

Education and careers of European analytical chemists

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What roles do analytical chemists play in the European labour force? Which chemical subdisciplines offer the most job opportunities? Does higher education in chemistry in Europe provide appropriate specialization for graduates? Reliable answers to these and other questions have been derived from the first European employment survey of chemists and chemical engineers, which was conducted in 2013. The American Chemical Society (ACS) regularly publishes an employment survey in *Chemical & Engineering News* [1]. Data are collected from ACS members working in the USA. The survey results clearly show in which subdiscipline graduates received their highest qualification and in which subdiscipline they are working after starting their professional career. It would be of utmost interest for decisions within Europe for us to have access to similar data.

The questionnaire for the European employment survey of chemists and chemical engineers was jointly developed by all

partners. The Web-based questionnaire has six general pages (“Personal”, “Education”, “Employment”, “Job”, “Training and “Salary”), which provide fields for free-text comments. Approximately 4500 responses were received. Industry employees (43 % of all participants) found special questions on an additional page. Three per cent of the participants were self-employed. Only 3 % of all participants were not employed or were seeking employment. Retired people submitted 2 % of all responses. Thirty-nine per cent of all participants were women. The median age of all participants was 38 years. The youngest responders were aged 20 years. The oldest participant was an 87-year-old woman.

Participation in the survey differed very much among countries. The top ten countries in descending order of the absolute number of responses were Italy, the UK, Belgium, Germany, Portugal, Switzerland, Slovenia, the Czech Republic, Romania, and Spain. The subsequent detailed evaluation focuses on these countries in order to ensure significance of the results.

Sufficient participation of industry employees was a great concern. About 72 % of the industry participants came from large enterprises, 27 % came from small and medium-sized enterprises and 2 % came from associations/platforms. About 8 % of all industry participants indicated that their employer started as a spin-off.

The European employment survey addressed both chemists and chemical engineers. They answered the same questionnaire, and their responses were evaluated jointly. Subsequently, we call this joint group of chemists and chemical engineers “chemists” for short. Similarly, the term “analytical chemist” will refer to graduates with their highest degree in analytical chemistry. It will be especially emphasized if the discussion refers not to graduates but to those working as an analytical chemist—regardless of in which subdiscipline they received their highest qualification.

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Table 1 Participants obtained their highest degree in these chemical subdisciplines

Subdiscipline	Proportion (%)
Organic chemistry	19
Chemical engineering	15
Analytical chemistry	15
General chemistry	11
Physical chemistry	9
Inorganic chemistry	8
Material chemistry	5
Biochemistry	5
Polymer chemistry	4
All others	9

Education in analytical chemistry

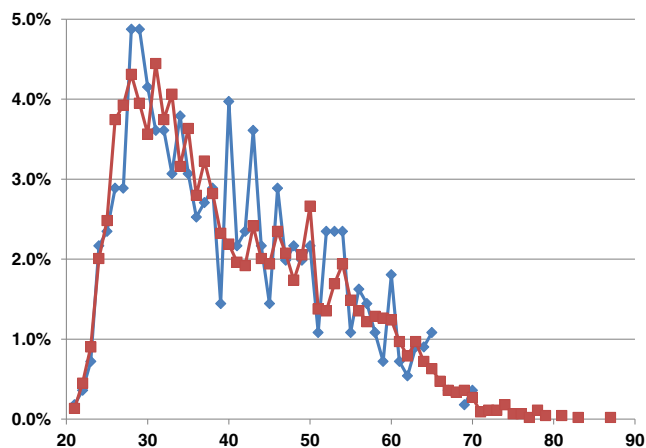
Analytical chemistry is one of the top three specializations for chemists across Europe (Table 1). The top three specializations are organic chemistry, chemical engineering and analytical chemistry. The preference for a particular degree differs significantly between subdisciplines. Analytical chemists are the largest group among those with a bachelor degree as the highest qualification. At master level, chemical engineers are the largest group; at doctorate level, the majority are organic chemists (Table 2). Other degrees are not considered here because of the distinctly smaller number of responses.

The median age of those who obtained their highest qualification in analytical chemistry is 38 years (the same median age as for all participants) (Fig. 1). Forty-five per cent of analytical chemists are women (all participants, 39 %).

This survey is the first of its kind in Europe. For this reason some of the results have to be treated with care. Clearly, such an example is the share of analytical chemists within the top ten responding countries. Compared with the average share of 15 % for all analytical chemists across Europe (Table 1), Italy shows a slightly larger share (19 %; Table 3), but the value for Spain is unbelievably low (2 %). The reason is apparently related to the very

Table 2 Shares of degree holders for the top three chemical subdisciplines in Table 1

	Bachelor (%)	Master (%)	Doctorate (%)
Organic chemistry	16	32	43
Chemical engineering	23	58	13
Analytical chemistry	29	42	22

**Fig. 1** Age distribution of all chemists (brown) and analytical chemists (blue)

strong Spanish Society for Analytical Chemistry, which practically hosts all Spanish analytical chemists but did not participate in the survey. This kind of fluctuation will certainly disappear in future surveys.

Qualification of analytical chemists

Most of the analytical chemists in Europe hold a master degree (43 %), followed by the group holding a doctoral degree (38 %). As could be expected, the median age of the doctoral degree holder is higher than that of the master degree holder (Table 4). On the other hand, bachelors do not seem to be younger than masters. For the validity of such conclusions, it has to be taken into consideration that the share of bachelors is distinctly lower than that of the other two groups. For all other degrees (4 % of all analytical chemists), the available data were insufficient for them to be included here.

Table 3 Share of analytical chemists in the top ten responding countries

Country	Share (%)
Italy	19
UK	15
Belgium	12
Germany	12
Portugal	6
Switzerland	7
Slovenia	14
Czech Republic	16
Romania	15
Spain	2

Table 4 Shares of degree holders for graduates in analytical chemistry

Qualification	Share (%)	Median age (years)	Women (%)	Working in native country (%)
Bachelor	15	36	46	95
Master	43	35	48	92
Doctorate	38	40	43	82
All analytical chemists	100	38	45	89

Table 5 Percentage of women in analytical chemistry who occupy a particular job type

Qualification	Women with a full-time permanent contract (%)	Women with a temporary full-time contract (%)	Women with a permanent part-time contract (%)	Women with a temporary part-time contract (%)
Master	37	63	75	75
Doctorate	34	64	75	80

The overwhelming majority of analytical chemists work full-time (85 %). Sixty-six percent of all analytical chemists have a permanent contract, and 14 % have a temporary contract. The percentage of women with a particular job type is significantly higher among those working part-time and among those with a temporary contract (Table 5).

Jobs for analytical chemists

In what employment sectors do graduates in analytical chemistry find a job? By and large, they find a job in the same employment sectors as all other chemists (Table 6). A more detailed look indicates a slightly higher job density for analytical chemists in research institutes and in the public sector, and a distinctly lower share in manufacturing industry.

Table 6 Employment sectors for chemists and analytical chemists

	Chemists (%)	Analytical chemists (%)
Industry, manufacturing	32	24
Research institute	19	21
Higher education	17	15
Industry, non-manufacturing	10	12
National government or public sector	8	13
Others	14 %	15 %

Table 7 Chemical subdiscipline dominating current jobs of analytical chemists (only top-ranked subdisciplines are shown)

Subdiscipline	Proportion (%)
Analytical chemistry	60
Environmental chemistry	9
General chemistry	4
Materials chemistry	3
Pharmaceutical chemistry	3
Food chemistry	3
Chemical engineering	2
Chemical education	2

Very interesting is the comparison of the preferred specialization listed in Table 1 (organic chemistry 19 %, chemical engineering 15 %, analytical chemistry 15 %) with the current jobs of all participants. The top three subdisciplines remain the same as above, but their order changed surprisingly. The response to the question “Which chemical subdiscipline is dominating your current job?” yielded: analytical chemistry (17 %), chemical engineering (9 %), and organic chemistry (9 %). This reveals a larger demand from the job market for analytical chemists than the supply by higher education institutions. The ACS survey [1] has produced the same result for many years.

Those who graduated in analytical chemistry responded very differently to the same question (“Which chemical subdiscipline is dominating your current job?”). The top subdisciplines—i.e. the most promising job areas—for analytical chemists are summarized in Table 7.

Job satisfaction of analytical chemists

Job satisfaction with the chosen profession or with the current job is complex to interpret. The responses to the corresponding questions were overwhelmingly positive (Table 8). If we

Table 8 Satisfaction of graduates in analytical chemistry with their current job

	My job is related to my field (%)	My job is commensurate with my training (%)	My job is challenging (%)	My job meets my expectations (%)
Very much	51	41	41	24
Yes	31	35	39	34
Somewhat	12	18	12	24
Not at all	4	4	5	16
No opinion	1	1	2	3

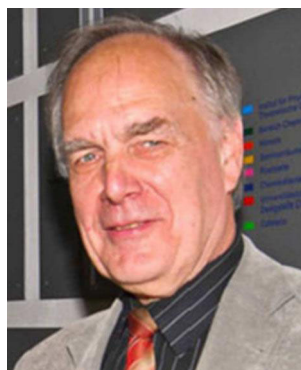
combine the rows with positive responses (“very much” and “yes”), we find roughly 80 % job satisfaction—except for the question concerning the expectations of the current job. Slightly less than 60 % see their expectations fulfilled.

Job satisfaction is usually related to advancement in position. Thirty-eight per cent of analytical chemists currently occupy management positions. Recruitment of new staff is a task for 28 % of analytical chemists. Both values are marginally lower than the ones reported for all participants.

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Reiner Salzer retired as Professor of Analytical Chemistry at the Technische Universität Dresden, Germany, in 2007. His main scientific interests include molecular monitoring for early diagnosis of diseases, integration of biologically active functions into polymers, and electronic media in university education. Professor Salzer has authored 14 patents in different fields of analytical chemistry, and over 250 books and scientific publications. Professor Salzer has been elected on

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