QUB–CSC Scholarship PhD Project Proposal
Mechanical and Aerospace Engineering
2018-2019

Title: Investigation of microplastics in water treatment systems

Project description:

Microplastics are small (< 5 mm) fragments of plastic, and their presence in the ecosystem and food web is a growing concern internationally due to their potential to cause harm to human health and the environment. Much of the research to date has focused on the effect of microplastics on fish and other marine wildlife, but more recent work has investigated the presence of microplastics in drinking water. A recently published international study of tap water samples found that 83% of samples were contaminated with plastic fibres [1], while research for the Irish Environmental Protection Agency reported that ingestion of water contaminated with microplastics may pose a much greater risk to human health than ingestion through consumption of contaminated fish [2]. Removal of microplastics from the water supply system is therefore a novel area of interest and it is a topic that is currently not well understood.

The aims of this project are to investigate the presence of microplastics in the clean water supply system and to understand microplastic behaviour at different treatment stages in the water treatment process.

The overall goals of the research are to:

- Investigate the occurrence and characterization of microplastics in the water treatment system (through literature review, sampling and laboratory testing);
- Develop numerical models to predict the behaviour of microplastics in a typical water treatment plant;
- Develop recommendations for removal of microplastics (where and how in the water treatment plant).

To achieve the stated goals the following methodology is proposed:

Work package 1: Literature review
Develop a comprehensive literature review related to: i) the water supply system and existing procedures for testing for the presence of and for the characterisation of microplastics in water; ii) the numerical models present in the literature on microplastic behaviour and the applicability of existing models to water treatment systems.

Work package 2: Testing and analysis
Propose a suitable method for testing for microplastics in water and extract and analyse samples from a water treatment plant to understand microplastic behaviour. This task will be carried out with the support of Northern Ireland (NI) Water at one of their sites.

Work package 3: Development of numerical models
The findings of the laboratory testing and literature review will inform the development of numerical models that are capable of predicting the behaviour of microplastics in the water treatment system.

Work package 4: Verification and validation
The model developed will then be verified and validated with in-situ experimental data. Model sensitivity and uncertainty analysis will also be carried out to better understand the applicability of the model. Model sensitivity and uncertainty analysis have the twofold benefit of quantifying the applicability of the model and also of reducing the decision uncertainty of possible model end-users.

Work package 5: Recommendations
Recommendations for improving the understanding of microplastic behaviour and modelling in water.
Recommendations for methods of removing microplastics from the water supply system.

Potential impact
The project aims to contribute to the development of novel methodologies and numerical models to predict microplastic behaviour in water treatment plants. This will contribute to the future development of optimised microplastic removal technologies for water treatment plants, with resulting benefits for human and ecosystem health.

The project address escalating UK/EU drives in legislation for improved resource efficiency and ties in with current funding from EPSRC under calls of 'Resource Efficiency' and Living with Environmental Change'.

The project will involve collaboration with NI Water, the supplier of water and sewerage services to a population of ~1.8 million people in Northern Ireland. NI Water delivers approximately 560 million litres of drinking water to 840,000 households and businesses every day.

The studentship will start on the 1st of October 2018. The PhD student will be based in QUB, but will also spend time in NI Water.

Application procedure: Applications are made through the online portal**.**
https://www.qub.ac.uk/International/International-students/International-scholarships/QueensUniversityChinaScholarshipCouncilPhDScholarships2018/

It is recommended that you read the terms and conditions on the website prior to completing the form. The closing date is 30 January 2018.

Before completing the form, please contact Dr Marco Geron or Dr Beatrice Smyth to discuss the opportunity by 26 January 2018 at the latest.

Key skills required for the post:

- Information on the required academic qualifications is available on the QUB website https://www.qub.ac.uk/International/International-students/International-scholarships/QueensUniversityChinaScholarshipCouncilPhDScholarships2018/
- The project would suit a student with a degree in Mechanical/Environmental/Civil/Chemical Engineering, Materials Science or similar.
- Experience or knowledge of fluid flow behaviour is preferable.
- High self-motivation and preparation for laboratory work and computational analysis is required.
- Students should demonstrate the potential to engage in innovative research and to complete the PhD within a prescribed period of study.
- English language proficiency is essential (please refer to https://www.qub.ac.uk/International/International-students/International-scholarships/QueensUniversityChinaScholarshipCouncilPhDScholarships2018/).

Key transferable skills that will be developed during the PhD:

At the end of the doctorate the candidate is expected to have developed generic and transferable skills in time management, problem solving, report writing and oral presentations. The student is also expected to develop a considerable skillset in the solid particles-fluid interaction area, in numerical code programming (with specific emphasis on C++ and python), and in the utilisation of OpenFoam CFD software. The project will also benefit from the collaborations with NI Water and several short visits to the company are expected, which should enhance both professional standing and competency.

The successful candidate will also have access to supplementary professional training, allowing him/her to develop skills in analytical and interdisciplinary thinking; improved oral and written communication skills through dissemination of research findings; contacts for future projects, employment and funding opportunities; and project management skills in preparation for future challenges in both industrial and academic settings.

First/Lead Supervisor and their contact details	Dr Marco Geron, School of Mechanical & Aerospace Engineering, Queen's University Belfast, m.geron@qub.ac.uk, 028 9097 4728
Second Supervisor and their contact details:	Dr Beatrice Smyth, School of Mechanical & Aerospace Engineering, Queen's University Belfast, beatrice.smyth@qub.ac.uk, 028 9097 4318
NI Water Supervisors:	Karen McDowell, Research and Development Manager, NI Water, Karen.McDowell@niwater.com
Top up available for this project?	The award covers international tuition fees, the maintenance stipend and one return economy class return journey to China. There is also the opportunity to undertake teaching and demonstration duties to earn a further ~£1,500 per annum.

[1] https://orbmedia.org/stories/Invisibles_plastics [2] http://www.epa.ie/pubs/reports/research/water/RR%20210Essentra_web.pdf