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Congratulations on the anniversary of Professor S.E. Kudaibergenov

The article is dedicated to the 70th anniversary of Sarkyt Elekenovich Kudaibergenov, a prominent Kazakh scientist-chemist. His career and the most significant events of his scientific life are briefly described here. The contribution of Professor S.E. Kudaibergenov to the development of physical chemistry of polymers and his participation in the internationalization of the polymer scientific school are shown.

This article is devoted to the 70th anniversary of Sarkyt Elekenovich Kudaibergenov, a prominent Kazakh scientist-chemist. S.E. Kudaibergenov is an internationally recognized expert in the field of physical chemistry of polymers, Doctor of Chemical Sciences (1991), Professor (1994), Laureate of the Kazakh SSR State Prize in Science and Technology (1987).

Professor S.E. Kudaibergenov is an enthusiastic person who has been inspiring his colleagues and a large number of young researchers working in the field of polymer science for several decades. His fundamental scientific works mainly devoted to the physical chemistry of hydrophilic polymers, stimulated significant progress in this field [1–6].

After graduating from the Faculty of Chemistry at Kazakh State University named after Kirov (now Al-Farabi Kazakh National University) in 1973, Sarkyt Kudaibergenov remained at this university as an engineer and then as a research intern. His academic career continued at the Institute of Chemical Sciences of the Academy of Sciences of the Republic of Kazakhstan in the Laboratory of Physical Chemistry of Polymers led by Academician E.A. Bekturov, a distinguished chemist. A truly important milestone in the career of Professor S.E. Kudaibergenov was the work on a candidate dissertation on the topic "Hydrodynamic properties of polyelectrolytes based on vinylethylpiperidoles-4", which he successfully defended in 1980. This work anticipated his innovative research on the development of the physical chemistry of polyelectrolytes [7, 8]. Studies of polymer complexation reactions were one of the many contributions that S.E. Kudaiberegenov made for the development of polymer science.

One of his first co-authored monographs "Polymer Complexes and Catalysts" describes the interaction of macromolecules with metal ions, explains the mechanisms and conditions of formation of polymer-metal complexes, which have great theoretical interest and practical application [9]. In this book the catalytic properties of some macromolecular compounds in solutions, which are models of biocatalyst-enzymes, are also described. These works formed the basis of the author's further research [10–12]. In 1991 S.E. Kudaibergenov defended his Doctoral Thesis "Complex formation reactions with participation of synthetic polyampholytes" at Lomonosov Moscow State University, in 1994 he has received a title of Professor. After productive work at the Institute of Chemical Sciences, Sarkyt Elekenovich works at responsible positions in the scientific structures of the Ministry of Education and the National Academy of Sciences of the Republic of Kazakhstan. In 1996 S.E. Kudaibergenov was invited to the position of Professor at al-Farabi Kazakh National University,

where he organized a scientific group for the production and research of "smart" polymeric materials based on hydrogels and interpolymer complexes. In 1999 Professor S.E. Kudaiberegenov founded a private research organization "Institute of Polymer Materials and Technologies", which successfully operates today and contributes to the development of polymer science in Kazakhstan. The special connection of the scientist with his small motherland is expressed in his cooperation with Semipalatinsk Shakarim State University, where he was a professor of the Department of Chemistry from 2005 to 2019. S.E. Kudaibergenov made a great contribution to the organization of scientific work of Kazakh National Technical University named after K.I. Satpayev, where he permanently headed the Laboratory of Engineering Profile (2008–2020).

As a famous scientist in the field of fundamental science Professor S.E. Kudaibergenov was able to apply the results of theoretical research to solve important practical problems, in particular to increase the efficiency of oil production. The scientist had experience as the head of scientific subdivisions of oil producing companies "KazTransOil" and "KazMunayGas" (2001–2004), headed the commercialization project "Development and implementation of polymer flooding technology to increase oil recovery". These works are important for the development of the economy of Kazakhstan.

In the early days of his scientific career, in 1995, S.E. Kudaibergenov completed a three-month internship at the National Science Foundation in the USA, where he became acquainted with the system of science funding in that country. Then in 1998, as a visiting professor, he researched at Waseda University (Japan) in the research group of Professor E. Tsuchida.

In 2002–2003 Professor S.E. Kudaibergenov was invited as a professor at Kwangju Institute of Science and Technology (South Korea), where he researched and shared his experience with young scientists. He is one of the first scientists in Kazakhstan who received several grants from international foundations, including Soros Fund (1994), INTAS-Kazakhstan (1997, 1999, 2001), INTAS-Aral (2003), NATO (2011–2014), projects with China (2015–2016, 2018–2019), EU Horizon-2020 (2019–2022). Professor S.E. Kudaibergenov is a member of the editorial board of several national English-language scientific journals and was also a guest editor of the special issue "Advanced Technologies in Polymer-Protected and Gel-Immobilized Nanocomposites" for the Polymers journal (MDPI, 2020). He is a regular guest lecturer at international scientific conferences and symposia and a member of the organizing committee of several prestigious scientific forums, including the IUPAC International Symposium on Macromolecule-Metal Complexes (MMC) and the International Symposium on Macro- and Supramolecular Architectures and Materials (MAM). S.E. Kudaibergenov initiated 8 International workshops on polymer specialty that were held in Almaty, Semey and Issyk-Kul (Kyrgyzstan). The last workshop was held at Karagandy University of the name of academician E.A. Buketov in 2019, sponsored by the International Science and Technology Center (ISTC). Invited by S.E. Kudaibergenov, well-known national and international scientists such as Hiroyuki Nishide (Waseda University, Tokyo), Sayora Rashidova (Institute of Physics and Chemistry of Polymers, Uzbekistan), Gulzhian Dzhardimalieva (Institute of Chemical Physics of RAS, Russia), Vladimir Lozinsky (Institute of Elementoorganic Compounds of RAS, Russia), Oguz Okay (Istanbul Technical University, Turkey), Hekki Tenhu (University of Helsinki, Finland), Vitaliy Khutoryanskiy (University of Reading, UK) made plenary reports at the VIII International Symposium on Specialty Polymers. The above mentioned demonstrates that Professor S.E. Kudaibergenov is a scientist of world renown, and the results of his research are recognized in the scientific community. He is also distinguished by his great desire to help young scientists choose their scientific direction, find foreign partners, and use the results for the benefit of the national scientific school.

Professor S.E. Kudaibergenov individually and in collaboration published 19 monographs in Russian, Polish and English languages, he has more than 400 scientific publications, including 17 review articles, 11 book chapters and more than 130 scientific articles published in English in international peer-reviewed journals with a high impact factor. In 2002 and 2021 he published fundamental monographs "Polyampholytes: Synthesis, Characterization and Application" in Springer and "Polyampholytes: Past, Present, Perspectives" in Kazakhstan publishing house. According to the Web of Science, Clarivate Analytics database, S.E. Kudaibergenov is the world's leader in the number of publications in the field of Polyampholytes [13–16]. The annual citation index of his works reaches up to 200 citations. His Hirsch index is 20.

As a member of the editorial board of the journal "Bulletin of the Karaganda university. Chemistry series" Professor S.E. Kudaibergenov contributes to the further promotion of our publication in international scientific bases, his articles and reviews published in the journal are the most demanded among readers. On behalf of the editorial board of the journal we congratulate Professor S.E. Kudaibergenov with his 70th anniversary! We wish you great success in scientific work, good students and followers, new scientific works.

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Е.М. Тажбаев, М.Ж. Бүркеев

Профессор С.Е. Құдайбергеновті мерейтойымен құттықтау

Мақала қазақтың көрнекті ғалым-химигі — Сарқыт Елекенұлы Құдайбергеновтің 70 жылдық мерейтойына арналған. Оның еңбек жолы және ғылыми қызметіндегі маңызды кезеңдері қысқа түрде сипатталған. Профессор С.Е. Құдайбергеновтің полимерлердің физикалық химиясын дамытуға және полимерлер ғылыми мектебін интернационалдандыруға қосқан үлесі көрсетілген.

Е.М. Тажбаев, М.Ж. Буркеев

Поздравление с юбилеем профессора С.Е. Кудайбергенова

Статья посвящена 70-летнему юбилею выдающегося казахстанского ученого-химика — Кудайбергенова Саркыта Елекеновича. В краткой форме описаны его трудовой путь и наиболее значимые события научной карьеры. Показан вклад профессора С.Е. Кудайбергенова в развитие физической химии полимеров и его участие в интернационализации полимерной научной школы.

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The use of Lewis acid $AlCl_3$ as a promoter in the Pd-complex catalytic system of the cyclohexene hydroethoxycarbonylation reaction

This paper presents the results of detailed studies of the possibility of using Lewis acid $AlCl_3$ as a promoter of the catalytic three-component system $PdCl_2(PPh_3)_2$–PPh_3–$AlCl_3$ in the hydroethoxycarbonylation reaction of cyclohexene at low carbon monoxide pressures (2.5 MPa). As a result a high catalytic activity of the three-component system was established and the reaction proceeds regioselectively with the formation of ethyl ether of cyclohexanecarboxylic acid. The optimal conditions of the process have been elaborated (molar ratio of the starting reagents [Cyclohexene]:[Ethanol] = 1:1; molar ratio of the components of the catalytic system = = $[PdCl_2(PPh_3)_2]$:$[PPh_3]$:$[AlCl_3]$ = 1:6:9; carbon monoxide pressure P_{CO} = 2.5 MPa; process temperature T = 120 °C and reaction time τ = 5 h) at which the target product yield reaches 80.7 %. To identify the obtained ethyl ester of cyclohexane carboxylic acid gas chromatographic analysis and mass- and IR- spectra were carried out. Based on the data obtained, a possible mechanism of the reaction route of cyclohexene carbonylation with carbon monoxide and ethanol in the presence of the three-component system $PdCl_2(PPh_3)_2$–PPh_3–$AlCl_3$ is proposed and discussed.

Keywords: cyclohexene, carbon monoxide, Pd-complex catalysts, phosphine ligands, aluminium (III) chloride, hydroalkoxycarbonylation, ethyl ester of cyclohexanecarboxylic acid, "Hydride" mechanism.

Introduction

Production technologies based on the use of carbon oxides are being developed recently throughout the world. Development of processes based on carbon monoxide use is motivated by a number of reasons. One of key reasons is the need to use alternative sources of raw materials. Starting from 40's of XIX century oil was the main source of raw material for chemical production, and petrochemicals production on its basis developed fast. However, a trend of crude production slowdown is observed today and effective processes that will be able to replace it are being searched for [1–3].

The carbonylation method is used, on an industrial scale, in the synthesis of carboxylic acids, hydroxy-acids, acid anhydrides, lactones, alcohols, ethers and esters, aldehydes and ketones. Many of these reactions have been well-studied and developed but a number of processes still undergo the search for catalyst systems with relatively high activity and selectivity.

It is possible to synthesize compounds with a large number of carbonyl groups having practical importance by carbonylation of unsaturated compounds. Interest to this reaction is preconditioned by the possibility of recovery of unsaturated compounds from non-petroleum raw material (natural gas, coal) [1–4].

The interaction of olefins with CO and H_2O leads to the formation of linear or branched carboxylic acids. Esters of carboxylic acids are obtained by replacing water with alcohol. The structure of the obtained esters depends primarily on the nature of the catalysts used, as well as the conditions of their use. Derivatives of

