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A Study on Carboxylic Acid's Reactivity and Function and Its Importance in Medicines

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ABSTRACT

This article research does not cover all of the potential uses for carboxylic acid molecules. Compounds that develop, break down, absorb, or release into the environment have a powerful effect on all the activities and reactions that take place in the body and the environment. As a concluding point, the carboxyl functional group and all of its derivatives are inseparable from life on this planet. Molecules with the carboxyl functional group linked to the hydrocarbon radical include carboxylic acids or organic acids. In the extraction of acids, different extraction and diluent compositions are used in various ways. The stoichiometry of reactive extraction, equilibrium parameters, and kinetic parameters can all be determined using a variety of models. The influence of diluent on carboxylic acid extraction equilibrium is also studied theoretically.

I. OVERVIEW

Carboxylic acids are significant chemicals that are frequently utilised as acidulants in food and beverage production, pharmaceuticals, and the chemical industry. Industrial production of carboxylic acids is carried out using the petrochemical feedstock. These acids are also produced by biotechnology based processes (fermentation processes), which uses renewable resources. Adapted downstream processing for product separation is required as the importance of biological production grows, with novel pathways and increased production rates. In order to make fermentation a realistic option, new fermentation procedures utilising extremely efficient separation techniques must be developed. As far as industrial and environmental considerations are concerned, removing mono-carboxylic acids like formic, acetic, and propionic acid from wastewater is also critical.

It's common for extraction to be the best method for simultaneously removing a product from a solution (liquid extraction, ultrafiltration, reverse osmosis, electro-dialysis), but there are a number of other options as well.

A chemical (solute and extractant reaction) phenomenon known as reactive extraction has been developed to enhance solvent extraction separation. It is possible to separate carboxylic acids from dilute aqueous solutions using organophosphorus-based and long-chain aliphatic amine extractants. These extractants are usually diluted with a diluent before use. Solubility and volume are controlled by this agent.

However, the diluent's chemical structure can also influence acid-amine complex formation in diverse ways. Reactive extraction for carboxylic acid recovery from fermentation broth and aqueous waste stream has been widely studied in relation to fermentation methods for carboxylic acids synthesis and recovery of carboxylic acids. These studies focus on various aspects such as solvent (extractant and diluent) selection, effects of temperature, pH, aqueous and organic phase compositions on extraction, in-situ product recovery, and chemical interactions involved in the complexation of acid with the extractant, kinetics of extraction, etc.

When using extractants, the usage of active diluent (modifier) is restricted. Formic acid, acetic acid, propionic acid, and butyric acid can also be separated from the aqueous waste industrial stream using this reactive extraction data. Few carboxylic acids with specified extractants can be

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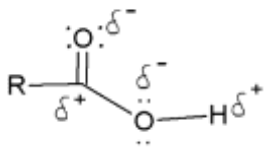
quantified using the LSER model or a model built around the u&ET parameters for diluent effect. The possibility of estimating the equilibrium parameters using an evolutionary optimization method [differential evolution (DE)] is not investigated. Reactive extraction data can be generated with less toxic or non-toxic amine/diluent systems for the improvement of propionic and nicotinic acid synthesis by fermentation in a wide range of different ways [1-6].

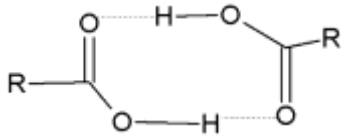
II. HYDROGEN BONDING OF CARBOXYLIC ACID

An organic functional group with a carboxylic acid moiety is considered very polar. Carbonyl (C-O) and hydroxyl (O-H) groups are strongly polarised, resulting in this polarity. A strong permanent dipole is formed when oxygen covalently bonds to carbon and hydrogen. Because of the neighbouring carbonyl moiety, the O-H group of carboxylic acids is much more polarised than the O-H group of alcohols. Additionally, the acidity of these compounds is due to these structural properties, as will be described later in this tutorial.

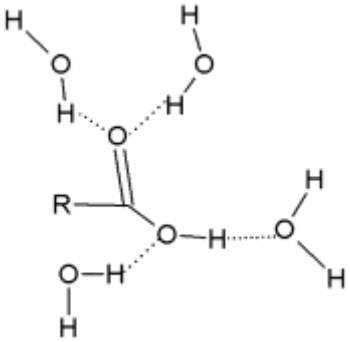


The dipolar nature of acids

Hydrogen bonding (H-bonding) interactions with similar molecules and water are made possible by the carboxylic acid dipoles, which operate as both a hydrogen bond giver and acceptor, as demonstrated below:



Laterinolecular H-Bonding



H-Bonding with Water

Other organic compounds with OH and/or C-O dipoles have lower overall H-bonding interaction energy than carboxylic acids. Comparatively speaking, carboxylic acids have both more and stronger dipoles than the other organic compounds, allowing them to build stronger and more H-bonds with other compounds that can form H-bonds. Tutorials on the dipolarity of various additional chemical functional groups provide more information on this topic.

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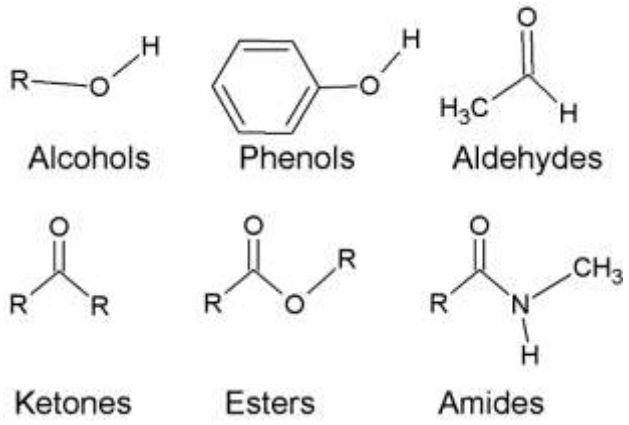

Boiling temperatures and water solubility of carboxylic acids are directly influenced by the energy associated with the dipoles present in these acids. The boiling points of carboxylic acids are high, as shown in the table below. Intermolecular H-bonding interactions between acid molecules are responsible for this, as illustrated in the earlier picture.

Because of the strong intermolecular contact, acids have far higher boiling temperatures than non-polar alkane, alkene, alkyne, and aromatic hydrocarbons. These compounds have higher boiling temperatures than ketones, amines, amides, aldehydes, and isosteric compounds of the same hydrocarbon structure (similar number of carbon atoms).

Carboxylic Acid Acidity:

The acidic character of carboxylic acids is the most significant chemical feature for drug synthesis. For the longest time, the term "acid" has only been used to describe substances that can really transfer protons into water. Strong acids are mineral acids (HCI, HBr), H_2SO_4, and H_3PO_4 because they undergo complete dissociation and transfer a proton to water to generate the hydronium ion.

III. USES OF ALDEHYDES AND KETONES

Smallest ketone and simplest aldehyde: what are these things? Formaldehyde is the simplest aldehyde, whereas acetone is the smallest ketone. It is common to find aldehydes and ketones in conjunction with other functional groups. As a matter of fact, numerous industrial processes necessitate the usage of aldehydes and ketones.

Plants, microbes, animals, and even people produce and consume aldehydes and ketones in large amounts. In plants and microorganisms such as carvone (spearmint and caraway), cinnamon bark, vanilla bean,helminthosporal (fungal toxin), Citra (lemongrass), and camphor (camphor trees), aldehydes and ketones are found.

Muscone in musk Meer, progesterone, testosterone, and cortisone are examples of aldehydes and ketones found in animal and human hormones. Addiction to opiates such as heroin, opium, and morphine can be treated with the ketone "methadone," a well-known and widely used substance. In this section, we'll look at all the different ways aldehydes and ketones can be put to use.

Aldehydes and Ketones

Carbonyl functional groups (C-O) are present in these organic molecules, with structures CHO for aldehydes and RC(=0)R' for ketones. Carbon substituents are denoted by the letters R and R' in this case. Other names for this category of molecules include methane or methyl groups. The remaining carbon atoms in this group are filled in by an aryl or alkyl group or its substitutes.

Ketones, on the other hand, are organic compounds in which the substituents in neither of the two remaining bonds are hydrogen. It is only an aldehyde if one of its substituents contains hydrogen. Using aldehydes and ketones depends heavily on the properties of the aldehydes and ketones themselves.

IV. IMPORTANT APPLICATION IN MAKING DRUGS

Sulfonamide antibacterials, certain diuretics, and sulfonylurea hypoglycemics all fall under the umbrella of the sulfonamide group (more on these below and in the Antidiabetic Drug Tutorial). There are two hydrogen atoms on the sulfonyl group in primary sulfonamides and one in secondary sulfonamides.

Again, the charge produced in the conjugate base can be stabilised by resonance, so these hydrogens

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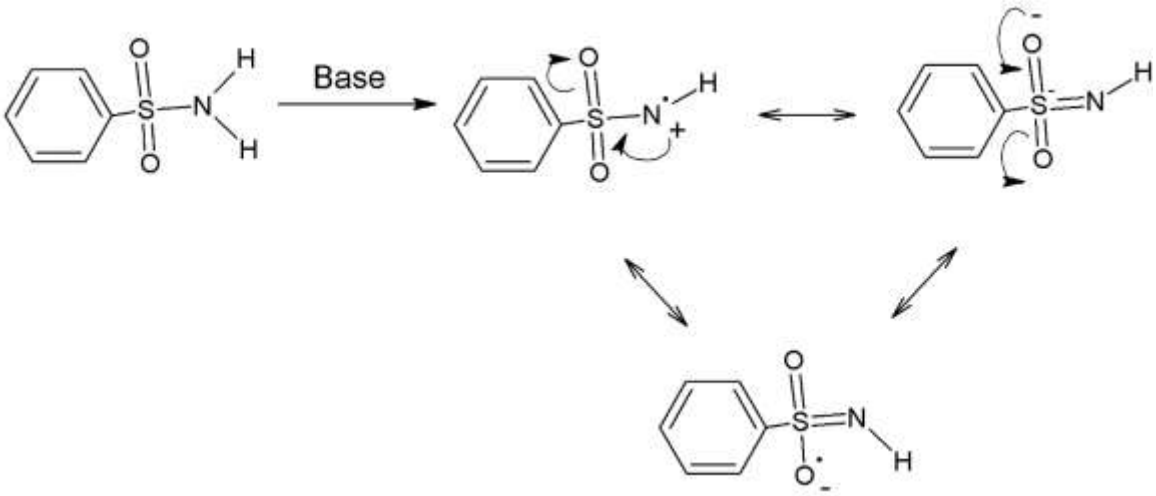
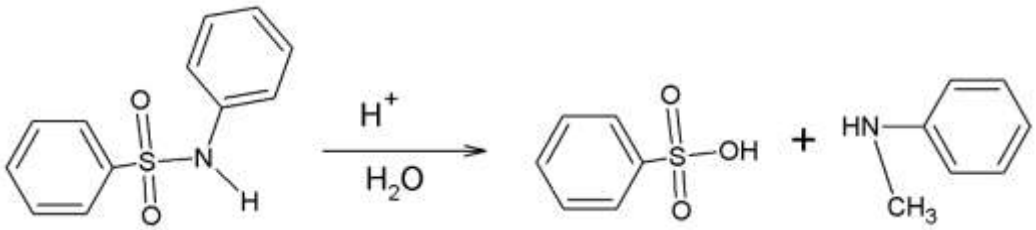
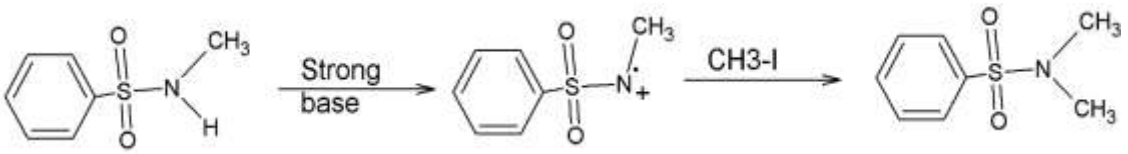
are relatively acidic. Sulfonamides are less acidic than carboxylic acids because a less electronegative nitrogen atom has a negative charge. Because the negative charge produced in the conjugate base may be sustained over more electronegative atoms, they have a higher acidity than amides.



Tertiary sulfonamides are not acidic because they do not contain a "ionizable" proton. This is vital to keep in mind. Sulfonamides, on the whole, have a low reactivity. The equivalent sulfonic acid and amine can be hydrolyzed under the following conditions:

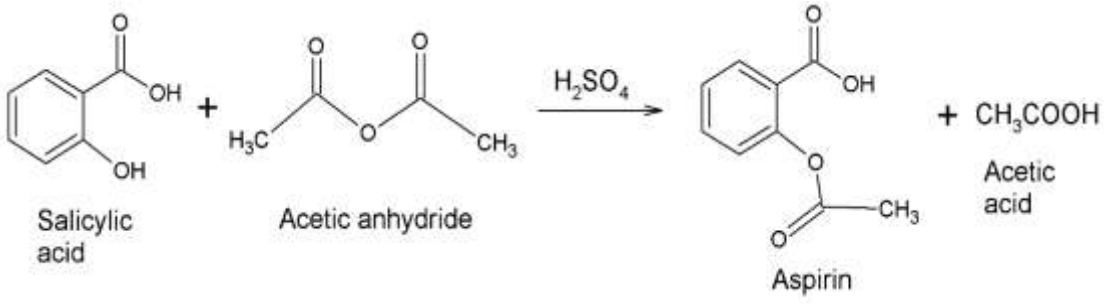


Additionally, primary and secondary sulfonamide anions can be changed to more nucleophilic anions upon treatment with strong bases, and these nucleophiles can engage in displacement reactions like ionised amides as demonstrated below:



Synthesis of Aspirin (acetyisalicylic acid)

An acid catalyst is used to mix salicylic acid and acetic acid to make aspirin (acetylsalicylic acid) and acetic acid. Catalyzing the reaction is frequently accomplished with sulfuric acid or phosphoric acid.



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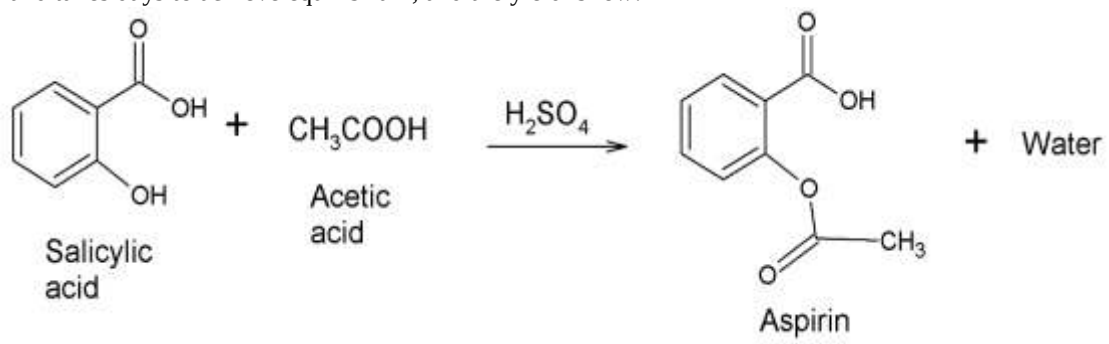
A reaction between salicylic acid and acetic (ethanoic) acid can be initiated, however the reaction is extremely slow and takes days to achieve equilibrium, and the yield is low:



To achieve a higher yield, the commercial production of aspirin makes use of the faster reaction between salicylic acid and the more reactive acetic anhydride, which results in a higher yield of aspirin.

Aspirin (acetylsalicylic acid)

- When it comes to pain relievers and antipyretics, aspirin is a frequently utilised drug in the medical community. It is also used to help people who are at risk of forming blood clots avoid heart attacks, strokes, and the formation of blood clots in their arteries.
- Aspirin (acetylsalicylic acid) is uncommon among aromatic chemicals in that it has both a carboxylic acid and an ester functional group.
- Insoluble in water due to aspirin's weak acidity.
- To create aspirin, combine salicylic acid and acetic anhydride with an acid catalyst.

V. CONCLUSION

The present study aims to accomplish the reactive phase equilibria and to obtain the data for the recovery of carboxylic acids. In the present study, extraction of acids from its aqueous solutions is performed to determine the optimum conditions for the recovery of acids from fermentation broth as well as an aqueous waste stream. The effects of various parameters on the reactive extraction are investigated with the aim of implementing the data obtained to a future industrial separation unit. Long-chain aliphatic amines and organophosphorus based derivatives dissolved in different diluents [inert, active (modifier) and a mixture of both] are used as the organic phases for the extraction of acids from aqueous solutions. Since the growth of microorganisms is inhibited by the toxicity of solvents in the fermentation units, equilibrium studies are also carried out using biocompatible system (extractant/diluent) for the reactive extraction of propionic acid and nicotinic acid.

For the extraction of formic acid, acetic acid, propionic acid, and butyric acid, researchers have used the LSER model to try to measure the effect of diluents on extraction efficiency (distribution coefficient) of the extractant (TOA). For the extraction of nicotinic acid, a model based on dipole moment (u) and E is used to quantify the impact of diluents on extraction efficiency (equilibrium constant) of extractant (TOPO). An optimization process [a population-based search algorithm termed differential evolution (DE)] and graphical methods are used to evaluate the solvation strength of complexes. TOA is used as an extractant for reactive extraction of propionic and nicotinic acids in the kinetic investigation to gather kinetic data.

Carboxylic acid from biological sources, such as those found in food and medicine, relies on it. A review of the literature on carboxylic acids shows that tremendous steps are being taken to improve microbiological production of (90 percent) lactic acid by utilising reactive extraction to separate the acid from aqueous solution. Even though a viable industrial bioprocess has not yet been created, nicotinic acid and propionic acid have enormous potential as building-block chemicals utilised in a wide range of industries. Data on reactive extraction for the recovery of nicotinic acid from aqueous solutions for the intensification of microbial production are currently rare.

REFERENCES

[1]. Rowe RC; Sheskey PJ; Quinn ME, Handbook of Pharmaceutical Excipients. 6th Edition ed.; Pharmaceutical Press: London, 2009.

[2]. Sims JL; Carreira JA; Carrier DJ; Crabtree SR; Easton L; Hancock SA; Simcox CE, A New approach to accelerated drug-excipient compatibility testing. Pharm. Dev. Technol. 8, 119-126, 2003.

[3]. Vueba ML; Veiga F; Sousa JJ; Pina ME, Compatibility studies between ibuprofen or ketoprofen with cellulose ether polymer mixtures using thermal analysis. Drug Dev. Ind. Pharm. 31, 943-949, 2005.
[4]. Verma RK; Garg S, Compatibility studies between isosorbidemononitrate and selected excipients used in the development of extended release formulations. J. Pharm. Biomed. Anal. 35, 449-458, 2004.
[5]. Phipps MA; Mackin LA, Application of isothermal microcalorimetry in solid state drug development. Pharm. Sci. Technol. Today 3, 9-17, 2000.
[6]. Thomas VH; Naath M, Design and utilization of the drug-excipient chemical compatibility automated system. Int. J. Pharm. 359, 150-157, 2008.