Chemistry in the Low Countries: A Comparison Between North and South, 1600-1900

Ernst Homburg[*]

Introduction

Aim of this paper is to compare the social history of chemistry in the North (the Netherlands) with in the South (Belgium) of the Low Countries. Many similarities, also many contrasts will be emphasised. To understand these similarities and differences in the social development of chemistry attention will be paid to:

- the differences in economic development,
- the social differences,
- the political factors,
- the cultural and religious factors,
- and in particular, to the influences emanating from the close subject area neighbours of chemistry: medicine and pharmacy; mining and metallurgy; industry; and esoteric alchemy.

First it is necessary to define more closely the geographical boundaries of the area studied, since these boundaries shifted over time. Five major time periods can be distinguished, between 1600 and 1900:

(1) 1600-1648: a period of war

These were the years of the 80 years war (1568-1648) between Protestants and Catholics; and between Spain, France and the Republic (1579). In Germany these were the years of the 30 years war (1618-1648). The peace treaties of Westphalia and Münster 1648 defined the border between the north and the south.

[*] University of Maastricht. Department of History. P.O. Box 616. 6200 MD Maastricht. The Netherlands. *e.homburg@history.unimaas.nl*

(2) 1648-1795: four major political entities

The 'North' consisted in this period of:

– the Republic of the Seven United Provinces;
– and of areas ruled by the States General (States' Brabant, Maastricht (partly), etc.).

The 'South' mainly consisted of:

– the Southern Netherlands, under Spanish rule until 1713, and under Austrian rule from 1715 to 1795;
– and of the Episcopate of Liège, ruled by a Prince-Bishop.

(3) 1795-1813: a period with a strong French influence

The South were occupied by France from 1795 to 1813, and the North from 1810 to 1813, but also between 1795 and 1810 the French influence in the North was very strong.

(4) 1815-1830; the years of United Kingdom of the Netherlands

The North and the South were united during these years, which ended with the Belgium revolution.

(5) 1830-1900: Belgium and the Netherlands were two independent states

As until today.

During all five time periods the North and the South also had many things in common. In the first place, this part of Europe was quite densely populated. During the years 1600-1900 more people lived in the South, compared to the North. This distribution changed completely during the 20th century (see Table 1).

The Low Countries were not only densely populated, they also were highly urbanised during the entire period. Between 1600 to 1800, before the Industrial Revolution, 40% of the population of the Republic lived in cities, and in the Province of Holland, 60%. In the 16th centuries cities such as Antwerp, Ghent and Bruges had populations between 30,000 and 100,000 inhabitants. After the outbreak of the Dutch revolt in 1568, the cities in the South went into decline. The population of Antwerp sank from 100,000 to 40,000 between 1580 and 1620, and the population of Ghent from 50,000 to 30,000. At the same time the towns in the

Table 1
The population of the North and the South, 1600-present (x 1,000,000)

Year	North	South
1600	1,4	-
1650	1,8	-
1700	1,8	-
1750	1,8	2,0
1800	1,9	3,2
1850	3,1	4,3
1900	5,1	6,7
Present	16,0	10,0

North grew tremendously, partly by the influx of highly skilled refugees from the South: Amsterdam from 40,000 to 100,000 inhabitants, Leiden from 23,000 to 44,000, and Harlem from 15,000 to 39,000 (Table 2).

Table 2
The population of the largest towns of the Low Countries, 1580-1620

Town	Population
Antwerp	100,000 > 40,000
Amsterdam	40,000 > 100,000
Ghent	50,000 > 30,000
Leiden	23,000 > 44.000
Harlem	15.000 > 39,000
Bruges	30,000 > ??

italic = towns in the North.

For a discipline such as chemistry, which in the early modern period strongly depended on urban life (e.g. pharmacists, universities, trade, industry), this high degree of urbanisation of the Low Countries is something to be noted, explicitly. It should also be noted, that there were many medium-sized towns, but, even in the 19th century, no true metropolis in the Low Countries, comparable to London, Paris, Vienna and Berlin. Amsterdam, and later Brussels, would come closest to those examples (see Table 3), but social life in the Netherlands and Belgium was too decentralised for the emergence of a true metropolitan culture. The strong development of metropolitan chemistry in cities such as London, Paris and Berlin, did not have an equivalent in the Low Countries.

Table 3
The population of the largest towns of the Low Countries around 1800

Town	Population
Amsterdam	200,000
Brussels	66,000
Antwerp	56,000
Rotterdam	55,000
Ghent	55,000
Liège	50,000

italic = towns in the North.

With respect to economic development the differences between the North and the South were larger than those of population. In the North, the 17th century was its 'Golden Age.' The Republic became a world power. However, during the 18th century there was stagnation, both of the economy and of the population, but despite this, the Republic still remained one of the most prosperous countries of Europe. In the 19th Century, industrialisation took place, but at a very slow pace. Until 1900 the Netherlands mainly remained a country of merchants, strongly oriented to both Germany and its colonies (Dutch Indies).

By contrast, between 1600 and 1800 the South strongly lagged behind with respect to economic growth. During the 19th century though, Belgium was one of the leading industrial countries of Europe. Now economic growth of the South was stronger than that of the North. The Netherlands started to lag behind, in industrial development.

Also in political life, during the entire period there were strong contrasts between the North and the South. In the North, between 1600 and 1795 there was a high degree of local autonomy. Then, between 1795 and 1900 a gradual process of centralisation and unification took place.

In the South, by contrast, there was already a growing process of centralisation between 1600 and 1795, especially under the Austrian rule. The period 1830-1900 was characterised by a strong influence of liberalism (and by conflicts between the liberals and the catholics), that seems to have been even stronger than in the quite liberal North.

In the cultural and religious domains the North was dominated by the Calvinist church, though Catholicism was tolerated. There was a great freedom of the press, and, as a result, a strong publishing industry, which produced books for the entire

European market. During the 19th century a strong growth of Catholicism took place in the North.

The South, by contrast, was dominated by the Catholic Church. During the entire period there were tensions between state power and church power. There also was censorship, first executed by the Jesuits, later by court advisors, such as Van Swieten (until 1795) (see below). During the 19th century the influence of liberalism grew strongly. In contrast to the period before 1795, there was then freedom of education.

Different degrees of institutionalisation of chemistry in North and South, 1600-1740

The major driving forces for the institutionalisation of chemistry in the 16th and 17th centuries Europe were (a) Court alchemy; (b) Mining and metallurgy; and (c) Medicine and pharmacy.

Applied to the Low Countries, the situations were as follows:

– Court alchemy played only a limited role at the courts in Brussels and Delft. It was quite important though at the court at Liège under Ernest of Bavaria, Prince-Bishop from 1580 to 1612, who actively supported the Paracelsian movement.
– Mining and metallurgy were absent in the North, and were not very important in the South before the end of the 18th century; with the exception of the investigation of mineral waters. Van Helmont, for instance, published on the analysis of mineral waters in 1624. After about 1760 mining and metallurgy started to play a growing role in the South.
– Against this background, between 1600 and 1740 medicine and pharmacy, the preparation of so-called 'chymical remedies' especially, certainly were *the* major driving force of the institutionalisation of chemistry in the Low Countries. Important roles were played by Jean Baptiste Van Helmont in the South, and by Franciscus dele Boë Sylvius in the North.

Institutionalisation of chemistry took place within the medical faculties of the Universities and other Institutes of Higher Learning, and in the context of the training of pharmacists.

In the field of higher learning the differences between the North and the South were huge. In the South, there was only one University, at Louvain/ Leuven, founded in 1425. Since 1562 there also was a university at Douai, until these territories were taken by the French in 1667-1668; but there seems to have been no

teaching of chemistry at that university. In the North, by contrast, six Universities were founded between 1575 and 1656 (Table 4). Moreover, there were also nine so-called 'Illustrious Schools' (or 'Illustrious Athenea', or 'Illustrious Gymnasia') in the North, established between 1599 and 1683, some of which later obtained university status (Harderwijk in 1648; Nijmegen in 1656; and Amsterdam in 1876). These 'Illustrious Schools' were a kind of arts faculties, which prepared the students for more advanced studies in law, theology and medicine at the universities. In that respect their teaching overlapped with the first 1-2 years of a university study. On the other hand, several of these schools, especially those in the area ruled by the States General (i.e. the schools at Bosch, Breda and Maastricht), were mainly directed to the training of clergymen for the Calvinist church. Although there was no exact equivalent of those schools in the South, there may have been certain similarities with the Jesuit Seminaries (and/or Colleges) of the South, as far as the teaching of theology was concerned. From the point of the institutionalisation of chemistry though, it is important to note that most of the 'Illustrious Schools' had chairs of medicine at some time in their existence, whereas the Jesuit Seminaries had not.

Table 4
The establishment of institutions of higher learning in the South and the North, 1425-1740

Universities (South)	**Universities (North)**
1425 Louvain	1575 Leiden
1562 Douai	1585 Franeker
	1614 Groningen
	1636 Utrecht
	1648 Harderwijk
	1656 Nijmegen
Illustrious Schools (South)	**Illustrious Schools (North)**
Jesuit Seminaries	1599 Harderwijk
(there were at least 23 Jesuit Colleges founded between 1542 and 1649, but it remains unclear how many had departments of higher learning annexed to them; and it is even more unclear whether there was any teaching of medicine and/or chemistry)	1630 Deventer
	1632 Amsterdam
	1636 Bosch (Bois le Duc)
	1636 Rotterdam
	1646 Breda
	1650 Middelburg
	1655 Nijmegen
	1683 Maastricht

If one looks at the institutionalisation of chemistry at the German universities, which has been well studied, four phases can be distinguished:

– First, between about 1560 and 1620 chymistry and chemiatry were introduced as teaching subjects at Medical Faculties of universities of the German Protestant States. At some universities, practical laboratory training was also offered, so that medical doctors could learn to make their own chymical medicines. Chemistry textbooks, in Latin, were written for these students of medicine. Chairs, laboratories and textbooks were the hall-marks of the institutionalisation of university chemistry.
– Then, between about 1600 and 1680, the new occupation of the 'chymist' emerged. These chymists started to supply medical doctors with chymical medicines.
– A third period, between about 1650 and 1720, was marked by the integration of the chymical medicines into the pharmacists' repertoire (in addition to Galenics). In Prussia, for instance, a special decree of 1685 declared that Prussian pharmacists were not allowed to buy their medicines from chymists. They should make these medicines themselves. As a result, a market for chemistry textbooks in the vernacular emerged, directed to pharmacist's apprentices.
– As another result, the practice of chemistry shifted from the medical men to the pharmacists. During the fourth period, between about 1720 and 1770, the teaching of practical chemistry at the Medical faculties declined.

The institutionalisation of chemistry in the Low Countries did not closely follow this German pattern. There was a more or less 'reverse order' of institutionalisation, in the sense that chemistry was first embraced by the pharmacists, before it got a firm foothold at the universities.

In the South, the major chemist during the first part of the 17th century was Jan Baptist van Helmont (c1579-1644), who was a critical follower of Paracelsus. He was a contemporary of the first Germany Professors of chymiatry and chymistry, and like them engaged in a revolution in medicine, by introducing an experimental approach. But unlike his colleagues in the German Protestant States he did not get a position at a university. Between 1624 and 1644 he had great problems with the Inquisition and with the Theology Faculty of the University at Louvain. As a result of this religious and political opposition, chemistry only hesitatingly entered pharmacy in South, and before it was accepted by the Medical Faculty at Louvain.

The first book published in the South on chymistry *and* pharmacy was Jan Bisschop's *Pharmacia Galenica & Chymica* (Ghent 1653). Contrary to similar publications in the North, this book was not by a true adept of chymistry. Jan Bisschop was a Jesuit pharmacist, who had studied and worked in Vienna. He was rather critical towards chymical medicines. His book went through many editions.

Eight years later (1661) the *Pharmacia Galeno-Chymica Antverpiensis* was published, and in 1665 an agreement between the town of Louvain and the university paved the way for the local pharmacists to study at university. Not much later, a medical doctor, Adrien Regnault, started to give private courses in chemistry at Louvain. So, it can be concluded that in the 1660s and 1670s chemistry started to be recognised in the South by some, as a subject relevant to pharmacists. This is further confirmed by the fact that in 1676 an edition of Glaser's *Traité de Chimie* was published in Brussels. Probably this was the first chemistry textbook in the vernacular published in the South. In 1683 pharmacists received a monopoly on the preparation of medicines from King Charles II. Medical doctors were not allowed to make their own medicines. Chymical medicines now had an officially recognised position in the South, and medical doctors should have enough knowledge to prescribe them. Therefore in 1685 an official chemistry chair was created at Louvain University, for Regnault.

Also in the North, chymistry was first introduced into pharmacy, before it entered medicine. Like in the South (Glaser) there were influences from France (Beguin, see below); but in the North there were also strong German influences.

In 1614, so about 60 years earlier than in the South, the first chemistry textbook in the vernacular was published in the Republic. It was a translation of Jean Beguin's, *Tyrocinium chymicum* with the Dutch subtitle, *Dat is de eerste proeve der chymie, vervatende meest alle manieren van preparatien der chymische medicamenten, nut ende bequaem voor medecijns, apteckers, ende chyrurgijns* (The first steps in chemistry, containing all methods to prepare chymical medicines, useful and adapted for medical men, pharmacists and surgeons) (Utrecht 1614). A second edition appeared in 1623, and a third in 1669. In 1640 H. à Mijnsicht published his *Thesaurus et armentarium medico-chymicum* (Leiden), and about 1644 the town of Nijmegen issued a decree that each pharmacist had to make his own chymical medicines, and was not allowed to buy them from others.

In the following decades strong German influences became apparent. Probably as a result of the devastating effects of the 30 years war in Germany, several trained chemists and pharmacists left their country for Holland. One of them was the famous Rudolph Glauber, who between 1640 and 1670 lived for almost 25 years

in Amsterdam, where he produced chemicals in a commercial laboratory. He had a great influence in Holland, partly via his co-workers and pupils.

Another German was Albert Kyper, who came from Königsberg in Prussia in 1638. In 1643 he studied at Leiden University, where he noted the lack of a chemical laboratory. This is a clear sign that the institutionalisation of chemistry in Germany was more advanced at that date. Three years later, in 1646, Kyper was appointed a teacher of medicine, anatomy and chemistry at the Illustrious School at Breda. He was the first teacher of chemistry at a Dutch Institute of Higher Learning. He used instruments in his teaching, or even fitted up a small laboratory, but this teaching of chemistry was discontinued when he became Professor of Medicine in Leiden in 1650.

Regular complaints by pharmacists (Leiden, 1647; Rotterdam, 1673) that medical doctors were producing medicines make it clear that the preparation of chymical remedies was practiced in the Republic in those years. From the 1650s onwards also the number of chemistry teachers grew. In 1656 Jacob Uwens started his lessons in anatomy and chemistry at the University of Nijmegen, and 1658-1659 even three persons, Sylvius, Stam and Marggraff started to give private lessons in chemistry to medical students at Leiden. An official chair was created for Sylvius in 1666. In the 1690s the Universities of Utrecht and Groningen followed, but at Utrecht the private teaching of chemistry had already started much earlier (Table 5).

After the death of Van Helmont, there were no major chemists in the South that followed in his footsteps. Between 1644 and 1740 only a few chemical textbooks and treatises were published. By contrast, in the North there were several important teachers of chemistry and publicists of the subject.

Franciscus dele Boë Sylvius (1614-1672) was certainly the most important academic chemist in the Republic during the second half of the 17th century. He was a follower of Van Helmont, and a friend of Glauber. After his appointment to a medical chair at Leiden University in 1658 he became a very influential teacher, who, as a iatrochemist, systematically tried to explain all physiological processes in terms of the actions of acids and bases. His doctrines were integrated into Cartesianism by several of his followers, such as Blankaart. In this form, Sylvius' Cartesian iatrochemical doctrines had an enormous influence on Dutch chemistry.

Steven Blankaart (1650-1704), although not a chemist known for original discoveries, should be mentioned among the important Dutch chemists of the second half of the 17$^{th.}$ century. He was a great populariser of Sylvian and Cartesian

Table 5
The start of chemistry teaching at Institutions of Higher Learning in the South and the North, 1425-1795

Universities (south)	**Universities (north)**
1670s? Leuven: Regnault *1685 Leuven: Regnault*	*1656 Nijmegen: Uwens* 1658-59 Leiden: Sylvius (1638 from Germany and France), Stam, and Marggraff (from Germany) *1666 Leiden: Sylvius in Med. Fac.* 1668 Utrecht: De Maets *1669 Leiden: De Maets in Phil. Fac.* 1694 Utrecht: J.C. Barchusen (from Germany) *1696 Groningen: Eyssonius* *1720 Franeker: Muys* *1754 Harderwijk: Van Haastenburg*
Illustrious Schools (south) Jesuit Seminaries?	**Illustrious Schools (north)** 1646 Breda: Kyper (1638 from Germany) *1785 Amsterdam:Van Rhyn* 1789 Deventer: Westenberg

italic = institutions with an official chemistry chair.

medicine, and the most prolific writer on chemistry in the North. Between 1678 and 1693 he published six major treatises on chemistry and pharmacy in the vernacular and most of them went through several editions. Blankaart also translated foreign textbooks into Dutch, for example, Lancilotti's book from the Italian in 1680, and Lemery's *Traité de chimie* in 1683. Blankaart also coined the Dutch word for chemistry 'scheikunde.' The fact that this word is used until today shows the influence of Blankaart's writings. He published following titles on chemistry:

– 1678 *De nieuwe hedendaagsche stof-scheiding ofthe chymia*
– 1678 *Nieuw lichtende praktijk der medicynen … nevens de hedendaagse chymia* (7 editions 1678-1735!)
– 1680 Carlo Lancilotti, *De brandende salamander, ofte Ontleedinge der chymicale stoffen: zijnde een weg-wijzer, oft institute om sich in alle operatien der schey-konst te oeffenen : Item den ontwaakten chymist*
– 1683 *'t Nieuw-ligt des apotheker, of Nieuwe-gronden en fondamenten der artzeni- en chymise-bereiding*

– 1683 Nicolas Lemery, *Het philosoophische laboratorium, of Der chymisten stook-huis: Leerende op een korte en ligte wyse alle de gebruikelykste medicamenten op de chymische wyse bereiden* (4 editions 1683-1725)
– 1693 K. Digby *Theatrum chimicum, ofte Geopende deure der chymische verborgentheden.*

In addition, Blankaart also published many works on medicine and botany.

At Utrecht University chemistry was taught by Johann Conrad Barchusen (1666-1723), who came from Germany as well. In 1694 he started giving private lessons on chemistry at Utrecht, and then he fitted up a laboratory. He was elevated to a formal university position in chemistry in 1698, the same year he published his textbook, *Pyrosophia.*

There can be no doubt that compared to the South chemistry in the North stood on a much broader basis in 1700 (cf. Table 5). This broad basis was a fertile ground in which to produce a star of first magnitude in chemistry, not only in the Republic, but in Europe as a whole, namely, Herman Boerhaave (1668-1738). As a student of medicine, Boerhaave followed the lectures on chemistry given at the university by De Maets and Le Mort, a pupil of Glauber. His most important teacher in practical chemistry was the pharmacist David Stam (1633-1711), who taught chemistry at Leiden since 1658. In 1702 Boerhaave started to give private lessons in chemistry. In 1709 he was appointed Professor of Medicine and Botany, and from 1718 to 1729 he also was Professor of Chemistry, as successor to Le Mort. His famous textbook *Elementa Chemiae* was published in 1732. Boerhaave's influence on the teaching of both chemistry and medicine has been enormous. Students from all over Europe came to Leiden to follow his lessons; in particular, students from Scotland, England and Germany.

Decline in the North and new initiatives in the South, 1740-1795

After the death of Boerhaave, chemistry in the North went into decline. At the same time, the cameralist policies of the Austrian rulers Maria Theresia and Joseph II led to an important renaissance of science in the Habsburg empire, and an improvement of economic life.

The career of Gerard van Swieten (1700-1772) illustrates perfectly this shift of the centre of gravity in chemistry from the Republic to the Austrian lands. Van Swieten was from a Catholic noble family. He started as pharmacist's apprentice

in Amsterdam and Leiden, in the apothecary shop of Nicolaas Stam, the son of Boerhaave's teacher David Stam. Parallel to this he followed Boerhaave's lectures from 1717 till 1738. 1720 he started his own 'chemist's shop' at Leiden, and in 1725 he was awarded the medical doctorate. After Boerhaave's death, Van Swieten started writing and publishing comments on Boerhaave's work, from 1742 onwards. This made him famous throughout Europe. In 1744 he was appointed personal physician to Maria Theresia, and moved to Vienna. Five years later he was made responsible for the reform of the Medical Faculty at Vienna. As part of these reforms, Van Swieten established a Chair of Botany and Chemistry. Chemistry was a subject which had not been taught in Vienna before. Van Swieten was also instrumental in attracting other important Dutch (Catholic) scientists to the Habsburg capital, for example, Nicolas Jacquin in 1752, and Jan Ingen-Housz in 1768.

After the reforms of medical teaching at Vienna, also the other medical faculties in the Habsburg Empire were restructured, first Prague, then Budapest, and also Louvain. In 1754 the Count de Neny independently started a whole series of reforms of Louvain University. One of these was the founding of Cabinet of Experimental Physics in 1755. Two years later, with the support of the Viceroy Charles de Lorraine, a Chemical University Laboratory was erected to replace the private laboratories used by the chemistry teachers until then. De Neny also ordered the Professors of Chemistry should use Boerhaave's textbook, and produce annual reports on their lectures and laboratory work.

Table 6
The founding of chemical laboratories at the Universities, 1660-1760

South	North
1757 Louvain	1669 Leiden
	1695 Utrecht
	1707 Groningen
	1752 Franeker

With four university chemical laboratories in 1757 the North was still leading in that respect, but the establishment of the chemical laboratory at Louvain was an important new start (Table 6). During the second half of the 18th century the level of chemical teaching and research in the South was definitely on a higher level than during the first half of the century.

Also in some parts of economic life there was a shift from the North to the South. After the great prosperity of the 17th century, the economy of the Dutch Republic

stagnated during the 18th. century, and some sectors even went into decline. One of these sectors was calico printing, which was the most important consumer of products of the contemporary chemical industries. Between 1678 and about 1725 Amsterdam had been, by far, the foremost European centre of calico printing. Dozens of calico printing shops, each with 25 to 40 workers, were active in the Amsterdam area. Between 1700 and 1750 though, competing calico printing centres emerged in London, Hamburg, Augsburg, and Geneva. After 1750, Dutch calico printing increasingly went into decline. Especially between 1783 and 1788 many works had to close because of strong foreign competition. In 1815 only one factory was left, of the dozens that had existed before. Only after the separation of Belgium and Holland in 1830 did Dutch calico printing industry have a renaissance. After 1830 several Belgium calico printers moved to Leiden and Harlem, in order to profit from the large Dutch colonial market.

These changes in the prosperity of the Dutch textile printing industry did not leave the chemical industries untouched. About 1750 there were more than 10 *aqua fortis* (nitric acid) works around Amsterdam, and several other chemical works. In those years the Dutch chemical industry was still one of largest in Europe, at least if the size of the population is taken into account. Later, sulphuric acid partly took over the role played before by nitric acid. Between 1764 and 1774 the lead chamber process was introduced into the Republic by J. Farquaharson, a partner of Roebuck, the inventor of the process. In 1790 a second sulphuric acid plant was build by Anthony Le Blanc. As a result of the decline in calico printing, between 1795 and 1815 all nitric and sulphuric acid works closed down. Only after 1830 was sulphuric acid manufacture reintroduced in the North, hand in hand with the resurrection of the Dutch calico printing industry.

In the South, calico printing started relatively late. The first factory was founded in Antwerp by Quirinus Vlemincks in 1751, with technical know-how from the North. Two years later the firm Jan Beerenbroek & Co. built a large calico print works at Dambrugge, close to Antwerp, with the help of technical experts from Germany and Holland. A monopoly was granted for 25 years, and as result the factory expanded tremendously. In 1767, so 'officially' *before* the 'Industrial Revolution,' the incredible number of 576 workers (including women and children) were employed in the Dambrugge factory. Despite the monopoly he had granted, Viceroy Charles de Lorraine founded his own court manufacture at Tervuren in 1758, with the help of the chemist Pierre de Schavye. In 1778 the 25-year period of the monopoly elapsed, and in the following years several new calico print-works were founded at Ghent and Brussels. One of these was a large company founded

at Ghent by Abraham Voortman, who was a Catholic calico printer from the North.

The establishment of calico print works in the South created a market for the chemical industry. After the Tervuren factory had been founded, Thomas Murry from England set up, in 1759, three sulphuric acid and aqua fortis works near Brussels, with the Royal protection by Charles de Lorraine. In 1762, Murry's sulphuric acid works were taken over by the State. In the following decades also mining and metallurgy developed in the South. As a consequence, between 1759 and 1790 more than 10 sulphuric and nitric acid works were founded near Brussels and Liège. During the French wars and the Continental blockade several of these works closed down. By 1815 only the factory of Vander Elst had survived. But during the 'United Kingdom' southern calico printing flourished again, and between 1815 and 1830 five new sulphuric acid works were erected near Ghent and other industrial centres.

Reflecting on these contrasting developments in the North and the South, it is concluded that they were partly the result of contrasting economic policies. In the South there was a policy of strong dirigism and protectionism by the enlightened Austrian state. Examples are the 1753 monopoly granted to the Dambrugge factory, the 1754-1757 university reforms at Louvain, the 1758 calico print works erected by Charles de Lorraine himself, and the role of the state in sulphuric acid manufacture 1759/ 1762.

In the North nothing comparable existed. Politics in the Republic of the Seven United Provinces was highly decentralised. A strong centralised economic policy was absent. Local elites determined the rules and regulations of the towns. The positive side of the coin, however, was that private initiative could flourish and that civic society was strongly developed. It can be no surprise therefore that it was not the state, but private persons who first expressed their worries on economic decline, especially in calico printing. Between 1779 and 1785 several pamphlets were written, as well as initiatives taken by local scientific and patriotic societies that called for action. The pharmacists and chemists Tieboel, Schonck, and Kasteleyn, for instance, argued that town governments should stimulate the teaching of chemistry in order to save the chemical and the calico printing industries.

That local scientific societies played a role in these debates was typical of civic society in the North. Public and private societies and clubs flourished. The great political and religious freedom that characterised the Dutch Republic gave ample room for local initiatives. After the Hollandsche Maatschappij van Wetenschappen had been founded in Harlem in 1748, three other important provincial

scientific societies followed. During the last decades of the eighteenth century, between 25 and 40 local natural science societies were founded in the Dutch towns. There were even a few 'chemical societies' among them: such as the Chemisch Gezelschap at Rotterdam (1767), the Scheikundig Gezelschap at Amsterdam (1790), the Gezelschap van Beminnaaren der Scheikunde at Delft (1792), and the Natuur- en Scheikundig Genootschap at Groningen (1801).

In the more centralised and less liberal South there seem to have existed hardly any (local) scientific societies. Fully in line with the centralised policies, in 1772 the Austrian rulers created the Académie impériale et royale des Sciences et Belles-Lettres, as a follow-up of a society founded three years earlier. In 1779 the Prince-Bishop of Liège supported the establishment of the Société libre d'émulation et d'encouragement pour les sciences et les arts. These two societies were the two most important scientific societies under the *ancien régime*. Next to them, there were private scientific societies in Ghent (1776) and in Ostende, as well as the Société de physique expérimentale de Bruxelles, founded in 1788, or earlier. It was only after the inclusion of the southern provinces into the French empire, in 1795, that the founding of new scientific societies really took-off. An early example is the Société de médecine, chirurgie et pharmacie (1795) at Brussels, founded, among others, by the pharmacistist Augustin Van den Sande, and the chemist Jean-Baptiste Van Mons.

It should be noted that in the calls for reform by the patriotic and scientific societies of the North the industrial, and agricultural relevance of chemistry was emphasised. From pamphlets and papers written by the chemists and pharmacists Tieboel, Kasteleyn and Driessen in 1785-1787 this becomes very clear. Obviously chemistry had acquired a new meaning. Whereas between 1600 and 1750 chemistry was identified almost exclusively with the preparation of 'chemical medicines', after 1750 this situation changed. The earliest examples of the recognition of the industrial and agricultural relevance of chemistry can be found in the works of the famous German chemist Georg Ernst Stahl (1660-1734) during the early 18th century. Other examples are William Cullen's, *The Plan of a Course of Chemical Lectures and Experiments directed chiefly to the improvement of the Arts and Manufactures* (1748) and the writings of Pierre Joseph Macquer (1718-1784) from the 1750s. The earliest example in the Netherlands dates from 1769 when a student society was founded at Groningen University (the future chemists Van Marum and Driessen were among its members) with the explicit aim to apply natural science to agriculture. By 1785 a true sense of crisis was felt. Several scientists argued that more chemistry chairs should be established, in order to educate and train both pharmacists and manufacturers.

Under French rule, 1795-1814

On the eve of French revolution social unrest came to a climax and even got a revolutionary character, both in the North, and the South. In the North many enlightened citizens were frustrated that the state was moving too slowly. In 1787 there was a patriotic revolt against the Prince of Orange. After the Prince of Orange had resumed power, with the help of German troops, several scientists and intellectuals fled to Belgium and France. One of them was Gadso Coopmans (1746-1810), Professor of Chemistry and Medicine at Franeker. During his stay in Brussels, from 1787 and 1790, he was asked to teach chemistry at the University, that had temporarily been transferred from Louvain to Brussels. When the Brabant revolt failed in 1790 (see below) and the Austrians returned, Coopmans fled to France.

In the South, by contrast, many citizens were frustrated that state was moving too quickly. A clear example was the transfer of the University of Louvain to the capital, Brussels, by the Austrians. Between 1787 and 1789 this led to heated conflicts between the Catholics and the secular Austrian state. This unrest was followed by the Brabant revolution of 1790, which temporarily led the Austrian troops leave the country. Also in the South several chemists were involved. Van Bochaute, for instance, lost his position as Professor of Chemistry at Louvain because he had followed the university to Brussels, and the chemist Van Mons was put into prison.

In 1795 the South and the southern parts of the Dutch republic were occupied by French troops, and integrated into France. In the North the Prince of Orange was forced to leave the country and the so-called Batavian Republic was established, with a constitution, and strongly under French control. In 1810 also the Northern Provinces were included into the French empire.

During these years, the teaching of chemistry expanded strongly. In the North new developments resulted from private initiatives, 'from below'. Already in 1785 local initiatives made the town of Alkmaar established a so-called 'town lecturer' in chemistry, to give chemistry courses to pharmacist's apprentices and manufacturers. In the same year, five Amsterdam merchants donated a large sum of money to the 'Atheneum Illustre' in Amsterdam, to erect a chemical laboratory and to pay the salary of a Professor of Chemistry.

After the patriotic revolt of 1787 had failed, the reform movement lost momentum. But after the creation of the Batavian Republic in 1795 new initiatives again flourished. In 1795 and 1796 no less than six town lecturers in chemistry were appointed in the largest Dutch towns (Table 7). Initiatives to establish large chemical-technological laboratories for industry in Amsterdam and Groningen were only partially successful, because of the lack of finances in those times of war and political instability.

Table 7
The growth of chemical education in the Low Countries, 1785-1800

Town lecturers (North)	**Ecoles Centrales (South)**
1785? Alkmaar	1797 Brussels: Van Mons
1785 Amsterdam: Van Rhyn (paid by 5 merchants)	1797 Antwerp: Van Aenvanck
1795 Haarlem: Van Marum	1797 Maastricht: Minckelers
1795 Leiden: Brugmans	1797 Luxemburg: Van den Sande
1796 Utrecht: De Fremery	1797 Gent: Coppens
1796 Rotterdam: Rouppe	1797 Mons: Lémerel; Ricourt
1796 Dordrecht: Van der Leeuw	1797 Liège: Robert; Villette; Vanderheyden
1796 Den Haag: Van Maenen	1797 Namur: Christian
1796 Amsterdam: plans for a new (applied) laboratory	1797 Bruges: Beyts; Devaux
1801 Groningen: plans for Chemical-Technical Institute	

N.B. Maastricht, later part of the North, then was part of the South.

In the South, the teaching of chemistry also proliferated. But here, as to be expected, the initiative came 'from above.' As a result of French legislation in 1797 the so-called Écoles Centrales were founded in the capitals of the southern departments. The schools had a hybrid character. On the one hand, they were a kind of secondary school, preparing for university study. On the other hand, evening lessons were given to adults. At each school there was a teacher of chemistry, who taught chemistry to the pupils of the school as well as to pharmacist's apprentices, artisans and manufacturers. The Écoles Centrales were an important initiative in the field of natural science teaching, but they were short lived. After their closure in 1802-1803 their role was partially taking over by Lycea, Athenea and Écoles de Médecine. Although less intense than between 1797 and 1802, the teaching of chemistry continued in one form or another in most departmental capitals of the South.

Also university life was strongly affected by French rule. In 1797 the University of Louvain was forced to close down, and between 1797 and 1808 there was no University in the South. Students were supposed to study in Paris, or at one of the other French Universities. In 1808 though, an imperial university was founded at Liège, who was short lived. After the integration of the North into the

French empire, the Universities of Harderwijk and Franeker were closed by the French, and the same happened to several of the "Illustrious Schools".

The last and important consequence of French rule was the suppression of the 'chemist's' profession (i.e. manufacturers of chemical medicines, without a pharmacist's degree), as a result of the French medical laws of 1801, and the founding of the École de Pharmacie at Paris. Probably this was effective immediately in the South in 1801. In the North at least, after the inclusion into the French empire in 1810 the chemist's profession was suppressed immediately. From then on only pharmacists were allowed to produce medicines.

Chemistry during the 'United Kingdom' of the Netherlands, 1815-1830

After the defeat of Napoleon, the Vienna Congress decided that the North and the South should be united into a 'United Kingdom of the Netherlands.' Several of the previous French laws remained in force, albeit sometimes in a somewhat modified form. The new King of the 'United Kingdom,' William I, tried to create a quite symmetrical situation between the North and the South in university education. In the North, instead of the five previous universities (Nijmegen had closed down long before), only three State Universities remained: Leiden, Utrecht and Groningen. And in South, instead of the single University at Louvain, also three Universities opened their gates: Louvain, Ghent and Liège. There were also three so-called Athenea in the North (that replaced the Illustrious Schools), in Amsterdam, Deventer, and Franeker, and three in the South, in Brussels, Luxemburg, and Namur. There was a seventh Atheneum at Maastricht, a town whose northern or southern status was unclear. In the royal decree of 1815 in which most of these decisions were formulated, it was also ordered that the Chemistry Professor should be part of the newly created Science Faculties, and not, as before, in the Faculties of Medicine.

From the point of view of chemistry teaching, a second important step was taken in 1818, when new rules were formulated for the examination of pharmacists. University education was not mandatory, but the level of chemical knowledge required for examination, made it necessary for pharmacy students to follow lectures given by professional chemists. In the South, the existing lecture courses connected to the hospitals at Antwerp, Brussels, Liège and Ghent were often given by the same persons who also had lectured at the Écoles Centrales to fulfill that role. In the North nothing similar existed, and therefore special Medical Schools for the training of pharmacists, surgeons and midwives were created from

1825 onwards in the towns of Haarlem, Hoorn, Maastricht, Middelburg, Alkmaar, Amsterdam, and Rotterdam. All these schools appointed Professors of Chemistry.

A third important event with respect to the teaching of chemistry was a decree by king William I in 1825, that obliged all Universities of the kingdom to give evening lessons on mechanics and chemistry for artisans and manufacturers, in order the raise the scientific level of the national industries. As a result, several chairs in applied chemistry were created, and industrial schools were established at the Universities of Leiden, Ghent and Liège, which in the last two cases, after Belgium independence, developed into engineering schools.

Diverging paths, again, 1830-1900

After the Belgium uprising of 1830, the North and the South were separated again, in practice immediately in 1830, formally only after the peace treaty of 1839, in which it was decided for instance that Maastricht should be a part of the Netherlands, not part of Belgium.

The political cultures of both countries were quite different. In the Netherlands, King William I and his successors followed quite autocratic and conservative policies, in agreement with large parts of the dominant Calvinist church, as well as with the generally quite conservative mentality of the ruling financial and merchant elites. In the highly industrialised Belgium, by contrast, a far more liberal attitude prevailed, that formed a marked contrast to the autocratic situation in the 18th century. Nevertheless, conflicts between the liberals and the Catholics continued to play a role during the rest of the 19th century.

These differences in political culture led to some marked contrasts between both countries in the field of higher education:

– in the Netherlands, previous study at a gymnasium (Latin school) was required for a university study, but in Belgium access to university was more open;
– in the Netherlands, like in northern Germany, university study was concluded by writing a dissertation (until 1850 mostly in Latin, thereafter in the vernacular), whereas in Belgium state examinations were held;
– in the Netherlands until 1876 there were only State Universities, but in Belgium next to two State Universities (Liège; Ghent), there were also two 'free' universities since 1834: a Catholic University at Louvain, and a liberal University at Brussels;
– in the Netherlands Universities, that required the study of Latin and Greek, were strictly separated from technical and industrial education. In 1842 an

engineering school was founded at Delft, which only acquired university status in 1905. In Belgium, by contrast, special schools for engineers and agronomists were integrated into the Universities.

These contrasts show that the Netherlands were a socially more segregated society, with a strict division between the educated and industrial classes, whereas in the more liberal Belgium society this division was less strict.

At the end of the 19th century there were important educational reforms in both Belgium and the Netherlands, that led to a situation of a greater educational convergence.

In the Netherlands a law on secondary education in1863 led to the establishment of about 40 modern secondary schools, with laboratories and chemistry teaching. This law had a great impact on the scientific 'start-level' of university students. In 1877 a law on higher education led to further improvement. Pharmacy now became a university study, and separate special doctorates in chemistry (Dr. Chem.) and pharmacy (Dr. Pharm.) were created, in contrast to the previous general Dr. Phil. degree. During the last decades of the 19th century scientific teaching and research at the Dutch Universities flourished, as is illustrated by the Nobel prizes given in the early 20th century to several Dutch chemists and physicists, such as Van 't Hoff, Lorentz, Van der Waals, and Kamerling Onnes.

In Belgium university studies were reformed by the laws of 1877 and 1890. Now, also in Belgium, secondary school certificates and/or entrance examinations were required before someone could enter a university. Writing of a dissertation, based on original research, replaced the previous state examinations. And at the end of the 19th century there was a strong growth in the number of chairs of chemistry, far greater than that happened in the Netherlands. In the Netherlands, similar to Germany, there were often only 2 or 3 chemistry Professors at a University, who each covered large parts of chemical science. In Belgium, similar to France, there were often a greater number of more specialised Chemistry Professors at each University, with more limited mandates.

Some Conclusions

From this study a few tentative conclusions have been formulated.

In the first place, it is hoped that the contrasting stories of chemistry in the North and the South have shown that politics, religion and economics do matter in its development in a national arena.

In the second place, it is considered that some national oriented histories of Belgium science, which tend to date the revival of Belgium science in 1830, as a result of the independence of the nation, are incorrect. It has been shown that the revival of Belgium science started between 1750 and 1790, under Austrian rule.

In the third place, history matters: the ranking of nations in the field of science is seldom stable over longer periods of time. In the case of chemistry in the Low Countries, between 1650 and about 1800 Dutch chemistry was leading, between 1750 and 1830 Belgium chemistry gradually took over, at least in quantitative terms. The 1863 law on secondary education in the North gave Dutch chemistry again a strong impetus (Van't Hoff), and northern chemistry again regained much of its previous leading position.

In the fourth and last place, it is suggested that strong States are good for science. For example, the state support to the industry and the Universities given in the South in the 1750s, and also the remarkable effects of the laws on secondary and higher education in the Netherlands of 1863 and 1877, which ended a long period of inactivity by the Dutch state.

Acknowledgements

I thank Brigitte Van Tiggelen for several additions and corrections to an earlier version of this paper, and for kindly, but tenaciously, insisting in publishing my lecture at all.

Bibliography

Annette André-Félix, *Les débuts de l'industrie chimique dans les Pays-Bas autrichien* (Bruxelles: Institut de Sociologie, Université Libre de Bruxelles, 1971).

D.P. Blok, et al. (eds.), *Algemene Geschiedenis der Nederlanden*, 15 Vols. (Haarlem: Fibula-Van Dishoeck 1978-1983).

Michel Bougard, "Jean-Baptiste Van Mons, een boegbeeld van de scheikunde," in *Geschiedenis van de wetenschappen in België 1815-2000*, eds. Robert Halleux, Jan Vandersmissen, Andrée Despy-Meyer, and Geert Vanpaemel (Brussel: Dexia Bank 2001), Vol. 1, 146-153.

Albert Bruylants, "Louis Henry (1834-1913) en de scheikunde te Leuven," in *Academiae Analecta* (AWLSK, Paleis der Academiën: Brussel, 1986) (= *Mededelingen van de Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België* 48 (4) (1986)), 101-112.

D. Thornburn Burns and Hendrik Deelstra, "Analytical Chemistry in Belgium: An Historical Overview," *Microchimica Acta* 161 (2008): 41-66.

D. Thornburn Burns and Hendrik Deelstra, "The Rise of Analytical Chemistry in Belgium," *Analytical and Bioanalytical Chemistry* 391 (2008): 1113-1117.

H. Deelstra, "De wet van 13 mei 1825, of de invoering van technisch onderwijs aan de hogescholen in de Zuiderlijke Nederlanden," in *Acta Octavi Conventus Historiae Scientiae Medicinae Mathesos Naturaliumque excolendae Bergae ad Zonam* [1977] *Pars altera* (Amsterdam: Ronald Meesters, 1978), 27-32.

H. Deelstra, "Het scheikundig onderwijs en onderzoek te Gent vóór de komst van A. Kekulé in 1858," *Tijdschrift voor de Geschiedenis der Geneeskunde, Natuurwetenschappen, Wiskunde en Techniek* 2 (3) (1979): 110-117.

H. Deelstra, "Het scheikunde-onderwijs aan de Rijksuniversiteit te Gent tijdens de 19de eeuw," in *Academiae Analecta* (AWLSK, Paleis der Academiën: Brussel, 1986) (= *Mededelingen van de Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België* 48 (4) (1986)), 113-128.

H.A. Deelstra, "Achtergronden van de wetten van 1890-1891 en de invloed op het natuurwetenschappelijk onderwijs in België," *Gewina* 16 (1993): 187-191.

H. Deelstra, "La professionnalisation de la chimie en Belgique," *Sartoniana*, 8 (1995): 85-101.

Hendrik Deelstra, "Bijdragen van de Belgische apothekers tot het wetenschappelijk onderzoek rond de eeuwwende," *Scientiarum Historia* 26 (1-2) (2000): 97-108.

Hendrik Deelstra, "De scheikunde aan de universiteiten en hogescholen," in *Geschiedenis van de wetenschappen in België 1815-2000*, eds. Robert Halleux, Jan Vandersmissen, Andrée Despy-Meyer, and Geert Vanpaemel (Brussel: Dexia Bank 2001), Vol. 1, 159-178.

Annette Félix, "L'enseignement de la chimie à la Faculté de Médecine de l'ancienne Université de Louvain," in *Academiae Analecta* (AWLSK, Paleis der Academiën: Brussel, 1986) (= *Mededelingen van de Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België* 48 (4) (1986)), 77-86.

Robert Halleux, "Chimistes provinciaux et révolution industrielle: le cas de la Belgique," *Archives internationales d'histoire des sciences* 46 (1996) : 6-22.

Robert Halleux and Anne-Catherine Bernès, "Le cour savante d'Ernest de Bavière," *Archives internationales d'histoire des sciences* 45 (1995) : 3-29.

Ernst Homburg, *Van beroep 'Chemiker': De opkomst van de industriële chemicus en het polytechnische onderwijs in Duitsland (1790-1850)* (Delft: Delftse Universitaire Pers, 1993).

E. Homburg (et al.), *Chemische techniek in Nederland in de negentiende eeuw* (Zutphen: Walburg Pers, 1994).

Ernst Homburg, "From Colour Maker to Chemist: Episodes from the Rise of the Colourist, 1670-1800", in *Natural Dyestuffs and Industrial Culture in Europe, 1750-1880*, eds. R. Fox and A. Nieto-Galan (Nantucket, MA: Watson Publ. Int., 1999), 219-257.

Ernst Homburg, "The Netherlands: Keeping the ranks closed: The Dutch Chemical Society, 1903-1914," in *Creating Networks in Chemistry: The Founding and Early History of Chemical Societies in Europe*, eds. Anita Kildebæk Nielsen and Soňa Štrbáňová (Cambridge: Royal Society of Chemistry, 2008), 186-222.

E.H. Kossmann, *The Low Countries, 1780-1940* (Oxford: Clarendon Press 1978).

G.A. Lindeboom, "David en Nicolaas Stam apothekers te Leiden," *Bulletin. Kring voor de Geschiedenis van de Pharmacie in Benelux* Nr. 48 (okt. 1973): 18-25.

Joel Mokyr, *Industrialisation in the Low Countries, 1795-1850* (New Haven and London: Yale University Press 1976).

Carmelia Opsomer and Robert Halleux, "De natuurwetenschappen, de scheikunde en de geneeskunde", in *Geschiedenis van de wetenschappen in België van de Oudheid tot 1815*, eds. Robert Halleux, Carmélia Opzoomer, and Jan Vandersmissen (Brussel: Gemeentekrediet 1998), 229-258.

F.L.R. Sassen, "Levensberichten van de hoogleraren der Kwartierlijke Hogeschool te Nijmegen," *Numaga* 9 (3) (1962): 104-127.

Ferd. Sassen, *Het wijsgerig onderwijs aan de Illustre School te Breda (1646-1669)* (Amsterdam: Noord-Hollandsche Uitgevers Maatschappij, 1962) (= *Mededelingen van de Koninklijke Nederlandse Akademie van Wetenschappen, Afd. Letterkunde*, Nieuwe Reeks, deel 25, No. 7).

H.A.M. Snelders, "Chemistry at the Dutch universities: 1669-1900," in *Academiae Analecta* (AWLSK, Paleis der Academiën: Brussel, 1986) (= *Mededelingen van de Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België* 48 (4) (1986)), 59-75.

H.A.M. Snelders, *Geschiedenis van de scheikunde in Nederland: Van alchemie tot chemie en chemische industrie rond 1900*, Vol. 1 (Delft: Delftse Universitaire Pers, 1993).

Henricus A.M. Snelders, "Jean-Servais Stas, een boegbeeld van de scheikunde," in *Geschiedenis van de wetenschappen in België 1815-2000*, eds. Robert Halleux, Jan Vandersmissen, Andrée Despy-Meyer, and Geert Vanpaemel (Brussel: Dexia Bank 2001), Vol. 1, 154-158.

Philippe Tomsin, "De industriële scheikunde," in *Geschiedenis van de wetenschappen in België 1815-2000*, eds. Robert Halleux, Jan Vandersmissen, Andrée Despy-Meyer, and Geert Vanpaemel (Brussel: Dexia Bank 2001), Vol. 2, 195-206.

[C. Vandenghoer, et al.], *300 jaar chemie te Leuven, 1685-1985. Tentoonstelling in de Universiteitshal, 14 november – 7 december 1985* (Leuven: J. Roegiers, 1985).

L.J. van der Wiele, "Het 'Licht der Apothekers'," *Bulletin. Kring voor de Geschiedenis van de Pharmacie in Benelux* Nr. 27 (okt. 1961): 1-9.

L.J. Vandewiele, "De farmacie onder Koning Willem I," in *Acta Octavi Conventus Historiae Scientiae Medicinae Mathesos Naturaliumque excolendae Bergae ad Zonam* [1977] *Pars altera* (Amsterdam: Ronald Meesters, 1978), 33-43.

L.J. Vandewiele, *Geschiedenis van de farmacie in België* (Beveren: Orion, 1981).

L.J. Vandewiele, "Broeder Petrus Gillis S.J. (1620-1697) auteur van Medicina Pharmaceutica of Drogbereidende Geneeskonst," *Bulletin. Kring voor de Geschiedenis van de Pharmacie in Benelux* Nr. 69 (mrt. 1986): 8-16.

Geert Vanpaemel, "Jan Frans Thijsbaert (1736-1825) en de School voor Experimentele Fysika te Leuven," *Tijdschrift voor de Geschiedenis der Geneeskunde, Natuurwetenschappen, Wiskunde en Techniek* 7 (4) (1984): 172-182.

Geert Vanpaemel, "J. B. van Mons (1765-1842) en het scheikunde-onderwijs aan de Rijksuniversiteit Leuven," in *Academiae Analecta* (AWLSK, Paleis der Academiën: Brussel,

1986) (= *Mededelingen van de Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België* 48 (4) (1986)), 87-100.

Geert Vanpaemel, "Onderwijs voor 'de meer beschaafde klasse'. Het Museum voor Wetenschappen en Letteren te Brussel (1826-1834)," *Scientiarum Historia* 23 (1) (1997): 3-19.

Geert Vanpaemel and Brigitte Van Tiggelen, "The profession of chemist in nineteenth-century Belgium," in *The Making of the Chemist*, eds. David Knight and Helge Kragh (Cambridge: Cambridge UP 1998), 191-206.

Brigitte Van Tiggelen, "De la chaire aux laboratories: Louis Henry et la professionalisation de la recherché en sciences naturelles en Belgique," *Gewina* 16 (1993): 192-203.

Bigitte Van Tiggelen, "Les réformes dans l'enseignement des sciences à la faculté des arts de Louvain au XVIIIème siècle," *Scientiarum Historia* 23 (2) (1997): 41-71.

Brigitte Van Tiggelen, "De natuurwetenschappen en de scheikunde", in *Geschiedenis van de wetenschappen in België van de Oudheid tot 1815*, eds. Robert Halleux, Carmélia Opzoomer, and Jan Vandersmissen (Brussel: Gemeentekrediet 1998), 339-364.

Brigitte Van Tiggelen, "De scheikundige theorieën," in *Geschiedenis van de wetenschappen in België 1815-2000*, eds. Robert Halleux, Jan Vandersmissen, Andrée Despy-Meyer, and Geert Vanpaemel (Brussel: Dexia Bank 2001), Vol. 1, 179-194.

Brigitte Van Tiggelen, *Chimie et chimistes de Belgique* (Bruxelles: Éditions Labor, 2004).

Brigitte Van Tiggelen and Hendrik Deelstra, "Belgium: From Industry to Academia: The Belgium Chemical Society, 1887-1914," in *Creating Networks in Chemistry: The Founding and Early History of Chemical Societies in Europe*, eds. Anita Kildebæk Nielsen and Soňa Štrbáňová (Cambridge: Royal Society of Chemistry, 2008), 23-42.

G.P.J. Verbong and E. Homburg, "Chemische kennis en de chemische industrie". In *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving, 1800-1890*, eds. H.W. Lintsen, et al., Vol. 5 (Zutphen: Walburg Pers 1994), 242-269.

Jan de Vries and Ad van der Woude, *The first modern economy: success, failure, and perseverance of the Dutch economy, 1500-1815* (Cambridge: Cambridge University Press, 1997).

D.A. Wittop Koning, *Compendium voor de geschiedenis van de pharmacie van Nederland* (Lochem/ Gent: De Tijdstroom, 1986).