НАУЧНЫЙ ЖУРНАЛ
НАУКА И МИРОВОЗЗРЕНИЕ

УДК-54

TECHNOLOGY OF OBTAINING CALCIUM HYPOCHLORITE BY SODIUM METHOD

Nunnakov Mergen

Supervisor: Lecturer of Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

Purmyradova Annasoltan
Student of Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

Introduction

Calcium Hypochlorite is an inorganic salt with white crystal solid appearance and strong chlorine odor. It figures among the few metal hypochlorites that are stable enough to be produced as a solid salt, and it is the principal form of hypochlorite commercially produced worldwide. One of its characteristics is the far greater chlorine availability comparing to other chlorine salts, ranging from typical values of 60-99%. The structure of Calcium Hypochlorite is presented below:

The vast majority of Calcium Hypochlorite is produced according to two main methods: the “calcium method”, and the “sodium method”. It is worth noting, however, that several variations of each method have been patented over the years approaching process improvements.

In the calcium method, basically, slaked lime reacts directly with chlorine generating a mixture of Calcium Hypochlorite, calcium chloride, calcium hydroxide and their hydrates. The proportions of each compound obtained vary from manufacturer to manufacturer, as well as the available chlorine, usually ranging from 24 to 37%.

The calcium chloride is an undesirable by-product generated, since it prevents formation of large, easy-to filter crystals of $Ca(OCl)_2$ and due to its hygroscopicity, impedes product drying, and affects product stability. In this context, industrial processes have been designed to minimize $CaCl_2$ during processing and in the final product.

The sodium method, in turn, mainly consists in passing chlorine into a slurry of slaked lime and sodium hydroxide, so as to avoid the formation of the by-product calcium chloride.

This method also generates sodium chloride (NaCl), which is not hygroscopic and does not have an adverse effect on Calcium Hypochlorite crystal size or product stability. At the end, the sodium method generates a High-Percentage Calcium Hypochlorite, with purity between 65-75 wt %, containing NaCl and water as the main impurities.

For safety reasons, the Calcium Hypochlorite is marketed as hydrated salt- the water reduces the risk of self-sustained decomposition because of organic contaminants or ignition. It is worth noting that impurity content varies widely by the manufacturers, grade and production grade.

Calcium hypochlorite is not flammable, although it should be kept away from heat sources, since it decomposes into hydrogen chloride and chlorine oxygen gas, which are highly dangerous. It is also a National Fire Protection Association (NFPA) Class 3 oxidizer which can cause a severe increase in fire intensity. Calcium hypochlorite is also classified by the NFPA as a health category 3 ("short exposure could cause serious temporary or moderate residual injury), so it should be handled with caution. Calcium Hypochlorite should be packed in plastic drums, with a net wieght limit of 45 kg. The maximum payload per container should not exceed 14 ton.

Commercial Forms & Applications

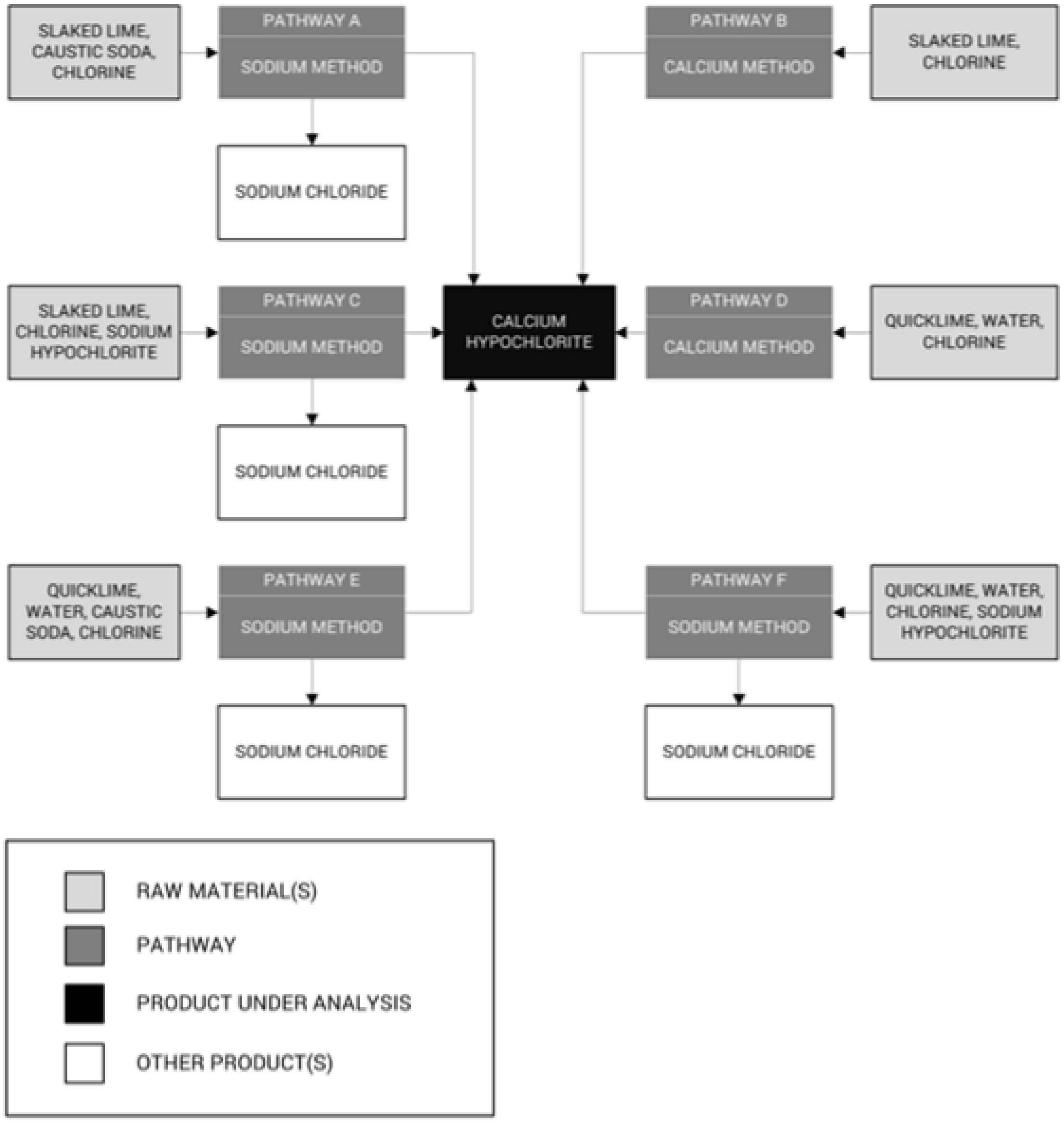
The uses and applications of Calcium Hypochlorite may vary according to the product grade. The main forms of Calcium Hypochlorite are:

Calcium Hypochlorite is mainly used as a sanitizer; oxidizer; bleaching agent; disinfectant and bactericide; fungicide; deodorant; oxidizing agent; and as a bleaching agent for paper and textiles; sugar refining; chlorine production; pharmaceutical preparation; tanning auxiliary; algicide; and odor control.

The largest use of Calcium Hypochlorite is for water treatment– in the United States, more than 75% of Calcium Hypochlorite demand is associated with water pool treatment, municipal and industrial water treatment.

Calcium Hypochlorite Production Pathways

Calcium Hypochlorite was produced for the first time in 1790, by passing chlorine gas over slightly moist calcium hydroxide. This process, still used nowadays, has been improved over the years aiming primarily to minimize calcium chloride formation. Currently, most of Calcium Hypochlorite is produced from sodium hydroxide and slaked lime. Different Calcium Hypochlorite production pathways are presented below.



Product(s) Generated

Calcium Hypochlorite

The main product obtained in the process under analysis is Calcium Hypochlorite powder, containing about 71 wt% of Calcium Hypochlorite, 16 wt% of sodium chloride, and 7 wt% of water. The balance of the composition is mainly composed of other inert compounds such as calcium carbonate, calcium dihydroxide and calcium chlorate.

Sodium Chloride The process under analysis also generates an aqueous solution containing 31 wt% of sodium chloride (NaCl) as by-product. It is assumed that the solution is commercialized to a nearby consumer plant (e.g., a chlor-alkali plant, which produces caustic soda and chlorine from sodium chloride).

Process Inputs. Raw Material(s)

Slaked Lime

Slaked lime is produced from limestone, a naturally occurring mineral consisting mainly of calcium carbonate. Limestone is thermally decomposed in quicklime (calcium oxide), which is then hydrated to slaked lime. The slaked lime used in the process contains about 97 wt% of calcium hydroxide, Ca(OH)2, and 3 wt% of impurities such as magnesium oxide, silica, ferric oxide, and aluminum oxide.

Chlorine

Chlorine figures among the most important chemical commodities. Most of chlorine produced on commercial scale is based on electrolysis of aqueous sodium chloride (brine), which also generates caustic soda and hydrogen as co-products (chlor-alkali processes). In the process under analysis, gaseous chlorine with 99.9% purity is used.

Caustic Soda

Sodium Hydroxide (NaOH), also known as caustic soda, is a major inorganic used in several industries. Most of caustic soda production is used in the manufacture of chemicals, such as propylene oxide and sodium salts. Electrolysis of sodium chloride accounts for most of today's installed capacity for caustic soda production, which also generates chlorine. In the process under analysis, a 50 wt% solution of sodium hydroxide is used.

Conclusions

The process technology under study was categorized according to its maturity. The technical maturity, while a measure of performance, reliability, and operating experience associated with the technology being assessed, serves as an important input in the definition of assumptions that have a relevant impact on process economics (e.g. process contingency, project contingency, costs related to start-up inefficiencies and R&D, etc).

The process technology maturity is defined by Intratec team through a method adapted from the so-called Technology Readiness Level (TRL) method, developed by NASA and nowadays used in a broad range of sectors/industries. There are nine TRLs, which describe the maturity of a technology, from basic technology reasearch to system test, launch and operations.

Originally intended to supporting decision-making over research and development activity, the nine technology readiness levels were divided into five major classes to portray the maturity level of chemical process technologies, from 'concept' to 'established technology'. The table in the next page describes such five classes according to which Intratec team classifies technologies being studied, as well as the TRLs included within each class.

References

1 Konstantinos D, Achilleas C, Valsamidou V (2011) Removal of nickel, copper, zinc and chromium from synthetic and industrial wastewater by electrocoagulation. Int J Environ Sci 1: 698-703.

2 Inglezakis VJ, Loizidou, Grigoropoulou (2003) Ion exchange of Pb2+, Cu2+, Fe2+, and Cr2+ on natural clinoptilolite: Selectivity determination and influence of acidity on metal uptake. J Colloid Interface Sci 261: 49-54.

3 Tchounwou PB, Yedjou CG, Patlolla AK, Sutton DJ (2012) Heavy metals toxicity and the environment. EXS 101: 133-164.

4 Dorne JL, Kass GE, Bordajandi LR, Amzal B, Bertelsen U (2011) Human risk assessment of heavy metals: Principles and applications. Met Ions Life Sci 8: 27-60.

5 Rzymski P, Tomczyk K, Rzymski P, Poniedziałek B, Opala T, et al. (2015) Impact of heavy metals on the female reproductive system. Environ Med 22: 259-264.

6 Nunez O, Fernandez NP, Martin MI, Bel LA, Locutura JF (2016) Association between heavy metal and metalloid levels in topsoil and cancer mortality in Spain. Environ Sci Pollut Res Int 24: 7413-7421.

7 Stern BR (2010) Essentiality and toxicity in copper health risk assessment: Overview, update and regulatory considerations. J Toxicol Environ Health A 73: 114-127.

8 Anyakora C, Kenneth NK, Awodele O, Nwadike C, Arbabi M, et al. (2011) Concentrations of heavy metals in some pharmaceutical effluents in Lagos, Nigeria. J Environ Chem Ecotoxicol 3: 25-31.

9 Khan S, Cao Q, Zheng YM, Huang YZ, Zhu YG (2008) Health risks of heavy metals in contaminated soil and food crop irrigated with wastewater in Beijing, China. Environ Pollut 152: 686-692.

10 Hernandoa MD, Mezcuaa M, Fernández-Albaa AR, Barcelób D (2006) Environmental risk assessment of pharmaceutical residues in wastewater effluents, surface waters and sediments. Talanta 69: 334-342.