DELIVERABLE NUMBER D1.3

Demonstration plant for testing and development at IVAR and Hias

NTNU, Stein W. Østerhus

April-2021

Achieving wider uptake of water-smart solutions
Project number: 869283
Project duration: May 2020 – April 2024
H2020-SC5-2019-2
WWW.WIDER-UPTAKE.EU

Disclaimer: This deliverable has not yet been approved by the European Commision and should be seen as a draft.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

D1.3 – Public

Demonstration plant for testing and development at IVAR and Hias

VERSION
01

DATE
30-April-2021

ABSTRACT

Deliverable D1.3 "Demonstration plant for testing and development at IVAR and Hias is part of Task 1.3 – "Fertiliser and soil improver by waste and wastewater resource recovery, Hamar and Stavanger, Norway", led by NTNU, IVAR and Hias with contribution from HØST, Sirkula and Hias How20, in WP1 - Demonstrations of water-smart solutions. This Deliverable aims at demonstrating the technical plants for testing and development at IVAR (enhanced removal of suspended solids (SS) prior to biological treatment by dissolved air flotation or drum filters combined with polymer dosage), and HIAS (a sludge processing line for recovery of P from the EBPR sludge) built and ready for use as part of T1.3.1 and T1.3.2, respectively. However, this document partly reports deliverable 1.3, as part of the deliverable (contracting and construction of the struvite plant at Hias) is delayed.

DELIVERABLE ID
D1.3

WORK PACKAGE
WP1

PLANNED DELIVERY DATE
30-April-2021

AUTHORSHIP AND APPROVAL INFORMATION

LEAD BENEFICIARY
NTNU

AUTHOR(S)
Stein W. Østerhus (NTNU)

REVIEWED BY
Reviewer 1: Herman Helness
Reviewer 2: Kamal Azrague

RELEASE HISTORY

VERSION	DATE	VERSION DESCRIPTION/MILESTONE* DESCRIPTION
01	30-April-2021	Preliminary version
02		

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

TABLE OF CONTENTS

LIST OF ANNEXES

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

1 Introduction

In WIDER UPTAKE, demonstration activities are covered by WP1. These activities ensure the application of water smart solutions in batch/pilot and real scale.

Within WP1 NTNU together with IVAR and Hias are the lead beneficiaries of T1.3 "Fertiliser and soil improver by waste and wastewater resource recovery, Hamar and Stavanger, Norway". The activities will be conducted on the demonstration wastewater treatment plants (WWTPs) in Stavanger (IVAR) and Hamar (Hias).

In particular, the following tasks have to be achieved:

T1.3.1: Wastewater treatment (Enhanced Biological Phosphorus Removal and optimised pre-treatment)
T1.3.2: Resource recovery (struvite and biogas)
T1.3.3: Value chains for recovered struvite and biogas

This document summarizes the preparation activities carried out by IVAR and Hias (from month 1 to month 12) related to Deliverable D1.3 "Demonstration plant for testing and development at IVAR and Hias". The technical plants for testing and development at IVAR (enhanced removal of suspended solids (SS) prior to biological treatment by dissolved air flotation or drum filters combined with polymer dosage), and HIAS (a sludge processing line for recovery of P from the EBPR sludge) are partly completed and ready for use as part of T1.3.1 and T1.3.2, respectively. However, this document only partly fulfils the planned reporting in deliverable 1.3, as part of the deliverable (contracting and construction of the struvite plant) is delayed.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

2 WWTP at IVAR (Stavanger)

IVAR IKS is a publicly company owned by 15 municipalities in the Rogaland county, South-West Norway. The activities are supply of water, treatment of wastewater and handling and treatment of solid waste for the 15 municipalities, serving a population of about 350000.

Within the areas of wastewater treatment, sludge treatment, handling, and treatment of solid organic waste the company has invested in new plants during the recent years. All processes are designed and operated for maximizing reuse of energy and nutrients.

The wastewater treatment plants have been retrofitted for optimum energy recovery by enhanced removal of suspended solids (SS) prior to biological treatment. Two main approaches, located at two different sites (Grødaland, IVAR-GD, and Sentralrenseanlegget nord-Jæren, IVAR-SNJ) are as follows:

1. IVAR-GD: Polymer precipitation along with dissolved air flotation (DAF) of wastewater influenced by food industry with high fat content, where flotation is the most suitable solution.

2. IVAR-SNJ: Primary filtration of domestic wastewater by drum filters with 100 µm pores. Polymer addition is planned to enhance SS separation.

2.1 Flotation unit at IVAR-GD

To facilitate enhanced removal of suspended solids (SS) prior to biological wastewater treatment, Grødaland was retrofitted with a Dissolved air flotation (DAF) unit with the possibility to add coagulating/flocculating chemicals. The treatment consists of two separate lines, each equipped with chemical addition and mixing, dispersion pumps, floatation tank, sludge scrapers (top & bottom) and sludge screws. Each line has a capacity of 100 l/s.

Chemical addition facilitates enhanced SS removal by coagulating and flocculating the particles (colloidal and suspended solids) in the wastewater. An inline mixer, immediately downstream the point of dosing, provides good mixing of the chemical with the wastewater. The dispersion pumps create micro bubbles by introducing air-saturated dispersion water into the process. The flocculated particles adhere to the bubbles and floats to the surface where they create a sludge blanket (Figure 1). The sludge blanket is removed by sludge scrapes (Figure 2) before the sludge is transferred to a small tank by screws (Figure 3). From the tank the sludge is pumped into a larger storage tank. Particles that settle on the bottom of the flotation tanks are removed by bottom scrapes and transferred to the sludge storage tank by pumps.

Figure 1: Flocculated SS floating to the surface starting to create a sludge blanket

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

Figure 2: Sludge blanket with the sludge scrape

Figure 3: Sludge screws transporting the sludge

This part is completed and today the DAF is operated with the addition of a polymer, and the chemical dosing has been optimized to remove approx. 60 % of SS in inlet wastewater (inlet wastewater contains 550 mg/L SS). Chemical dosing (l/h) is controlled by the flow (l/s) of incoming wastewater.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

2.2 Primary filtration unit at IVAR-SNJ

2.2.1 Process description

Figure 4: HydroTech drum filters at IVAR SNJ (Photo: Kjetil Birkedal Pedersen, IVAR)

The filter system (Figure 4) is composed of 20 HydroTech drum filters with 100 µm pores. The filters are evenly distributed on each side of a distribution channel. The inlet to the filters is through the centre of the drum, and the filtered wastewater flows through the filters, while particles larger than 100 µm are retained on the screens.

The primary sludge accumulating on the filter cloth reduces the hydraulic throughput of the filters, and the level in the channel increases unless the filters are back flushed. Back flushing of the filters is controlled by a set point for the water level in the channel, enabling a pressure drop of 150-200 mm over the filter cloth. The filters are washed in groups of four, the factor T-delay determining flushing frequency. This factor determines the time interval between back wash start for subsequent filter groups and will vary inversely with the distribution channel water level. Consequently, the filters are flushed more/less frequently as the channel water level is increased/reduced. If the T-delay reached the minimum value and the level in the channel continues to rise, the wastewater will eventually overflow into the biological treatment stage.

The filters are back flushed with process water at 6 bars, distributed over 60 nozzles located on the outside of the filter cloth. Accumulated sludge is flushed from the inside of the cloth to an integrated sludge trough and pumped to a thickener system. Filtered wastewater is passed over an overflow and into the biological treatment stage.

Automatic hot water flushing at 80 bars is performed weekly on each filter. The filters are also equipped with a connection point and nozzles for chemical rinsing. Chemical cleaning of the screens is performed as needed, commonly every 2-3 months.

The filters have been prepared for polymer dosage.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

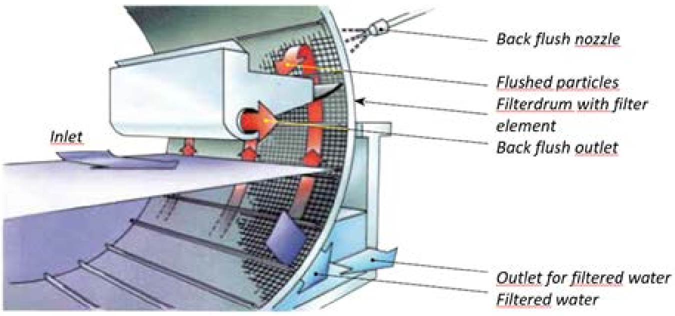

Figure 5: Main principle of primary filtration

2.2.2 Performance of the filters

The main objective of the drum filters is to reduce the load on the biological treatment stage, thus reducing the energy requirement for aeration. The primary sludge removed in the filters also provides additional sludge for biogas production. Thus, the primary filtration both saves and yields energy. The filtration plant was designed to remove at least 50 % TSS at design flow, see Table 1.

Table 1: Design parameters

Parameter	Value	Unit
$Q_{average}$	6100	m³/h
Q_{design}	7400	m³/h
$Q_{maksdesign}$	10100	m³/h
Design load	33000	kg TSS/d
TSS removal @ Q_{design}	50	%
TSS removal @ $Q_{maxdesign}$	40	%

Figure 3 shows the filter plant performance between April 2020 and April 2021.

The average hydraulic load on the filters during this period was 4 850 m³/h, and the average TSS removal within this period was 52,6 %. As per Table 1, the filters performed according to design.

However, there have been major technical and mechanical challenges with the filter plant since the middle of 2018. These include (but are not limited to):

- Repeated mechanical issues with the back flushing nozzles, and malfunction of the hot water flushing system – both of which affected the capacity of the filtration plant
- Breakage and cracking of the structural elements in the filters
- Breakage of bolts in the main drive – probably due to imbalance in the filter drums caused by water entering through the cracks in the filter structure

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

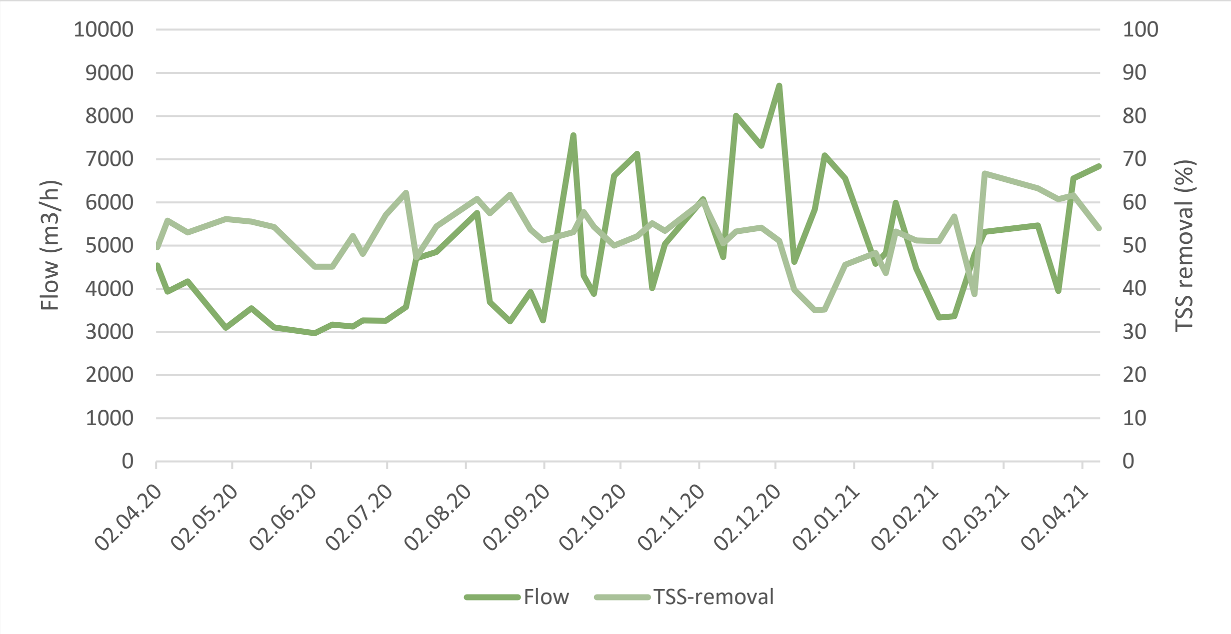

Figure 6: Drum filter performance April 2020 - April 2021

These challenges have greatly delayed the optimization of the filter plant. However, the filtration plant has been prepared for polymer dosing as specified in the deliverable, and the initial intention of adding polymer to maximize the TSS removal is still relevant and will be implemented during the Wider Uptake project period. However, the mechanical issues listed above, need to be solved before any optimization efforts with polymer can be conducted.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

3 WWTP at Hias (Hamar)

Hias IKS is a publicly company owned by 6 municipalities in the East of Norway. The largest owner is the city of Hamar, where also the WWTP is located. The activities are supply of water, treatment of wastewater and handling and treatment of solid waste for the 6 municipalities, serving a population of about 60000. The WWTP is treating wastewater from a population of 60000 with an additional industrial load.

The Hias WWTP was a chemical precipitation plant which now is being converted to an Enhanced Biological Phosphorus Removal (EBPR) process based on a new developed configuration with Moving Bed Biofilm Reactors (MBBR).

3.1 Short status at Hias WWTP

One out of two EBPR process lines (50000 pe) have been completed and are working satisfactory. The second line will be completed later this year, giving the WWTP an EBPR capacity (including primary and final settling) of 110000 pe which is considered as sufficient for normal operation.

Part of the "old" chemical precipitation plant will be converted to a storm water treatment facility.

3.2 Sludge processing line for recovery of P

The part of deliverable D1.3 which Hias is responsible for, consist of a sludge processing line for recovery of P from the EBPR sludge. The sludge processing line for recovery of P from the EBPR sludge comprises of several elements, including a magnesium trap for handling issues during possible operational problems. These elements are constructed and completed ready for use. However, the final struvite reactor unit, which is essential for the P-recovery line, is delayed.

Contracting of the struvite reactor was delayed and approved by the board 13th of April 2021. However, the signature of the contract has been delayed further due to a competitor complaint which needs to be settled in court before the contract can be signed. The case will appear in court the 12th of May 2021. After final settlement in court, the contract will be signed, and the installation of the struvite reactor can be completed. The delay is not expected to have any negative impact on the project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

4 Conclusions

This report summarizes the activity by IVAR and Hias related to D1.3 “Demonstration plant for testing and development at IVAR and Hias”. All the activities in D1.3 have been completed, except the installation of the struvite reactor at Hias which is delayed and not yet build (see also Milestone reporting). This report therefore only partly reports D1.3 and is provided as a preliminary version. The last part of the report on the struvite reactor will be provided when the struvite reactor has been installed, and a complete version of the report will then be submitted.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author’s view.
The Commission is not responsible for any use that may be made of the information it contains.