6. Etymology, Lexicography/Lexicology, Language for Specific Purposes

15. The Language of Chemistry in the Romance Languages

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Summary

The language of chemistry has seldom been the object of study by philologists, who prioritize literary works. Nevertheless, in recent years it has developed at a different pace in Romanic languages. This essay therefore offers a description of the current state of research in French, Spanish, Italian, Portuguese, Romanian and Catalan, which has advanced greatly thanks to the work of science historians who, aware of the field's peculiarity, have traditionally focused on its language.

The characteristics of the language of chemistry are then discussed. Toward the end of the 18th century French chemists spearheaded a terminological revolution: a radical change came about when traditional terms used in alchemy were replaced by structured, systematic nomenclature that was quickly adopted by the scientific community. Thus it is important to observe the dissemination process of new chemical nomenclature in each country and in each language through the translation of French chemical texts, many of which were of pedagogical nature, which also conditioned discourse typology.

The analysis of this new nomenclature is crucial, as it is firmly based on classic languages, particularly Greek, and it adopts a broad range of suffixes and prefixes for systematization. During the 19th century this system steadily consolidates as the field of chemistry develops, until a standardized international nomenclature is established.

From a lexicographical standpoint, both the manner in which chemical terms are entered in general dictionaries as well as the status of specialized dictionaries are studied. Indeed, traditional lexicography has mistakenly etymologically classified chemical terms as Hellenisms, although research carried out by scientific language historians have changed this perception and they are now recognized as Gallicisms.

Lastly, the procedures Romanic languages follow to coin chemical lexicon –both to name elements and chemicals and to express chemical combinations by means of word formation processes– are examined.

Keywords: Language for specific purposes, French, Italian, Spanish, Portuguese, Romanian, Catalan, language of chemistry, history of specialized languages.

1. Introduction

The study of the language of chemistry has not been a field of particular interest to philologists. Scientific and technical language, and in general non-literary language has been the focus of philological interest solely in order to study language in eras in which literature was not yet fully developed, or did not enjoy much prestige. Legal, notarial, religious and medical texts, as well as chronicles, etc., have been the object of study, often treated with the same methods used for literary analysis.

Although this tendency has changed in the last few decades (in some languages more than in others), research on scientific language in general, and in the language of chemistry in particular has been scarce.

Nevertheless, the interest science historians have shown for the lexicon of this discipline proves to be an advantage toward learning the development of the language of chemistry. It should be taken into account that the development of many sciences has initially been tied to the creation of taxonomies, and that chemistry in particular has used language as an instrument of conceptualization, fusing language with the development of science as in few other circumstances. On the other hand, it would seem unnecessary to invariably justify a multidisciplinary focus on a field of study such as languages for special purposes (Blecua, Gutiérrez Cuadrado & Pascual, 2003).

The language of chemistry is a product of long-standing tradition that developed throughout the centuries, on occasion specific of each language and culture, yet also fruit of an exchange and transmission of knowledge. As of a certain point in time, the scope of this expansion has been to create a universal language that would enable communication beyond historical boundaries and languages.

Romanic languages have had varying weight in this development. Of them all, French was the language that, especially as of the 18th and during the first half of the 19th century, set the tone due to the scientific progress France enjoyed and sustained throughout the Enlightment and for most of the following century, until it was surpassed by Germanic chemistry. The other Romanic languages have generally been recipients of knowledge and of the words with which this knowledge was expressed, with a few exceptions that will be mentioned further on.

This is an overview of the main aspects related to the language of chemistry affecting Romanic languages. It consists of a description of the characteristics of the language of chemistry from its origins in alchemy, moving on to the period in which chemistry was first recognized as a science, with special attention to how it was adapted and developed in each Romanic language, until the 20th century arrives, a time when the discipline is formalized and is unified with the founding of international associations. Lastly, the mechanisms employed by Romanic languages for the creation of chemical vocabulary are described.

2. Research on the language of chemistry in Romanic languages

There is a tendency to believe that the language of chemistry is highly formalized, and it is, in part. The existence of an international regulatory body of chemical nomenclature such as IUPAC sets chemistry apart from other disciplines, but this association only approves the standards for the naming of the chemical elements and their corresponding symbols, compounds, and chemical notation and formulation (Laszlo, 1993: 51). Thus understood, the language of chemistry responds to what Kocourek (1991: 11) calls *langage symbolique*: an artificial language based on a natural language and aimed at perfecting it, closely linked to writing, devoid of subjectivity and in pursuit of the elimination of synonymy and polysemy, possessing a limited and controlled repertoire of signs and used by specialists through rigorous conceptualization.

This is only one of the many aspects of the language of chemistry, however, because there are also so-called specialist languages or languages for specific purposes, as subcodes of natural language, endowed with elements from symbolic language. In this sense, in the language of chemistry different levels of communication and subsequent historical layers coexist. On the one hand, language of chemistry has penetrated in general language and is part of the vocabulary of all speakers, in part because science in general and chemistry in particular have taken up an important part of everyday life, as well as in compulsory education (Nieto-Galan, 2011). Thus due to this rise in scientific culture, practically all speakers are exposed to the language of chemistry with varying degrees of intensity. On the other hand, there are many traditional names of products and chemicals of everyday use that endure in the language of chemistry in Spanish (*amoníaco, bicarbonato, sosa caústica*).

All this yields a complex panorama in which the limits between the language's various levels of specialization are blurry, and in which philological research has approached variably in each Romanic language.

In Romanic languages the current language of chemistry has been the object of attention within the scope of specialized languages (Giovanardi, 1987; Lerat, 1995; Vivanco 2006), with some specific studies on the language of chemistry (Crosland, 1962; Laszlo, 1993; García Belmar & Bertomeu Sánchez, 1999). Its relation to word formation due to its particular system of prefixes and suffixes typical of chemical nomenclature (Giovanardi, 2004), the functioning of the language of chemistry in comparison with the structure of other specialized languages (Betsch, Rainer & Wolborska-Lauter, 2017) or due to its peculiarities for the purposes of translation (Maillot, 1997) have also aroused interest. Another important front is the presence and adaptation of chemical lexicon in dictionaries (Popescu-Marin, 1981, Granados & López Rodríguez, 1989), even from a historical point of view (Garriga, 2018).

From a discourse standpoint, pedagogy has generated a few specific studies on the language used in teaching chemistry, such as Rouquérol & Vigneron (2011); Quintanilla, Merino & Cuellar (2012), Marzabal & Izquierdo (2017), etc. It is precisely this component between teaching and translation that has spurred the proliferation of contemporary chemical dictionaries in various languages. There are those that have a more encyclopedic emphasis, but the ones that are of most interest in this context are linguistic dictionaries such as the work of Menten de Home (2013) for French, of Costa (2005) for Spanish, of Barbosa (1999) for Portuguese, of Vilalta et al. (2011) for

Galician, of Mojdik (1998) for Romanian, and Termcat's (2016) online dictionary with a terminological and standardizing focus for Catalan. Additionally, there are several dictionaries that have been translated from English or from German, not taken into consideration here, as well as numerous online resources for various languages, sometimes of rather dubious quality.

The language of chemistry's history is surely its most studied aspect, especially in specific periods. As mentioned previously, research carried out by science historians should be considered reliable, as their conception of chemistry as a discipline from a language standpoint gives them special sensitivity toward linguistic aspects. In addition, there is a considerable number of studies concerning the language of chemistry in the 18^{th} and 19^{th} centuries, fixed fundamentally on the period that begins with the publishing of *Méthode de nomenclature chimique*, and which describe the reception of chemistry and its language in the various Romanic languages.

Spanish stands out in this sense, as the study of the history of the language of chemistry from a philological perspective has greatly developed thanks to the initiative of Juan Gutiérrez Cuadrado. In an early study (Gutiérrez Cuadrado, 2001), this scholar set up a research program based on chemistry as a model for the study of the history of specialized languages. The reasons behind choosing chemistry as a starting point were: a) the clear leadoff that marked the Chemical Revolution as of the late 18^{th} century with the transformation of alchemy into a scientific discipline; b) the institutionalization process similar to that of other sciences it underwent in the 18^{th} and 19^{th} centuries; c) the prominent place controversies and linguistic discussions had in the inception of chemistry; d) the use of language to articulate this field of knowledge; e) the transnational nature of its terminology, combined with the preservation of quite a few traditional names. Thus the language of chemistry has been the preferred object of attention, making Spanish the Romanic – and possibly non-Romanic – language which boasts the most studies on the history of this discipline's language.

3. The characteristics of the language of chemistry

3.1. The language of alchemy

The language of chemistry cannot be broached without first referring to alchemy. The word itself, *alchemy*, present in all Romanic languages (*alchimie* in French, *alquimia* in Spanish and Portuguese, *alchimia* in Italian, *alchimie* in Romanian, and *alquímia* in Catalan) has an Arabic etymology, as proven by the presence of the article *al-* joined to a root of probable Greek origin χυμεία 'liquid mixture', although it could also be linked to Coptic *chame* 'black', a name applied to Egyptians and to the arts attributed to them (Corominas & Pascual 1980-1991, s.v. *alquimia*). The word was already present in medieval Latin, and it was documented in the 13th century in Romanic languages more or less in the same period: in 1250 in Spanish, in 1275 in French, in 1295 in Catalan, etc. (TLF, s.v. *alchimie*).

As researched by García Belmar and Bertomeu Sánchez (1999: 33), the language of alchemy is difficult to interpret for various reasons: alchemists strove to keep their knowledge hidden because their practices were linked to magic and the supernatural. Their knowledge was primarily transmitted orally from masters to disciples and when there were texts, they were fraught with errors. Many of the names used in alchemy experienced important changes in meaning; furthermore, the language of alchemy was full of allegories for each alchemist to interpret as they saw fit (Laszlo, 1993: 19). The analogies alchemy established with respect to other disciplines have been studied by Crosland (1962: 3 and ss.), who points at astronomy, mythology, religion or the human body as the main sources of the creation of alchemical vocabulary. Words such as *mercury, body,* and *spirit* are examples of this, although some of these procedures were also used for chemistry to coin new terms as of the 18th century.

The language of alchemy was formed with words from various origins. Greek and Latin were the basis of this vocabulary because knowledge came partially from classic cultures, as well as the words used to name the substances under study (*atom, copper, gold, iron*). Arabic was also fundamental due to the political and scientific importance of Arab culture during the Middle Ages and because Arabic texts served as transmitters of alchemy following the conquest of Alexandria, with authors such as Jabir ibn Hayyan (8th century), Avicena (ss. VIII-IX) or Al-Razi (825-925). Arabian alchemy penetrated Europe through the Cordoba Caliphate, the Toledo School of Translators, the island of Sicily –which was under Arab rule–, and the Crusades (Esteva de Sagrera, 1991: 32), leaving behind words such as *alcohol, alkali, alembic, alchemy, elixir*, etc., present in practically all Western languages. Hebrew or vernacular languages that were gaining importance are also present in the language of alchemy: López Piñero (2007: 291), for example, describes how alchemical manuscripts attributed to Ramon Llull or to Arnau de Vilanova mixed Latin and Catalan in their writings, and how some of them circulated in versions translated into other Romanic languages, such as French or Occitan (Calvet, 2012). Indeed, alchemical vocabulary in Europe must have indiscriminately used words from all the aforementioned languages (Crosland, 1962: 24), but the fact that the language of scientific communication had been Latin up until the 18th century ensured a relatively homogeneous transmission of the lexicon. As Esteva de Sagrera (1991: 32) notes, it is thought Gerard of Cremona (1114-1187), linked to the Toledo School of Translators, was the first translator of Arabic alchemy manuscripts into Medieval Latin.

French	Italian	Spanish	Portuguese	Romanian	Catalan
alambic	*alambicco*	*alambique*	*alambique*	*alambíc*	*alambí*
alcali	*alcali*	*álcali*	*álcali*	*alcáliu*	*àlcali*
alcool	*alcool*	*alcohol*	*álcool*	*alcoól*	*alcohol*
borax	*borace*	*bórax*	*bórax*	*bórax*	*bòrax*
élixir	*elisir*	*elixir*	*elixir*	*elixir*	*elixir*
mortier	mortaio	*almirez*	pilão	mojár	morter
plomb blanc (étain)	piombo bianco (stagno)	*albayalde* (estaño)	chumbo branco (estanho)	plumb alb (stániu)	blanc de plom (estany)
soufre	*zolfo*	*azufre*	*enxofre*	*sulf*	*sofre*
vif-argent (mercure)	argento vivo (mercurio)	*azogue* (mercurio)	*azougue* (mercúrio)	argint viu (mercúr)	argent viu (mercuri)

Table 1: Arab alchemy words (in italic) present in Romanic languages

On the other hand, procedures to generate alchemical vocabulary had been diverse. It was common practice to take into account physical properties when naming certain substances: their odor, flavor, color, texture, etc. Reference could also be made to obtainment methods, their curative properties, their applications, provenance, etc. Their composition, however, was not taken into consideration because it was believed that all bodies were composed of the four elements enunciated by Aristoteles: *water, earth, aie* and *fire*. Díez de Revenga (2012) studied how the names of gemstones had remained stable in Spanish during the Middle Ages, while their color, composition or purity varied due to the often metaphorical purposes attributed to them by authors. This naming method caused interpretation problems because often the same term was used to name more than one substance, or there was disagreement in the perception of a substance’s characteristics, or regarding its medicinal properties. In addition to this, there is the perception that in alchemy cases of falsification and scams were frequent, and that its language was cryptic, partly due to the use of symbols (Principe, 2013). As Bensaude-Vincent (1994: 13) asserts, as soon as the study of chemistry was included in universities and the educated public began to attend public demonstrations, alchemists' impenetrability became untenable.

3.2. The language of artisans: pharmacists, metallurgists, dyers, winemakers…

Alchemy's relation to medicine has been documented since ancient times. It is evident that in Early Medieval Catalan medical recipe books, which contained frequent alchemical recipes, the use of vernacular language is common (Cifuentes, 2016). Alchemy turned into chemistry thanks to its applications, which embodied empirical knowledge. Pharmacy is important in this process, as the application of alchemy in the preparation of new therapeutic products by Paracelsus and his followers contributed to experimental culture, which is fundamental to the scientific revolution of the 16th and 17th centuries (Debus, 1987).

Similarly, metallurgy, which was strongly developing in the new territories in the Americas, essayed systematically with metal purification processes, coining new names both for minerals, many of which already had a long-standing tradition (Puche 2008), and for the processes themselves. The mention of the treatise *De re metallica*, written by Bernardo Pérez de Vargas (1568), is essential in that it includes words from Latin, Greek, Arabic, etc., but above all words referring to devices, processes, materials, and techniques created with elements characteristic to Spanish (Cantillo, 2010; Puche, 2016).

Indeed, *De re metallica*, based on the homonymous work of Georgius Agricola (1556), which should not be considered a translation but rather an original text, is proof of how vernacular languages began to break into manual and treatise publications, thus stimulating the lexical renovation of these languages.

In the case of mining, for example, there are early publications in Spanish, such as the *Diccionario y maneras de hablar que se usan en las minas*, by García de Llanos (1609) or Alonso Barba's (1640) *Arte de los metales* (Alonso, 2002; Puche, 2016). In chemistry, Nicolas Lémery's (1675) *Cours de Chymie*, is worthy of note. Originally written in French, it was translated into Latin, German, Italian, Spanish and English (Wisniak, 2005: 125); Claudio Francesco Iobelot (1695) translated it into Italian and Félix Palacios y Bayá (1703) into Spanish. Lémery's *Cours* enjoyed great popularity and was an authentic publishing success (Bertomeu Sánchez & García Belmar, 2006: 19).

Dyeing and alcoholic distillation are other activities strongly linked to the initial development of chemistry (Nieto-Galan, 2001) and are evidence of an artisanal tradition with its own patrimonial vocabulary in each language that often clashed with the acceptance of new practices that chemistry contributed with as well as with the words it employed, as found by Bajo Santiago (2003) for Spanish. This dialog between age-old artisanal traditions and science intensified as of the 18th century, just as chemistry started to formalize a new nomenclature far from the language used in traditional crafts.

3.3. The language of chemical science

The words *alchemy* and *chemistry* were used indistinctly until the late 17th century, when *alchemy* was reserved for arts related to the obtainment of gold via the transmutation of other substances, and *chemistry* (*chimie* in French and Romanian, *química* in Spanish, Portuguese and Catalan, *chimica* in Italian) for all other purposes.

Toward the mid-17th century scientists such as German chemist Georg Stahl (1659-1734) began to develop an explanatory theory for phenomena such as combustion, respiration or calcination of metals. They proposed the existence of a fire-like principle, called *phlogiston*, as the origin of the combustion of certain substances. Various methods to collect gases were developed. Indeed, the word *gas*, although defined vaguely, had been coined a few years previously by Belgian physician Jean-Baptiste van Helmont (1577-1644), perhaps from the German *gascht* (Cartwright, 2000: 20) or the Greek *χάος* (Gutiérrez Rodilla 1998: 113). Yet it was only in the 18th century when the existence of various types of gases was proven, and terms such as *fixed air* or *phlogisticated air* and *dephlogisticated air* were coined. The phlogiston theory is Germanic in origin, despite its rapid spread first to England and then to France thanks to chemistry articles from Diderot and d'Alembert's *Encyclopédie Méthodique* (Bensaude-Vincent, 1994: 19) and later through authors such as Rouelle or Macquer, and thence to the other Romanic languages. All these words became international and were adapted to the various Romanic languages, although only *gas*, whose evolution in Spanish was studied by Gutiérrez Cuadrado (2002), has survived in modern languages.

Chemistry was then undergoing a renewal process that would lead to an overhaul of its language, in part as a reflection of Linnaeus's botanical nomenclature revision, in part due to the rationalist idea of a universal language, in part due to the need to set order to nomenclature that had been accumulating previous terms at different stages and traditions. There were various attempts at establishing nomenclature for chemistry, as studied by Beretta (1993), but *Méthode de nomenclature chimique*, written by Louis-Bernard Guyton de Morveau, Antoine Laurent Lavoisier, Claude-Louis Berthollet and Antoine-François Fourcroy (1787) –considered the starting point of the so-called Chemical Revolution– stands out from a chemical language standpoint.

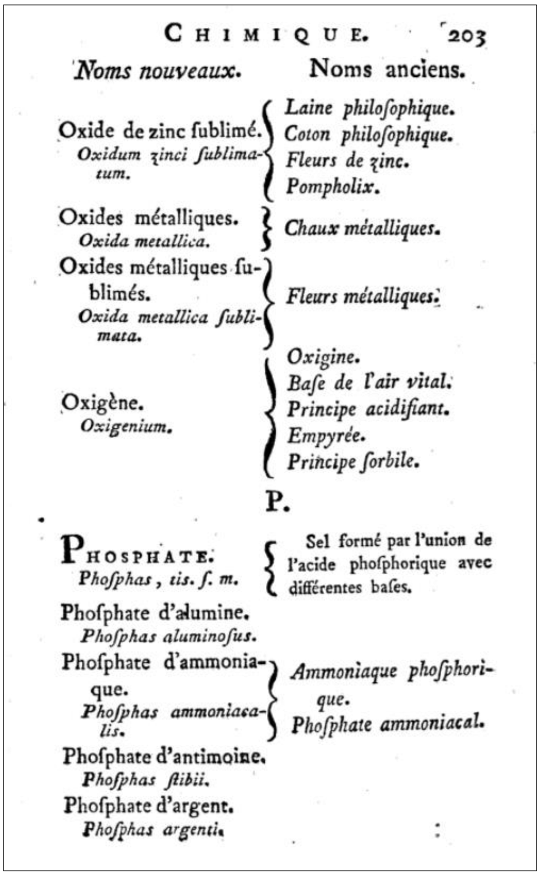
Scientifically, the Chemical Revolution meant abandoning the phlogiston theory and substituting it with a new combustion theory involving a new concept: *oxygen*. Science historians nevertheless question this rupture vision because Stahl's ideas stimulated the search for global explanations for a series of chemical phenomena (Bensaude-Vincent, 1995; García Belmar & Bertomeu Sánchez, 2006), and from a linguistic perspective numerous enduring neologisms were coined. In addition, this initial period set France in the limelight, and French became the language of chemistry.

The new nomenclature established a list of simple indecomposable substances that had to be designated with a single name, and a set of rules to create the names of compounds through the addition of certain suffixes. The difference between simple and compound substances enabled the establishment of different names for both types of substances. Most of the names of the elements remained unaltered (*sulphur*, *phosphorus*, *carbon*, *antimony*), but there were a few new elements that turned into the symbols of the new chemistry, such as *oxygen*, *hydrogen* and *nitrogen*.

The term *oxygen* referred to the same element Priestley had discovered in 1774 and called *dephlogisticated air*; it had already received other names such as *pure air* and *vital air*. Through various experiments, Lavoisier reached the conclusion that this chemical element was part of the composition of all the acids, so he decided to compose its name "du grec οξυς *acide* & γείνομαι *j'engendre*" (Morveau, Lavoisier, Berthollet & Fourcroy, 1787: 32). But Lavoisier's conclusion proved inaccurate when it was demonstrated that there were acids which excluded oxygen and that this element could combine with other, non-acidic substances. This led some chemists, such as Italians Vincenzo Dandolo and Louis Valentino Brugnatelli, Pierre François Chavaneau in France or Juan Manuel de Aréjula and Trino Antronio Porcel in Spain to propose more appropriate names according to the properties of this element (Gago, 1982: II; Garriga, 2003), but the rapid spread and acceptance of the new nomenclature prevented the modification of the term *oxygen* (Halleux, 1989). Following this same method, nomenclature authors proposed the term *hydrogen*, derived from ὕδωρ 'water', and γείνομαι 'generate'.

French chemists' proposal for *phlogisticated air*, also called *(atmospheric) skunk* due to its unbreathable and therefore life-inhibiting quality, would not be as fortunate. This property led them to propose the term *azote*, "de l'α privatif des grecs & de ζωή *vie*" (Morveau, Lavoisier, Berthollet & Fourcroy, 1787: 36). The French term *azote*, although criticized by contemporaries because it was a word that already existed in alchemy with another meaning (Crosland, 1962: 187), was initially accepted by the scientific community, but was replaced a few years later with *nitrogen* –Fourcroy had proposed *alcaligène* (Bensaude-Vincent, 1994: 59)–, consolidating a very productive word formation paradigm in chemistry ending with -*gen*, as Garriga (2016) researched for Spanish.

The "Dictionnaire pour la nouvelle nomenclature chimique" (Morveau, Lavoisier, Berthollet & Fourcroy, 1787: 144-237) collected the equivalents among the new names being proposed for traditional elements and substances, but it also included their Latin translation because the idea of French chemists was, as Morveau (1787: 27) explained, that the new names should adapt to other languages from Latin, not from French, thus contributing to the uniformity of the language, which they deemed essential for scientific progress.



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Noms nouveaux.	Noms anciens.
Oxide de zinc ſublimé. *Oxidum zinci ſublimatum.*	*Laine philoſophique. Coton philoſophique. Fleurs de zinc. Pompholix.*
Oxides métalliques. *Oxida metallica.*	*Chaux métalliques.*
Oxides métalliques ſublimés. *Oxida metallica ſublimata.*	*Fleurs métalliques.*
Oxigène. *Oxigenium.*	*Oxigine. Baſe de l'air vital. Principe acidifiant. Empyrée. Principe ſorbile.*

P.

PHOSPHATE. *Phoſphas, tis. ſ. m.*	Sel formé par l'union de l'acide phoſphorique avec différentes baſes.
Phoſphate d'alumine. *Phoſphas aluminoſus.*	
Phoſphate d'ammoniaque. *Phoſphas ammoniacalis.*	*Ammoniaque phoſphorique. Phoſphate ammoniacal.*
Phoſphate d'antimoine. *Phoſphas ſtibii.*	
Phoſphate d'argent. *Phoſphas argenti.*	

Image 1: a page from the "Dictionnaire pour la nouvelle nomenclature chimique" (Morveau, Lavoisier, Berthollet & Fourcroy, 1787).

https://books.google.es/books/content?id=13dUAAAAYAAJ&hl=es&pg=PA203&img=1&zoom=3&sig=ACfU3U1i5Vk3l9cvTTAbuHgcWy-Gz_l9ng&ci=21%2C160%2C819%2C1374&edge=0

To be sure, the new chemical nomenclature was adopted quickly in other countries and was adapted to various languages from French (Crosland, 1962: 207-214; Bensaude-Vincent & Abbri, 1995). In some of the other Romanic languages, adoption was particularly prompt.

In Spain the scientific isolation the country found itself in was surmounted, especially during the reign of Charles III, when new scientific institutions were founded and foreign chemists — French, on the most part (Proust, Chavaneau) — were hired to run laboratories, while Spanish chemists were given grants to train in the most advanced European centers (García Belmar & Bertomeu Sánchez, 2001). In the late 18th century, the most important chemistry texts were translated into Spanish (Garriga, 1996). The result was rapid reception of the new language: in 1788, only a year after its publication in French, Pedro Gutiérrez Bueno translated the new chemical nomenclature in Spanish. In the ensuing years there is well-founded criticism of the word *oxygen* (Gago & Carrillo, 1979) and new versions of nomenclature with a few changes are published, with the adoption of -*o* suffixes for chemical elements (Garriga, 1997):

French	Italian	Spanish	Portuguese	Romanian	Catalan
azote	azoto	ázoe	azoto	azót	azot
hydrogène	idrogeno	hidrógeno	hidrogénio	hidrogén	hidrogen
manganèse	manganese	manganeso	manganês	manganéz	manganès
molybdène	molibdeno	molibdeno	molibdénio	molibdén	molibdè
oxyde	ossido	óxido	óxido	oxíd	òxid
oxygène	ossigeno	oxígeno	oxigénio	oxigén	oxigen
platine	platino	platino	platina	platină	platí
tungstène	tungsteno	tunsteno	tungsténio	tungstén	tungstè

Table 2: Terms coined in Romanic languages during the Chemical Revolution

In those years activity revolving around chemistry in Spain was especially dynamic, as shown by the discovery and subsequent naming of *platino* [platinum] and *wolframio* [wolfram], or the correction made by Martí i Franquès (1750-1832) on the proportion of oxygen in the air determined by Lavoisier (Nieto-Galan, 1995; Nieto-Galan, 1996). The new chemistry's lexical novelties also arrived early to American Spanish. The first translation into Spanish of Lavoisier's *Traité élémentaire de chimie [Elements of Chemistry]* was published in 1797 in New Spain by Vicente Cervantes (1755-1829), a professor at the Mexico City Royal Botanical Garden, for use at the Real Seminario de Minería (Aceves Pastrana, 1990), a year before Juan Manuel Munárriz (1761-1831) published his own translation at the Madrid Royal Print House.

In Italy, correspondence between Lavoisier and chemists such as Volta, Spallanzani, Landriani, Dandolo and Lorgna shows active collaboration in establishing the new theory. In the Kingdom of Naples in 1786 Matteo Tondi (1762-1835) published the first Lavoisierian chemistry manual (Seligardi, 2013). The first translation of its nomenclature came to light in Venice in 1790 thanks to pharmacist Pietro Calloud, although the translation was not very accurate and it barely had an impact on the promulgation of the new vocabulary in Italy (Beretta, 1995: 227). The following year Vincenzo Dandolo (1758-1819) published a new and much improved translation of the nomenclature (together with another translation of Lavoisier's *Traité élémentaire de chimie [Elements of Chemistry]*) that became a great success. Dandolo's contribution from a linguistic standpoint is appreciable because it questioned Lavoisier's and Condillac's idea that language is an analytic method, and that words should correspond to the meaning of the concepts they represent (*oxygen* = *acid generator*). The Italian scholar "distinguished between *intuitive* knowledge based on ideas and sensations and *symbolic* knowledge based on the signs used to express the ideas" (Beretta, 1995: 230). In any case, Italian closely followed French nomenclature, adopting terms such as *ossigeno*, *idrogeno* and *azoto*, although in the first texts in which they appeared there was some hesitation (*ossigeno / ossìgene / ossigenio / ossigene; idrogeno / idrògene / idrogenio / idrogene*) (Abbri, 1995; Guerra, 2018).

As for Portugal, the university reform in 1772 backed by the Marquis of Pombal following the expulsion of the Jesuits in 1759 meant deep changes in scientific study programs. An important and well-equipped laboratory was set up in the University of Coimbra, run by Italian naturalist Domenico Vandelli (1730-1846) (Amorim da Costa, 1995: 157). In 1783 Manoel Henriques de Paiva published *Elementos de Chimica e Farmácia*, the first manual written in Portuguese. One of the first students at the University of Coimbra following the Reform was Vicente Seabra Telles, who published several chemistry manuals within the scope of the new theories, among which

Elementos de Chimica (1788-1790), a text in which the chemistry of oxygen was defended. A few years later, faced with the need to establish new chemical nomenclature, Seabra Telles (1801) published *Nomenclatura Chimica Portugueza, Franceza, e Latina*, a 121-page volume in which chemical nomenclature in Portuguese with old terms along with their new equivalents were synoptically presented. In order to adapt new chemistry terms to Portuguese, Seabra Telles showed a preference for a closer resemblance to Latin than to French, as Gutiérrez Bueno had done in the translation of *Nueva nomenclatura* in Spanish published twelve years previously, a text that Seabra Telles probably used as a reference point (Luna, 2013). Thus the forms *oxigenio* and *hydrogenio* were coined and the new technical value of suffixes such as -*ico*, -*oso*, -*ato*, etc., with endings in -*o*, (Rio-Torto, 2017: 168) were set down just as in Spanish. The ideas of the new chemistry also quickly reached Brazil, and several essays in Portuguese were published on atmospheric air (Marques & Filgueiras, 2010).

As for Romania, there are late 17th century records around the figure of Dimitrie Cantemir, prince of Moldavia, a scholar with encyclopedic interests who learned of the ideas of van Helmont from his book *Physices universalis doctrina et cristianae* (Roşca & Luca, 2009: 3), and created a bridge between alchemy and chemistry (Cepăreanu, 2011: 212), but the growth of chemistry as a science in Romania is linked to the appearance of institutions of higher education, toward 1835.

The ideas of the new chemistry also arrived early in Catalan-speaking territories, and some of the main scientists who contributed to the rapid spread of new chemistry knowledge in Spain were Catalan, but the texts they wrote were in Spanish because in the 18th century the Catalan language was culturally absent from scientific spheres and was only used in a few minor publications aimed at peasants or artisans (Nieto-Galan, 2000: 44). Among the Catalans who wrote in Spanish were Melcior de Guàrdia i

Ardèvol, translator of de Morveau, Maret, and Durande's *Élémens de Chymie théorique et pratique* (1788) (Garriga, 1998); Francesc Carbonell i Bravo, dean of the School of Chemistry under the Barcelona Trade Board (Nieto-Galan, 1996), author of the first scientific winemaking manual in Spanish (Bajo Santiago, 2001) and translator of *Corso analittico di chimica* (1818) written in Italian by Giuseppe Mojon (Gutiérrez Cuadrado, 1998); Josep Garriga i Buach, coauthor of *Curso de química general aplicada a las artes* (1804-1805) (Garriga, 2004); and in particular Antoni de Martí i Franquès, who corrected Lavoisier himself by obtaining more accurate results regarding the composition of atmospheric air (Nieto-Galán, 2006: 658). It is in his memoir *Sobre algunas producciones que resultan de la combination de varias sustancias aeriformes* (1787) where the term *oxígeno* [*oxygen*] is documented for the first time in Spanish (Garriga, 2003: 105).

3.4. The 19th century

The ideas introduced by Lavoisier and his collaborators led to the development of chemical analysis, which in turn brought about the discovery of a great number of elements in the first decades of the 19th century. Methods to name the new substances were developed and various systems consisting of signs and symbols to represent them –some of alchemical origin – were proposed, which contributed nothing to the modern idea of offering the maximum and most accurate information in reduced space, as the chemical formula would later pursue.

Swedish chemist Jean Jacobs Berzelius' proposal of abbreviating the elements according to the initials of their Latin names, on the other hand, was very successful: Fe = iron, Ph = phosporus, K = potassium, Ag = silver, Au = gold, s = sulphur, etc. In general terms, inorganic chemistry remains within the guidelines established by the authors of *Méthode de nomenclature chimique.*

Organic chemistry develops quickly in the early years of the 19th century, and the chemicals that need to be named multiply. Initially there was an attempt to apply the binomial method that used the roots of the elements to form expressions, but it soon proved unfeasible. The solution was to use certain suffixes to create a systematic naming method based on knowledge of the substances' chemical properties (Crosland, 1962: 299). In a few years various word endings for different types of components were established, such as *-ina* for alkaloids, *-ona* for acetones, *-ol* for alcohols and phenols, which were adapted to each language's phonic and orthographic characteristics. Even if these aspects have been studied little, there are works regarding Spanish on the *-ina* (*cafeína, morfina, nicotina*) suffix (Garriga, 2001), on the *-ona* suffix (*acetona, hidroquinona, cortisona*) (Garriga, 2002), or on the *-ato* and *-uro* suffixes to form salts (Muñoz Armijo, 2014), although some of these suffixes transcend the scope of the chemical lexicon (Muñoz Armijo, 2016). Giovanardi (2004: 580) for Italian and Toma (2009: 47) for Romanian also stress the importance of word formation in the creation of chemical vocabulary.

The need to standardize the language of chemistry and avoid synonymy becomes ever pressing as the 19th century advances and chemistry is consolidated as a science (Sala, 2001). Germany gains more and more weight in European chemistry and Romanic languages magnify their role as recipients of lexical loans. In the case of Spanish and Portuguese, the language was a barrier, with French acting as a bridge during this stage, and thus German manuals were frequently translated into Spanish or Portuguese through the French translation (Gutiérrez Cuadrado, 1998; Messner, 2001; Messner, 2004). Examples of this are Berzelius's *Traité de chimie* (1845) and Liebig's *Traité de chimie organique*, both translated into Spanish by Sáez Palacios and Ferrari Scardini from the French version (Garriga, 2001).

Important in the standardization of the chemical nomenclature was the 1860 Karlsruhe Congress (Crosland, 1962: 342), whose objectives were to set the meaning of the terms a*tom* and *molecule*, discuss chemical nomenclature and reach an agreement on the value of atomic weights. The process continued in the 1892 Geneva Congress, when the standardization of chemical terminology was boosted, and culminated with the creation of the International Union of Pure and Applied Chemistry (IUPAC) in 1919, of which France, Italy, Spain, Portugal and Romania are members (Fennell, 1994).

Romanian and Catalan deserve special mention. Romanian's institutionalization as a language is complex and late in arriving, as was the practice of chemistry as a science; chemistry was included as an academic course in Romania in 1835, at the "Mihaileanu Academia", a precursor of the University of Iasi, and the first laboratories date back no earlier than 1840, located in Iasi and in Bucharest (Roşca & Luca, 2009: 3). Only until the second half of the 19th century did the first chemistry texts in Romanian begin to appear with the publication of Petru Poni's (1841-1925) chemistry manuals. Poni studied at Paris University's School of Sciences with Marcelin Berthelot (1827-1907), Sainte-Claire Deville (1818-1881) and Charles A. Wurtz (1817-1884). In 1869 his *Curs de Chimie elementară* was published in 1869 and *Elemente de fisică pentru uzul claselor inferioare de licee* in 1874 (Siminiceanu, 2009: 12).

As for Catalan, it is a language that for long stretches of time had very restricted use for certain purposes, including scientific communication. It is significant to note that, although there were important chemists who contributed to the circulation of ideas concerning the new chemistry in Spanish, it was not until 1919 that the first Lavoisier text was translated into Catalan: the first part of Lavoisier's *Traité élémentaire de chimie [Elements of Chemistry]* (Nieto-Galan, 2000: 46). After the Civil War, the use of the Catalan language was once again restricted in public spheres. An enormous effort had to be made to reinstate the language after the dictatorship so that Catalan could recover its status as a scientific language. Essentially, as concerns the language of chemistry, the importance of the *Gran Enciclopèdia Catalana* (1968-1980), whose chemical entries were written under the supervision of Enric Casassas (1920-2000) and Heribert Barrera (1917-2011), and the role of the *Societat catalana de química* of the *Institut d'Estudis Catalans* contributed in giving the Catalan language an up-to-date chemical vocabulary and made its use possible in education once the political situation allowed it.

Currently, therefore, the language of chemistry is extremely accurate with respect to the specialized treatment of terminology, and presents a high degree of homogeneity in all languages. But the multiplicity of contexts in which the language of chemistry is used (for research, in classrooms and laboratories, through the media, in ordinary non-specialist communication) also conditions the level of specialization of the language used in response to its speakers' communication needs; thus both specialized and traditional terms coexist in the current language of chemistry.

4. The lexicon of chemistry

As a consequence of its long history, the names of chemicals have been created following different methods of term formation. For a long time physical properties such as color, flavor, odor, texture or shape were the only features that enabled characterizing chemicals: *green vitriol*, *Prussian blue*, *methyl red*, etc. Some loan words from classical languages or modern languages also allude to color: *cesium* (from Latin *caesius* 'sky blue'), *chlorine* (from Greek χλωρός 'green'), *bismuth* (from German *weiße Masse*, 'white mass'). Flavor is what originally determined the name of *salts* as well as of substances such as *glycerin* or *glucose* (from Greek γλυκύς 'sweet'). With chemistry's consolidation as a science, chemicals began to be named according to their chemical behavior: *oxygen* (from Greek ὀξύς 'acid' and -γενής 'producer of'), *hydrogen* (from Greek ὑδρο- ‘water’), *pyroacid* (from Greek πυρο ‘fire’), etc.

Mining and metallurgic tradition was also a source of inspiration for vocabulary; a great number of names for chemical elements come from minerals and their names derive from them. The names of most metals derive from minerals, such as *aluminum, sulphur, cobalt, tin, iron, zinc*, etc., as well as noble metals such as *gold, silver* and *platinum.*

Another important set of names are eponymous; in other words, they derive from proper nouns including personal names (*curium, mendelevium, nobelium*), places (*francium, germanium, polonium*), planets (*mercury, plutonium, uranium*), mythology (*morphine, palladium, thorium*), etc.

Chemical elements have been assigned internationally accepted symbols used in chemical formulation; they are sometimes unrelated to current names because they refer to their Latin or Greek names: *Na* ‘sodium’, *Sb* ‘antimony’, *Pb* ‘lead’, *Sn* ‘tin, *Fe* ‘iron’, *Ag* ‘silver’, *Au* ‘gold’, *K* ‘potassium’, etc.

Symbol	French	Italian	Spanish	Portuguese	Romanian	Catalan
Ag	argent	argento	plata	prata	argínt	argent
Au	or	oro	oro	ouro	áur	or
Fe	fer	ferro	hierro	ferro	fier	ferro
K	potassium	potassio	potasio	potássio	potásiu	potassi
Na	sodium	sodio	sodio	sódio	sódiu	sodi
Pb	plomb	piombo	plomo	chumbo	plumb	plom
Sb	antimoine	antimonio	antimonio	antimónio	antimóniu	antimoni
Sn	étain	stagno	estaño	estanho	stániu	estany

Table 3: Examples of chemical element names whose symbols do not always coincide with their initials in Romanic languages

Lastly, some names originate from acronyms and abbreviations, such as *CFC* ‘chlorofluorocarbon’, *PFC* ‘perfluorocarbon’, *PVC* ‘polyvinyl chloride’. In some cases acronyms are formed from their English names, and in these cases the adaptation does not correspond with the order of the initials in Romanic languages, as may be observed from the following examples in Italian: *COD (Chemical Oxygen Demand),* is ‘domanda chimica di ossigeno’ and *IUPAC, (International Union of Pure and Applied Chemistry)* is ‘Unione internazionale di chimica pura e applicata’.

On the other hand, based on the chemical nomenclature suggested by Lavoisier and his colleagues, a set of standardized prefixes and suffixes whose endings may vary in each language but which have been accepted by the scientific community have been established. Some examples of suffixes in Spanish are: -*ato* to name polyatomic anions (*nitrato, sulfato*); -*ico* for acids, -*ilo* for radicals, -*ina* for hydrogen compounds, -*ona* for acetones, -*ol* for alcohols, -*uro* for monatomic anions (*cloruro, fluoruro*), etc. However, this does not imply that the current language of chemistry is wholly rationalized by an unambiguous system of prefixes and suffixes (Sager, 1990: 97, Giovanardi, 2004: 581). Standards have changed even in this affixation system: *hipo*- and *per*- prefixes combined with -*ico* and *–oso* suffixes, which belonged to traditional nomenclature that enabled combinations such as *hipocloroso, cloroso, clórico* and *hiperclórico,* have become obsolete in the scientific community, although some dictionaries continue to include them with their chemical value (Pharies, 2002: s.v. -*oso*).

As any other specialized language, the language of chemistry makes use of word formation rules using composition and derivation mechanisms typical of Romanic languages, albeit with a tendency toward greater use of certain procedures such as nominalization, prefixation with a quantifying meaning (see the example of *bi*- in Rainer, 1993: 314, and Gutiérrez Rodilla’s inventory, 2005: 52), composition with neoclassic elements (Cottez, 1980) or syntagmatic composition (Kocourek, 1991: 105; Lerat, 1995: 49).

As can be observed, names and name combinations in chemistry respond to different periods of this discipline, with varying sources that have produced polysemous and synonymic phenomena considered undesirable in scientific communication. To mitigate these difficulties, the scientific community relies on IUPAC for the standardization of chemical lexicon.

Further reading

As mentioned in the beginning, the language of chemistry in Romanic languages is a field that still requires attention in aspects not yet studied under a linguistic standpoint. There is no introductory manual on the subject, nor are there studies that compare it between Romanic languages, for instance. Nevertheless, despite having been written from the perspective of the history of science, Crosland's classic work (1962) with a panoramic view of the language of chemistry from its origins, as well as the research of García Belmar and Bertomeu Sánchez (2001), which has the added value of not restricting itself only on Spanish, are recommended reading. Laszlo's manual (1993) also focuses on the history of the language of chemistry, but it centers on the performance of the language of chemistry in modern times. For a full picture of the moment in which new chemical nomenclature was being coined and its reception in Romanic languages, the work of Bensaude-Vincent (1994) for French, Giovanardi (1987) for Italian, Garriga (2003) for Spanish, Rio-Torto (2017) for Portuguese and Nieto-Galan (2000) for Catalan may be useful.

References

Abbri, F. (1995). Chimica e artiglieri: Lavoisier e la cultura scientifica napoletana. In P. Amat di San Filippo (Ed.), *Atti del VI Convegno di Storia e Fondamenti della chimica*, (pp. 245-258). Roma: Accademia Nazionale delle Scienze.

Academia Română (2010). *Dicţionarul limbii române*. Bucureşti: Editura Academiei Române.

Academia das Ciências de Lisboa (2001). *Dicionário da Língua Portuguesa Contemporânea*. Lisboa: Academia das Ciências de Lisboa.

Aceves Pastrana, P. (1990). La difusión de la química moderna en el Real Jardín Botánico de México y en el Real Seminario de Minería. *Quipu* 7(1), 5-35.
Alonso, A. (2002). El *Diccionario y maneras de hablar que se usan en las minas* de García de Llanos: el comienzo de la terminología minera en castellano. In M. Campos Souto & J. I. Pérez Pascual (Eds.), *De historia de la lexicografía*, (pp. 23-36). Noya: Toxosoutos.
Bajo Santiago, F. (2001). El Arte de hacer y conservar el vino de Francisco Carbonell y Bravo: primer manual de enología científica española. In J. Brumme (Ed.), *La historia de los lenguajes iberrománicos de especialidad*, (pp. 131-144). Barcelona - Frankfurt am Main – Madrid: IULA (UPF) - Vervuert - Iberoamericana.
Bajo Santiago, F. (2003). *La terminología enológica en el español en el siglo XIX*. Tarragona: Universitat Rovira i Virgili.
Barbosa, A. L. (1999). *Dicionário de química*. Goiâna: AB- Editora.
Bensaude-Vincent, B. (1994). Une charte fondatrice. In G. Morveau, A. L. Lavoisier, C. L. Berthollet & A. F. Fourcroy, *Méthode de nomenclature chimique*, (pp. 9-60). Paris: Du Seuil.
Bensaude-Vincent, B. (1995). Sur la notion de révolution scientifique: une contribution méconnue de Lavoisier. In Ch. Demeulenaere-Douyère (Ed.), *Il y a 200 ans Lavoisier*, (pp. 275-283). Paris: Technique et documentation.
Bensaude-Vincent, B. & Abbri, F. (Eds.) (1995). *Lavoisier in European Context. Negotiating a New Language for Chemistry*. USA: Science History Publications.
Beretta, M. (1993). *The Enlightenment of Matter. The definition of Chemistry from Agricola to Lavoisier*. Canton, Mass.: Science History Publications.
Beretta, M. (1995): Italian Translations of the *Méthode de Nomenclature Chimique* and the *Traité Élémentaire de Chimie*. In B. Bensaude-Vincent & F. Abbri (Eds.), *Lavoisier in European Context. Negotiating a New Language for Chemistry*, (pp. 225-247). Canton, Mass.: Science History Publications.
Bertomeu Sánchez, J. R. & García Belmar, A. (2006). *La revolución química. Entre la historia y la memoria*. Valencia: Publicaciones de la Universidad de Valencia.
Betsch, M., Rainer, F. & Wolborska-Lauter, J. (2017). The structure of economic and business terms. In G. Mautner & F. Rainer (Ed.), *Handbook of business communication: linguistic approaches*, (pp. 407-432). Boston/Berlin: de Gruyter.
Blecua, J. M., Gutiérrez Cuadrado, J. & Pascual, J. A. (2003). La historia de los textos científicos en la mirada del filólogo y del científico. *Asclepio*, LV/2, 3-5.
Calvet, A. (2012). Les traductions françaises et occitanes de l'œuvre alchimique du pseudo-Arnaud de Villeneuve (XIVe siècle - XVe siècle). In A. Alberni, L. Badia, Ll. Cifuentes, A. Fidora (Ed.). *El saber i les llengües vernacles a l'època de Llull i Eiximenis*, (pp. 50-70). Barcelona: Pub. de l'Abadia de Montserrat.
Cantillo, Mª T. (2006). Los americanismos en el *Diccionario y maneras de hablar que se usan en las minas* (1609), de García de Llanos. In M. Campos Souto, F. Córdoba Rodríguez & J. I. Pérez Pascual, *América y el diccionario*, (pp. 21-30). La Coruña: Servicio de Publicaciones.
Cantillo, Mª T. (2008). Terminología minera de origen americano en el *Arte de los metales* (1640), de Álvaro Alonso Barba. *Actas de II Congreso Internacional de Lexicografía Hispánica*, (pp. 628-632). Alicante: Universidad de Alicante - Fundación Biblioteca Virtual Miguel de Cervantes.
Cantillo, Mª T. (2010). Procedimientos morfológicos de formación de tecnicismos en *De Re Metallica* (1568), de Bernardo Pérez de Vargas. In A. M. Medina Guerra & M. C. Ayala Castro (Eds.), *Los diccionarios a través de la historia*, (pp. 91-109). Málaga: Servicio de Publicaciones de la Universidad de Málaga.

Cepăreanu, L. E. (2011). L'alchimie - un repèe dans le monde ancien roumain. In L. Badescu (Ed.), *Perspectives contemporaines sur le monde médieval*, 2, (pp. 210-213). Pitesti: Tiparg.

Cifuentes, Ll. (2016). El receptari mèdic baixmedieval i renaixentista: un gènere vernacle. In L. Badia, L. Cifuentes, S. Martí, J. Pujol (Ed.), *Els manuscrits, el saber i les lletres a la Corona d'Aragó, 1250-1500*, (pp. 103-159). Barcelona: Publicacions de l'Abadia de Montserrat.

Corominas, J. & Pascual, J. A. (1980-1991). *Diccionario crítico etimológico castellano e hispánico*. Madrid: Gredos.

Costa, J. M. (2005). *Diccionario de química física*. Barcelona: Díaz de Santos – Universitat de Barcelona.

Cottez, H. (1980). *Dictionnaire des structures du vocabulaire savant: éléments et modèles de formation*. Paris: Robert.

Crosland, M. P. (1962). *Historical studies in the language of chemistry*. London / Melbourne / Toronto: Heinemann.

Debus, Allen G. (1987). *Chemistry, alchemy and the new philosophy, 1550-1700*. London: Variorum reprints.

Díez de Revenga Torres, P. (2012). El uso de los nombres de los minerales en la literatura medieval hispánica. In A. Martínez Pérez & A. L. Baquero Escudero (Eds.), *Estudios de literatura medieval. 25 años de la Asociación Hispánica de Literatura Medieval*, (pp. 337-344). Murcia: Servicio de Publicaciones de la Universidad de Murcia.

Esteva de Sagrera, J. (1991). *La química sagrada. De la alquimia a la química en el siglo XVII*. Madrid: Akal.

Fennell, Roger (1994). *History of IUPAC, 1919-1987*. Oxford: Blackwell Science.

Gago, R. (1982). Introducción. In A. L. Lavoisier, *Tratado elemental de química*, (XIII-LXVIII). Madrid: Alfaguara.

Gago, R. & Carrillo, J. L. (1979). *La introducción de la nueva nomenclatura química y el rechazo de la teoría de la acidez de Lavoisier en España*. Málaga: Universidad.

García Belmar, A. & J. R. Bertomeu Sánchez (1999). *Nombrar la materia. Una introducción histórica a la terminología química*. Barcelona: Ed. del Serbal.

García Belmar, A. & J. R. Bertomeu Sánchez (2001). Viajes a Francia para el estudio de la química, 1770 y 1833. *Asclepio*, LIII-1, 95-140.

Garriga, C. (1996). Apuntes sobre la incorporación del léxico de la química al español: la influencia de Lavoisier. *Documents pour l'histoire du français langue étrangère ou seconde*, 18, 419-435.

Garriga, C. (1997). La recepción de la Nueva nomenclatura química en español. *Grenzgänge*, 8, 33-48.

Garriga, C. (1998). Química, enseñanza y divulgación de la terminología: las *Lecciones de química teórica y práctica* de Morveau, Maret y Durande. In J. Brumme (Ed.), *La historia de los lenguajes iberorrománicos de especialidad (siglos XVII-XIX); soluciones para el presente*, (pp. 163-174). Barcelona: Universitat Pompeu Fabra.

Garriga, C. (2001). Notas sobre el vocabulario de la química orgánica en español: Liebig y la divulgación de los derivados en *–ina*. In M. Bargalló, E. Forgas, C. Garriga, J. Schnitzer & A. Rubio (Eds.), *Las lenguas de especialidad y su didáctica*, (pp. 169-180). Tarragona: Universitat Rovira i Virgili.

Garriga, C. (2002). Notas sobre la incorporación del sufijo técnico -ona al español. In Mª T. Echenique *et al.* (Eds.), *Actas del V Congreso Internacional de Historia de la Lengua Española*, (pp. 2093-2106). Madrid: Gredos.

Garriga, C. (2003). La química y la lengua española en el siglo XIX. *Asclepio*, 55 (2), 93-117.
Garriga, C. (2004). El *Curso de química general* y la estandarización del léxico químico a principios del siglo XIX. In V. Alsina, J. Brumme, C. Garriga & C. Sinner (Eds.), *Traducción y estandarización*, (pp. 127-141). Madrid - Frankfurt am Main: Vervuert / Iberoamericana.
Garriga, C. (2016). Etimología y terminología en el español de la ciencia y de la técnica: el caso de *–geno*. In M. Quirós *et al.* (Eds.), *Etimología e historia en el léxico del español*, (pp. 679-696). Madrid: CSIC.
Garriga, C. (2018). Las voces de la química. In G. Clavería & M. Freixas (Ed.), *El diccionario de la Academia en el siglo XIX: la 5ª edición (1817) al microscopio*, (pp. 313-337). Madrid: Arco/Libros.
Giovanardi, C. (1987). *Linguaggi scientifici e lingua comune nel settecento*. Roma: Bulzoni.
Giovanardi, C. (2004). Formazione delle parole nelle termninologie tecnico-scientifiche: Chimica. In M. Grossmann & F. Rainer (Ed.), *La formazione delle parole in italiano*, (pp. 580-585). Tübingen: Max Niemeyer.
González de Madariaga, M. J. (2001). El léxico de la minería y el arte de los metales en el virreinato de Perú. In H. Perdiguero (Ed.): *Estudios sobre el español de América*, (pp. 663-672). Burgos: Universidad.
Granados, C. E. & López Rodríguez, M. (1989). *Las definiciones de los elementos químicos en el «Diccionario de la lengua española»*. Madrid: Real Academia Española.
Guerra, C. (2018). Les artilleurs traducteurs et leurs ennemis. La première traduction italienne du Traité élémentaire de Lavoisier à Naples. *La Révolution française: Cahiers de l'Institut d'histoire de la Révolution française*, 13. http://journals.openedition.org/lrf/1952 [26/04/18]
Gutiérrez Cuadrado, J. (1998a). F. Carbonell y Bravo y su texto *Curso analítico de química* escrito en italiano por F. Mojón. In C. García Turza, F. González & J. Mangado (Eds.), *Actas del IV Congreso Internacional de Historia de la Lengua Española* (pp. 219-230). Logroño: AHLE - Gobierno de La Rioja - Universidad de La Rioja.
Gutiérrez Cuadrado, J. (1998b). Muñoz Torres de Luna y la lengua de la química en el siglo XIX. In J. L. García Hourcade, J. M. Moreno & G. Ruiz (Eds.), *Estudios de historia de las técnicas, la arqueología industrial y las ciencias*, (pp. 701- 711). Valladolid: Junta de Castilla y León.
Gutiérrez Cuadrado, J. (2001). Lengua y ciencia en el siglo XIX español: el ejemplo de la química. In M. Bargalló, E. Forgas, C. Garriga, J. Schnitzer & A. Rubio (Eds.), *Las lenguas de especialidad y su didáctica*, (pp. 181-196). Tarragona: Universitat Rovira i Virgili.
Gutiérrez Cuadrado, J. (2002). La expansión de *gas* en español. In Mª T. Echenique *et al.* (Eds.), *Actas del V Congreso Internacional de Historia de la Lengua Española*, (pp. 2127-2142). Madrid: Gredos.
Gutiérrez Rodilla, B. (2005). *El lenguaje de las ciencias*. Madrid: Gredos.
Halleux, R. (1989). Ruptures et cointinuités dans le vocabulaire de la chimie et des sciences minérales. In C. de Schaetzen (Ed.). *Terminologie diachronique* (pp. 87-93). Paris: Conseil International de la Langue Française.
Kocourek, R. (1991). *La langue française de la technique et de la science*. Wiesbaden: Brandstetter.
Laszlo, P. (1993). *La parole des choses ou le langage de la chimie*. Paris: Hermann.

Lerat, P. (1995). *Les langues spécialisées*. Paris: Presses Uniuversitaires de France.

Luna, F. J. (2013). Vicente Seabra Telles e a criacão da nomenclatura em português para a química 'nova' de Lavoisier. *Quimica Nova*, 36 / 6, 921-926. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-40422013000600032#t5 [26/04/18]

López Piñero, J. M. (200-7). La història natural. L'alquímia i el paracelsisme. In J. Vernet & R. Parés (Eds.), *La ciència en la història dels Països Catalans – II: Del naixement de la ciència moderna a la Il·lustració* (pp. 269-300). València: Institut d'Estudis Catalans – Universitat de València.

Maillot, J. (1997). El vocabulario de la química. In *La traducción científica y técnica*, (pp. 248-259). Madrid: Gredos.

Marques, A. J. & Filgueiras, C. A. (2010). A química atmosférica no Brasil de 1790 a 1853. *Química Nova*, 33 / 7, 1612-1619.

Marzabal, A. & Izquierdo, M. (2017). Análisis del libro de texto de química como discurso didáctico. *Enseñanza de las ciencias*, 35, 111-132.

Mendoza, G. (1983). Terminología y tecnología minera en el área andina de Charcas: García de Llanos, un precursor. In R. Molina (Ed.), *García de Llanos: Diccionario y maneras de hablar que se usan en las minas*, (pp. VI-LXXI). La Paz: MUSEF.

Menten de Home, P. de (2013). *Dictionnaire de chimie. Une approche étymologique et historique*. Bruxelles: De Boeck.

Messner, D. (2001). Los caminos de las nomenclaturas: desde Francia hasta España y Portugal. In M. Bargalló, E. Forgas, C. Garriga, J. Schnitzer & A. Rubio (Eds.), *Las lenguas de especialidad y su didáctica*, (pp. 41-58). Tarragona: Universitat Rovira i Virgili.

Messner, D. (2004). La traducción de textos franceses de especialidad a la slenguas iberorrománicas en el siglo XVIII. In J. Brumme *et al.* (Ed.), *Traducción y estandarización*, (pp. 19-33). Madrid – Frankfurt am Main: Iberoamericana – Vervuert.

Mojdik, K. (1998). *Dicţionar de termeni chimici: român, maghiar, englez, german, francez*. Cluj-Napoca: Editura Pro Tehnica.

Molina, R. (Ed.) (1983). *García de Llanos: Diccionario y maneras de hablar que se usan en las minas*. La Paz: MUSEF.

Morveau, L. G.; Lavoisier, A. L.; Berthollet, Cl. & Fourcroy, A. F. (1787). *Méthode de nomenclature chimique*. Paris: Cuchet.

Muñoz Armijo, L. (2014). La difusión de la nomenclatura química en la lexicografía académica española: el sistema derivativo para la formulación de sales y compuestos. In M. P. Garcés Gómez (Ed.), *Lexicografía especializada: nuevas propuestas*, (pp. 209-224). A Coruña: Anexos de la Revista de Lexicografía.

Muñoz Armijo, Laura (2016). Evolución morfológica y semántica del sufijo *-ina*: notas sobre la recepción de sus derivados en la lexicografía académica española de los siglos XIX y XX. In R. Cotelo (Ed.), *Entre dos coordenadas: la perspectiva diacrónica y diatópica en los estudios léxicos del español*, (pp. 277-296). San Millán de la Cogolla: Cilengua.

Nieto-Galan, A. (1995). The French Chemical Nomenclature in Spain, In B. Bensaude-Vincent & F. Abbri (Eds.), *Lavoisier in European Context. Negotiating a New Language for Chemistry*, (pp. 173-191). USA: Science History Publications.

Nieto-Galan, A. (1996). Martí i Franquès, Carbonell i Bravo, i els usos de la nova química a la Catalunya il·lustrada. In M. Izquierdo *et al.* (Eds.), *Lavoisier i els*

orígens de la química moderna, 200 anys després (1794-1994), (pp. 159-184). Barcelona: SCHCT.
Nieto-Galan, A. (2000). Introducció. In A. L. Lavoisier, *Tractat elemental de química*, (pp. 9-53). Barcelona: Institut d'Estudis Catalans / Pòrtic / Eumo.
Nieto-Galan, A. (2001). *Colouring Textiles. A History of Natural Dyestuffs in Industrial Europe*. Dordrecht: Kluwer.
Nieto-Galan, A. (2011). *Los públicos de la ciencia. Expertos y profanos a través de la historia*. Madrid: Marcial Pons.
Pharies, D. (2002). *Diccionario etimológico de los sufijos españoles*. Madrid: Gredos.
Popescu-Marin, M. (1981). Între lingvistică şi chimie (termeni de chimie în DEX şi DLR). *Limba Română*, 2, 175-179.
Portela, E. (1999). *La química ilustrada*. Madrid: Akal.
Principe, Lawrence M. (2013). *The Secrets of Alchemy*. Chicago: The University of Chicago Press.
Puche, M. Á. (2008). Origen y evolución de los nombres de minerales. *Revista de Investigación Lingüística*, 11, 265-285.
Puche, M. Á. (2016). Sobre el origen del léxico minero español. In M. Quirós, J. R. Carriazo, E. Falque & M. Sánchez Orense (Eds.). *Etimología e historia en el léxico del español. Estudios ofrecidos a José Antonio Pascual (Magister bonus et sapiens)*, (pp.5 81-598). Madrid - Frankfurt: Iberoamericana – Vervuert.
Quintanilla, M., Merino, C. & Cuellar, L. (2012). Análisis del discurso del profesorado de química en ejercicio y su contribución a la evaluación de competencias de pensamiento científico. Un estudio de caso en Chile. *Educación química*, 23 /2, 188-191.
Rainer, F. (1993). *Spanische Wortbildungslehre*. Tübingen: Niemeyer.
Rio-Torto, M. G. (2017). La renovación terminológica de la química en la Universidad de Coímbra a partir de 1788. *Revista de Investigación Lingüística*, 20, 157-175.
Roşca, S. & Luca, C. (2009). Societatea de chimie din România la 90 de ani de la constituire. *Buletinul Societății de Chimie din România*, XVII, 2-9.
Rouquérol, F. & Vigneron, M. (2011). Quel langage adopter pour enseigner la chimie? *L'actualité chimique*, 352, 30-34.
Sager, J. C. (1990). Features of chemical nomenclature. *Practical Course in Terminology Processing* (pp. 96-97). Amsterdam / Philadelphia: Benjamins.
Sala, L. (2001). Multiplicidad sinonímica en el vocabulario de la química del siglo XIX. In J. Brumme (Ed.), *La historia de los lenguajes iberrománicos de especialidad*, (pp. 119-130), Barcelona - Frankfurt am Main – Madrid: IULA (UPF) - Vervuert - Iberoamericana.
Seligardi, R. (2013). La chimica nel Settecento: laboratori, strumenti e sperimentazione. *Enciclopedia Treccani*. http://www.treccani.it/enciclopedia/la-chimica-nel-settecento-laboratori-strumenti-e-sperimentazione_%28Il-Contributo-italiano-alla-storia-del-Pensiero:-Scienze%29/ [13/04/18]
Termcat (2016). *Diccionari de química: Química orgànica i inorgànica* [en línia]. Barcelona: Termcat (Centre de Terminologia). http://www.termcat.cat/ca/Diccionaris_En_Linia/212/Presentacio/ [26/04/18]
Toma, A. (2009). Terminologiile ştiinţifice româneşti în secolul al XIX-lea: fizică şi chimie. *Analele Universității "Alexandru Ioan Cuza*" din Iași. Secțiunea IIIe. *Lingvistică*, LV, 43-53.

TLFi: *Trésor de la langue Française informatisé*. Paris: ATILF - CNRS & Université de Lorraine. http://www.atilf.fr/tlfi [26/04/2018].
Vilalta, R. et al. (2011). *Dicionario de química*. A Coruña: Universidade da Coruña.
Vivanco, V. (2006). *El español de la ciencia y la tecnología*. Madrid: Arco Libros.
Wisniak, Jaime (2005). Reseña biográfica: Nicolas Lémery, *Revista CENIC Ciencias químicas*, 36 / 2, 123-130. http://revista.cnic.edu.cu/revistaCQ/sites/default/files/articulos/CQ-2005-2-123-130.pdf [26/04/18].