Chemical Environmental Science
Chalmers University of Technology
Göteborg, Sweden

The first six Doctors of Chemical Environmental Science together with Olle and Göran
Picture from 1992 after the first dissertations (Lars and Ann-Margret)
Tomas Rydberg, Olle, Magdalena Svanström, Gunnar Barrefors and Göran
Front - Lars Löfgren, Ann-Margret Strömvall and Ulf Östermark

Chemical Environmental Science
25 years of research

Olle Ramnäs and Göran Petersson

An overview 2012 – original version in Swedish

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Chemical Environmental Science since 1986

On the 1st of October 1986 Chemical Environmental Science was established as the first department at Chalmers with environmental science as the main subject and with fully independent undergraduate and graduate education.

Background: Several environmental issues became important in media and politics notably in western Sweden in the early 1980s. At Chalmers a center for environmental technology in Göteborg brought together environmental scientists and initiated education, public lectures and seminars. Göran Petersson was then responsible for the performance of many of these activities.

Platform: In the period1978-1986 Olle Ramnäs and Göran Petersson started one compulsory and several optional environmental courses at the School of Chemistry. In parallel with education, environmental research was started up dealing mainly with the analytical determination of hydrocarbons in air. The results for both vehicle exhaust and industrial emissions were widely recognized and Göran Petersson contributed to hundreds of reports in media.

The name issue: The head of Chalmers at the time, Sven Olving, supported the choice of Chemical Environmental Science as the name of the new unit.

Refueling and Benzene

For many years research was focused on environmental and health aspects of air pollutants. Analytical methods were developed and applied to various problems of particular interest.

Gas stations: Göteborg was first in Europe to introduce recovery of gasoline vapors during refueling. This permitted Pia Berglund to do comparisons for her licentiate exam of hydrocarbons in air at gas stations. The results contributed to a rapid breakthrough of recovery of vapors.

Gasoline and work environment: In the 1980s Olle Ramnäs initiated many student projects on chemical workplace exposure and safety in cooperation with Rolf Nordlinder. For his licentiate exam Rolf concentrated on workplace aspects and analytical determination of the carcinogenic hydrocarbon benzene. He also contributed to improved analytical methods for volatile hydrocarbons.

CONIFERS	TRAFFIC
TERPENES	HYDROCARBONS
FORESTRY	EXHAUST
PULP MILLS	GASOLINE

Conifer Terpenes and Urban Hydrocarbons

First to achieve PhDs in Chemical Environmental Science were Lars Löfgren and Ann-Margret Strömvall. Their research was based on similar methods but with completely different applications.

Conifer terpenes: Conifers emit terpene hydrocarbons which are reactive and difficult to analyze in air. Monoterpenes with ten carbon atoms predominate and are important in atmospheric chemistry. Analytical methods applied to gasoline hydrocarbons were modified by Göran Petersson for monoterpenes in forest air.

Forest industry: Logging and industrial processes give rise to large emissions of terpenes from softwood. Ann-Margret Strömvall studied concentrations and proportions of monoterpenes from logging and barking and from the production of mechanical and thermo-mechanical pulp, sulphite pulp and sulphate pulp. The atmospheric chemistry and the formation of toxic photo-oxidants were clarified. The research was independent relative to the forest industry.

Car emissions: For urban air Lars Löfgren further developed analysis of many gasoline hydrocarbons and included hazardous combustion-formed species such as ethylene and 1,3-butadiene. The technique was based on flexible sampling on tubes with several adsorbent layers. Thermal desorption was combined with gas chromatography on capillary columns suitable for hydrocarbons. This permitted a more complete determination of hazardous volatile hydrocarbons from traffic. The results adressed key environmental issues including human exposure.

Careers: Ann-Margret Strömvall later on returned to Chalmers for teaching and environmental research. Lars Löfgren specialized in analytical studies within the pharmaceutical industry.

Road Tunnels, Tobacco Smoke, Gasoline and Mopeds

In the 1990s, further developed methods permitted increasingly flexible studies of hydrocarbons from different sources in critical air environments.

Motorists in tunnels: Large projects for traffic in Stockholm and Göteborg came up with plans for several kilometer-long road tunnels. Gunnar Barrefors studied the levels of exhaust hydrocarbons in the Tingstad tunnel in Göteborg. Despite ventilation these were very high due to restricted dilution. Motorists including children and people with allergies are affected. The alarming results were spread by the press and contributed to less extensive tunnel plans.

Indoor air and combustion: The analytical methods were further adapted to tobacco smoke with deviating proportions of specific hydrocarbons as compared to vehicle exhaust. These two predominant sources of indoor air pollution were clearly distinguished analytically. Gunnar Barrefors also studied the proportions of volatile hydrocarbons from the burning of wood and other biofuels at varying combustion efficiency.

Alkylate petrol: Gasoline produced from alkylate without hazardous aromatic and other unsaturated hydrocarbons was introduced at an early stage in Sweden. The hydrocarbons in vapors and exhaust were determined by Ulf Östermark in comparison to conventional gasoline.

From refinery to exhaust: Ulf Östermark studied the emissions from catalytic cracking and the composition of hydrocarbons in the resulting naphtha. Alkylate produced from the naphtha is most beneficial for two-stroke engines with their incomplete combustion. A study was therefore performed based on sampling of hydrocarbons in the exhaust gas while driving a moped.

Careers: Ulf Östermark has been active for many years as an environmental consultant. Gunnar Barrefors has been responsible in different positions for regional environmental protection.

More air pollution studies: The licentiate thesis of Susan Björkqvist included articles on isoprene in exhaled air, furans from wood burning, and terpenes in biogas from household solid waste. The biogas project was an extention of the MSc thesis of Hanna Härelind who later on achieved a PhD from Chalmers.

Magdalena Svanström after her licentiate exam before Christmas 1993
Left to right – Olle, Göran, Magdalena, Ulf, Tomas and Gunnar

Life Cycle Assessment and Freons

Olle Ramnäs and co-workers extended analytical research to CFCs (Freons) and other gases, and included environmental performance aspects.

Chlorinated hydrocarbons and LCA: In the 1990s several volatile chlorinated hydrocarbons with an extensive technical use were rapidly phased out because of environmental and health hazards. Tomas Rydberg studied these compounds in the development of the concept Life Cycle Assessment. After his dissertation Tomas continued studies related to environmental technology within consulting companies.

Freons and plastic foams: The phasing out of CFCs to protect the ozone layer was a major environmental issue around 1990. Olle Ramnäs developed methods for analysis of CFCs and other insulating gases in foam. Magdalena Svanström studied the prevalence, properties and replacement of chlorofluorocarbons, CFC, mainly for district heating pipes. During one year she broadened her research at MIT in the US. After her dissertation Magdalena continued as a researcher and lecturer at Chalmers focusing on sustainable development.

ANTIOXIDANTS PHENOLS WOOD PELLETS	WOOD BURNING PYROLYSIS COMBUSTION

Biofuels – Fire and Smoke

With access to new mass spectrometric technique, Göran Petersson developed the analysis of phenolic substances in smoke from biomass. Priority was given to particular properties of these substances as antioxidants. Jennica Kjällstrand was involved in the projects. In later years she has been central environmental coordinator at Chalmers.

Wood burning: Phenols in smoke from forest biomass materials were studied systematically in laboratory experiments. Jennica Kjällstrand also performed field studies of smoke from controlled forest burning. Research continued with chimney analysis of key hydrocarbons and phenols from small-scale wood burning. The phenols were characterized as antioxidants. Smoke from burning of wood was a controversial issue and further studies were supported by a grant from the Swedish Energy Agency.

Wood pellets: An alternative fuel of rapidly increased use was wood pellets from sawdust. Maria Olsson made an inventory report and continued with detailed studies of smoke from the burning of pellets. Pilot tests for different stages of combustion were made in the laboratory. Measurements of chimney smoke were made in the field for both pellet stoves and pellet boilers. Maria also took part in several subsequent studies of biofuels as Maria Perzon.

Smoking and grilling: Antioxidant aspects of wood smoke were emphasized particularly through the analysis of smoke from the burning of hardwood chips used for smoking of foods. The phenolic antioxidants protect the food but also affect the consumer. Phenols as antioxidants were central to the PhD thesis of Jennica. Maria contributed with a food-related study of smoke from charcoal for grilling.

Four PhDs in Chemical Environmental Science following the first six:
Morgan Fröling and Jennica Kjällstrand behind Sara Mangs och Maria Olsson
on a picture from 2001 between Camilla Holmgren and Olle behind Göran

District Heating

For Olle Ramnäs, district heating became a major research area in cooperation with a research team in building physics. Olle developed methods for improved determination of insulating gases and his PhD students broadened the research.

Life Cycle Analysis: The major interest of Morgan Fröling was applications of LCA on district heating and district heating pipes. After his dissertation Morgan spent two years at MIT doing research on energy, environmental technology and Life Cycle Assessment.

Insulating materials: Research on insulation was continued by Sara Mangs with studies of plastic foams for district heating pipes. Opportunities to replace the predominant polyurethanes using other materials with better environmental performance were investigated.

Building technology: The research included close collaboration between Olle Ramnäs and several external graduate students in building physics. One of them was Camilla Holmgren on the picture.

Geranium sylvaticum, midsummer 2011

New approaches and initiatives

The last five of the 25 years have brought several major changes.

District heating: Olle Ramnäs has moved to the group focusing on building technology. He is doing analytical studies relating to long-term properties of isolating materials. Current research at Chemical Environmental Science no longer depends on instrumental methods.

Health: Göran Petersson has focused on independent research and particularly on biochemical evaluation of consumer products. Many critical reports on health aspects of food products have been published in Swedish from Chalmers with free public access.

Sustainability: Morgan Fröling and Magdalena Svanström have cooperated with each other and with external researchers nationally and internationally. Life cycle assessment and sustainable development are the main tracks. Magdalena is also involved in the development of teaching at Chalmers.

Employees: Morgan Fröling recently moved to a northern university position in Östersund. Instead, Gregory Peters with a background from Australia has joined as a staff member. Among several new PhD students Gunilla Clancy pioneers.