

Evaluation of the Research and Professional Activity of the Institutes of the Czech Academy of Sciences (CAS) for the period 2010–2014

Final Report on the Evaluation of the Institute

Name of the Institute: Institute of Chemical Process Fundamentals of the CAS,
v. v. i.

Fields, in which the Institute registered its teams:

Chemical engineering, Materials engineering, materials science and nanotechnology

Observer representing the Academy Council of the CAS: Jiří Chýla

Observer representing the Institute: Petr Klusoň, substitute observer Jaroslav Tihon

Commission No. 8: Engineering and technology

Chair: em Prof.DI.Dr.Dr.hc. Hans Peter Nachtnebel

Date(s) of the visit of the Institute: October 12 - October 21, 2015

Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:

*No. 1 - Eduard Hala Laboratory of Separation Processes; No. 3 - Department of Catalysis
and Reaction Engineering; No. 4 - Department of Multiphase Reactors*

EVALUATION OF THE INSTITUTE OF CHEMICAL PROCESS FUNDAMENTALS

1. INTRODUCTION

1.1 Location of the institute and its dept., labs. & sub units.

Institute of Chemical Process Fundamentals of the CAS, v.v.i.
Rozvojová 135/1, 165 02 Praha 6 - Suchbátka

1.2 Brief history of the institute

The institute was founded at the Czechoslovak Academy of Sciences in 1960. In 1989 several restructurings had been carried out that lead to a gradual decrease of staff by 50%. Since 2007, the Institute has become a public research institution.

1.3 Mission and research topics

Current activities of the Institute have character of both basic and applied research and they include e.g., the theory of chemical processes, especially in chemical engineering, physical chemistry, chemical technology and environmental engineering, etc. The Institute consists of 6 research departments: E. Hala Laboratory of Separation Processes, Laboratory of Aerosols Chemistry and Physics, Department of Catalysis and Reaction Engineering, Department of Multiphase Reactors, Department of Analytical and Material Chemistry, and Environmental Process Engineering Laboratory.

1.4 Staff size and full time equivalents age distribution

In the full time equivalent, the Institute has currently 151.3 employees, 67.3 from which are researchers. Age structure of all Institute employees is summarized in Table 1.

Tab. 1 – Age structure of the Institute employees

Age category	< 25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	≥ 70
No. of members	9	26	29	26	8	10	16	20	13	15	9

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

Both theoretical and experimental research topics of the Institute are very exacting. They are focused on serious current problems in the top research areas, especially in the current fundamental chemical process engineering and have auspicious potential in the future.

2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

National and international grants and commercial contracts are for the Institute substantial and indispensable part of overall budget, because institutional financial aid covers only 44 %. The Institute have proved the admirable ability to get some additional sources.

2.3 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

Collaboration between individual departments of the Institute is beneficial; its intensity depends on the current needs, e.g., co-utilization of the special instruments and personal potential; joint participation on the projects, etc. Cooperation of the Institute with other external research subjects and universities both in the Czech Republic and abroad is intensive and fruitful.

2.4 Position of the institute within the Czech scientific community and its international position

The Institute holds a leading position in fundamental chemical process engineering research in the Czech Republic, and its position in international scientific community is also substantial.

2.5 Reasonability of the structure of the institute and the departments

The Institute consists of 6 departments; this structure is reasonable; it is based on the heterogeneity of the individual research topics.

2.6 Comments on the age structure

High ratio of young employees (about 35 % under 35 years) is very positive and perspective for the following area. Young researchers and students have possibilities to be in close contact with highly qualified and experienced older colleagues of international stature.

2.7 Frequency and quality of publications

Publication activity of the Institute researches is on the high level both from quantitative and qualitative point of view. During the 2010-2014 period, 561 various outputs were published; 348 of them (i.e., 62 %) in top decile (1*) and quartiles 1-2 by AIS of journals. This fact was fully confirmed in the Evaluation Phase I, when 67 (i.e., over 50 %) from 131 selected publications were classified as world-leading or internationally excellent.

2.8 Patents and role in contractual work

In comparison with the Institute staff size, number of patents or patent applications is outstanding. As an example, 25 patents were applied in 2014. In the evaluated area, one of the patents was solved to an implementer abroad.

3. WEAKNESSES AND THREATS

3.1 Budget: Ratio of institutional budget, grants and contractual resources, international funds

Number of international grants is so far rather limited. Also rather higher percentage of contractual financial resources would be beneficial.

3.2 The overall capacity of staff

More acquisition of foreign postdocs and young scientists will be welcomed.

3.3 Comments on the age structure

Relatively high ratio of employees over 60 years (about 20 %) in combination with the gap in the middle age sector would result in some personal problems in the next years; especially in high management positions.

4. RECOMMENDATIONS

It is possible to recommend intensive activities in the field of career development which will be focused especially on the financial and other motivation of young, talented researchers both from the Czech Republic and other countries with the aim to reduce potential personal problems at the Institute.

5. DETAILED EVALUATION

5.1 Declaration on the quality of the results and share in their acquisition

Characterisation of the main research activities (experiments, theoretical areas)

The Institute has character of multidisciplinary scientific institution - its research niche is in the areas of chemistry, nanotechnology, biotechnology, mathematics, physics, and machinery. The main research activities of the Institute have a character of very exacting theoretical approaches and/or sophisticated experimental research.

Relevance in the national and international context

Research activities of the Institute have very import relevance both in the national and in the international context. The Institute holds a leading position in fundamental chemical process engineering research in the Czech Republic, and it is a responsible partner in teams of EU Framework Programme and other international projects. The Institute also takes substantial part in the organization of many international events as conferences, congresses, workshops etc. The Institute has benefits from long-term scientific contacts with various partners and close and fruitful links to the Czech chemical industry companies.

Overall quality of publications

Scientific outputs of the Institute researchers have generally very good quality, most of them are published in top decile (1*) and quartiles 1-2 by AIS of journals. This fact was fully confirmed in the Evaluation Phase I, when 67 (i.e., over 50 %) from 131 selected publications were classified as world-leading or internationally excellent. Also intensity of citations of these publications is very good.

Specification of the main achievements

The Institute is focused on the top research in the pure inorganic, organic, analytical, and physical chemistry, applied chemistry in homogeneous and heterogeneous catalysis, chemical reaction engineering, separation and material science, and other related technological areas (e.g., hydrodynamics of multiphase flow systems, environmental biotechnology, aerosol formation and transformation, chemical processes accelerated by laser beams or microwave field, etc.). The main achievements were obtained in the field of

- Separation Processes in Chemical Engineering,
- Aerosol Chemistry and Physics,
- Heterogeneous Catalysis and Reaction Engineering,
- Hydrodynamics of Multiphase Reactors,
- Analytical and Material Chemistry,
- Environmental Processes.

Specification of the contributions of the team to publications

Although some joint publications have co-authors from other research organizations, the contribution of the Institute staff members to the presented outputs is substantial.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

The Institute cooperates with many universities in the Czech Republic (especially University of Chemistry and Technology Prague, and also Charles University in Prague, Czech University of Life Sciences Prague, University of Pardubice, University of J. E. Purkyně in Ústí nad Labem, University of Hradec Králové, and VSB - Technical University in Ostrava. Numbers of BSc., MSc. and PhD theses under supervision of the Institute staff members in the evaluation period is summarized in Tab. 2. Involvement of students, especially doctoral, in the research activities of the Institute is very fruitful.

Tab. 2 - Supervising students in 2010-2014 period

Type of study	No. of supervisors (theses, dissertations)	No. of consultants and co-supervisors	Theses defended in 2010-2014
Bachelor	10	36	44
Master	9	36	41
Doctoral	22	9	18

Particular contributions of students to research

Contribution of undergraduate and doctoral students to the research at the Institute is very fruitful because under supervision of experienced scientists and technicians, they are very often able to do very useful research work. They participate on the activities of the Institute in the framework of various research projects, etc. This kind of collaboration between Institute and universities is very beneficial for both contracting parties.

Number of defended PhD students in relation to students involved (success rate)

In 2010-2014, altogether 22 Ph.D. students had their supervisors from the Institute. In the same period, 18 Ph.D. theses were successfully defended (see Tab. 2). These facts evidence the very good success rate of pedagogical activities of the Institute staff members.

Employment of former Ph.D. students (career options)

After defending their thesis, majority of doctoral students, who want to apply for a scientific position at the Institute, was encouraged to leave the laboratory for at least a year to gain experience in some competitive research institutes in the Czech Republic or abroad as a postdoctoral research fellow. This personnel policy led to the improvement of age distribution of the Institute staff. Employment of former Ph.D. students is generally welcomed, but the institutional part of the Institute budget is restricted and thus financial possibilities of admission of new young research workers depend especially on the success of project proposals.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

The Institute budget consists of 44 % institutional source, 38 % inland grants, 6 % international grants, 3.5 % industrial contracts, and 8.5 % other sources. From this summary it is evident that success in grant application and acquisition of commercial contracts is entirely substantial for the Institute economy.

Impacts of the results and other activities on education

Cooperation of universities with the Institute is very intensive both in research and education. Participation of students on the solution of particular research problems is very beneficial part of their education. For undergraduate and doctoral students, possibility of utilization of unique experimental instruments under supervision of experienced members of the Institute staff offers very good opportunities. Aside from supervision of students' works, researchers have many various special lectures at several Czech universities.

Outputs providing information relevant for public policy decisions in all fields of life Services for research (libraries, data bases, collections,...)

Library of the Institute is collecting, processing, keeping and making available the required scientific information, takes care of online access to scientific journals, databases), it manages subscription to scientific information resources, and information exchange among libraries, it takes care of printed versions of journals and books, and it collects and archives research results of the Institute scientists.

Information Technology Department of the Institute provides network administration services for the whole campus of Czech Academy of Sciences located in Prague 6 - Lysolaje, and maintains computing clusters, servers and information systems for support of research groups.

The Institute has provided the long-term QA/QC data on physical and chemical properties of atmospheric aerosols into European database EBAS which is available for global atmospheric modelling groups. The Institute also has provided data on liquid-liquid equilibria of binary mixtures of ionic liquids and molecular compounds into database that is subsequently processed into a review paper in Journal of Physical and Chemical Reference Data.

Popularisation and similar activities, impacts of the results and other activities on culture

Apart from education, the Institute paid considerable attention to the popularisation of its research activities for wide public. In the evaluated period, the Institute took part in many events of this character, e.g., annual Doors Open Days, Chemistry Fun Fairs, Schola Pragensis, Night at the Library, Week of Science and Technology of the Czech Academy of Sciences, International Year of Chemistry: Women Sharing a Chemical Moment in Time Networking Breakfast, Tycho de Brahe's tomb opening, Glass-making celebration in Nový Bor, Presentation of microwave glass melting furnace, etc.

It is obvious, that some of the mentioned events are very closely related to the culture activities.

Summary of the basic information about the Institute and its activities for the public was also presented in the form of article in Scientific American journal and DVD-Video.

5.4 Declaration on the position in the international and national context

Position of the team in the national context, comparison of the position, recognition, outputs and impacts with leading and international teams, role and position in international collaboration, breadth/completeness of the research activities compared to world leading teams of comparable size

Uniqueness of the Institute is grounded on their orientation both on the process and chemical reaction engineering research and on the novel instrumentations and technology development. In the Czech Republic, the Institute holds a leading position in fundamental chemical process engineering research.

The Institute is very responsible partner in the international collaboration: it is widely involved in the Framework Programmes of the EU, NATO Research Programmes, and in many other projects based on bilateral cooperation agreements between Czech Academy of Sciences and foreign research institutions, as well as in various other forms of joint research projects and partnerships.

Breadth and quality of the Institute research activities are fully compared to the world leading scientific teams of comparable size with orientation on similar topics.

Ability to attract foreign researchers at different levels

The Institute has been employing scientists and researchers from abroad: currently 1 from Bulgaria, 1 from Croatia, 1 from UK, 1 from Ireland, 1 from Russia; 2 from Belorussia, 2 from Portugal, 2 from Ukraine, and 3 from Slovakia. Wider involvement of foreign researchers is restricted mainly by two following factors:

- So far, Czech salaries level is too low for the scientific workers from the most EU countries.
- The employment of workers from countries outside the EU is rather hindered by many legislative barriers.

5.5 Declaration on the vitality and sustainability

Composition of staff with respect to age and gender, qualification, international experience

Age structure of the Institute employees is given in Tab. 1. From the data presented is evident a gap in the middle age sector (between 40 and 55 years). High ratio of young employees

(over 35 % under 35 years) is very perspective; close contacts between young researchers and students and older, very experienced and highly qualified experts of international stature is very positive and beneficial. But relatively high ratio of workers over 60 years (about 20 %) in combination with the mentioned gap in the middle age sector would result in some personal problems in the next years. Exact information about the gender issue is missing, but it is possible to estimate that females comprise about one third of the Institute research staff.

Attraction of research programmes for young people

The Institute strategy for young people involvement is based mainly on three activities:

- internal “grant agency” for support of Ph.D. students, and financial support of young, talented scientists from abroad,
- postdocs research fellowship before job application at the Institute,
- establishing the relatively young, motivated teams with international experience and ability to start new research programs.

Funding (structure of the resources and its comparison with the outputs, grants and project activity)

The ratio of the institutional support on the Institute budget is about 44 %. Rest of the budget is made up of domestic or international grants, and industrial contracts, thus it is clear that success in grant application and active cooperation with commercial sector is entirely substantial for the Institute economy.

Effectiveness of research (based on comparing size of groups, funding and output)

Quantity and quality of the research outputs correspond to both size of research staff and financial sources.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

The Institute consists of 6 individual research departments; cooperation between them is efficient and fruitful. The organisational structure is suitable; it is based on the variety of the research problems at the Institute. Incentives for young peoples and international researchers mentioned above are adequate to the Institute current possibilities.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

In the following years, the main activities of the Institute will be focused especially on

- more intensive involvement in international projects (e.g. Horizon 2020),
- acquisition of foreign postdocs and young scientists,
- deeper collaboration with perspective commercial enterprises,
- attempt to produce the research outputs in the form which will be “more ready” for application.

The mentioned strategy and presented research plans are relevant, perspective and beneficial for the further progress in the Institute activities.

Adequacy of available means and human resources to achieve these plans

The Institute has adequate both technical and human resources to achieve the out lined plans for next years.

EVALUATION OF THE INSTITUTE OF CHEMICAL PROCESS FUNDAMENTALS

Dept. of Catalysis and Reaction Engineering

This report refers to the Evaluation of the Institute of Chemical Process Fundamentals – Department of Catalysis and Reaction Engineering - of the Academy of Sciences of the Czech Republic, 2010-2014, and is written according to the guidelines reported in the Appendix 6.1 and 7.1 as well as the Recommendation for Elaboration of the Final Report drawn by the CAS. This evaluation is based on the materials provided from the Institute of Chemical Process Fundamentals and from the particular Department, from the web pages [www.icpf.cas.cz], from particular presentations, and last but not least from discussions with researchers and management of the Institute (all within the “on site visit” on October 16, 2015).

1. INTRODUCTION

1.1 Location of the institute and its dept., labs. & sub units.

Laboratories and the other facilities of this department are in the campus of the Institute (Rozvojová 135, 165 02 Praha 6).

1.2 Brief history of the institute (department)

The Institute was created in 1960 from the former Department of Organic Technology, Institute of Chemistry, and the Chemical Engineering Laboratory of the Czechoslovak Academy of Sciences. Its previous name was the Institute of Theoretical Fundamentals of Chemical Technology of the CSAS. The current name was adopted as of 1 July, 1993.

In 1964 the Institute moved to a new campus located on the northwest outskirts of Prague (on the border between the suburban districts of Suchbátka and Lysolaje). The Institute deals with research in the domain of the theory of chemical processes, covering especially the fields of chemical engineering, physical chemistry and environmental engineering.

[Based on materials provided and materials from www.icpf.cas.cz]

1.3 Mission and research topics

The main expertise has covered all major aspects of homogeneous and heterogeneous catalysis, materials science with special focus on texture and morphology studies, transport phenomena, environmental processes, mathematical modelling, nanotechnology and biotechnology.

1.4 Staff size and full time equivalents age distribution

The Department 3 (Department of Catalysis and Reaction Engineering) is relatively large. The sum of the full time equivalents as of December 31, 2014,

technical workers: 10.92 (15 persons, 6 women),

researchers 12.15 (16 persons, 10 women),
among them 3 Ph.D. students and 6 postdoctoral fellow.

Age structure of the Team 3 [under the Institute Report]

Age	<25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	>70
number	2	4	4	5	0	1	1	4	3	3	3

In general the Department has a beneficial and perspective high number of young researchers below 35 – 40 years. Low fraction of researchers between 40-55 years might be certainly a threat in the next period for the continuation of present research directions.

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The research strategy of the department is very good; it is focused on serious current problems in the top research areas, especially in the current fundamental chemical process engineering, it relies on cumulative building of a knowledge base through fundamental research projects and dissemination through applied research within a framework of contractual projects with industrial partners. This concept reflects also a combination of in-depth focus and diversity of projects. Diversity seen through a large number of projects is able to deliver a flow of new ideas and impulses pushing the staff forwards.

Involvement of the department in the Strategy of the CAS AV21

The research programme “**Efficient energy conversion and storage**” of the new Strategy AV21 includes several research topics, or sub-programmes. The Department of Catalysis and Reaction Engineering is involved in one of them, called “New fuels for efficient and clean combustion”, which is coordinated by Miroslav Puncochar, the head of the Institute.

2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

It is evident the research activities were very diverse and broad. The Department profits of its international recognition based on long-term scientific contacts, intensive publication activities, high rate of success in reaching the grant funding, and close links to the Czech and also abroad industry. During the years 2010 – 2014 the Department’s profile has significantly changed due to the increased number of PhD students and young researchers. It can be accentuated that the organization structure of the Department is optimized to promote the internal collaboration, to increase chances in fund-raising and to promote the level of scientific education and skills of young researchers and PhD persons.

The Department activities can be clearly visible in the numbers of projects which have been solved within last five years; 4 EU projects, 1 NATO project, 8 eight collaborative international projects supported by Ministry of Education, 15 grants supported by Grant agency of the Czech republic, and 1 by Academy of Sciences of the Czech Republic, 8 projects supported by Technology Agency of the Czech Republic including a Centre of Competence focused on Biotechnology and 4 another technology related projects supported by Ministry of industry. It is necessary to emphasize the project

numbers had tremendously increased in comparison with the period 2005-2009. Moreover, the Department had also carried out the contract research for variety of Czech and international companies.

The Department has an institutional support based on Institutional Research Plan (ca 44 %), targeted support from Grant Agencies and R&D Programmes in the Czech Republic (38 %), foreign R&D Funds and European Programmes (14 %), and contracts with industry (4 %). Contractual research funding was rather limited and insignificant compared to the funding from other funding sources.

This diversity can be also seen as a threat. On the other hand it is a great success and strength of the Department that has been able to **succeed** in numerous project applications and it is an opportunity to the future that with this skill it will be able to succeed in further projects and grants.

In conclusion, the budget is adequate to the planned activities. Efforts could be done to improve the external (competitive) research funding, also looking at international projects and non public (industrial) contractual research and technological transfer activities.

2.3 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

Position of the department both national and international scientific community is very important. The department is and has been participating on **five international projects** over the last five years. The position within the European research environment is now well established and negotiations on participation on next international collaborative projects are on the way.

The research teams at the Department of Catalysis and Reaction Engineering extensively cooperated on the international level in the fields relevant to department's activities: catalysis, reactors design, preparation of functional materials, synthesis of uniform nanoparticles, mathematical modelling of nanoparticles, photoprocesses, photonic devices, electrochemical characterization and utilization of new conductive and semiconductive materials, adsorption properties of various solids, synthetic organometals, utilization of active plasma, analytical environmental chemistry, remediation strategies, risk assessment etc.

Cooperation of the Institute with other external research subjects and universities both in the Czech Republic and abroad is intensive and fruitful. The major cooperating institutions were Department of Chemistry, University of Wales in Bangor (electrochemistry), Queen's College Belfast (ionic liquids), European Institute of Membranes, CNRS and University of Montpellier (templating principles), University of Szeged, Hungary (synthesis of phthalocyanines), University of Oulu, Finland (texture studies), Université Catholique de Louvain, Belgium (catalytic tests of dichloromethane and chlorobenzene oxidation), and many others.

There had been also many important industrial partners and collaborators participating on the technology research. Among others Dekonta (photocatalytic and photooxidation processes, electrocoagulation), Invos (smart optical sensors), Teluria (new dyes), Synthesia (production of pigments), Abbott Laboratories, GmbH (solving of technology problems concerning pancreatic production), LASAK (dental replacement), COC Ltd. (optical sensors and phthalocyanines), Elentec and First Elements (electrocoagulation), Rabbit, Brikli, Ecofuel and Agra (biotechnological processes) should be mentioned.

There is a good flow of communication and a very good degree of collaboration among research teams at the Institute. Collaboration between individual departments of the Institute is beneficial. This collaboration is manifested mainly by teams sharing special equipments, facilities and expertise, its intensity depends on the current needs. In the Czech Republic main collaborating institutions included

Charles University in Prague, Czech Technical University, Prague, Palacky University, Olomouc, Institute of Macromolecular Chemistry of the CAS, and Institute of Molecular Genetics of the CAS.

2.4 Position of the institute within the Czech scientific community and its international position

The Department holds a leading position in fundamental chemical process engineering research in the Czech Republic, and its position in international scientific community is also substantial. There is a very well built **network of cooperation** with universities, and companies.

2.5 The overall capacity of staff

The Department 3 (Department of Catalysis and Reaction Engineering) is relatively large. The sum of the full time equivalents as of December 31, 2014

technical workers: 10.92 (15 persons, 6 women)

researchers 12.15 (16 persons, 10 women), among them 3 Ph.D. students and 6 postdoctoral fellow.

The gradual build-up of the staff of the Department of Catalysis and Reaction Engineering is a result of long-term strategy constituting very good **multidisciplinary team** able to address a large variety of problems. Low fluctuation of employees and single location ensure that the employees and management know each other personally for reasonably long time to build very efficient way of cooperation and communication. High ratio of young employees (under 35 years) is very positive and perspective.

2.6 Comments on the age structure

The Institute should face the problem of not very homogeneous age composition of the staff and the gap in the number of researchers of the age between 40 – 55 years. Department has a relatively high number of young researchers below 35 – 40 years, it is very positive and perspective for the future, young researchers and students have possibilities to be in close contact with highly qualified and experienced older colleagues. Low fraction of researchers between 40-55 years might be certainly a threat in the next period for the continuation of present research directions. Programs on the level of Academy of Sciences of the type “Návrat” or similar internal programm might be of a great help.

2.7 Frequency and quality of publications

During the 2010-2014 period, there were published papers in journals with IF (115 in total), papers in other journals (28 pieces), and papers at conferences (325). There were 12 applied results. In the Evaluation Phase I, 13 selected publications were classified as internationally excellent, and 10 as internationally recognized. This shows that the quality of the publications is very good – an amount of publications within narrow research specializations have shown that this publication activity is well comparable with the European standard.

More, publications in technical sciences represent only a part of the outputs. The **overall outputs** of the department seen together with applied research, knowledge and technology transfer, dissemination of the results and contribution to the competitiveness of national economy must be judged as very good.

Department of Catalysis and Reaction Engineering – results during the period 2010 – 2015

Papers in journals with IF	115
Papers in other journals	28
Scientific books	1
Papers at conferences	325
Patents	7
Applied results	12
Number of scientists	12.15 (16 persons, 10 women)
Number of other workers in department	10.92 (15 persons, 6 women)

2.8 Patents and role in contractual work

During the 2010-2014 period 7 **patents** were supplied by the department. Contractual work is a source of average incomes. The role of the Department on contractual work is generally not related to patents but in the solution of practical problems.

3. WEAKNESSES AND THREATS

3.1 Budget: Ratio of institutional budget, grants and contractual resources, international funds

The Department has an institutional support based on Institutional Research Plan (ca 44 %), targeted support from Grant Agencies and R&D Programmes in the Czech Republic (38 %), foreign R&D Funds and European Programmes (14 %), and contracts with industry (4 %). Contractual research funding was rather limited and insignificant compared to the funding from other funding sources.

This diversity can be also seen as a threat. On the other hand it is a great success and strength of the Department that has been able to **succeed** in numerous project applications and it is an opportunity to the future that with this skill it will be able to succeed in further projects and grants.

Research program of the Institute and its departments is often influenced by random success in the short-term grant project competitions, which represents a decisive weakness. Although the limitations of the research funding in the Czech Republic have been well known, the Institute has been fairly successful in reaching for funds to purchase relatively expensive instruments. This has been achieved mainly by joint applications for funding with partners from industry.

The Comment of the Commission: The department as well as the whole Institute would prefer a larger part of the funding provided directly by the Academy of Sciences, without competition. The evaluation commission understands that it would be much more comfortable for the institute to have a larger amount of non-competitive funding. It can support the stability of the research department from the point of view of staff and research directions.

A threat, to which most research teams in western and middle Europe are confronted with, including the Institute of Chemical Process Fundamentals, is the tendency for reduction of the funding possibilities on the national level and thus continue involvement in projects with EU funding or international funding. The institute is fully aware of this necessity. The Department of Catalysis and Reaction Engineering has succeeded in participating in several EU projects. Clearly, continued efforts in trying to participate in EU projects are necessary.

3.2 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

There is a good flow of communication and a very good degree of collaboration among research teams at the Institute. This collaboration is manifested mainly by teams sharing special equipments, facilities and expertise. In the Czech Republic main collaborating institutions included Charles University in Prague, Czech Technical University, Prague, Palacky University, Olomouc, Institute of Macromolecular Chemistry of the CAS, and Institute of Molecular Genetics of the CAS.

4. RECOMMENDATIONS

4.1 Re-organization of the internal structure of the institute and departments, laboratories, teams and groups considering the critical mass of each unit, the overlap of units

At the moment we **do not recommend** some type of re-organization of the internal structure of the Department No 3. It must be prepared to solve new research topics in future. For these purposes it is desirable to looking for other adequate personal and financial sources in the future.

The Institute should face the problem of not very homogeneous age composition of the staff and the gap in the number of researchers of the age between 40 – 55 years. More acquisition of foreign postdocs and young scientists will be welcomed.

4.2 Internal programs to stimulate actions to enforce strengths and to reduce weaknesses

Within the Institute they have various programs to enforce strengths and to reduce weaknesses. Emphasis is on contributions in high quality journals. There are internal programs and incentives to stimulate a conversion of results from conference contributions into regular journal articles. Focus on strengthening of international collaboration. The teams are under the supervision The Director and The Council.

4.3 Identification of new research topics

The research plan of the whole institute (for 2015–2019) sets the main goal to utilize researches' intellectual potential and up-to-date equipment and enhance existing methods of investigation of nanoworld, microworld and macroworld in the relevant areas of physics, biology, medicine and engineering. There does not seem a direct need to search for another new research topics. These come spontaneously. Relevance of the plans is limited by funded grants and projects.

The **most important trends** within the group of Catalysis and Reaction Engineering are works concerning the rational design and research of special catalysts for photochemical processes. Similarly as for newly applied techniques of green chemistry for biomass utilization to the high added-value products and energy sources. Biotechnologies enable to obtain food supplements, fodders and fertilizers, new-generation biofuels and energy from biomass of microbial, plant or animal origin.

5. DETAILED EVALUATION

5.1 Declaration on the quality of the results and share in their acquisition

Characterisation of the main research activities (experiments, theoretical areas)

The main research activities of the Team have **very complex** character and they include both theoretical approaches and sophisticated experimental research. Main results can be shortly divided into three groups, reflecting the division of the Team into three groups (1. Catalysis, Transport and Texture studies, 2. Nanomaterial for Sensors, Environment and Energy, 3. Biotechnology).

Relevance in the national and international context

The effort of the department resulted in a number of high quality results in both fundamental and applied research. The results were achieved within the framework of Czech research projects, international projects, and international cooperation. High number of contributions on international conferences broad international collaboration and very high number of project mainly from CSF proves the relevance both in the national and international context.

Overall quality of publications

Publications in technical sciences represent only a part of the outputs. The **overall outputs** of the department seen together with applied research, knowledge and technology transfer, dissemination of the results and contribution to the competitiveness of national economy must be judged as very good in **quantity and quality**.

The results from evaluation phase I shows that the quality of the publications is very good and the department is **concentrating on quality** of the publications. The majority of evaluated publications belongs to internationally excellent (13), internationally (10) and nationally recognized outputs (2). Five papers are published in top decile (1*) and quartiles 1-2 by AIS of journals (4 + 9). These facts were confirmed in the Evaluation Phase I. Also intensity of citations of these publications is on a good level.

Specification of the main achievements

Thanks to a diversity of research topics over the specified period the main achievements can be presented as the results of the numerous research projects in a following short overview:

Development of a membrane with a proton conductivity, thermal stability and low dimensional changes.

Development of MEAs with high loading of Pt catalyst membrane optimization, electrode design and process optimization.

The technology development for hydrogen production through underground gasification of coal in a dynamic geo-reactor including process control through dynamic changes in temperature and pressure.

Identification of the environmental fingerprints of the technology on air, water and strata stability.

Sandwich structure of sorbents (for sorption barriers) - an optimal and applicable as a reactive bed for tests in the experimental mine.

TiO₂ and ZnO thin layers including dopands.

Sensors for Detection of Aminoacids on ZnO Layers.

Advanced Oxidation Processes. Photocatalysis on TiO₂ and Photolysis for water treatment including Electrocoagulation pretreatment.

Specification of the contributions of the team to publications

The **contribution to the results** presented within the evaluation is in all cases a sole or a majority. In all collaborative projects the share of the department is dominant. No result is a product of any collaboration where the department might be only a small contributor.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

Institute of Chemical process Fundamentals is not authorized to award academic titles (BSc, MSc, PhD) as such. It is however accredited as a scientific research workplace for the students of universities. Experienced researchers at the Institute serve as students' PhD, MSc and BSc supervisors, approved by scientific boards at the respective universities. Students generally work on topics of their supervisors.

High level of the scientific work, experience of the researchers and many unique experimental instruments offer very good **opportunities** for many students. During the evaluated period 4 Ph.D. theses were defended, together with 10 Master thesis and 10 Bachelor ones. This represents a massive involvement of students. The department has 2 professors (prof. Kaštánek and prof. Ponec), 1 associated professor (doc. Klusůň) and 7 other scientists entitled to supervise Ph.D. thesis. Involvement of students, especially doctoral, in the research activities of the Institute is very fruitful.

The institute collaborates with several Czech universities (University of Chemistry and Technology, Prague, Charles University, Prague, Czech University of Life Sciences Prague, University of Pardubice, Faculty of Chemical Technology, University of J. E. Purkyně in Ústí nad Labem, University of Hradec Králové, Faculty of Science, and VSB - Technical University of Ostrava).

Particular contributions of students to research

Students are involved into the research of the department within the frame of their bachelor, master and doctoral studies. Students are **significant** contributors to all scientific outputs.

In the framework of various national projects, many doctoral and undergraduate students are introduced into the joint research team. They can do very useful scientific work and help their advisors in their research tasks. Collaboration with doctoral and undergraduate students often results in publications co-authored by the students. This kind of collaboration with Universities is very beneficial for the both contracting parties.

Number of defended PhD students in relation to students involved (success rate)

For the Department No 3 there were 4 successfully defended Ph.D. students. This shows a success rate was about 66 %, but this number is distorted by the fact, that the number of 6 Ph.D. students include those, who started their study in this period but did not finish it yet (they still go on studying).

Supervision of students (Team No 3)

type of study	No of supervisors	No of consultants or	Theses defended in
---------------	-------------------	----------------------	--------------------

		co-supervisors	2010-2014
Bachelor	6	4	10
Master	3	6	10
Doctoral (Ph.D.)	10	2	4

Employment of former Ph.D. students (career options)

Recruitment possibilities by the department and career possibilities of former Ph.D. students are very good. Several former students, including female students, are now members of the research department. Some of them were encouraged to leave the laboratory for at least a year to gain experience in some competitive research institutes in the Czech Republic or abroad as a postdoctoral research fellow. The possibility to open new positions for postdocs within the teams of the department is given by the **successes in grants** and projects which provide funding for them.

5.3 Declaration on societal relevance

Societal relevance of the Department of Catalysis and Reaction Engineering can be seen primarily through **applied research** (contract based) which **contributes significantly** to the **competitiveness of the national economy**. The department is well established in the region as a research group with application potential and has built a network of partners with long-term collaboration. The department has developed a number of instruments and methods for industrial processes.

Impacts of the results and other activities on economy

As stated above, the department follows a concept of balanced combination of **fundamental and applied research**. The strategy has been described as core knowledge/ technology/experience base vs. project diversity. Many of the diverse projects target specific applied research problems. It is evident that success in grant application and acquisition of commercial contracts is entirely substantial for the Institute economy. The **contribution to the competitiveness** of the Czech industry through applied research is very good.

During the 2010-2014 period, the following awards were granted for excellent results in research:

- The Visegrad Group Academies Young Researcher Award 2011 in Chemical Sciences, Dr. Luděk Kaluža, for his excellent scientific results among young chemists from Poland, Czech, Slovak and Hungary.
- In Warsaw, Poland, 2014, the Association of Polish Inventors and rationalizers delivered „Silver medal“ to L. Obalová, K. Jiráková and F. Kovanda for the invention „A method of removing N₂O from over optimized oxidic catalysts“.

- Hlávka award for scientific contribution to chemical engineering, prof. Kaštánek

- Balling award for scientific contribution to bioengineering, prof. Kaštánek

Research activities and their results have very strong impact on the Institute economy as well, both income from grants and projects supports the budget which depends on the quantity and quality of the outputs.

Impacts of the results and other activities on education

High level of the scientific work, experience of the researchers and many unique experimental instruments offer very good opportunities for many students. The department had **2 professors, 1 associated professor** and 7 other scientists entitled to supervise Ph.D. thesis. The staff contributes also to teaching on various levels. Researchers participate actively in educational bachelor, master and doctoral programs mainly at University of Chemistry and Technology, Prague, Charles University, Prague, Czech University of Life Sciences Prague, and University of Pardubice. The involvement of Teams in student supervision is also very good. Participation of students on the solution of particular research problems is very beneficial part of their education.

Impacts of the results and other activities on culture

This impact should be in the field of applied chemistry and technology seen through propagation and promotion of science especially of technical subjects, which is now a national priority. Popularisation of science is mentioned below.

Outputs providing information relevant for public policy decisions in all fields of life

The institute is not dealing with social sciences or humanities, so this is not relevant.

Services for research (libraries, data bases, collections,..)

There are various types of services for research. Library is collecting, processing, keeping and making available the required scientific information from one's own specialized library source for demand of scientific departments. It maintains an inventory of about 15 000 volumes (books, periodicals, research reports, etc.).

Library takes care of online access to scientific journals, databases (Web of Knowledge, SciFinder, Reaxys), manages subscription to scientific information resources, manages information exchange among libraries, take care of printed versions of journals and books in the ICPF and arranges access of users to them.

Library also collects and archives research results of scientists of the ICPF. Library is regularly completing the ARL - data base of publications available at the server of the Main Library CAS. It includes publications since 1993.

Popularisation and similar activities

The Department No 3 participates (in the frame of the whole Institute) in activities of popularisation of science. Members of the Department took a part in courses and lectures for the public, e.g. in The Week of Science 2011 (A public lecture on a history of poisons), The Week of Science 2012 (A public lecture on a history of ergot alkaloids), The Science Café 2013 (A public lecture on a history of toxins and other natural alkaloids). Members of the Department also published the most important results as popularization articles in magazines *Natura* (Leonardo), *Planetarium*, *Meteor*, *Academic Bulletin*, etc. and had an extensive number of contributions for the Czech radio. The most important seems to be publishing of the popularization book at Academia Publishing House – *The Poisonous Trace* (Prof.

Kluson: Jedova stopa). Every autumn the Institute of Chemical Process Fundamentals opens its gates to the general public and welcomes its visitors with a range of exciting lectures, short excursions to its laboratories, and interactive and hands-on experiments.

The evaluation commission judges the effort of the institute and particular teams in science popularisation as very good.

5.4 Declaration on the position in the international and national context

There is a unique expertise developed with respect to its scientific impact opens many cooperation opportunities (joint grant applications).

Comparison of the position, recognition, outputs and impacts with leading and international teams

Position of the Department of Catalysis and Reaction Engineering in both national and international scientific community is very important, it holds a leading position in its part of fundamental chemical process engineering research. Research activities of the group have undoubtedly significant relevance not only in the national, but also in international context. Researchers of the Department are members of many relevant scientific societies, committees, boards, commissions, international associations etc. The Department is very responsible partner in the international collaboration, it is involved in four programmes of the EU, and one for NATO researchs.

Role and position in international collaboration

The department is and has been participating on **five international projects** over the last five years. The position within the European research environment is now **well established** and negotiations on participation on next international collaborative projects are on the way.

Breadth/completeness of the research activities compared to world leading teams of comparable size

The department should be compared to the best European research oriented chemical institutions. This approach strongly helps in competing with world leading teams of comparable size. Breadth and quality of the Institute research activities are fully compared to the world leading scientific teams of comparable size with orientation on similar topics.

Ability to attract foreign researchers at different levels

The ability to attract foreign researchers and students is not limited by the scientific reputation of the institute but by (in general) a low range of wages in comparison with modern developed countries. Nevertheless, the Institute is able to attract former Czech students after their return from long-term stages abroad.

The limited internationalization is reported by the Institute as a weakness point, and although the share of foreign researchers working in the Institute has been growing (1 from Bulgaria, Croatia, UK,

Ireland, Russia; 2 from Belorussia, Portugal, Ukraine; and 3 from Slovakia), there is no doubt that the ability to attract foreign researchers has to be improved.

It is quite common to consider teams with a large portion of foreigners as desirable. On the other hand it is questionable whether it is really an advantage or whether it is in the rich countries only a reflection of the fact that only a decreasing number of native young people are willing to do science.

Possible missing research directions

There are no missing research directions.

Position of the team in the national context

Position of the Team both national and international scientific community is very important. The Team belongs to leading groups at the national level with established collaborations with several Czech teams mainly at universities. The number of contractual research and projects funded by grant agencies confirms only partly this statement.

5.5 Declaration on the vitality and sustainability

Composition of staff with respect to age and gender, qualification, international experience

The research team is composed by highly educated and eruded research workers with a large fraction of young researcher below 40 years. The age composition suffers, however, by a noticable gap between 40 - 55 years and relatively high fraction of researchers in the age of retirement. This reality might have a significant influence on a continuation of the research in the prezent extant. On the other hand this department is of a very good distribution including students, young researchers, post docs, research fellows and women (16).

Attraction of research programmes for young people

The research programmes seem very attractive for young people. The research groups use modern methods and unique facilities. Recruitment possibilities by the department and career possibilities of former Ph.D. students are very good. Several former students, including female students, are now members of the research department. The former Ph.D. students can continue their contract as so-called “post-docs”. There is also an internal “grant agency” for support of Ph.D. students, and financial support of young, talented scientists from abroad (this “grant agency” is the same for the whole Institute).

Funding (structure of the resources and its comparison with the outputs, grants and project activity

The Department has an institutional support based on Institutional Research Plan (ca 44 %). targeted support from Grant Agencies and R&D Programmes in the Czech Republic (38 %), foreign R&D Funds and European Programmes (14 %), and contracts with industry (4 %). Contractual research funding was rather limited and insignificant compared to the funding from other funding sources.

The Institute policy guarantee sufficient personal resources for a further development. The structure of financial sources of the Institute can raise some problems for the sustainability in next years since it is more and more based on competitive grants with relatively small financial subsidies limiting thus long-term investment.

Effectiveness of research (based on comparing size of groups, funding and output)

The output of the department seen through the number of overall outputs, including publications, their quality, development of instrumentation and technologies, methodologies and applied research is very good. In technology oriented research the efficiency should be judged also through societal impact on the economy, which is very good (see above).

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

Recruitment possibilities by the department and career possibilities of former Ph.D. students are very good. Several talented former students, including female students, are now members of the research department. The former Ph.D. students can continue their contract as so-called “post-docs”. The chance for postdocs to become members of the team is given by the ability of the department researchers (primarily the senior researchers) to succeed in project proposals and to keep the department project funded and open new positions as a result of huge effort.

The career development of the research scientists is governed by the Career System of the Czech Academy of Sciences and the Wage Directive of the Institute of Chemical Process Fundamentals. At least once in 5 years every researcher undergoes the assessment process overseen by the Attestation Commission of the Institute. Based on the recommendations of the Attestation Commission the Director of the Institute updates the qualification and wage categories of the employees. The remuneration policies put emphasis on the individual performance. The researchers publishing in journals with impact factors are also rewarded with special bonuses. The amount of the bonus is governed by an internal regulation and increases with the quality of the journal. The employees can easily determine the bonus from the regulation, which motivates them to publish in the best possible journals. Successfully completed grants and research contracts and national and international patents are also rewarded with bonuses. The managerial quality of the team leaders and their ability to achieve objectives set out for their teams is also evaluated regularly.

5.6 Declaration on the strategy and plans for the future

Relevance of the outlined strategy and research plans

Research plan of the Department of Catalysis and Reaction Engineering for 2015-2019 **is prepared in great detail**. Plan of the department is especially based on its human resources and budget. The department will continue in participation of existing three directions:

Catalysis, Transport and Texture studies,
Nanomaterial for Sensors, Environment and Energy,
Biotechnology.

The plan covers the following items:

- 1) Continuation of the EU projet (IMMEDIATE 2: Innovative autoMotive MEa Development – implementation of Iphegenie Achievements Targeted at Excellence - tailoring of Pt particles, Carbon content and Process optimization),
- 2) Continuation of the EU projet MEGA (Methane production through underground coal gasification from deep European coal seams),
- 3) Continuation of Nanomaterial for Sensors, Environment and Energy
 - Advanced Identification element for Archives Recognition Project Ministry of the Interior,
 - Water treatment and Metal recycling –Projets TACR,
 - Hydrogen production and storage – Project GACR,
 - Electropunne nanofibrous materials – catalysts, sorbents,
 - Enhancement of the power transformer operation security and prevention of their failures caused by the corrosive sulphur effect methods and sorbents – EU Project in preparation,
- 4) Biotechnology microalgae, plants and their waste and animal waste, variety of technologies.

The lined strategy and research plans for the future are adequate.

Adequacy of available means and human resources to achieve these plans

The **capabilities** of the existing research department are very good. The Department has adequate both technical and human resources to achieve the out lined plans for next years. Supplementary recruitment of researchers can be necessary maybe later. Obtaining **supplementary funding** will also be necessary. Also they want to keep a friendly and cooperative atmosphere at the Department so that everybody can enjoy the creative work.

Missing issues in the strategy

There are no missing issues, provided that the department is serious about setting up strategic co-operations with industry and foreign research teams with the objective of acquiring funding from EU sources.

EVALUATION OF THE INSTITUTE OF CHEMICAL PROCESS FUNDAMENTALS

Department of Multiphase Reactors

1. INTRODUCTION

1.1 Structure and location of the department

The department of Multiphase Reactors is part of the institute of Chemical Process Fundamentals and is located in Prague.

1.2 Mission and research topics

The research topics of the department are centred during the evaluation period around the behaviour of multiphase dispersed systems of different kinds: gas-liquid, gas-solid, liquid-solid and gas-liquid-solid.

1.3 Staff size and full time equivalents age distribution

The number of research staff of the department itself is on average about 7.75 FTE during the evaluation period. There is a modest supplementary contribution by Ph.D. students to the research. So, the research team is rather small. At the end of 2014, the number of physical persons in the scientific team was 14 (including 3 persons leaving at that time). The age distribution over the 5-year categories is quite even, with a peak in the category 30-35 years. About 30 % of the researchers are female. So, the age distribution and the gender distribution of the department are very favourable.

2. STRENGTHS AND OPPORTUNITIES

2.1 Topicality of research subjects

The research topics of the department are very fundamental, but have high value for a number of industrial applications.

2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

The funding of the department was exclusively of Czech origin during the evaluation period. There is no funding from EU or international origin.

2.3 National collaboration and international involvement

The department collaborates with a research team of the Technical University of Ostrava. The department is not clear about the funding of this collaboration, but it is very likely through common

Czech funded projects. The department collaborates also with several teams from foreign universities. But these collaborations are rather loose in the sense that the external teams are not funded partners in common research projects with external funding. This means that the collaborations are only scientifically driven.

2.4 Frequency and quality of publications

The number of publications of the department is very high. In the evaluation period, there are 35 publications in journals with impact factor, 1 chapter in a book and 126 conference contributions; this all, with a team of about 7.75 FTE. The level of the journals is excellent; 70 % of the journal publications are in first-decile, first-quartile and second-quartile journals. The publications that were ranked in Phase 1 of the evaluation were all from these high-level journals and were put for 13.3 % in class 1 and 33.3 % in class 2. The number of citations is not very high, but this is normal for recent publications. So, overall, quantity and quality of the publications are very good.

2.5 Patents and role in contractual work

The department lists 3 patents as scientific outputs. This is very good. The contractual research is very limited.

3. WEAKNESSES AND THREATS

3.1 Topicality of research subjects

The research topics of the department are extremely relevant on the fundamental level and towards industrial use. There are no weaknesses and threats related to research topics.

3.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

The funding sources are all on the national level in the evaluation period. This is a threat.

3.3 Intensity of national collaboration and international involvement

There are no project-type collaborations within EU-projects or international projects with foreign research institutes and university teams. This is a weakness.

3.4 Capacity of the staff

The number of staff members is rather small, but the age distribution is very favourable. So, there are no weaknesses and threats related to capacity of the staff.

3.5 Frequency and quality of publications

There are no weaknesses and threats related to publications.

3.6 Patents and role in contractual work

There are no weaknesses and threats related to patents and contractual work. The amount of contractual work of the department is very limited, but this is not abnormal, taking into account the very fundamental character of the research.

4. RECOMMENDATIONS

4.1 Re-organisation of the internal structure of the departments, laboratories, teams and groups considering the critical mass of each unit, the overlap of units

Re-organisation of the department is not a relevant subject. The department is a small research team.

4.2 Internal programs to stimulate actions to enforce strengths and to reduce weaknesses

Strict internal programs cannot be a subject in a small research team. The department should think about the opportunity of identifying a limited number of complementary foreign research partners, who can also be partners in EU-funded projects.

4.3 Identification of new research topics

There is no need to search for new research topics. The number of research topics planned for the next future (5) is already quite high for the rather small research team.

5. DETAILED EVALUATION

5.1 Declaration on the quality of the results and share in their acquisition

Characterisation of the main research activities (experiments, theoretical areas)

Research activities are experimental, theoretical and numerical.

Relevance in the national and international context

The research is very relevant in the national and international context.

Overall quality of publications

The overall quality of the publications is very good.

Specification of the main achievements

The department has acquired a high expertise on behaviour of multiphase dispersed systems.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

There does not seem to be strong direct involvement of Ph.D. students in the research projects that are done in the department itself.

Number of defended PhD students in relation to students involved (success rate)

There is 1 defended Ph.D. thesis with co-supervision by members of the department in the evaluation period. This is not a high number. But, there are 5 ongoing supervisions.

Employment of former Ph.D. students (career options)

There is no information by the department on recruitment during the evaluation period of Ph.D. students with whom members of the department have had contact during the Ph.D. work. But it seems natural that such Ph.D. students are contacted for recruitment by the department.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

There is certainly a contribution to the economy by the activities of the department. This contribution is indirect, because the research is very fundamental and not directly oriented towards industrial valorisation.

Impacts of the results and other activities on education

The department participates in education.

Popularisation and similar activities

The department participates in activities of popularisation of science.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams

The department publishes in journals of the highest quality (first-decile; first and second quartile). This means that the work of the department is internationally very well visible.

Role and position in international collaboration

There are no structured collaborations with foreign research teams, in the sense that these are partners in funded research projects. The department should do an effort in identifying partners. This may be beneficial for maintaining the quality of the research and may certainly help in obtaining funding on the European or international level.

5.5 Declaration on the vitality and sustainability

Composition of staff with respect to age and gender, qualification, international experience

There is 1 member of the department in the age category 60-65 years and one member in the age category 65-70 years. Replacement of these researchers cannot be very far away. The department should consider recruiting some new researchers in the coming period of 5 years.

Attraction of research programmes for young people

The research programmes seem very attractive for young people.

Funding (structure of the resources and its comparison with the outputs, grants and project activity)

Funding of the department is purely national up to now. The department should consider targeting to funding from EU sources.

Effectiveness of research (based on comparing size of groups, funding and output)

The output of the department in number and quality of publications is very good.

5.6 Declaration on the strategy and plans for the future

Relevance of the outlined strategy and research plans

The research plans for the near future are very good. The targeted research is a natural continuation of the past research.

Adequacy of available means and human resources to achieve these plans

The capabilities of the existing research team are very good. Supplementary recruitment of some researchers seems advisable, taking into account that some members of the department are approaching the retirement age. Obtaining supplementary funding of international origin most probably will be necessary. It seems very unlikely that the department will be able to maintain its high quality of research and will be able to realise its research plans with only funding of Czech origin.

Missing issues in the strategy

The department does not envisage setting up strategic co-operations with foreign research teams and does not target to acquiring funding from EU sources.

EVALUATION OF THE INSTITUTE OF CHEMICAL PROCESS FUNDAMENTALS

Eduard Hala Laboratory of Separation Processes

1. INTRODUCTION

This report refers to the Evaluation of the Institute of Chemical Process Fundamentals)-Eduard Hala Laboratory of Separation Processes Advanced (EH) Laboratory of the Academy of Sciences of the Czech Republic, 2010-2014, and is written according to the guidelines reported in the Appendix 6.1 and 7.1 as well as the Recommendation for Elaboration of the Final Report drawn by the CAS.

1.1 Location of the institute and its dept., labs. & sub units.

Laboratories and the other facilities of this department are in the campus of the Institute (Rozvojová 135, 165 02 Praha 6).

1.2 Brief history of the institute

1.3 Mission and research topics

Mission: The main expertise had covered all major aspects of separation processes with special focus on the **research fields** listed below

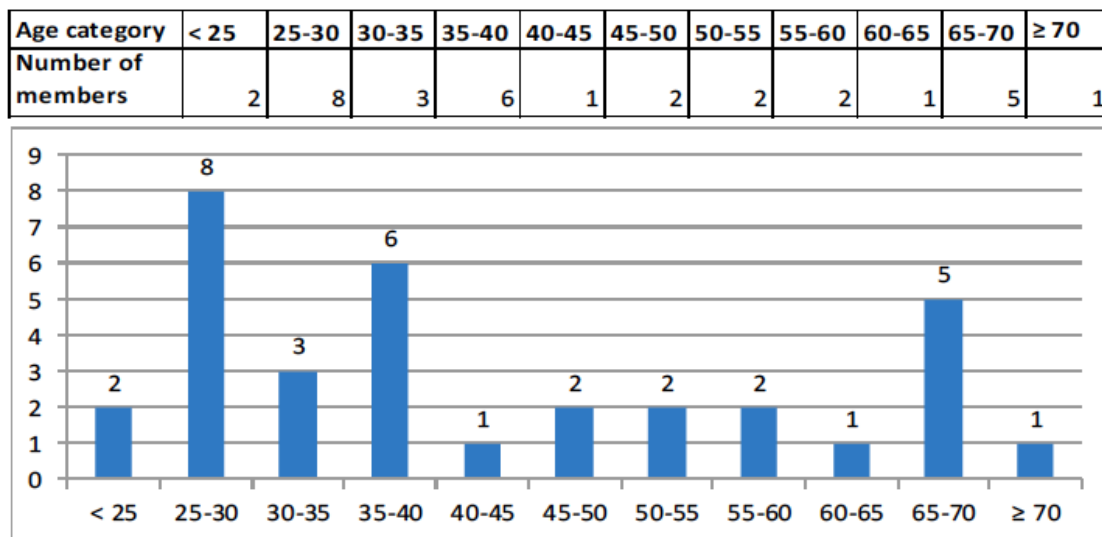
- Phase Equilibria in Systems of Low Molar Mass Components
- Vapour–Liquid Equilibria in Systems Containing Polymer
- Volumetric Studies
- Thermodynamic Properties and Liquid Phase Behaviour in Systems of Ionic Liquids
- Study of the Mass Transport in Polymeric Membranes and in Ionic Liquids
- Flow of Condensable Gases Through Porous Membranes
- Supercritical Fluid Extraction of Bioactive Compounds from Plants and its Mathematical Modeling
- Liquid-liquid Extraction
- Flow Hydrodynamics in Packed Beds, Mathematical Modelling and Microtechnology

Goals:

The laboratory has acquired highly valued know how as well as high international recognition in all of its research domains, namely the experimental thermodynamics, membrane separation processes, supercritical extraction, liquid/liquid extraction, and flow hydrodynamics in packed beds, mathematical modelling and microtechnology. The goals and specific contribution of the Laboratory consists in providing the fundamental research in chemical engineering with stress on patenting and application of the results in industrial practice. Research is aimed at the development of experimental methods for investigation of phase equilibria, membrane separations, supercritical and liquid/liquid

extractions, microreactors.

1.4 Staff size and full time equivalents age distribution



The team is formed by 20 researchers and 16 other workers.

In terms of full time equivalent age distribution, the Group is formed by 13.17 FTE researchers and 8.01 FTE other workers (at 31.12.2014).

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The research topics of the Lab are aligned with the current major international research subjects in the field. In particular the laboratory has acquired highly valued know how as well as high international recognition in all of its research domains, namely the experimental thermodynamics, membrane separation processes, supercritical extraction, liquid/liquid extraction, and flow hydrodynamics in packed beds, mathematical modelling and microtechnology. These subjects are aligned with the societal needs and the timeliness of the overall research activity is considered **very good**.

2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

The EH Lab in the evaluation period was able to get the following grants:

- 38 National Grants projects
- 3 EU projects

No data are provided and the total budget obtained by these projects.

The contractual research with companies is not quantitatively high and fixed in about 338 k€.

2.3 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

In the Institute:

No data are provided about the cooperation among the EH Lab and the other Depts of the Institute.

In the National environment (national cooperation):

- University of Chemistry and Technology Prague (UCT)
- University of Pardubice, Faculty of Chemical Technology
- Technical University of Ostrava / Nanotechnology Centre
- Czech University of Life Sciences Prague, Institute of Tropics and subtropics
- Charles University in Prague

In the International environment (International long-term cooperation)

While it is clear that the position of the EH Lab in international scientific community is important and that extensive international cooperation is active, with **3 EU projects** funded in the assessment period, **it is not clear** which are the Universities/Centers the Labs is mostly cooperating with. Just for topic 5 (Study of the Mass Transport in Polymeric Membranes and in Ionic Liquids) a list of the most relevant cooperation is given:

prof. S.-Y. Suen, National Chung Hsing University, Taichung,

prof. R. Noble, University of Colorado, Boulder, USA

Dr. S. Kononova, Institute of Macromolecular Compounds, Russian Academy of Sciences, St. Petersburg, Russia

Dr. J. Jansen, Institute on Membrane Technology, ITM-CNR, Italy.

The intensity of cooperation of the Group is rated **as good**.

2.4 Position of the institute within the Czech scientific community and its international position

The reputation of the Lab in the Czech Scientific community and the international community is **very good** and characterized by a wide range of subjects of interest.

2.5 The overall capacity of staff

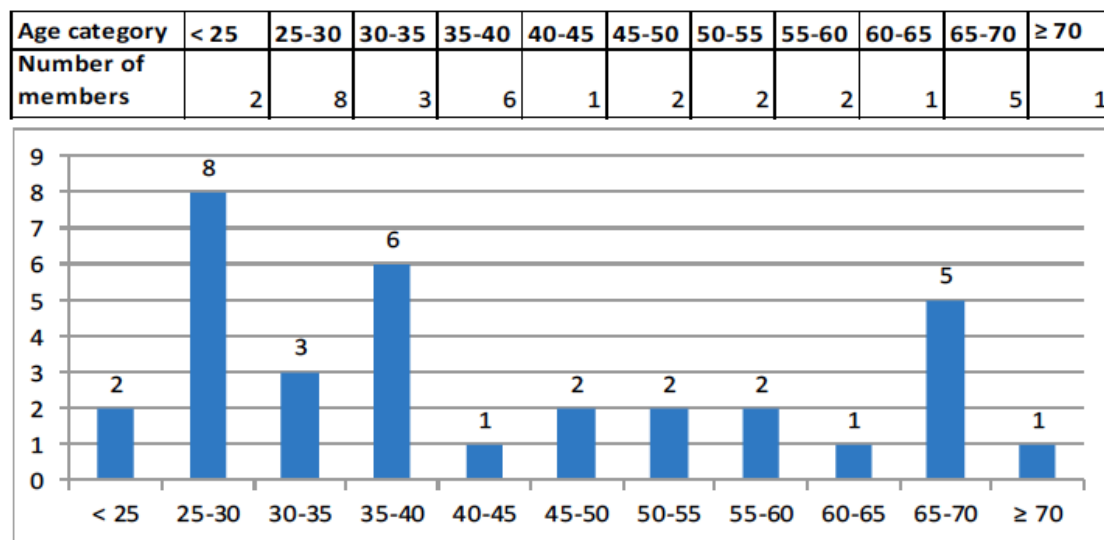


Figure 1 – Age structure of the EH Lab

The overall capacity and the age structure of the staff is illustrated in Figure 1.

The staff is divided into 4 Groups: Membrane Separation, Chemical Thermodynamics, Micro technology and Microreactors, Supercritical Fluid Extraction but the composition and the structure of each group is not shown. From a quantitative point of view, the age structure of the team is well balanced and the overall capacity of the staff is **very good but it is not clear the situation for the single groups.**

2.6 Reasonability of the structure of the institute and the departments

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2.7 Comments on the age structure

The age structure of the EH Lab is balanced with many young and junior researchers and a appreciable number of senior staff members.

2.8 Frequency and quality of publications

The total outputs of the group is 397 with 84 papers published in impacted journals. In Figure 2 it is shown the quality of the outputs by journal ranking.

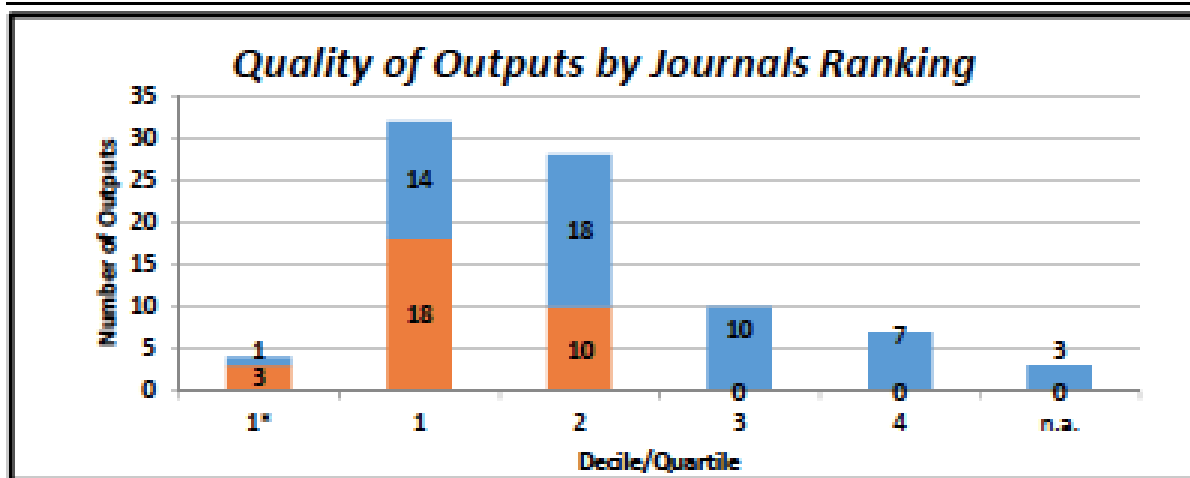


Figure 2 – Quality of outputs by Journal Ranking.

The journals where the papers were published are in great part excellent and the number of citation relevant.

If we refer to the output as Ranked in Phase I: 31 papers were considered and, among them, 2 was ranked 1 (world-leading in terms of originality, significance and rigour) 14 were ranked 2 (internationally excellent), 13 were ranked 3 (recognized internationally) and 2 were ranked 4 (recognized nationally). No papers were ranked 5 (below the standards). Finally, the quality of the output can be defined **very good**.

2.9 Patents and role in contractual work

The EH Lab has got 5 patents and 9 pilot plant installations in the period of assessment.

The role of the Lab in the contractual research does not appear relevant as regards the budget achieved by this kind of grants.

3. WEAKNESSES AND THREATS

3.1 Budget: Ratio of institutional budget, grants and contractual resources, international funds

It was not possible to find any quantitative data about that.

4. RECOMMENDATIONS

Based on the strengths, opportunities, weaknesses and threats some recommendations can be elaborated. Sub-sections (topics) may refer to:

4.1 Re-organisation of the internal structure of the institute and departments, laboratories, teams and groups considering the critical mass of each unit, the overlap of units

The EH Lab is well organized and well identified, but interactions among the different groups should be better clarified. Due to the great investments needed to run the different research lines it would be useful to have a clear idea on how to get the budget required for the future and which are the most promising research lines: **this seems to be clear just for Group 3, MicroTechnology and Microreactors.**

Indeed 9 research lines seems too much for the dimension of the Labs: even if this is reasonable due to the fact that then Lab started not so many years ago, it would be useful to start considering a possible re-organization for an optimal use of the available and future resources.

4.2 Internal programs to stimulate actions to enforce strengths and to reduce weaknesses

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4.3 Identification of new research topics

The view of the Group for new research lines is adequate.

5. DETAILED EVALUATION

5.1 Declaration on the quality of the results and share in their acquisition

Characterisation of the main research activities (experiments, theoretical areas)

The research activities of the EH Labs are mainly addressed toward the development of processes with a potential industrial exploitation, with significant outputs in terms of patents and pilot plants. . The subjects of interest are mostly very beneficial for different industrial sectors and with possible societal impact.

Overall quality of publications

The publications of the Group are well balanced among the different subject and generally published in high-ranked (1-2 quartile) journals. The total number of papers in journals with IF is 84, 1 book, 132 presentations (with one key-note presentation), 7 book chapters, 5 patents, 1 gold medal awarded at international exhibition INOVA 2011.

Specification of the main achievements

The main achievements are represented by the patents and their industrial potential and that can be considered the final synthesis of the scientific achievements by the Lab:

- Gruber, Václav ; Rousková, Milena ; Heyberger, Aleš ; Staf, M. Způsob získávání extraktů s obsahem europia a yttria Ústav chemických procesů AV ČR, v. v. - SAFINA, Vestec, a.s. 2011. Číslo patentového spisu: 302854. Datum udělení patentu: 14.12.2011. <http://isdv.upv.cz/portal/pls/portal/portlets.pts.det?xprim=1607034&lan=cs>

- Izák, Pavel ; Poloncarzová, Magda ; Vejražka, Jiří. Způsob obohacování bioplynu z čističek odpadních vod nebo ze zemědělské prvovýroby o methan a zařízení k provádění tohoto způsobu Česká hlava s.r.o. 2012. Číslo patentového spisu: 303106. Datum udělení patentu: 23.02.2012.
<http://isdv.upv.cz/portal/pls/portal/portlets.pts.det?xprim=1537890&lan=cs>.
- Izák, Pavel ; Poloncarzová, Magda ; Vejražka, Jiří. Způsob separace plynné směsi a zařízení k provádění tohoto způsobu Česká hlava s.r.o. 2012. Číslo patentového spisu: 303107. Datum udělení patentu: 23.02.2012.
- Lederer, J. ; Kovač, D. ; Veselý, Václav ; Hanika, Jiří ; Nečesaný, F. Způsob výroby vodíku parciální oxidací vysokovroucích uhlovodíkových směsí a biomasy, a zařízení k provádění způsobu Výzkumný ústav anorganické chemie, a. s. 2012. Číslo patentového spisu: 303392. Datum udělení patentu: 29.08.2012.
<http://isdv.upv.cz/portal/pls/portal/portlets.pts.det?xprim=1568991&lan=cs>
- Heyberger, Aleš ; Tříška, Jan ; Rousková, Milena ; Krtička, M. Způsob a zařízení k získávání fytosterolů Ústav chemických procesů AV ČR, v. v. i. Praha : Úřad průmyslového vlastnictví, 2010. Číslo patentového spisu: 301716. Datum udělení patentu: 22.04.2010.
<http://isdv.upv.cz/portal/pls/portal/portlets.pts.det?xprim=1228063&lan=cs>

Specification of the contributions of the team to publications

The contribution of the Institute members to the outputs is quite decisive in the published papers and the patents.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

The EH Lab

Co-supervised 19 bachelor students with 19 theses defended

Co-supervised 19 master students, 18 theses defended

Supervised 10 PhD students and co-supervised 7 PhD students, 0 theses defended

Particular contributions of students to research

The data provided do not allow any assessment about this.

Number of defended PhD students in relation to students involved (success rate)

The total number of PhD theses defended in the evaluation period is 0 versus 10 PhD students supervised.

Employment of former PhD students (career options)

The possible carrier development is strongly dependent on the successful grants achieved by the group.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

Societal relevance of EH Lab can be seen primarily through **applied research** (collaborative and contract based) which **contributes significantly** to the **competitiveness of the national economy**. The **contribution to the competitiveness** of the Czech industry through applied research is very good. During the 2010-2014 period, the following awards were granted for excellent results in research for the invention of liquid condensing membrane for purification of raw biogas to CNG quality 2014:

- Winner of E.ON Global Energy Award, category: Company
- Award of ERSTE Corporate banking
- Award of Ministry of the Environment of the Czech Republic
- Price of Kapsch, Invention – Technical Science – Czech Head
- Research activities and their results have very strong impact on the Institute economy as well, both income from grants and projects supports the budget which depends on the quantity and quality of the outputs.

Impacts of the results and other activities on education

The involvement of the EH Lab in education through supervised students and through courses is good. High level of the scientific work, experience of the researchers and many unique experimental instruments offer very good opportunities for many students. The staff contributes also to teaching on various levels. Researchers participate actively in educational bachelor, master and doctoral programs mainly at University of Chemistry and Technology, Prague, Charles University, Prague, Czech University of Life Sciences Prague, and University of Pardubice.

Impacts of the results and other activities on culture

The impact of the activities is mainly academic and industrial.

Services for research (libraries, data bases, collections,..)

These services are integrated in the Institute the EH Lab belongs to.

Popularisation and similar activities

M. Bendova, J. Hanika, P. Izak, M. Karaszova and M. Sajifrtova wrote many papers in national and international magazines for a general audience.

M. Bendova, V. Jincny et al. gave lectures in Schools and Universities for a general audience. Many members of the Labs participated at Days of Open doors at ICPF.

M. Bendová is member of CAS Board for the Popularization of Science (2009- present) and she was with her colleagues a coordinator of many science popularization events

Wagner Z. – author, popularization play Taming of the Evil Acid (Zkrocení zlékyseliny, in Czech), staged in June 2013 at Ostrava University

Sajfrtová M. – TV documentary: Popularization of botanical pesticides extraction with supercritical CO₂ at Czech Television (M. Sajfrtová in a report Ivana Lukáše, 2011)

Jiříčný V., Křišťál J., Stavárek P.: Lecture for foreign journalists within EUSJA Study Trip 2013.

5.4 Declaration on the position in the international and national context

There is a unique expertise developed with respect to its scientific impact opens many cooperation opportunities (joint grant applications).

Comparison of the position, recognition, outputs and impacts with leading and international teams

Position of the EH Lab in both national and international scientific community is very good. Research activities of the group have undoubtedly significant relevance not only in the national, but also in international context. Researchers of the Department are members of many relevant scientific societies and committees.

Role and position in international collaboration

The department is and has been participating on **three international projects** over the last five years. The position within the European research environment is now **well established**.

Breadth/completeness of the research activities compared to world leading teams of comparable size

The research activities cover a wide range of the subjects that are of present major interest. No other activity can be implemented if the staff is not increased.

Ability to attract foreign researchers at different levels

The Lab was visited by 33 junior and senior researchers from EU and 12 junior and senior researchers from outside of EU. The attractiveness of the Labs for foreign researchers in terms of permanent staff is limited so far and could be improved by applying a strategy to be shared with the Institute and the CAS board.

Possible missing research directions

There are no missing research directions.

Position of the team in the national context

Position of the Team both national and international scientific community is very important. The Team belongs to leading groups at the national level with established collaborations with several Czech teams mainly at universities.

5.5 Declaration on the vitality and sustainability

Composition of staff with respect to age and gender, qualification, international experience

The research team is composed by highly educated and eruded research workers with a good fraction of young researcher below 40 years. The age composition suffers, however, by a noticable gap between 40 - 55 years and relatively high fraction of researchers in the age of retirement. The involvement of women is good (8 vs 21 researchers) but improvable.

Attraction of research program for young people

The research programs are very attractive for young people. The research groups use modern methods and unique facilities and cn count on solid cooperation with well known research centers. . Recruitment possibilities by the department and career possibilities of former Ph.D. students are good even if based on the acquisition of projects.

Funding (structure of the resources and its comparison with the outputs, grants and project activity)

No detailed data about the structure of funding is provided but the Labs has gained 38 national projects and 3 EU projects in the evaluation period. The structure of financial sources of the Lab can raise some problems for the sustainability in next years. As emerged in the on-site discussion the strategy to get the budget for the future is only partially clear (just for one group seems clear) while the present research topics need strong investment.

Effectiveness of research (based on comparing size of groups, funding and output)

The output of the department seen through the number of overall outputs, including publications, their quality, patents is very good.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

This is aligned with the structure of the ICPF.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

The Research plan of the Lab has been drawn referring to the Groups of the Labs. While the subjects are clear for all the Labs' Groups, the way to achieve the expected results is clearly indicated just for Group 3 – MicroTechnology and Microreactors. The plan includes the following projects and/or proposals:

- Process Intensification through Adaptable Catalytic Reactors made by 3D Printing (PRINTCR3DIT, 2015-2018) - Horizon 2020 project
- Application of microreactors for the intrinsic kinetic studies of gasphasecatalytic reactions Project application (Czech Science Foundation, 2015-2018, underevaluation)
- Development and application of new immobilized photosensitive clusters to micro-photoreactor for photo-induced reaction - Initial study for project application in cooperation with IIC AS CR

The involvement of the EH Lab in the AV21 program is not clear.

Adequacy of available means and human resources to achieve these plans

The **capabilities** of the Lab are good. Supplementary recruitment of researchers can be necessary if the intended proposal are successful.

Missing issues in the strategy

There are no missing issues.

Date: January 20, 2016

Commission Chair: em Prof.DI.Dr.Dr.hc. Hans Peter Nachtnebel