

THE ACIDULOUS RADICALS.

Introduction.—The twenty-seven radicals which have up to this point mainly occupied attention are (admitting ammonium, NH_4) metals; and they have been almost exclusively studied not in the free state, but in the condition in which they exist in salts. Moreover, these metals have been treated as if they formed the more important constituent, the stronger half, the foundation or *base* of salts. Attention has been continuously directed to the metallic or *basyulous* side of salts. And indeed there is still one more basyulous radical which must be mentioned, though it is usually supposed to play only a subordinate part in medicine—Hydrogen. Unlike the salts of most metals, those of hydrogen (the so-called acids) are never, in medicine or the arts generally, professedly used for the sake of their hydrogen, but always for the other half of the salt, the *acidulous* side. And it is not for their basyulous radical that these hydrogen salts are now commended to notice,* but in order to study, under the most favorable circumstances, those acidulous groupings which have continually presented themselves in operations on salts, but which were for the time of secondary importance. These *acidulous radicals* may now be treated as the primary object of attention; and there is no better way of doing so than in operating on their compounds with hydrogen, the apparently inferior medicinal importance of which element, as compared with potassium, iron, and other basyulous radicals, will serve to give the desired prominence to the *acidulous radicals* in question.†

Common Acids.—These salts of hydrogen (hydrogen easily displaceable, or in certain cases, in part, by ordinary metals) are the

* It must not be forgotten that the commonest salt of any radical whatsoever is a salt of hydrogen, the oxide of hydrogen (H_2O), or hydrate of hydrogen (HHO), *water*. In the reactions already performed the value of this compound has been constantly recognized, both for its hydrogen and for its oxygen, but most of all as the vehicle or medium by which nearly all other atoms are enabled to come into that contact with each other without which their existence would be almost useless; for some atoms are like some animals—out of water they are as inactive as fishes. It is true that both fishes and salts have usually to be removed from water to be utilized by man; but before they can be assimilated, either as food or as medicine, they must again seek the agency of water in becoming dissolved.

† Actually, it is as difficult to determine the relative importance of the different atoms or groups of atoms in a molecule as of the different parts or members of an animal or vegetable, the different units or societies in a community, the different planets or solar systems of the universe; nay, the different pieces or parts of an engine or the pigments or portions of a picture: *l'union fait la force*.

ordinary sharp, sour bodies termed *acids* (from the Latin root *acies*, an edge). The following Table includes the formulæ and usual names of the most important; others will be noticed subsequently. A few of those mentioned are unstable or somewhat rare; in such cases a common metallic salt containing the acidulous radical may be used for reactions.

HCl	hydrochloric acid.
HBr	hydrobromic acid.
HI	hydriodic acid.
HCN (HCy)	hydrocyanic acid.
HNO_3	nitric acid.
HClO_3	chloric acid.
$\text{HC}_2\text{H}_3\text{O}_2$	acetic acid.*
H_2S	hydrosulphuric acid.†
H_2SO_3	sulphurous acid.
H_2SO_4	sulphuric acid.
H_2CO_3 ?	carbonic acid.
$\text{H}_2\text{C}_2\text{O}_4$	oxalic acid.
$\text{H}_2\text{C}_4\text{H}_4\text{O}_6$	tartaric acid.
$\text{H}_3\text{C}_6\text{H}_5\text{O}_7$	citric acid.
H_3PO_4	phosphoric acid.
H_3BO_3	boracic acid.

The old names are here retained for these acids, but, in studying their chemistry and chemical relations to other salts, they are usefully spoken of by such more purely chemical names as (for hydrochloric acid) chloride of hydrogen, (for nitric acid) nitrate of hydrogen, and so on—sulphate of hydrogen, tartrate of hydrogen, phosphate of hydrogen.

A prominent point of difference will at once be noticed between the basyulous radicals met with up to the present time and the acidulous groupings included in the above tabular list. The former are nearly all elements, ammonium only being a compound; the latter are mostly compounds, chlorine, bromine, iodine, and sulphur being the only elements. This difference will not, however, be so apparent when the chemistry of alcohols, ethers, and such bodies has been mastered, for they may be regarded as salts of *compound* basyulous radicals.

* The hydrogen on the acidulous side must not be confounded with the basyulous hydrogen in all these hydrogen salts or acids; the two perform entirely different functions. Hydrogen in the acidulous portion is like the hydrogen in the basyulous radical ammonium: it has combined with other atoms to form a group which plays more or less the part of an elementary radical, and to which a single symbol is not unfrequently applied (Am; Cy, A, O, T, C, etc.). Cobalt, chromium, iron, platinum, etc., resemble hydrogen in this respect in often uniting with other atoms to form definite acidulous radicals, in which the usual basyulous character of the metals has for the time disappeared. In *hydrides* (p. 122) hydrogen itself is an acidulous radical.

† Synonyms: sulphydric acid and sulphuretted hydrogen.

Rarer Acids.—The above acids contain the only acidulous groupings that commonly present themselves in analysis or in pharmaceutical operations. There are, however, several other acids (such as hypochlorous, nitrous, hypophosphorous, valerianic, benzoic, gallic, tannic, uric, hyposulphurous, hydroferrocyanic, hydroferridcyanic, lactic, etc.) with which it is desirable to be more or less familiar; reactions concerning these will therefore be described. Arsenious, arsenic, stannic, manganic, and chromic acids have already been treated of in connection with the metals they contain; in practical analysis they always become sufficiently altered to come out among the metals.

Quantivalence.—A glance at the foregoing Table is sufficient to show the quantivalence of the acidulous radicals. The first seven are clearly univalent, then follow six bivalent, leaving three trivalent.

These all combine with equivalent amounts of basylous radicals to form various salts; hence they may be termed monobasylous, dibasylous, and tribasylous radicals. The acids themselves were formerly spoken of as monobasic, dibasic, and tribasic respectively, or monobasic and polybasic, in reference to the amount of *base* (hydrates or oxides) they could decompose; but the terms are no longer definite, and hence but little used in mineral chemistry.

Antidotes.—The antidotes in cases of poisoning by the strong acids will naturally be non-corrosive alkaline substances, as soap and water, magnesia, common washing "soda," or other carbonates. Vinegar, lemon-juice, and weak or non-corrosive acids would be the appropriate antidotes to caustic alkalies.

Analysis.—The practical study of the acidulous side of salts will occupy far less time than the basylous. Salts will then be briefly examined as a whole.

Caution.—Once more: it is only for convenience in the division of chemistry for systematic study that salts may be considered to contain basylous and acidulous radicals, or separate sides, so to speak; for we possess no absolute knowledge of the internal arrangement of the atoms (admitting that there are such things) in the molecule of a salt. We only know that certain groups of atoms may be transferred from compound to compound in mass (that is, without apparent decomposition); hence the assumption that these groups are radicals. A salt is probably a whole, having no such sides as those mentioned.

QUESTIONS AND EXERCISES.

410. Mention the basylous radical of acids.
411. Give illustrations of univalent, bivalent, and trivalent acidulous radicals, or monobasylous, dibasylous, and tribasylous radicals.
412. What is the difference between an elementary and a compound acidulous radical?
413. Name the grounds on which salts may be assumed to contain basylous and acidulous radicals.

HYDROCHLORIC ACID AND OTHER CHLORIDES.

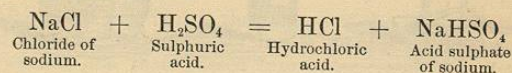
Formula of Hydrochloric Acid HCl. Molecular weight* 36.4.

The acidulous radical of hydrochloric acid and of other chlorides is the element chlorine (Cl). It occurs in nature chiefly as chloride of sodium (NaCl), either solid, under the name of *rock-salt*, mines of which are not unfrequently met with, or in solution in the water of all seas. Common table-salt is more or less pure chloride of sodium in minute crystals. Chlorine, like hydrogen, is univalent (Cl¹); its atomic weight is 35.4. Its molecule is symbolized thus, Cl₂, chloride of chlorine.

REACTIONS.

Hydrochloric Acid.

First Synthetical Reaction.—To a few fragments of chloride of sodium in a test-tube or small flask add about an equal weight of sulphuric acid; colorless and invisible gaseous hydrochloric acid is evolved, a sulphate of sodium remaining. Adapt to the mouth of the vessel by a perforated cork a piece of glass tubing bent to a right angle, heat the mixture, and convey the gas into a small bottle containing a little water; solution of hydrochloric acid results.



Hydrochloric Acid.—The product of this operation is the nearly colorless and very sour liquor commonly called hydrochloric acid. When of certain given strengths (estimated by volumetric analysis) it forms *Acidum Hydrochloricum*, U. S. P. (*Acidum Muriaticum*), and *Acidum Hydrochloricum Dilutum*, U. S. P. The former has a specific gravity of 1.16 and contains 31.9 per cent. of real acid. The latter, specific gravity 1.049, with 10 per cent. of the real acid, is made by diluting 6 fluid parts of the strong acid with 13 of water. The above process is that of the manufacturer, larger vessels being employed, and the gas being freed from any trace of sulphuric acid by washing. Other chlorides yield hydrochloric acid when heated with sulphuric acid; but chloride of sodium is always used, because cheap and common.

Common yellow hydrochloric acid is a by-product in the manufacture of carbonate of sodium from common salt, a process in which the chloride of sodium is first converted into sulphate, hydrochloric acid being liberated. This impure acid is liable to contain iron, arsenic, fixed salts, sulphuric acid, sulphurous acid, nitrous compounds, and chlorine.

The process for the preparation of hydrochloric acid is as follows: it may be carried out by the student with about one-twelfth of the quantities mentioned:—

* The weight of a molecule is the sum of the weights of its atoms.