milwaukee County. A charcoal furnace was in operation at Mayville in 1849.\textsuperscript{23} The charcoal was produced locally. This furnace, or another at Mayville (built in 1853) was operated by the Northwestern Iron Company, the owners of the Mishawaka furnace in Indiana.\textsuperscript{24}

In 1857, two more charcoal furnaces were put into operation. The one near Black River Falls was operated for only a short period by a company of German immigrants. The Ironton furnace was built by Jonas Tower to produce iron for castings. It had a capacity of three tons of iron per day, using ore mined in the nearby Baraboo Range. Another charcoal furnace was built in 1865 at Iron Ridge, near Mayville, by the Wisconsin Iron Company, operating out of Milwaukee.

The next decade saw a vigorous development of iron smelting in Wisconsin. Seven charcoal furnaces were put to blast in the lower Fox River valley during the years 1869–72. These furnaces were located where they could benefit from lake transport of ores from the Marquette Range which was being opened at that time in the Michigan peninsula. Hardwood forests in the counties adjacent to the Fox River provided the charcoal supply.

Milwaukee also began to develop as an iron working center. Two furnaces were put into operation by the Milwaukee Iron Company in 1870 and 1871. Another was built for the Minerva Iron Company in 1873. All three furnaces utilized Lake Superior

\textsuperscript{22} Ibid., p. 120–21.
\textsuperscript{23} Raney, ref. 18, p. 335.
ores. None of them used charcoal as a fuel but utilized anthracite coal and coke brought in by lake boats.\footnote{Ibid.}

In 1880 there were 14 furnaces in the state. Eleven of these still utilized charcoal but the three Milwaukee furnaces operated on mineral fuel. From this point, the use of charcoal in iron smelting went into rapid decline. The combination of a rapidly dwindling supply of timber for charcoal and the competition of Lake Superior ores proved deadly for the operators in the central portions of the state. The opening of the Menominee Range in Michigan (and Florence County, Wisconsin) in the early seventies provided a rich ore low in phosphorus against which the low grade central Wisconsin ores could not compete.\footnote{Usher, Ellis B., “Nelson Powell Hulst, the Greatest American Authority on Iron”, \textit{Wis. Mag. Hist.}, 1, 385–405 (1924).} Although the furnaces in the Iron Ridge region continued in operation for some time, the center of Wisconsin’s iron smelting moved to Milwaukee where lake transportation brought in coke from the Indiana–Illinois fields and rich ore from the Menominee Range. Wisconsin continued to figure in ore production with the opening in 1883 of the Gogebic Range on the Wisconsin–Michigan border near Ashland.

The thriving foundry operations in Wisconsin, based at first on flour mill and saw mill machinery, grew with the rapid development of agricultural machinery which was taking place at the time. As the milling of flour gave way to the sawing of lumber, which in turn gave way to agriculture, the need for castings and forgings grew. The rising paper industry also began to absorb products of the iron-working factories and the rapid expansion of the railroads during the period made another large demand. During the decade between 1870 and 1880, Wisconsin rose in iron production from twelfth place among the states to sixth. After this time, the state, while showing continued growth in tonnage of iron produced, lost ground relatively and slipped to eighth position by 1890.\footnote{Swank, J. M., \textit{History of the Manufacture of Iron in All Ages.}, American Iron and Steel Association, Philadelphia, 2nd. edn., 1892, p. 331.} By this time, nearly all of the old charcoal furnaces in the state had been abandoned, though a large charcoal furnace, 60 feet high and 12 feet in diameter at the bosses, was placed in operation at Ashland as late as 1888. This furnace, called “Hinkle”, had the best production record of any charcoal furnace in the United States.\footnote{Ibid., p. 330.} As long as it could draw upon the nearby Gogebic ores and charcoal from nearby forests its operation was a profitable one.
An indication of the drain on forest resources by charcoal furnaces is given by Billinger.29 His remarks refer to Pennsylvania furnaces of an earlier day but it is probable that Wisconsin furnaces were at least equivalent in their charcoal demand. One furnace required 800 bushels of charcoal every 24 hours. This could be supplied from 20 cords of wood, the average cut from an acre of woodland.

MAPLE SYRUP AND SUGAR

These saccharine products of maple sap are typically American. The natural abundance of maple trees in Wisconsin resulted in widespread production of both syrup and sugar from the earliest days of the region. Whether or not the Indians were producing maple sugar when the white man came to North America is still a moot question. The best evidence leads to the assumption that the Indians were using maple sap but were taught the art of converting it into sugar by the French. In any case maple sugar became an important item of trade between the French and Indians.

When white settlers populated the region in the nineteenth century, maple syrup and sugar production became a part of their springtime activities in those sections where maple groves flourished. Production was mostly on a small scale by individual families and has largely continued so even to the present day. The operations of boiling, clarification with eggs or lime, and crystallization are little changed from the techniques used by the Indians.30

CONCLUSION

As a result of our survey of the early development of chemical industry in Wisconsin we must conclude that the industry was timber-based. The types of products and processes were the result of Wisconsin's primary resource. Had Wisconsin been a prairie state, instead of being heavily forested, its chemical industry could not have shown the development it did. Even the lead and iron industries, which at first glance appear unrelated to wood resources, could not easily have developed commercially in Wisconsin had there been no available charcoal for smelting. By the time that charcoal resources were depleted, the iron-

Working industry of the state was sufficiently well established to maintain itself on imported ore and coal brought in by lake boats.

It is true that certain industries, such as brickmaking,\textsuperscript{31} earthenware, lime, and cement, which formed a part of the chemical industry of early Wisconsin can hardly be associated with timber unless one considers the fuel needs in the preparation of the products. They developed locally due to the presence of such minerals as clay and limestone, as they did in many other states. Hence, they can hardly be considered typical Wisconsin industries as can potash, tanning or pulp and paper.

Depletion of timber resources resulted in considerable shifting of emphasis, primarily toward industries based upon the agricultural pursuits which grew up following the clearing of the land. The rise of the dairy industry from 16th position in 1880 to first position in value of products by 1920 was paralleled by the development of such companies as the Marschall Dairy Laboratory in Madison and Chris Hansen's Laboratory in Milwaukee. These companies supplied testing materials, cheesemaking enzymes, and bacterial cultures to the vigorously growing industry. The fermentation industry too, which grew in importance in Wisconsin following the immigration of German brewers after mid-century, is agriculture based. Timber-based industry, representing the first stage of Wisconsin's chemical industry, was giving way to a new phase at the turn of the century.

\textbf{ACKNOWLEDGEMENT}

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\textsuperscript{31} Milwaukee was nicknamed the "cream city" at one time because of the many cream-colored buildings constructed of bricks made of the light-colored clay in the region.