The aim of this paper is to show that, in 18th century Chemistry, at least in French Chemistry, there was nothing anymore but an instance of reality to consider, the existence of bodies itself. Chemistry gave up the idea of Principles, of a Reason or of a Nature transcending all the chemical phenomena, which prevailed hitherto in this science, without necessarily taking refuge in another system supposing an inaccessible reality; the only existing reality is that which appeared in laboratory. In this direction, without real base hidden behind tangible appearances, therefore without Nature, Chemistry abandoned natural Philosophy by definition. Chemistry’s works fitted in at that moment with ‘tragic processes’ consisting in refusing any ‘metaphysical’ argument from any thought system to practise a clearly experimental physics, or rather something which sounds like an oxymoron, a ‘physics of artifice’; the artifice would not be anymore a continued Nature since, for chemists, Nature was henceforth defined as continued artifice. Without any order in Nature, Chemistry felt free to push back its boundaries and so chemical theory and practice find their “application to Physics, natural History, Medicine & animal Economy” to repeat the second part of Macquer’s title in 1766 to Dictionnaire de Chimie, and as one can see in the Encyclopédie of Diderot and d’Alembert. Certainly 18th century Chemistry still seems to declare itself as a part of natural Philosophy and Physics. However, at the very beginning of the century, Wilhelm Homberg openly claimed a practice which was not simple Physics, but precisely, “chemical Physics”. The way, in the Système des Connaissances Humaines at the beginning of the first volume of the Encyclopédie, which leads from a Knowledge Tree trunk to Chemistry, was not rightly followed by Gabriel-François Venel in his article “Chymie” in the third volume: Chemistry was not either for him simple Physics or as he named it “ordinary Physics”. Chemistry was distinguished clearly by its studies on the world’s small body phenomena; but if ordinary Physics tried to explain this world, Venel warned “all there will be badly”. This concern of distinguishing Chemistry like particular
Physics, like particular natural Philosophy, was neither exclusively justified by its characteristic experimental dimension, neither by its interest for phenomena whose cause is invisible. From a chimico-chemical point of view, it was not the sign of a rupture either between Alchemy and Chemistry. This distinction stems rather from a new way of looking at bodies, starting with the search for an order—not natural— but artificial one. Chemists had opted for a world without nature, without metaphysical reason, without invisible reality hidden behind the palpable one; a world in which they approved unconditionally the existence of chemical bodies and facts, and not anymore a world in which they accepted their existence provided that there was any theoretical explanation. Eighteenth-century chemists place themselves within a world they absolutely didn’t know. They gradually gave up their naturalist representations, while settling in artificialist ones. Adopting a tragic point of view on the matter probably gave them more self-confidence or even certain superiority in the field of natural sciences. Their work was not been curbed anymore by alleged natural materials they could only purify or damage or imitate, in other words they could only undo and redo what nature did; now their productions were their own creations: they were able to make by their own. Chemists gave up any a priori intellectual command of matter. This renunciation could look like a kind of humility when faced with the matter which was hard to know. So Homberg did not think to isolate true principles of mixts anymore (inaccessible anyway in their pure forms), but he only wanted to set apart some indecomposable and perfectly tangible substances from the last resolution of mixts. As for Venel, he claimed the right to work in “vagueness” and “approximation”, and out of any system (for him, “Cartesian, corpuscular, Newtonian, academic or experimental” systems), even if he admitted that, in the history of Chemistry, systems played a role in the formation of Chemistry as a science. However this humility did not mean chemists gave up the hope of any progress in Chemistry, but it only expressed their ‘artificialist’ posture, in opposition to the naturalist posture which was current in Chemistry hitherto. But chemists were far from being pure empiricists. They fully accepted the complication of the world of substances they tried to order, after the simplicity of the former world of Chemistry of Principles become chaotic. Vagueness and approximation would become a scientific practice for Venel, “a specific right” (un droit particulier) of Chemists who have “their own & independent manner” (leur manière propre & indépendante); what it was about here was their “boldness” (hardiesse) (“one said the madness” (on a dit la folie), Venel writes), “Chemists’ enthusiasm” which “can give rise to genius” (qui peut prêter au genie). The idea of Nature in Chemistry was suggesting, not only a natural foundation for the chemical compounds—in other words being behind the appearance—, but
an order which transcended the disorder and the diversity of chemical substances. In the absence of a metaphysical postulate, or a Reason of things, 18th century chemists, like Homberg, or Geoffroy with his famous affinity table, or Rouelle with his neutral salt table, tried to gather chemical facts and bodies in wholes which made sense. With 1702 Homberg’s Chemistry definition, matter took on the form of simple bodies still identified like principles, and ceased being a constraint in Chemistry’s practice; knowledge of matter was not certain, neither was it a precondition. It was not anymore necessary for these principles to be themselves principles; it was enough that they were principles for the chemist in his relation with experiment. The “undisputed truth” (la vérité certaine) was related, for Homberg, with the immediately verifiable existence of bodies in laboratory. So that substances called salt, mercury, sulphur, water and earth were not anymore, as they were in the former century, instances of true principles of same names. Salt, mercury, sulphur, water and earth represented mainly, in the truth of their existence, some genera of bodies containing several species. For example, the genus salt was the genus of soluble and sapid substances, and contained the following species, acid salts, “salts which smell like urine” and alkaline salts, to which Homberg added another species, the essential salts, obtained by extraction, then crystallisation. Therefore Chemistry was organised according to a new order, and not anymore according to an order following the triple nature of the production and conservation force sometimes called universal Spirit or universal Nature. The very start of 18th century corresponded to a multiplication of the number of substances: after Salt Chemistry in 17th century for example, the “chemistry of the salts is the great affair” of the next century, according to Jean-Jacques Rousseau.

In the first decades of 18th century, chemical bodies tended thus to take their place in a new general plan of all substances. Chemical experiments didn’t really focus on a single subject, but on a species or a genus, as one can see, for instance, with Homberg’s studies on the force of acid salts and alkali salts in 1699 and 1700, and on volatile salts of plants in 1701. It was specially the case in 1718 with Etienne-François Geoffroy’s “table des différents rapports observés entre différentes substances”. Taxonomy and nomenclature in Chemistry become real methods of knowledge. The absence of a transcendent order after the disappearance of the idea of Nature was offset by the classification and a certain nominalism. Chemists probably gave a name or classified more to know, than to recognise. Geoffroy’s table summed up approximately 75 possibilities of combinations of classified bodies according to a relative order of binding tendency in relation to the body at the top of each column. Geoffroy did not contend himself with summarising the behaviours of the 19 substances contained in the table, but gathered
some of them in 4 species in order to expose their general behaviours (these species were the acid liquors, salts, metals and the absorbing earth). According to Geoffroy, the table required only to be supplemented with additional experiments in order to identify other affinities. The lack of theoretical explanations about the various phenomena of selective substance displacements shown in the table (in 1718 Geoffroy's memoir as well as in his 1720 memoir on the same subject) must have disconcerted the French Academicians at the time. Fontenelle, the perpetual secretary of the Academy, most probably suspected a Newtonian reason to explain them, since he was the first to translate Geoffroy's word “rapport” by “attraction”. However in the review he gave on the table, he wrote that it is to be regretted that there is no reason to justify the various binding suitabilities between bodies observed in laboratory; he said: “[...] But from what active principle can one understand this more [or less] suitability?” (“[…] Mais quel principe d'action peut-on concevoir dans ce plus [ou moins] de convenance ?”). A few chemists initially tried to put forward some reasons for these affinities (e.g. Stahlian reasons for Gilles Boulduc, Cartesian ones for Louis Lemery) before accepting the table for what it was: The table just revealed a very useful order to establish operational strategies in Chemistry and to deduce the mechanism from confusing operations; and that “whatever the [active] principle may be”, as Fontenelle rather disconcertingly notes it. Geoffroy was indeed neither a Newtonian nor a Stahlian chemist but a chemist in close touch with his time; a chemist whose way of practicing Chemistry fully showed an artificialist approach. Therefore it is not needed to postulate any theoretical structure for the substances of the table, it was enough to contemplate this table; the reason is in the table and not in the bodies. Knowledge of a particular natural body was then substituted by artificial knowledge of the place of this body in a particular table's column. But it is to be noticed that Geoffroy did not speak of a law, even less a natural law, but quite simply of a “rule” in the chemical behaviours which he reported. Indeed, what his table was about was not an external power (like subtle matter, or Newtonian attraction) which would drive bodies to be combined or to be separated. Affinities were what made combinations possible and not what caused them. In this artificialist approach, affinities in Chemistry were always considered just like laboratory results; in contrast a naturalist approach just considered the antecedents. In other words, chemical affinities were related to some circumstances in laboratory and not to the essence of bodies; they just referred to the possibility for elements to unite. Certain combinations happen to occur, others did not: Geoffroy's affinities did not refer anything else than this shared possibility to unite. Chemical affinities were not used differently by chemists till the middle of the century; hence the incomprehension of Buffon who wished to subsume all
these phenomena under a mathematical expression based on Newton’s law attrac-
tion.\textsuperscript{27} His incomprehension was not on the doctrine, Buffon is very well informed
about Chemistry, but on the way of thinking about the chemical phenomena of the
artificialist Chemistry which used no metaphysical postulate. He wrote: “The
darkness of Chemistry is mainly due to the fact that one not much generalized its
principles, & because one did not join them together with those of the high
Physics. Chemists adopted affinities without understanding them, i.e. without
understanding the relation between the cause and the effect which is neverthe-
less not other than that of the universal attraction” ("L’obscurité de la chimie vient
en grande partie de ce qu’on en a peu généralisé les principes, & qu’on ne les a pas
réunis à ceux de la haute physique. Les chimistes ont adopté les affinités sans les
comprendre, c'est-à-dire sans entendre le rapport de la cause à l’effet qui, néan-
moins n’est autre que celui de l’attraction universelle").\textsuperscript{28} However, affinities
according to Venel, could only be a relative property of a heterogeneous matter.

The result of element combinations in the left part of Geoffroy’s table was the sub-
ject of a new research on an artificial classification. This part related to the saline
bodies, acid salts and alkali salts, which combined and formed mixts called “neu-
tral salts”. In 1743, Guillaume-François Rouelle suggested in a communication
published in the volume for 1744 of Mémoires de l’Académie Royale des Sciences,
a table of neutral salts according to their external crystalline shapes, and also
according to the degree of heat and the way they crystallised. The memoir’s title
was very significant besides: “Memoir on neutral salts, in which one suggests a
methodical division of these salts, which facilitates the means to reach the theo-
ry of their crystallisation” ("Mémoire sur les sels neutres, dans lequel on propose
une division méthodique de ces sels, qui facilite les moyens pour parvenir à la
théorie de leur crystallisation").\textsuperscript{29} Actually, this study was very far from a natu-
ralist study of the crystallisation phenomena, but it was carried out with the hope
to produce a theory of crystallisation by using nominalism and arbitrary taxano-
my. Neutral salts did not relate back to natural reality, but to a subjective defini-
tion also containing some well defined categories of substances: “I call [...] neutral
salt, any salt formed by the combination of any acid, either mineral or vegetable,
with a fixed alkali, a volatile alkali, an absorbing earth, a metal substance, or an
oil”.\textsuperscript{30} Neutral salts gather, according to the expression of Rouelle, in “families” or
“classes”, because of their common shapes and properties, and not according to a
similarity of nature; they can undergo a “methodical division” by regarding close-
ly “the only phenomena of crystallization”. The reasons of the neutral salts’ disso-
lution and of their crystallisation were unknown for Rouelle; he only noted that
the opinions on those subjects are divided. He just observed that the parts of salts
group together into crystals, what he called “the first law of crystallisation”.

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\textsuperscript{27} Eighteenth Century Chemistry: Between Natural Philosophy Without Nature and Physics…

\textsuperscript{28} 6\textsuperscript{th} International Conference on the History of Chemistry
Rouelle defined three degrees of heat, each one divisible into three others,, order to distribute neutral salts into six sections made up of four genera, which contained several neutral salt species; the last section being more or less that of the saline bodies that were unclassifiable elsewhere. The well known neutral salt species which existed in nature had already a chemical symbol to be represented, according to an algebraic model, linking the symbol of the acid with the symbol of the base using the sign “+” he calls the small cross. Rouelle also suggested in 1754 a completely different neutral salt taxonomy, but still with an artificialist mind. Rouelle’s work will not be detailed further, however it must be emphasised that a neutral salt was really a chemical concept at this date in history. Later Buffon estimated that the number of possible combinations between acids and bases was 474; in other words, there were 474 possible neutral salts. Lavoisier, after having identified new acids and new salifiable bases, raised this number to 1152 possible neutral salts. The substances about which they talked did not correspond to materials observed in laboratories or elsewhere. Rather, for the most of part, they corresponded to beings to be created, as they already belonged to a world established by artificialist reason; once they are obtained by the chemist, they become, in the words of Bachelard, “concepts which have been attained” (des concepts réalisés). To a certain extent, can one say from then on that these saline bodies were natural? Chemists left the realms of actual reality for the realms of possibility. So, not only the real did not reach all the possibility, but the very possibility of Nature was far from being able to compete with the chemists’ possibilities. Artificialist Chemistry clearly went beyond the framework of naturalist Chemistry, and that occurred a hundred years earlier than Bachelard thought.

Space does not permit to discuss the great mechanical philosophers’ interest in Chemistry, which was partly due to its ‘artificialism’. Nor about chrysopoetic works, as pure artificial productions for Geoffroy, Du Fay, Grosse, and Hellot. In the first half of 18th century Chrysopoiea became a thought of the present time, i.e. of what actually exists, and not a thought of past time, with its attempts to rediscover the elusive truth of Principles, as Malouin explained in his article “Alchimie” in the Encyclopédie. Unfortunately neither is it possible to comment on Venel’s position on Chemistry; Chemistry was according to him completely independent from ordinary Physics because of the absence of any metaphysical postulate. For him, the last two centuries Chemistry were “rich in facts, and in real chemical knowledge” (i.e. experimental) (riche en faits, en connaissances vraiment chimiques), but unfortunately “it lost its way by rising up” (i.e. in speculations) (elle s’est égarée en s’élevant), while prevailing itself to be the art which makes possible to go up to ‘divine Architect’, or even “the rival & reforming art of
Nature ([l’art] rival & réformateur de la Nature); generally in Physics, one has often mistaken “abstract notions for truths of existence” (notions abstraites avec vérités d’existence). However a paradox must be noted: French Physicists practised a Newtonian Physics which tended to ‘disanimate’ Nature while replacing it by an inert matter which cannot escape a strict mechanism because it was subjected to blind laws. Therefore one can think that 18th century Chemistry, by claiming the right to work in ‘vagueness’ and ‘approximation’, unlike Physics which, for Venel, wanted at all costs to explain everything, or which, according to Fontenelle, finds the first origins of everything “by delicate speculations”, let more place in its doctrine to Nature; Chemistry never really left Nature, in fact, it multiplied it.

Nevertheless the change in 18th century Chemistry was neither sudden nor necessarily radical. It was not sudden, because the recognition of only one instance of reality –the existence of bodies– was the completion of 17th century Chemistry movement (which has first rehabilitated the ‘corporal’ with the use of Salt Principle (Joseph Du Chesne), then the body with the practice of the second and palpable Principles (in Chemistry handbooks), and at last it had attempted to establish only probable —i.e. not ‘metaphysical’, not indemonstrable— Principles (Samuel Cottereau Du Clos, François Saint André). It was not either necessarily radical, because the practice of Chemistry —which was not reduced to a simple empiricism— to try to determine a coherent order in the substance diversity for which Chemists can still use sometimes an indemonstrable Reason. But one can finally question oneself if the abandonment of a transcending Principle of unit in Chemistry in 18th century was not definitive.

Notes


17 According to Frederic L. Holmes (*Eighteenth-Century Chemistry as an investigate enterprise* (Berkeley: Univ. of California, 1989), 39-41), the affinity table was “a nodal point in the continuing evolution of a pragmatic chemistry of operations oriented around the concept of middle salts”.


24 Nevertheless, it is true that Geoffroy writes twice in the first page of his memoir (p. 202) the word ‘laws’, but in the plural form. Indeed, for him, there are only particular laws for particular substances. Each law -i.e. each ‘rapport’- is about the specific regular behaviour of a single substance (except for the two chemical genera: acid spirits and metal substances). No natural law exists, but a ‘steady rule’ (une règle constante) (p. 212). According to Geoffroy, his Table represents just a ‘method’ (p. 203), not more.


26 Combinations were not “a result of affinities”, as Mi Gyung Kim says (Affinity, That Elusive Dream: A Genealogy of the Chemical Revolution (Boston: MIT, 2003), 145). The rapport table is not, as she also affirms it (pp. 144-146), “a theoretical system”, and affinities do not represent “a theory domain” either, but just a “method” as Geoffroy simply presents it (p. 203). According to him, his table, built from chemical operations, has a practical “utility” (p. 206) indeed, since it is to lighten the practice. Geoffroy writes the “rapport” in Chemistry is a “property” (p. 203) of which the effects are thus observable in laboratory. Once its existence is noted, the “rapport” appears like the “key” -to take again Geoffroy’s word (p. 203)- which allows explaining the recombinating of substances mixed together, and only “predicts” (p. 206) what was already observed before or in other circumstances.


30 “J'appelle sel neutre moyen ou salé, tout sel formé par l’union de quelqu’acide que ce soit, ou minéral ou végétal, avec un alkali fixe, un alkali volatil, une terre absorbante, une substance métallique, ou une huile” (Rouelle, “Mémoire sur les sels neutres”, 353). Everybody will not accept the oil in the definition of neutral salts, like d’Holbach; see Paul Tiry d’Holbach, “Sel”, in Diderot, d’Alembert, *Encyclopédie*, vol. 14, 903-904.


32 See at the bottom of the final table in 1744 Rouelle’s memoir, “Mémoire sur les sels neuters”.


36 Bachelard, *Le pluralisme coherent*, 68.


42 Franckowiak, “La chimie du XVIIe siècle”.

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**Rémi Franckowiak**

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