AQUARIUS

NEWSLETTER

November 2017—Issue 2

Message from the coordinator

With the second issue of the AQUARIUS newsletter we would like to start a series of technical reports that focus on the research undertaken within the project. The aim is to provide—besides the general project work progress and other relevant news—also more ground-laying and background information as well as details about the technology behind the research work. Each of the subsequent newsletter will focus on a selected area of expertise. As a starting point consortium member KWR Water B.V. from The Netherlands, who is mainly responsible for system validation, provides an insight into today's water treatment challenges, technologies, possible solutions and how the AQUARIUS project will contribute to addressing the challenges.

IN THIS ISSUE

Water treatment challenges—being prepared for prospective challenges

Water treatment is subject to many demands, while circumstances are becoming increasingly complex. In addition to this, global **water withdrawals increase faster than the global population growth**. Industries, municipalities and agriculture all withdraw, use and return water. Depending on the world region, the withdrawal for industrial uses varies from 5% to 65%, for municipalities from 5% to 33% and for agriculture from 16% to 89% of the total withdrawal, respectively. Thus, the **water industry is facing pressures** from both a quantitative and qualitative point of view, while regional **differences** in withdrawal rates and **regulations** create a complex web of needs that research organizations and technology providers are looking to solve.

Today's water treatment technologies have to be adapted to rapidly changing circumstances. While the **quality** and **availability of raw water are deteriorating worldwide**, treatment processes are expected to **supply healthy**, **safe** and **reliable drinking water**, at acceptable cost and energy consumption levels, and with a minimum of waste and by-products. The challenge is to develop and implement **innovative processes** and **concepts** for water treatment, so that the water sector can supply water of impeccable quality far into the future.

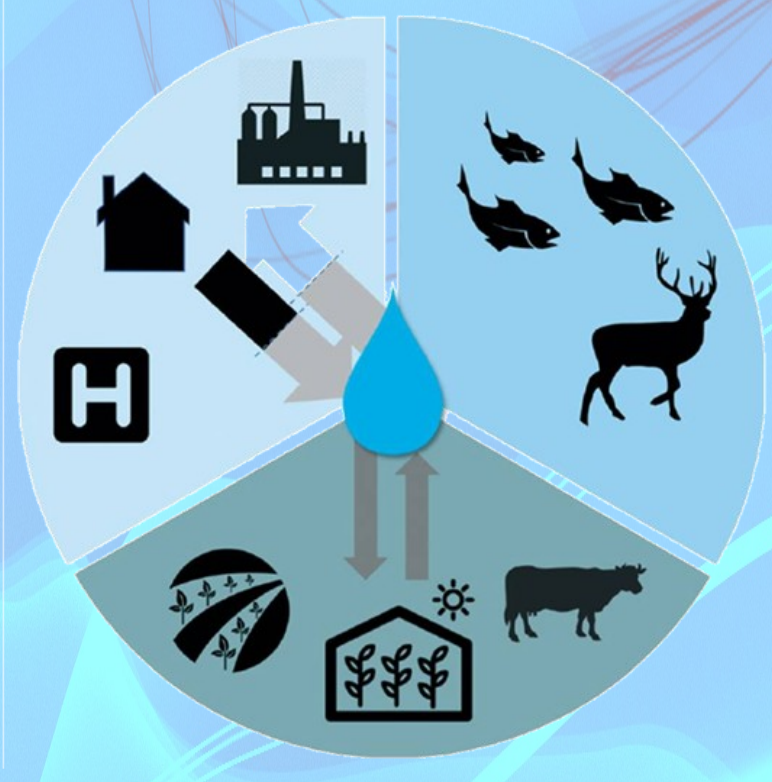
As one of the leading research organizations in the water cycle, **KWR's multifaceted expertise** in the field of water treatment technologies addresses a number of the questions facing the water sector. This helps **increase the innovativeness**, **efficiency** and **sustainability** of drinking water treatment. KWR's research into innovation in water treatment focuses on **technical solutions** – from membrane filtration to advanced oxidation, softening, rapid filtration, coagulation, online and offline monitoring, etc. - as well as increased efficiency, design optimization and operational management, data processing, soft sensing (simultaneous processing of multiple data) and improved process modeling. This enables the water sector to innovate and **increase the efficiency** and **sustainability of water treatment**. Thanks to data-driven models (soft sensors), statistics (data mining and data analytics) and process modeling, we are able to demonstrate how drinking water treatment processes can be organized more efficiently. We do this for a wide range of drinking water installations, such as UV or UV/UV/H2O2 installations, ozone installations, softening reactors and service reservoirs.

The chemical contamination challenge

After its use, water quality is changed with regard to chemicals, micro-organisms and renewable resources present in the water. This affects fit-for-purpose quality of the water for other users in the water cycle, and human and environmental risks related to the water quality. The water system integrates these various uses and requests, and upstream water use and return influence possible down-stream uses in a river basin (see figure on the right).

Chemicals are used for various beneficial purposes, such as crop protection, flame retardation, food conservation, disease recovery, etc. Over 347 000 chemicals are registered and regulated via national and international authorities (CHEMLIST), and new chemicals enter the market continuously. The global volume of production of chemicals grows faster than the global human population. The chemicals and their transformation products enter the aqueous environment as a result of emissions that can occur during all stages of their life cycle. Major environmental entry routes are household and industrial effluent treatment plants, agricultural run-off, infiltration into groundwater, combustion and evaporation and incidental spills. Since the analytical capabilities to detect the presence of chemicals in the water increase, many stakeholders in the water cycle are more aware of the presence of many chemicals in waste water effluent, surface and ground water and drinking water [1].

Generally, the most studied emerging contaminants are perfluorinated compounds, pharmaceuticals, biocides and organic compounds used in chemical processes. These compounds or emerging contaminants are a possible threat to the public health and environment. The **AQUARIUS project** aims to address the challenge by **developing a smarter, more efficient** and **cost-effective method** to measure and assess oil-in-water. Further, similar organic compounds in water could be assessed by the measurement principle. This is aimed at helping the water sector to realistically assess the human and environmental risks of emerging contaminants, and make decisions about water treatment.



The water system as integrator of urban and rural water withdrawals and returns, where sectors and nature demand sufficient water quality fit for purpose. Arrow widths summarize volumes abstracted in the EU context (FAO AQUASTAT data) for urban withdrawals (industry and municipalities) and rural withdrawals (agriculture); arrow darkness represents the presence and concentration of chemicals.

[1] A.P. van Wezel, T.L. ter Laak, A. Fischer, P.S. Bäuerlein, J. Munthe, L. Posthuma, Mitigation options for chemicals of emerging concern in surface waters; operationalising solutions-focused risk assessment, Environ. Sci.: Water Res. Technol. 3 (2017) 403-414.

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Consortium:	8 partners (5 countries)
Project Coordinator:	Dr. Klaus-Michael Koch coordination@aquarius-project.eu
Technical Leader:	DI Wolfgang Ritter w.ritter@quantared.com
Project Website:	www.aquarius-project.eu

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The AQUARIUS project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 731465.This project is an initiative of the Photonics Public Private Partnership.

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AQUARIUS - BROADBAND TUNABLE QCL BASED SENSOR FOR ONLINE AND INLINE DETECTION OF CONTAMINANTS IN WATER

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Technical Meeting in Freiburg, Germany

From **5th – 6th July 2017**, the **AQUARIUS Technical Meeting** took place in **Freiburg, Germany** and was hosted by partner FRAUNHOFER IAF. The first day was dedicated to provide a status update of the technical work packages. Therefore, each WP-Leader presented their progress and results in depth, which led to some technical discussions. Within the first six month of the project eleven deliverables have been submitted to the EC. Hence, during this meeting some further explanations took place, e.g. on the **specifications for online and inline oil in water analyser** and as well for **subsystem broadband MIR laser spectrometer**. The day was summed up by having a great common dinner in the city centre of Freiburg, where discussions continued in a less formal way. On the second day, there were further technical presentations supported by focused discussions. Summing up, it was a very successful and engaging meeting, providing many inputs that could be used for further research and developments within the AQUARIUS project.

AQUARIUS group picture at technical meeting in Freiburg

Technical progress since May 2017

In **WP1 "Requirements and specifications for Online and Inline Oil in water analyser"** initial versions for the specification documents were created and the preliminary system specification were continuously discussed and extended. As a result, 3 specification deliverables were finished and submitted on time. One deliverable summarized the specifications for the online Oil in Water (OiW) system, and another for the inline OiW analysis system. The main optical interface between the spectrometer sub-system was discussed in detail with all involved partners. This lead to optical, mechanical and electrical interface definitions. This interface specification is included in two of the deliverables and detailed in a further deliverable, which also describes the main sub-system parameters of the broadband laser-based spectrometer. Different options for the operational mode of the laser source were integrated, whereas the most suitable will be selected for integration in the final spectrometer sub-systems. The work on one of the work package 1 deliverables led to a detailed analysis of the OiW market including a review of the state of the art. This also included the review of offline methods which are the basis of standard methods for use in regulatory frameworks. A list of analytes for enhanced water monitoring was compiled and discussed between several partners. Based on the list of potential analytes the user information was collected in form of interviews with 9 representative industry experts. The feedback from experts led to promising conclusion regarding AQUARIUS system feasibility and future scaling actions for the technology. There is a high interest in the AQUARIUS technical solution, especially in the field of process control for production purposes, influent and effluent monitoring for the wastewater treatment plants in industrial facilities, but also for cooling water and functional fluids monitoring. Further, an interest in enhanced systems based on the generic AQUARIUS technology platform was identified and important operational parameters were mentioned.

Regarding **WP2 "Broadband tunable mid-infrared laser source for spectroscopy"** Quantum Cascade Laser (QCL) material based on a bound-to-continuum design fulfils the requirements for AQUARIUS. Focused Ion Beam(FIB) milling of laser facets to produce angled facets has started and first results are promising. External cavity (EC) operation of a laser with an angled facet has been demonstrated and a subsequent AR coating of this laser will be done and is expected to deliver a considerably lower reflectivity than the coating alone. A first MOEMS EC QCL module covering the Aquarius spectral range has been realized and tested. It enables real-time spectroscopic measurements and will be integrated in the first spectrometer version. Initial experiments with a laboratory cw MOEMS EC QCL with variable cavity length have been performed. Strongly improved spectral resolution was demonstrated by transmission measurements on atmospheric water vapor.

In **WP3 "Broadband MIR laser spectrometer"** the sensors were optimised and produced. The measurement method and the expected signal parameters at each step are defined. To meet the need to verify various methods of measurement, created specification enables maximum flexibility of the designed sub-modules.

First experiments with porous enrichment layers were made in **WP4 "Inline oil in water spectroscopy with functionalized sensor"** and showed fast diffusion into the layer and fast regeneration.

The work in **WP5 "Online OiW analyser by automatic extractor for hydrocarbons in water"** included the creation of a list of samples of interest for the chemometric database and the measurement analysis of those samples with different analytical techniques. An extensive inter-laboratory study was carried out to demonstrate the robustness of the liquid-liquid extraction method. These results were used to update and improve an ASTM standard test method.

As part of **WP7 "Dissemination, Communication, Exploitation, and Standardization"** a press release has been published in the local media and the project was promoted via the social media channels.

*** AQUARIUS Video ***

The video was designed to provide some general information about the project and its partners, to highlight its objectives and innovations, and to give an overview of the work structure. View the short clip on our project website: https://aquarius-project.eu/downloads/aquarius_final_1_x264.mp4

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