CALCIUM CYCLE IN CHEMISTRY TEACHING AT THE LOWER SECONDARY SCHOOL

Karel Kolar
University of Hradec Kralove & Charles University, Czech Republic
E-mail: karel.kolar@pedf.cuni.cz

Martin Bilek
University of Hradec Kralove & Charles University, Czech Republic
E-mail: martin.bilek@pedf.cuni.cz

Katerina Chroustova
Charles University & University of West Bohemia, Czech Republic
E-mail: chroustk@cbg.zcu.cz

Jiri Rychtera
University of West Bohemia, Czech Republic
E-mail: jaretchyr@gmail.com

Veronika Machkova
University of Hradec Kralove, Czech Republic
E-mail: veronika.machkova@uhk.cz

Abstract

The research is focused on the use of experimental calcium cycle in chemistry teaching at the lower secondary school. The cycle is based on four reactions: 1. thermal decomposition of calcium carbonate, 2. reaction of calcium oxide with water, 3. calcium hydroxide with hydrochloric acid, 4. reaction of calcium chloride with sodium carbonate. The calcium cycle was tested at lower secondary schools (and equal classes from comprehensive schools). Despite the difficulty of taking some steps, the cycle was accepted by both teachers and learners.
Keywords: *chemistry teaching, experimental cycle, calcium cycle, lower secondary education*.

Introduction

Experimental cycles are fewer common alternatives to organizing and conducting school experiments. They are based on the mutual transformations of chemicals, while the starting material of the cycle is also its final product. They are based on chemical transformations of inorganic substances as well as organic substances, they also take other forms, such as waste recycling. Cycles based on chemical transformations of inorganic substances are most used in teaching at the lower secondary school. In this context, a copper cycle, based on a series of copper and its compound reactions (Condike, 1975), has taken an important position in this field of school experiments. The cycle is attractive in terms of teaching, it is associated with significant colour changes

in substances, changes in the reactant state and variety of reaction types, for example, acid-base reaction of oxidation-reduction etc. A certain disadvantage is the toxicity of some of the substances formed during the cycle. Experimental cycles have proved to be an interesting, less common way of presenting chemical transformations. They were subjected to further investigation in relation to their use in teaching thematic units of chemical reaction at the lower secondary school.

In this context, an experimental calcium cycle has been proposed as an alternative to the already used copper cycle. So far, little attention has been paid to calcium if it is in experimental cycles for teaching. For example, the calcium cycle in nature (Duesing, 1985), or processes associated with practical activities: limestone burning, lime slaking, mortar solidification (Luna Vera, Guancha Chalapud, Castillo Viveros, & Vasquez Medina, 2018, Royal Society of Chemistry, 2008). In this context, a simple cycle was designed based on four reactions. The starting compound was calcium carbonate. The first cycle step was thermal cleavage of calcium carbonate leading to calcium oxide. In a second step, calcium oxide was converted to calcium hydroxide by reaction with water. The third step – calcium hydroxide reaction with hydrochloric acid gave calcium chloride as the product, which in the fourth step reacted with sodium carbonate to calcium carbonate – the starting compound of the cycle (see Figure 1).

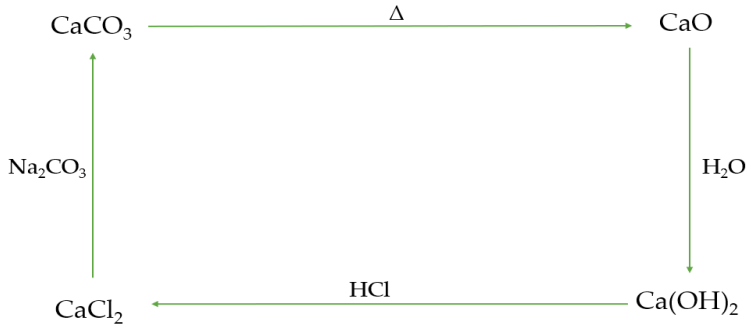

Figure 1. Diagram of calcium cycle.

The cycle is a multi-layered set of reactions that can be interpreted in several contexts. For example, the first and second steps symbolize the already cited technological processes (limestone burning and lime slaking), as well as reactions that occupy significant positions in terms of chemical reaction classification – chemical decomposition and chemical compounding. The next step of the cycle is chemical replacement, according to other criteria an acid-base reaction. The last step is a double exchange and from another point of view a precipitation reaction. The experimental cycle is based solely on changes in the state of matter – colourless solutions change to white precipitates and vice versa. Therefore, the experimental cycle is complemented by a series of tests relating to individual products, which are again mainly based on precipitation reactions. It is also necessary to measure pH, which accompanies all steps of the experimental cycle (Kolar, Bilek, Machkova, Rychtera & Chroustova, 2018). The main purpose of presented research is to verify the new module with the topic Chemical Reaction for teaching of chemistry at the lower secondary school.

Research Methodology

The experimental cycle of calcium was tested in chemistry education at the lower secondary school through methods of action research. Three teachers and 81 15-year old learners in four classes took part in the evaluation process of the calcium experimental cycle in March and April 2019. The evaluation of the results of the experimental cycle of calcium in teaching was mediated by teachers through their observations of lessons and through their group interviews with learners.

Research Results

The teachers' observations and their summarizing of results from group interviews with learners show that the experimental cycle was generally favourably accepted. The teachers had several comments to implement. Above all, it is the number of lessons, teachers believe that laboratory exercises cannot be fully realized during two lessons. Regarding the actual realization of the experimental cycle, the greatest difficulty appeared to be with the first step of the experimental cycle – thermal decomposition of calcium carbonate. The conversion of calcium oxide to calcium hydroxide was then only a routine matter. With some problems, the reaction of calcium hydroxide with hydrochloric acid was also associated with overdose. Teachers evaluate the complexity of the experimental cycle as a benefit, because it is not only related to conducting their own experiments, but relates to a closer understanding of different types of reactions, in conjunction with chemical nomenclature, chemical calculations, the way notes on the realization of experiment and the formulation of conclusions (protocols). Small problems were identified only on technical and material support of lessons realisation.

Conclusions

Experimental cycles in terms of pedagogy fully meet the requirements of the school experiment. The copper cycle, which carries security risks, was replaced with a cycle of calcium, which does not produce such significant colour changes but is safer and allows learners to perform experimentation. After verifying this cycle in chemistry teaching, despite all the difficulty of carrying out the experiment especially the thermal decomposition of calcium carbonate, it was accepted by the teachers and the learners with understanding. Teachers also pointed to the fact that conducting an experimental cycle teaches learners careful accuracy and responsibility in experimental work.

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