Mineral Catalyzed bio-degradation of Pharmaceuticals from Hospital wastewater at the plant of Isala hospital in Zwolle

Bachelor thesis by: Peng Dong

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Mineral Catalyzed bio-degradation of Pharmaceuticals from Hospital wastewater at the plant of Isala hospital in Zwolle

Bachelor thesis Land and water management at Van Hall Larenstein, the Netherlands

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Hans Van Den Dool (VHL)

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Van Hall Larenstein University of Applied Sciences

Vitens drinking water company, NL

Preface and Acknowledgement

These five months' practice period provided me a great opportunity for experiencing real office life, laboratory work and in creating this academic research. My involvement in this placement started with a meeting with Mr. Jacques van Paassen, Jacques made a brief introduction of our project at wastewater treatment plant of Isala hospital in Zwolle, Netherlands at the beginning of this February 2011. It is my great pleasure to acknowledge the staffs that helped us on this project during the past five months.

This research took the combined efforts of many people. I especially wish to acknowledge the following people:

- Mr. Hans Van den Dool from Van Hall Larenstein, my supervisor, without his efforts, I couldn't get this wonderful practical opportunity. Thank you for giving me lots of valuable advice and providing us different academic support.

- Mr. Jacques van Paassen, who as the external supervisor offered this great opportunity for me to do this research, under his guidance I could carry out the research well and developed the research along the correct direction, and he always kept patient and professional when we had meetings or laboratory work. Furthermore, Mr. Jacques Paassen van introduced some specialists to help me.

- Mr. Zhai Jun, he is a specialist of sewage treatment who helped me to collect the related data during the laboratory work. And he also taught me how to build and perform the experiment.

I also want to thank the staff from Vitens and Wageningen University, who warmly welcomed me and provided us with a great working environment.

Peng Dong

May, 2011

Summary

The project is about the waste water treatment of hospital under SLIK/PILLS (pharmaceutical input and elimination from local sources). SLIK stands for “Sanitaire Lozingen Isalaklinieken”. The PILLS is an EU-project that focuses on finding solutions for pharmaceutically burdened waste water directly from the source. The goal of the SLIK project is to build and operate the first full-scale wastewater treatment plant to treat the sewage containing rests of medicines and hormones from the Isala hospital in Zwolle. To obtain more insights on the treatment steps, operational aspects and costs through the project can help improve the water quality in and near Zwolle.

There is a SLIK project started at Wageningen UR cooperated with Vitens. It is drafted by Dr. Jun Zhai and named as “Mineral Catalyzed bio-degradation of Pharmaceuticals from Hospital wastewater under SLIK/PILLS project”. The Project will develop new process of waster water treatment and test in the plant of Isala hospital in Zwolle. The objectives of this project are: phase 1, to find one or several mineral(s) or a combination of some minerals to enhance the biological degradation (Reductive or oxidative) of some (emerging) micropollutants in wastewater, phase 2, to (further) investigate the mechanism on the developed new mineral catalyzed biological process for organic pharmaceuticals removal from wastewater, phase 3, to develop a new process to treat (selected) pharmaceuticals in wastewater with low cost, low healthy risk and easy operation as the advantages.

The research started with the understanding of the project, process with the experiments at Wageningen University. The research base on the experiments and the results from the experiments will be test at the pilot plant at Isala. The results proved that the mineral(s) or a combination of some minerals do catalyze the biological process for organic pharmaceuticals removal from wastewater but in different levels. Some of the chemical reactions of the minerals can be circulated and that increased the efficiency of the process. The experiments show that the “Fe (II) +Fe (III)” can enhance the reaction dramatically. And it is in anticipation that “MnO_2 + sludge” has the best performance in decomposition of Methylene Blue.

Content

1. Introduction

1.1 Background

The presence of pharmaceuticals in the water is a growing concern. All experts agree that actions are needed to be taken to reduce this contamination. As the current sewage treatment plants do not remove pharmaceutical residues from the water, the PILLS-partners intended to find out which wastewater treatment methods are best suited to eliminate pharmaceutical residues from the water. Therefore they construct pilot plants at high concentrated point sources as e.g. hospitals. Moreover, they would like to highlight the problem of contamination of the water with pharma-ceutical re-sidues across Europe and raise the awareness for a sustainable approach to face this problem.

Project Pills is embedded in project SLIK by the waterboard Groot Salland. The goal of the SLIK project is to build and operate the first full-scale wastewater treatment plant to treat the sewage containing rests of medicines and hormones from the Isala hospital in Zwolle. To obtain more insights on the treatment steps, operational aspects and costs through the project can help improve the water quality in and near Zwolle. SLIK stands for `Sanitaire Lozingen Isalaklinieken´, which means sanitary discharge of the Isala hospital. Vitens take an active role in the project SLIK.

Isala is the one of the biggest non-academic hospital (the 5th) in the Netherlands. It employs 2700 people; there are 1076 beds, 470,000 policlinic visits and 40,000 hospitalisations per year. Isala has received in the recent years more and more highly specialized functions. The plant is next to the hospital. (Dr.ir, Herman Evenblij 2010 Research plan SLIK/PILLS)

Figure 1 Isala hospital and the plant (Mirabella Mulder 2011)

The project “Mineral Catalyzed bio-degradation of Pharmaceuticals from Hospital wastewater under SLIK/PILLS project” is drafted by Dr. Zhai Jun. Mr. Zhai Jun is a visiting scholar in Wageningen UR from Chongqing UR. The project proceeds in the laboratory of Wageningen UR.

1.2 Problem description

Isala clinics in Zwolle are situated at two locations: Weezenlanden and location Sophia. In future Sophia will be extended in order to concentrate all departments at one location and location Weezenlanden will be ultimately closed. The wastewater from Isala clinics (both locations) is at this moment treated at WWTP Zwolle. The Wasterboard Groot Salland (WGS) took an initiative to decouple hospital wastewater from the sewer and to remove problematic compounds, mainly human pharmaceuticals and their residues, on site. This is being realized within two projects PILLS/SLIK explained elsewhere. (Dr.ir, Herman Evenblij 2010 Research plan SLIK/PILLS)

Advanced Oxidation Processes (AOPs) are generally recognized as promising measures for removing biologically toxic or non-degradable materials from waste water. These techniques are relatively complex in operation and expensive. They demand a very efficient pre-treatment to optimise a target oxidation. AOPs, being a rapid reaction, are also suspected to generate some undesirable oxidation by-products which may induce some health risks and environmental problems when the water effuses? (Chang and Young 2000). So it is very interesting to develop a new technology to treat the pharmaceuticals in wastewater efficiently (mineralization) at a lower cost, with lower health risk and easier operation.

Some researches (Borch, Kretzschmar et al. 2010) have proven that the biogeochemical behavior of some not redox-active elements and compounds may be indirectly coupled to redox transformations of organic matters, in particular (hydr)oxides of iron (Fe) and manganese (Mn), Fe-bearing clay minerals, and Fe sulfides. Redox-active functional groups associated with mineral surfaces can further catalyze the oxidation or reduction of ions and molecules, including many organic contaminants (Kappler and Haderlein 2003; Alvarez, Perez-Cruz et al. 2010).

Several studies have demonstrated that, in contrast to pure aqueous Fe2+, Fe (III) oxide phases such as goethite that have been reacted with Fe (II), in most case cooperated with bacteria, can significantly enhance the transformation rates of many reducible contaminants such as nitro-aromatics (Borch, Inskeep et al. 2005), chlorinated solvents (Amonette, Workman et al. 2000), pesticides (Chun, Penn et al. 2006), and disinfectants. It is possible that the Fe (III) - Fe (II) combination system can similarly enhance the reduction of pharmaceuticals, hormones and personal care products as well. The enhanced reactivity of Fe (III) oxide surfaces reacted with Fe (II) is poorly understood.

Recent studies have shown that manganese oxides common in soils, such as birnessite, are also able to oxidize emerging contaminants such as antibacterial agents (i.e., phenols, fluoroquinolones, aromatic N-oxides, and tetracyclines) (Zhang, Chen et al. 2008), bisphenol A (Lin, Liu et al. 2009) (an endocrine disrupting chemical used in plastic production), and 17α-ethynylestradiol (synthetic hormone used in contraceptive pills) (de Rudder, Van de Wiele et al. 2004). (Dr. Jun Zhai, 2011)

1.3 Research objective

The final objective is: develop a new process to treat (select) pharmaceuticals in wastewater with low cost, low healthy risk and easy operation as the advantages.

To achieve this objective, the following research questions are formulated:

Which mineral(s) or a combination of some minerals can catalyze biological process for organic pharmaceuticals removal from wastewater?
How to test the effect of waste water treatment in different reagents?
What’s the difference of the result of waste water treatment in different reagent?
What’s the better mineral(s) or a combination for catalyze waste water treatment?

2. Methodology

2.1Project set up

Phase 1 initial phase

Find mineral(s) or a combination of some minerals to enhance the biological degradation (Reductive or oxidative) of some (emerging) micropollutants in wastewater.

From the research of Dr. Zhai Jun the minerals selected from the most common catalyzer of which do enhance the biological degradation. See table 1.

Phase 2 data analysis phase

Investigate the mechanism on the developed new mineral catalyzed biological process for organic pharmaceuticals removal from wastewater.

During the experiments the mineral(s) or a combination will be founded which have better effect to enhance the biological degradation. The results during the experiments were compared and analysised.

Phase 3 conclusion and discussion

Develop a new process to treat (select) pharmaceuticals in wastewater with low cost, low healthy risk and easy operation as the advantages.

After the experiments the results will be tested at the plant in Isala in the future. According to the test results the new process will be develop.

SN	Reagents	Reactor & Operation condition	Objectives
(1)	Reactive Red 2 + Goethite (FeOOH) +Anaerobic Sludge	Bottle (sealed) + Magnetic stirrer + Sludge mixed with Goethite fixed in an iron wire made box	• To roughly investigate the performance of Goethite (FeOOH) + Fe^{2+} on Reactive Red 2 Reduction with anaerobic bacteria. • To roughly investigate the effect of pH or other factors that influence the performance. • Other minerals or iron oxide will be tested, if the first proposed mineral (Goethite) does not have obvious function to catalyze Reactive Red 2 biological reduction.
(2)	Reactive Red 2 + Goethite (FeOOH) + Fe^{2+} +Anaerobic Sludge	Bottle (sealed) + Magnetic stirrer + Sludge mixed with Goethite fixed in an iron wire made box	
(3)	Reactive Red 2 +Anaerobic Sludge (Control)	Bottle (sealed) + Magnetic stirrer + Sludge	
(4)	Reactive Red 2 ++ Goethite (FeOOH) + Fe^{2+} (Control)	Bottle (sealed) + Magnetic stirrer + Goethite fixed in an iron wire made box	

SN	Reagents	Reactor & Operation condition	Objectives
(5)	Methylene Blue + Pyrolusite ore (MnO_2) +Aerobic Sludge +Air	Beaker (open) + Magnetic stirrer + Sludge mixed with Pyrolusite ore fixed in an iron wire made box, aerate in 20 Degree Celsius Room	• To roughly investigate the function of proposed minerals catalyzing biological oxidation on Methylene Blue. • Selection of minerals for the biological oxidation of pharmaceuticals. • To roughly investigate the effect of pH or other factors that influences the performance. • Other minerals will be tested, if the first proposed minerals (Pyrolusite ore or Goethite) do not have obvious function to catalyze Methylene Blue biological oxidation.
(6)	Methylene Blue + Mn^{2+} +Aerobic Sludge +Air	Beaker (open) + Magnetic stirrer + Sludge with + Mn^{2+}, aerate in 20 Degree Celsius Room	
(7)	Methylene Blue + Goethite (FeOOH) + Fe^{2+}+Aerobic Sludge +Air	Beaker (open) + Magnetic stirrer + Sludge mixed with Goethite fixed in an iron wire made box, aerate in 20 Degree Celsius Room	
(8)	Methylene Blue +Aerobic Sludge +Air (Control)	Beaker (open) + Magnetic stirrer + Sludge, aerate in 20 Degree Celsius Room	
(9)	Methylene Blue + Pyrolusite ore (MnO_2) +Air (Control)	Beaker (open) + Magnetic stirrer + Pyrolusite ore fixed in an iron wire made box, aerate in 20 Degree Celsius Room	
(10)	Methylene Blue + Mn^{2+} +Air (Control)	Beaker (open) + Magnetic stirrer + Mn^{2+}, aerate in 20 Degree Celsius Room	
(11)	Methylene Blue + Goethite (FeOOH) + Fe^{2+} +Air (Control)	Beaker (open) + Magnetic stirrer + Goethite fixed in an iron wire made box, aerate in 20 Degree Celsius Room	
(12)	Diphenylamine +selected mineral from (4-6) + Aerobic Sludge +Air	Beaker (open) + Magnetic stirrer + Sludge mixed with selected mineral fixed in an iron wire made box, aerate in 20 Degree Celsius Room	• To further investigate the possibility for minerals to catalyze biological oxidation on more persist organic dye. • To find the optimum reaction environment.
(13)	Diphenylamine +Aerobic Sludge +Air (Control)	Beaker (open) + Magnetic stirrer + Sludge, aerate in 20 Degree Celsius Room	

Table 1 Potentials analysis for mineral catalyzed biological degradation of organic persistent compounds with parallel beaker experiments on selected organic dyes

2.2The data introduction

In order to reduce the risk and improve the efficiency of the second phase experiment, a pre-experiment is designed. Three kinds of organic dyes are selected to represent organic pharmaceuticals for analogous chemical structures but they are much easier to be detected with UV-Vis spectrophotometer. Two parallel series of beaker experiments will be performed: (1) one to study mineral catalyzed biological reduction on organic dye and (2) another one is for the mineral catalyzed oxidation.

An azo dye, Reactive Red 2, is first selected as the reagent and indicator for reductive reaction accelerated by minerals. Azo dye, aromatic moieties linked together by azo

(-N≡N-) chromophores, can be reduced in anaerobic condition. The decompose rate of Reactive Red 2 will be studied and compared with the control experiment.

Methylene Blue and Diphenylamine are selected as the reagents and indicators for oxidation reaction. Methylene Blue is relatively easy to be oxidized and Diphenylamine is a more persistent dye than the former.

2.2.1 The Materials and methods of Decomposition of Methylene Blue with minerals and aeration

- Materials and methods

Chemicals：
- Methylene blue diluted in water, with concentration around 1.5 mg/L

Minerals:
- Pyrolusite ore, MnO_2 (Φ=1-3mm)
- Magnetite ore, Fe_3O_4 (Φ=1-3mm)
- Quartz sand, (Φ=1-3mm)
- Ceramsite, (Φ=10mm)

Equipments:
- Magnetic stirrer
- Centrifuge (SIGMA 3K15), 10,000r/min, 0℃,1min
- SHIMADZU UV2550 (665nm)

2.2.2 The Materials and methods of Decolorization of Reactive red 2 at the surface of Magnetite without aeration

- Materials and methods

Chemicals:
- Reactive red 2 (Azo dye) diluted in water, with concentration around 8 mg/L
- $FeCl_2.4H_2O$

Minerals:
- Magnetite ore, Fe_3O_4 (Φ=1-3mm)
- Sea sand, (Φ=0.5mm)

Equipments:

- Magnetic stirrer
- Centrifuge (4500 r/min, ambient temperature)
- UV-Vis Spectrophotometer (539nm)

3. Results

In order to answer the research questions, we carried out the research from the following two parts:
- Decomposition of Methylene Blue with minerals and aeration (in Chong Qing University)
- Decolorization of Reactive red 2 at the surface of Magnetite without aeration (in Wageningen University)

The two experiments working at the same time in two places. The results analysed in WUR. After the experiments the results will be tested at the pilot plant at Isala.

3.1 Decomposition of Methylene Blue with minerals and aeration

3.1.1 Beaker experiment design and note

S.N.	Name	Description
1	Sludge	**50ml Aerobic Sludge** + 1900ml distilled water
2	Ceramsite + sludge	**50ml Aerobic Sludge+280ml ceramsite** + 1500ml distilled water
3	Sand + Sludge	**50ml Aerobic Sludge+280ml quartz** + 1500ml distilled water
4	Fe_3O_4 + Sludge	**50ml Aerobic Sludge+280ml Magnetite ore** + 1500ml distilled water
5	MnO_2 + sludge	**50ml Aerobic Sludge + 280ml Pyrolusite ore** + 1500ml distilled
6	MnO_2	**280ml Pyrolusite ore** + 1500ml distilled water

Table 2 Design of Decomposition of Methylene Blue with minerals and aeration.

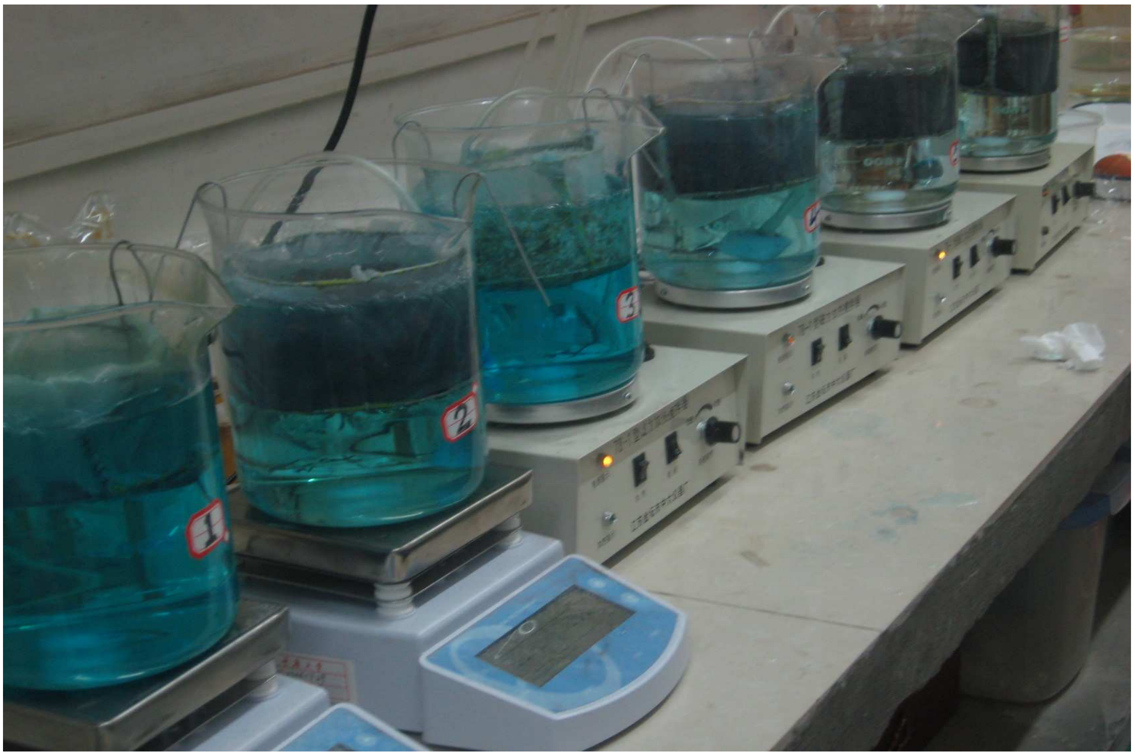

Figure 2 Decomposition of Methylene Blue with minerals and aeration

March 3rd, set up experiment facilities and added sludge, began incubation with feeding 1mg methylene Blue every day and continues aeration.
March 11th, first experiment test, in room exposed under lamp.
March 20th, second experiment test, in dark room.
March 23rd, third experiment test, in dark room.
March 25th, forth experiment test, in dark room.
March 28th, fifth experiment test, in dark room.

3.1.2 Result

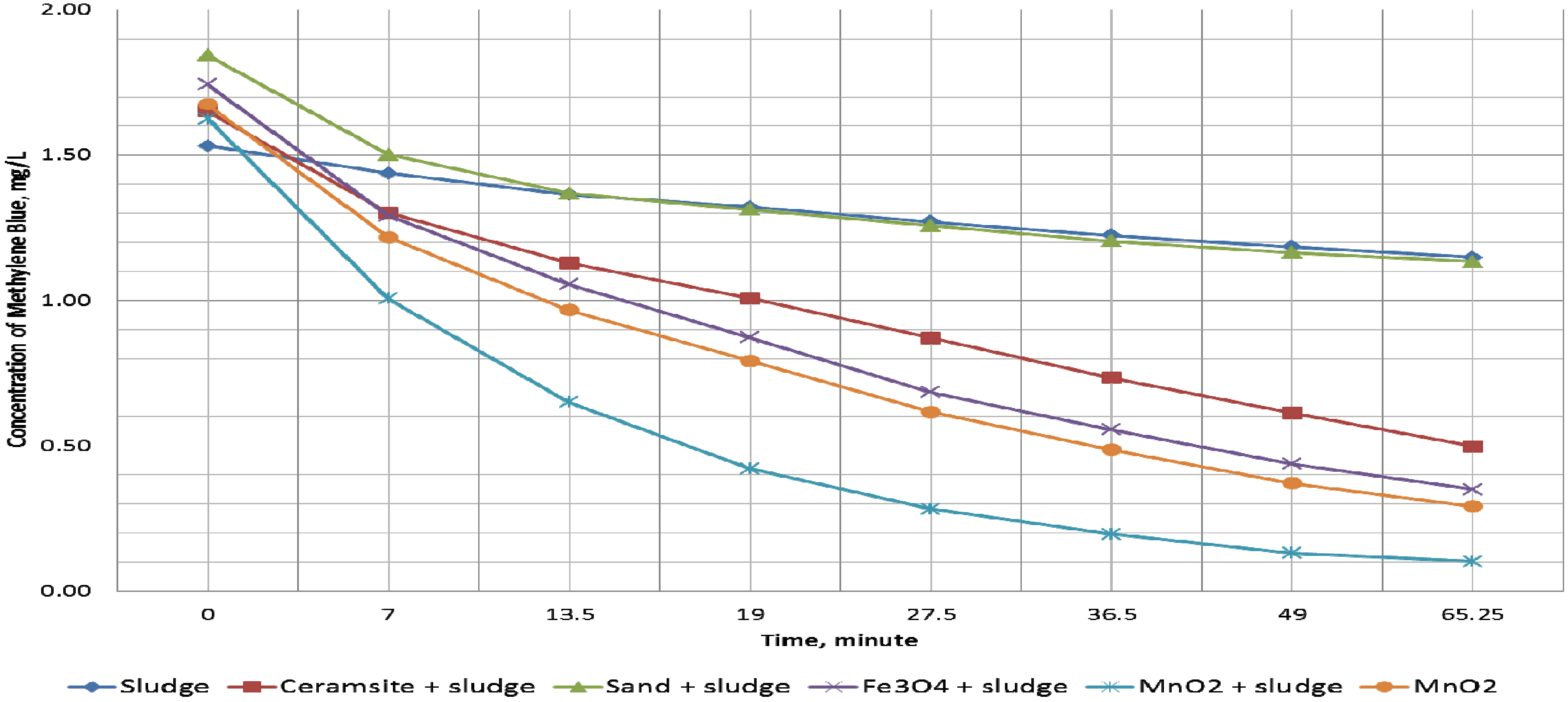

Figure 3 result of the Decomposition of Methylene Blue with minerals and aeration

The data of Figure 3 based on the last experiment on March 28th. More results will be found in appendix.

From the Figure 3 we can see the performance order:
MnO_2+sludge ＞ MnO_2 ≈ Fe_3O_4+sludge ＞ceramsite + sludge ＞ sand + sludge ＞ sludge

From the Figure all the materials had catalyzed effect but had different efficiency. The “MnO_2+sludge” had quick catalyzed effect at the beginning and had strong durability to the end. It is in anticipated that MnO_2 + sludge has the best performance.

3.2Decolorization of Reactive red 2 at the surface of Magnetite without aeration

3.2.1 Beaker experiment design and note

S.N.	Name	Description
A	Fe_3O_4	**100ml Magnetite** + Reactive red2 solution (100mg/l) 80 ml + 900 ml milli-Q water
B	Sea sand	**100ml Sea sand** + Reactive red2 solution (100mg/l) 80 ml + 900 ml milli-Q water
C	Fe_3O_4 + Fe(II)	**100ml Magnetite + 200.9 mg FeCl2.4H2O**+ Reactive red2 solution (100mg/l) 80 ml + 900 ml milli-Q water
D	Fe(II)	**201.2 mg FeCl2.4H2O**+ Reactive red2 solution (100mg/l) 80 ml + 900 ml milli-Q water

Table 3 Decolorization of Reactive red 2 at the surface of Magnetite without aeration.

Figure 4 Decolorization of Reactive red 2 at the surface of Magnetite without aeration.

March 16th, calibrated the standard curve line of the Abs and the concentration of Reactive red 2.

March 16th -18th, first try, only 2 reactors: Magnetite, Sea sand, no Fe (II), no aeration. Results showed Magnetite had slight performance on Reactive red 2 decomposition, while sea sand had no improvement on it.

March 18th -22nd, second try, 4 reactors, with 40mg/l $FeCl_2$ in C, D, no aeration, during the weekend, only 3 batches of data. Results showed the reacting speed was limited by the insufficient Fe (II).

March 22nd -24th, third try, 4 reactors, with around 200mg/l $FeCl_2$ in C, D, no aeration. Higher density of detection at the starting time, more data points achieved. An obvious trend was showed as follows.

3.2.2 Result

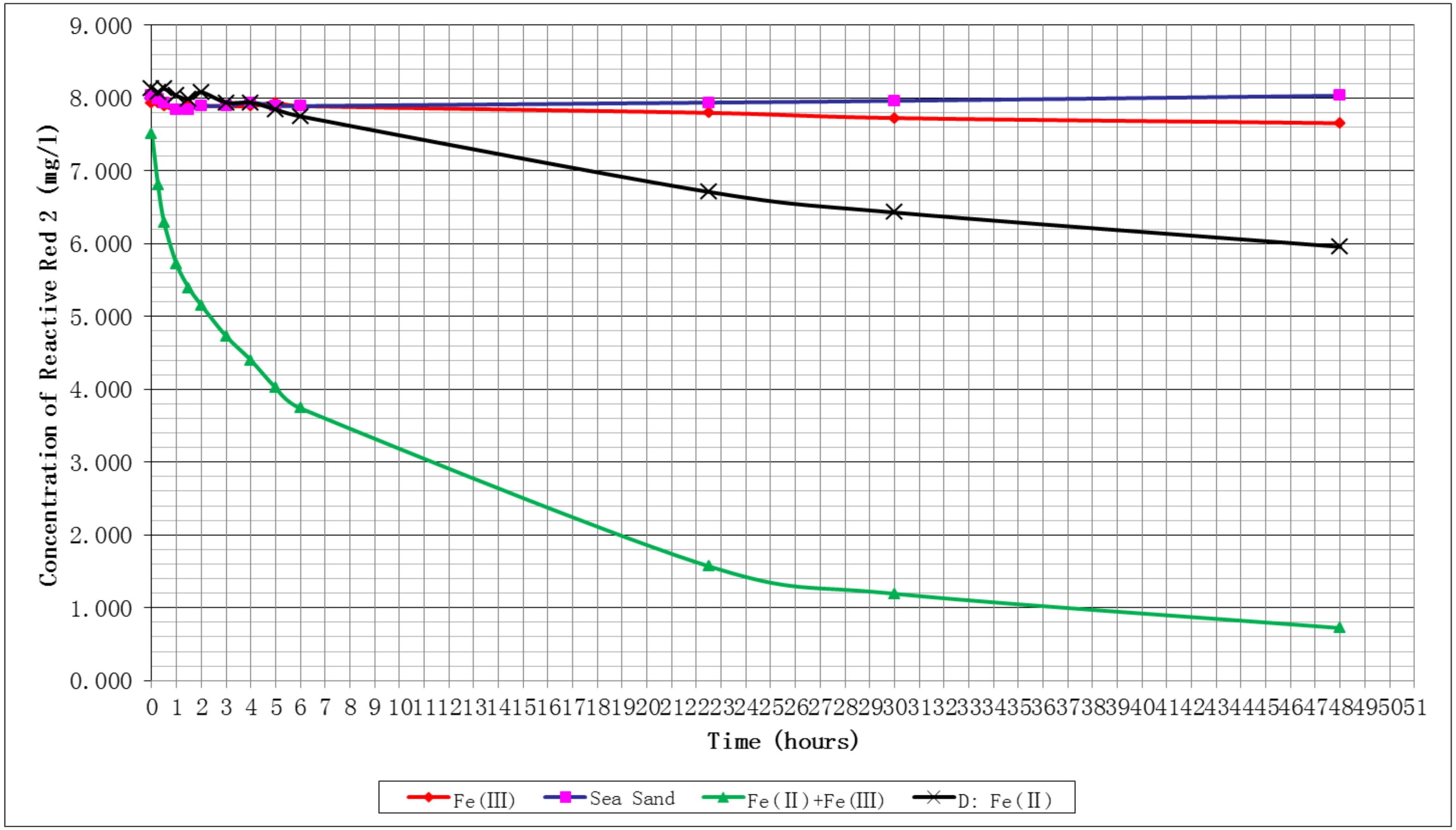

Figure 5 result of the Decolorization of Reactive red 2 at the surface of Magnetite without aeration

The data from Figure 5 based on the last experiment on March 22nd. More result will be found in appendix.

From the Figure 5 it is obvious that neither pure Fe (II) nor Magnetite can have few performances on reductive decolorization of Reactive red 2, while the combination of these two contents: “Fe (II) +Fe (III)” can enhance the reaction dramatically.

From the Figure 5 the reaction of “Fe (II) +Fe (III)” had quicker reaction at first 6 hours than after 7^{th} hour. The good velocity at the beginning of the reaction means the “Fe (II) +Fe (III)” has great effect on reductive decolorization of Reactive red 2. As time goes on “Fe (II) +Fe (III)” have the ability of continuous reaction it is also an advantageous ability on wastewater treatment. The “Fe (II) +Fe (III)” combination system can similarly enhance the reduction of pharmaceuticals.

4. Discussion

4.1 Decomposition of Methylene Blue with minerals and aeration

From the result of Figure 3 it is easy to see that “MnO_2 + sludge” has the best performance. But, are there any bacteria that can cooperate with mineral (to convert Mn_2+ back to MnO_2)? That needs more detail investigation.

It is a little beyond expectation that “Fe_3O_4+sludge” has better performance than “ceramsite + sludge”. There are still something happened on the surface of Iron mineral. In aerobic condition, Fenton like reaction is supposed to happen at the surface of Magnetite. The reactions on Methylene blue are very fast. It is difficult to do further mechanism investigation. More persistent Diphenylamine is proposed to apply.

4.2 Decolorization of Reactive red 2 at the surface of Magnetite without aeration

From the result of Figure 5, we can see that the Fe (II) +Fe (III) can enhance the reaction with high efficiency. There seems to be a trend existing that the decolorization of Reactive red 2 is increasing with time in the reactor of “Fe (II)”. It is supposed that newly generated Fe (III) oxide can produce the similar surface as natural iron mineral. With further question: Is it possible to cultivate the bacteria that can convert Fe(III) oxide back to Fe(II), and make the existing reductive reaction of Fe(II) on Reactive red 2 at the surface of magnetite faster? More detailed experiments are needed.

The combination of anaerobic sludge and iron mineral is planned to implement further experiments. In further experiments, different minerals should be tested for optimizing the selection of minerals.

5. Conclusion

The ultimate objective of this research is to gain an understanding of wastewater treatment and test in experiments. The main part of this research is laboratory work which will show the way to develop the process of wastewater treatment. The result of this project, including literature study findings, laboratory work and data processing show that the minerals can enhance the biological degradation (Reductive or oxidative) of some (emerging) micropollutants in wastewater.

The beaker experiments are easy to test the effect of waste water treatment in different reagents. It is easy to control the beakers with different reagents in same situation. The beaker experiments show that the “Fe (II) +Fe (III)” combination system can similarly enhance the reduction of pharmaceuticals. And it is in anticipation that “MnO2 + sludge” has the best performance in decomposition of Methylene Blue. These results have great value to do the further experiments. From the results the effective reagents have great efficiency of waste water treatment in quality and velocity.

The results will be tested in Isala hospital in Zwolle. Based on all the findings, in order to ensure the further experiments in laboratory and test at the plant in Isala hospital the minerals to enhance the biological degradation (Reductive or oxidative) are every effective.

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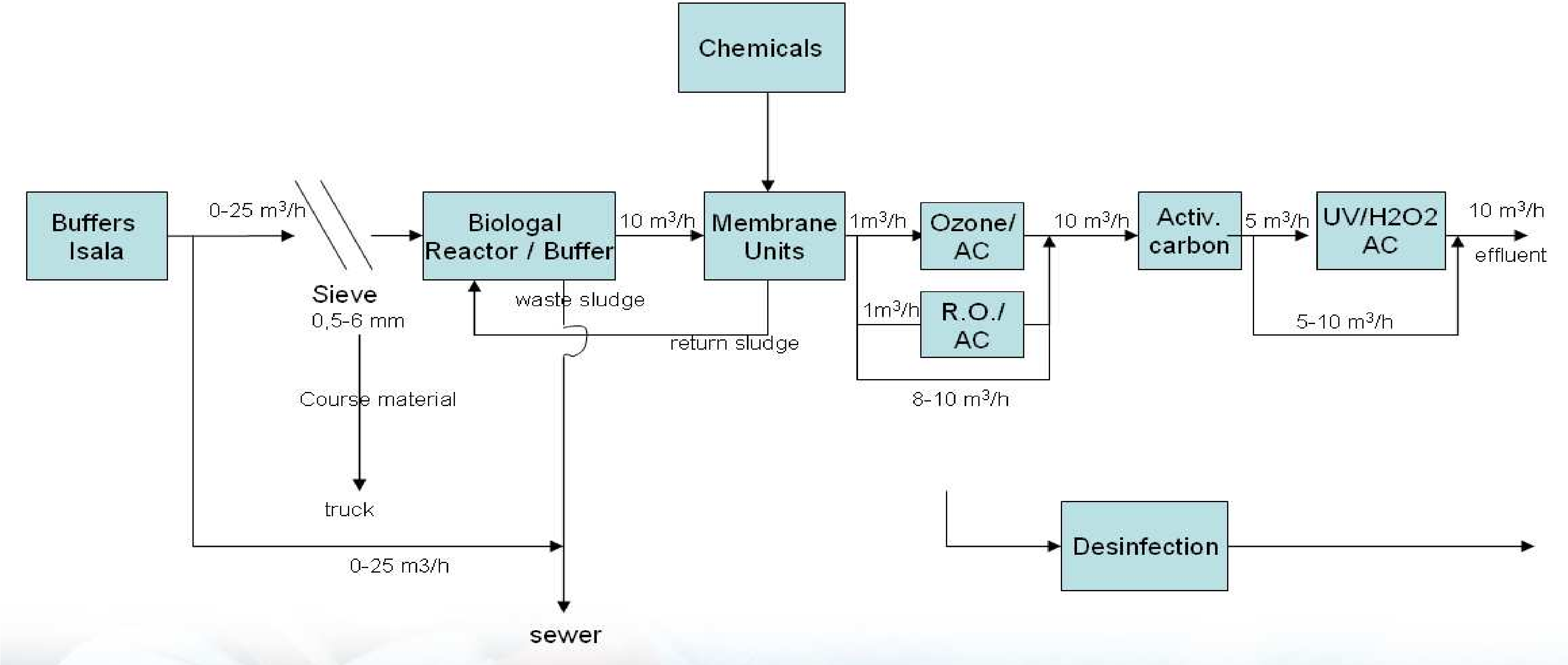
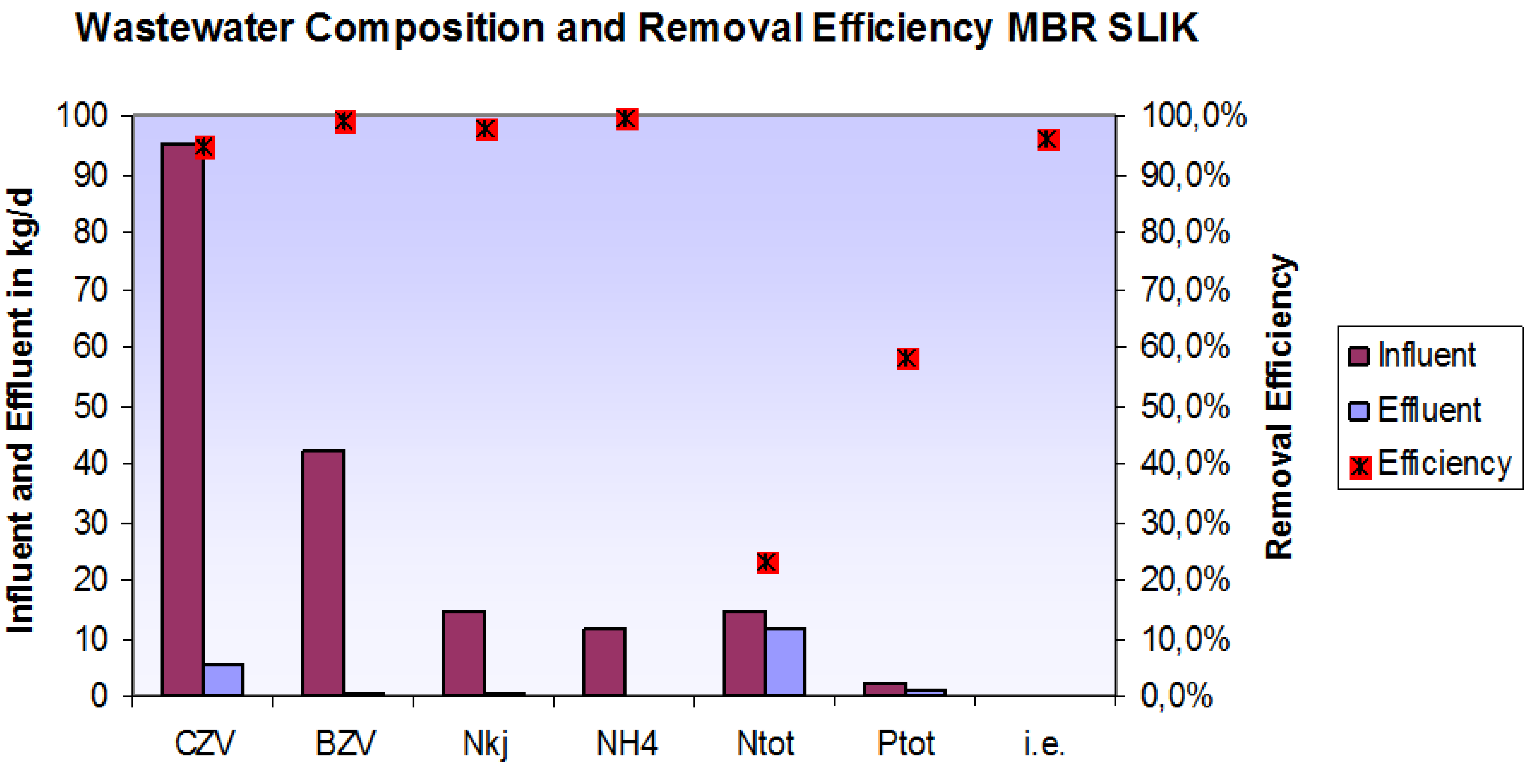
http://www.pills-project.eu/index.php?id=156&lang=uk&from=135

http://www.pills-project.eu/index.php?id=186#faq1

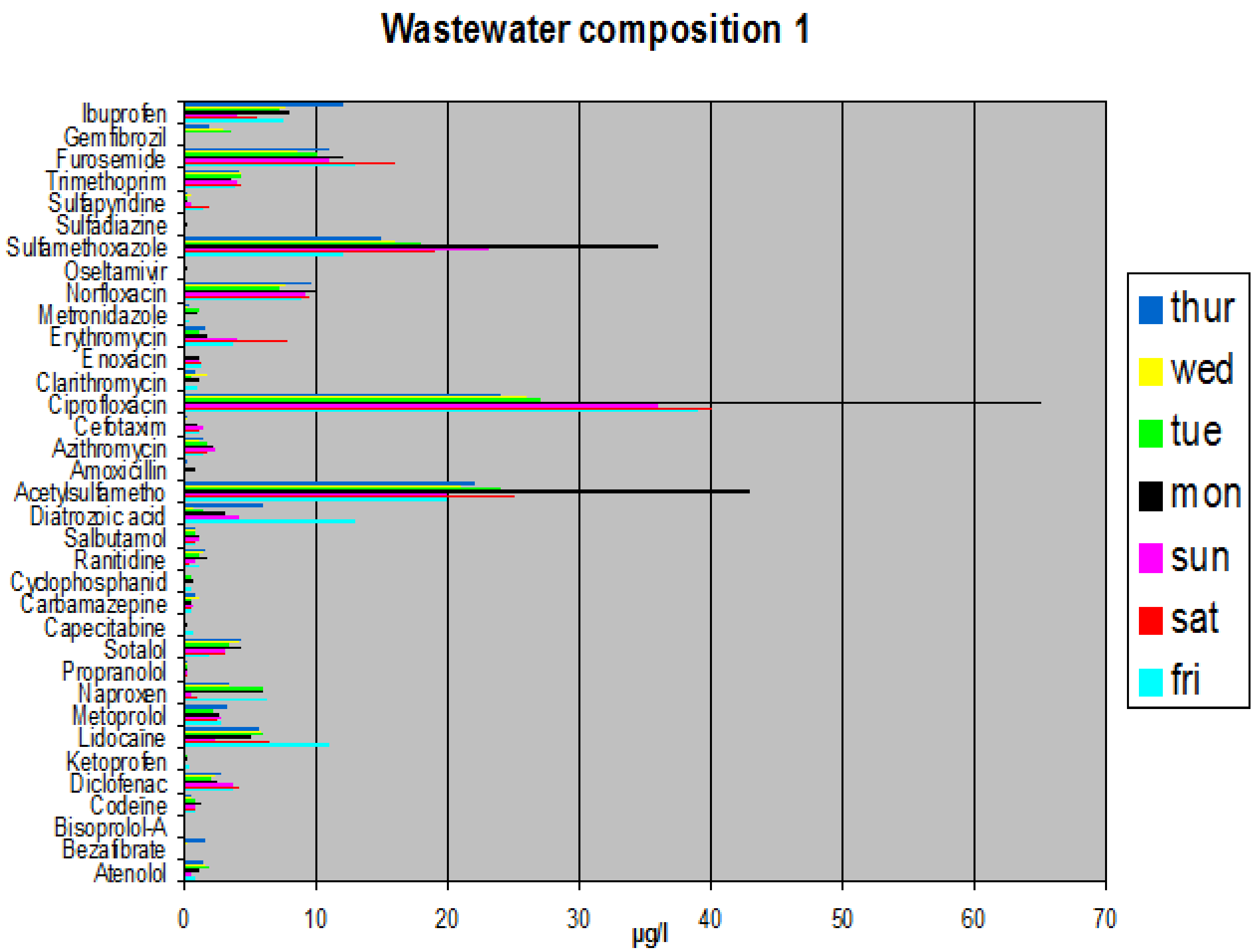
Appendix I. Plant in Isala hospital



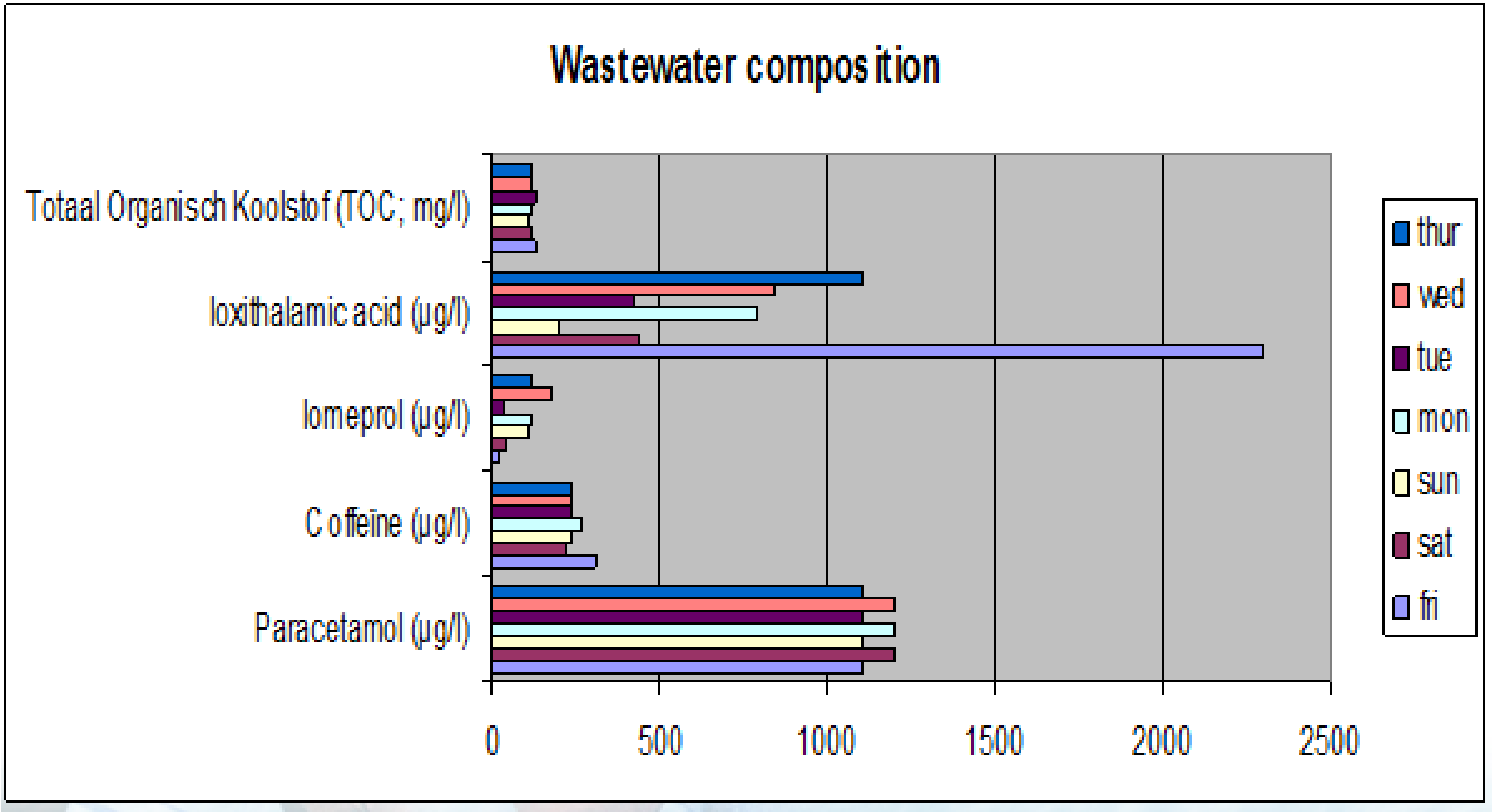
The synopsis of the Plant in Isala hospital



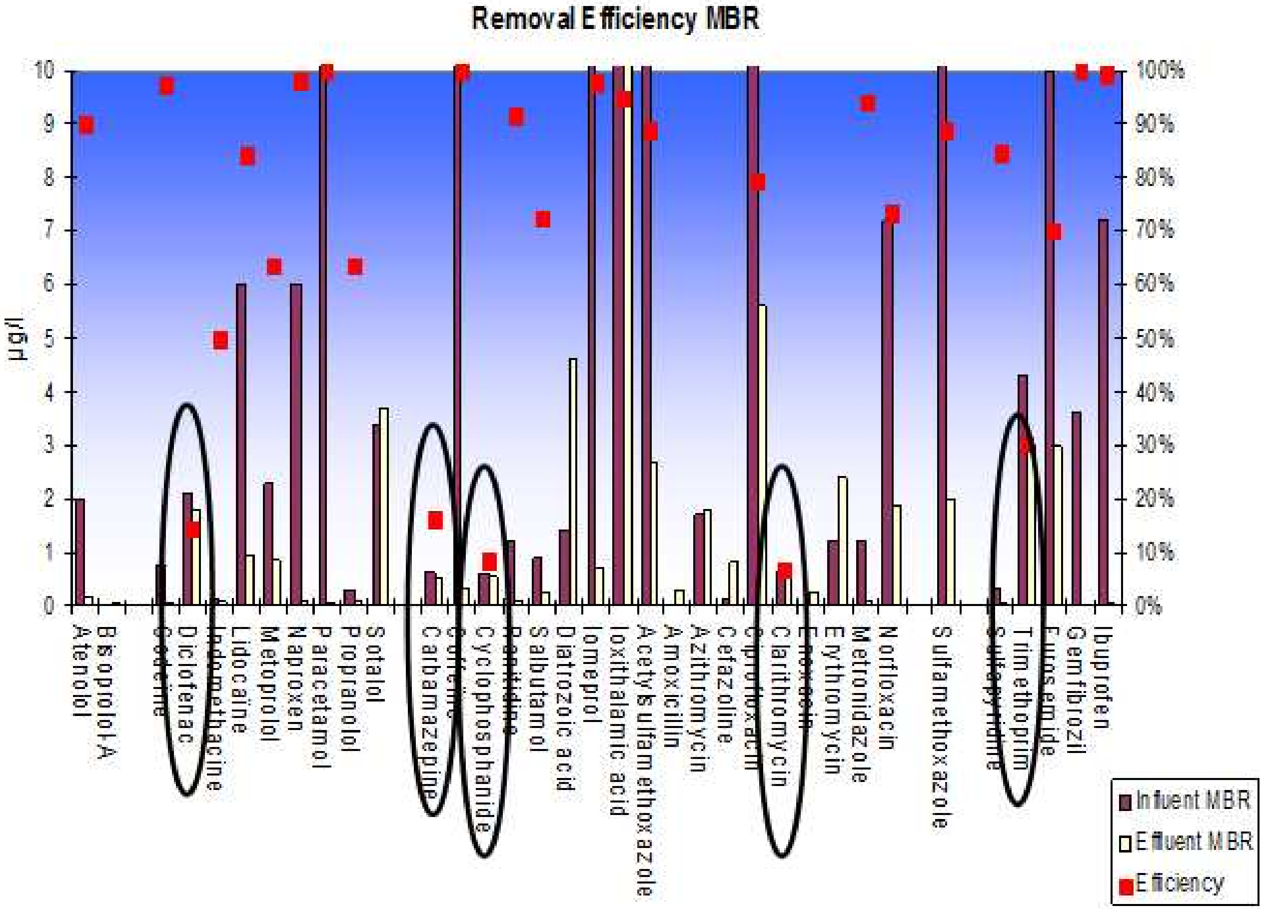
Wastewater composition and removal efficiency MBR SLIK



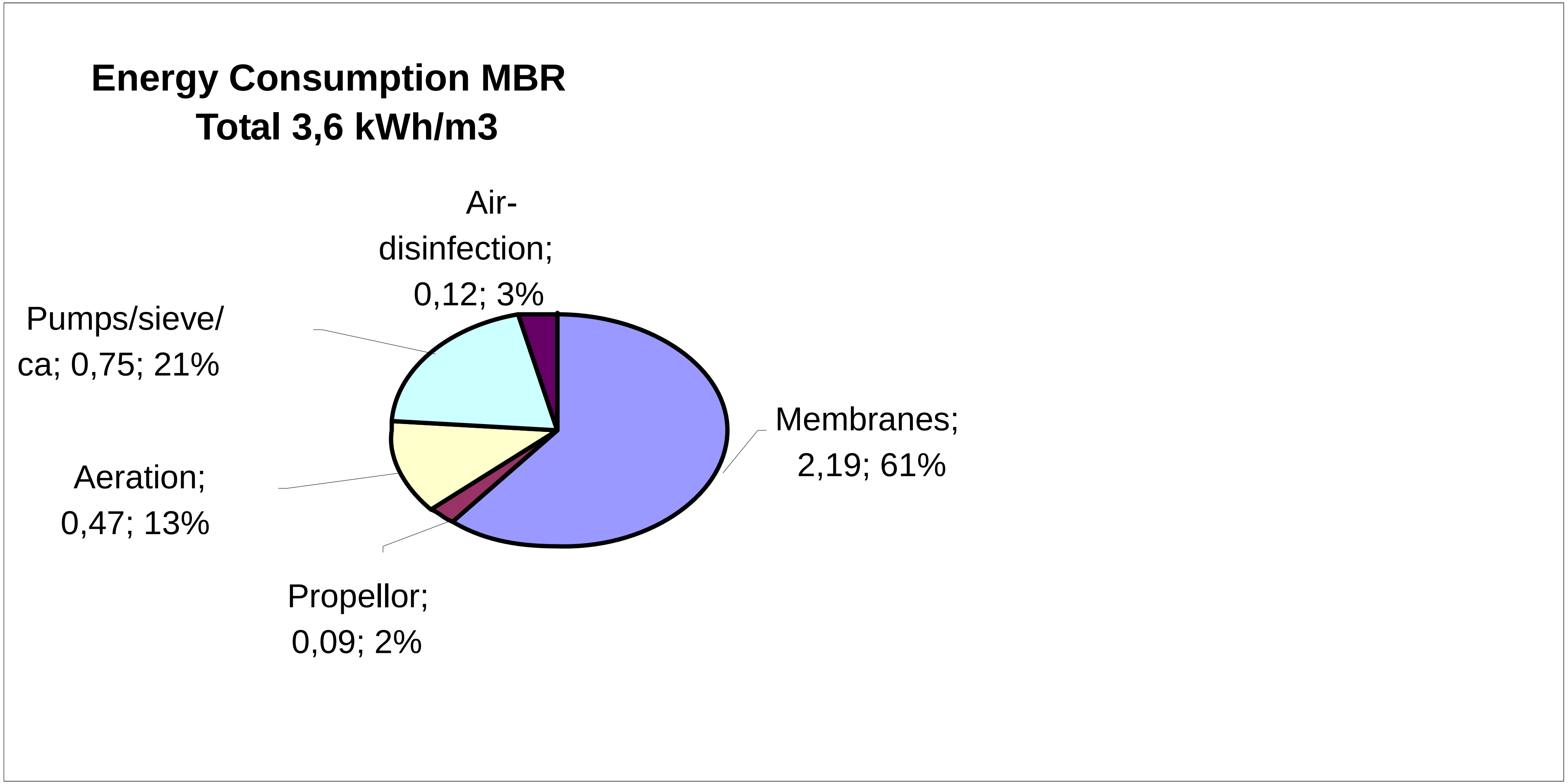
Wastewater composition



Wastewater composition

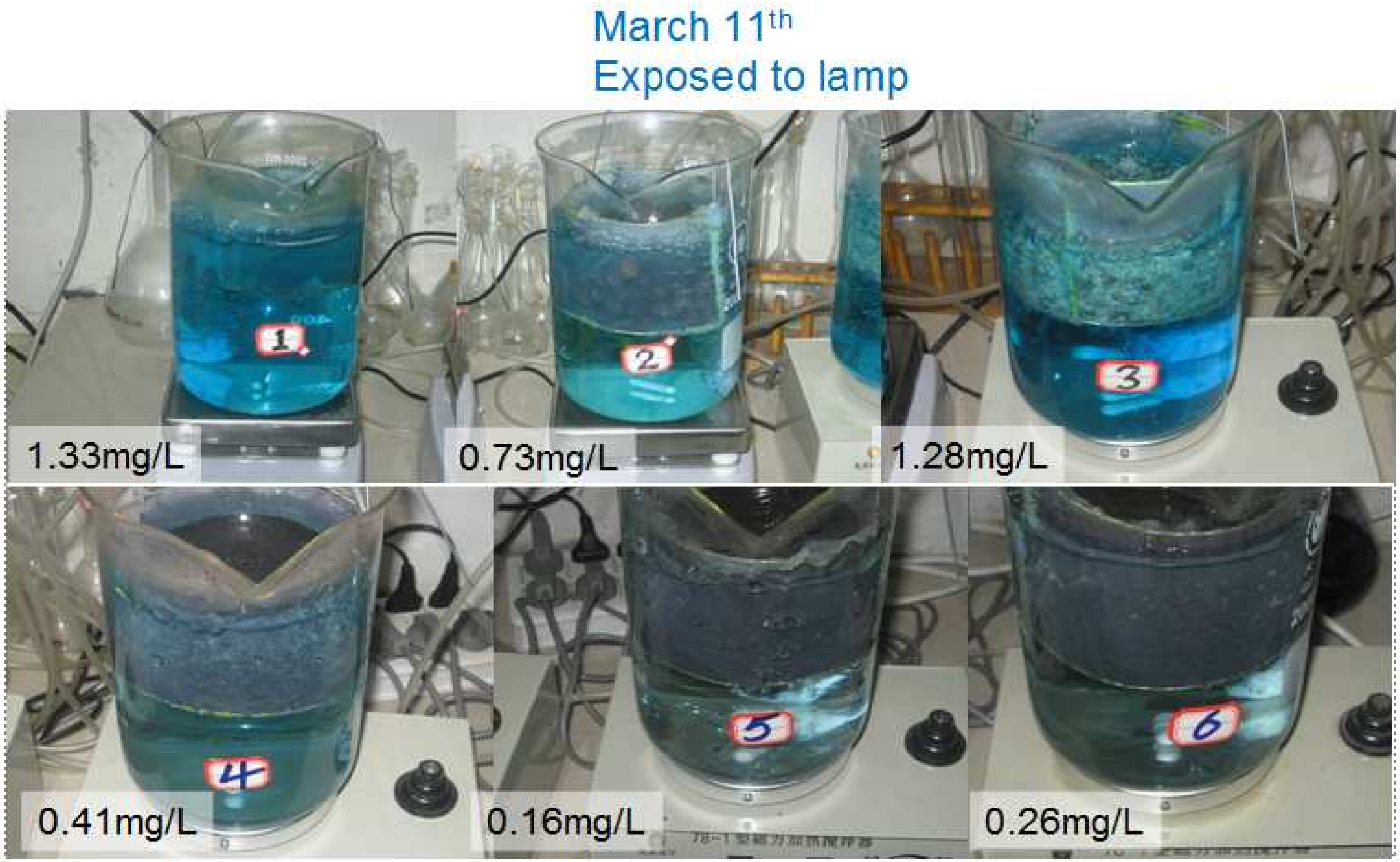


Removal efficiency MBR



Power consumption of the plant

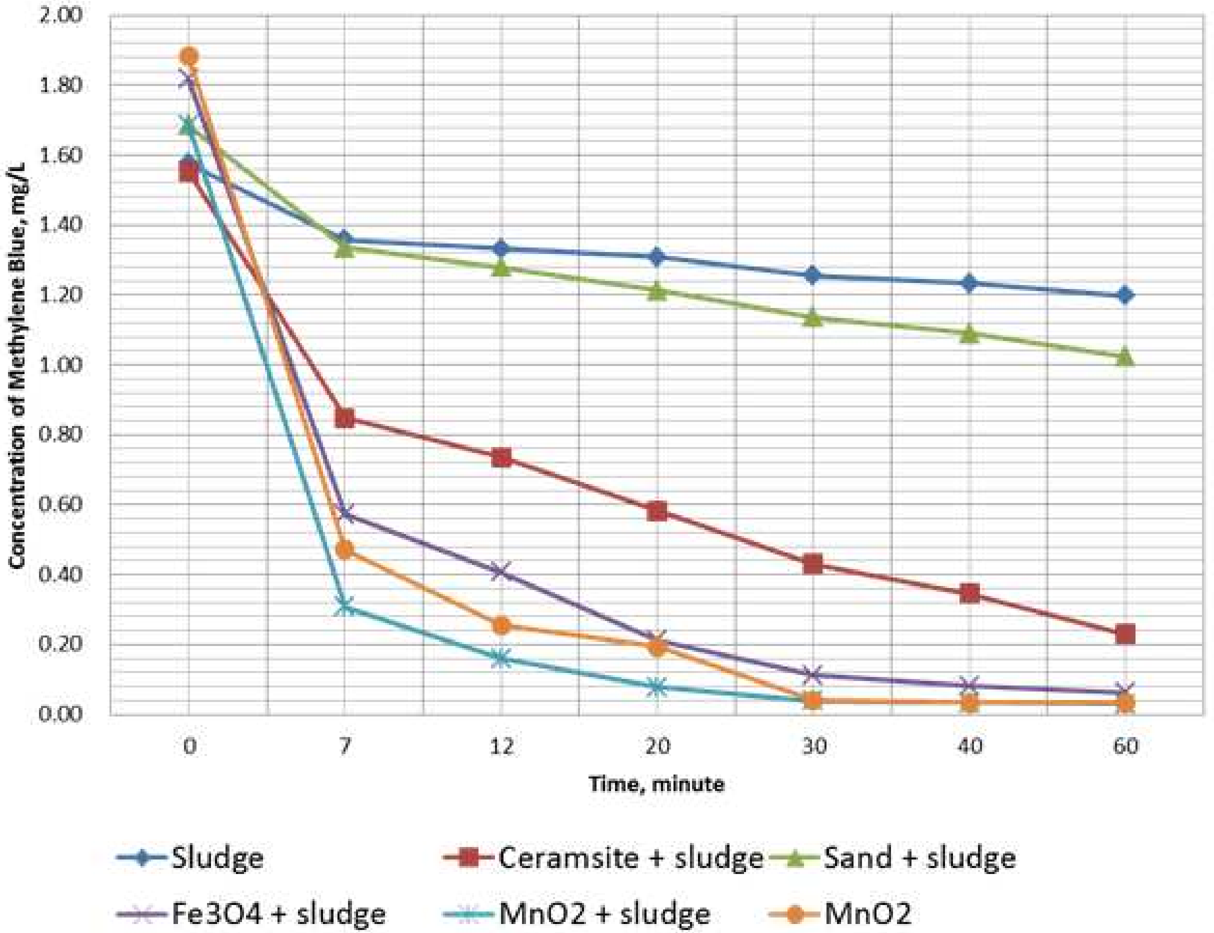
Appendix II. Results of the experiments



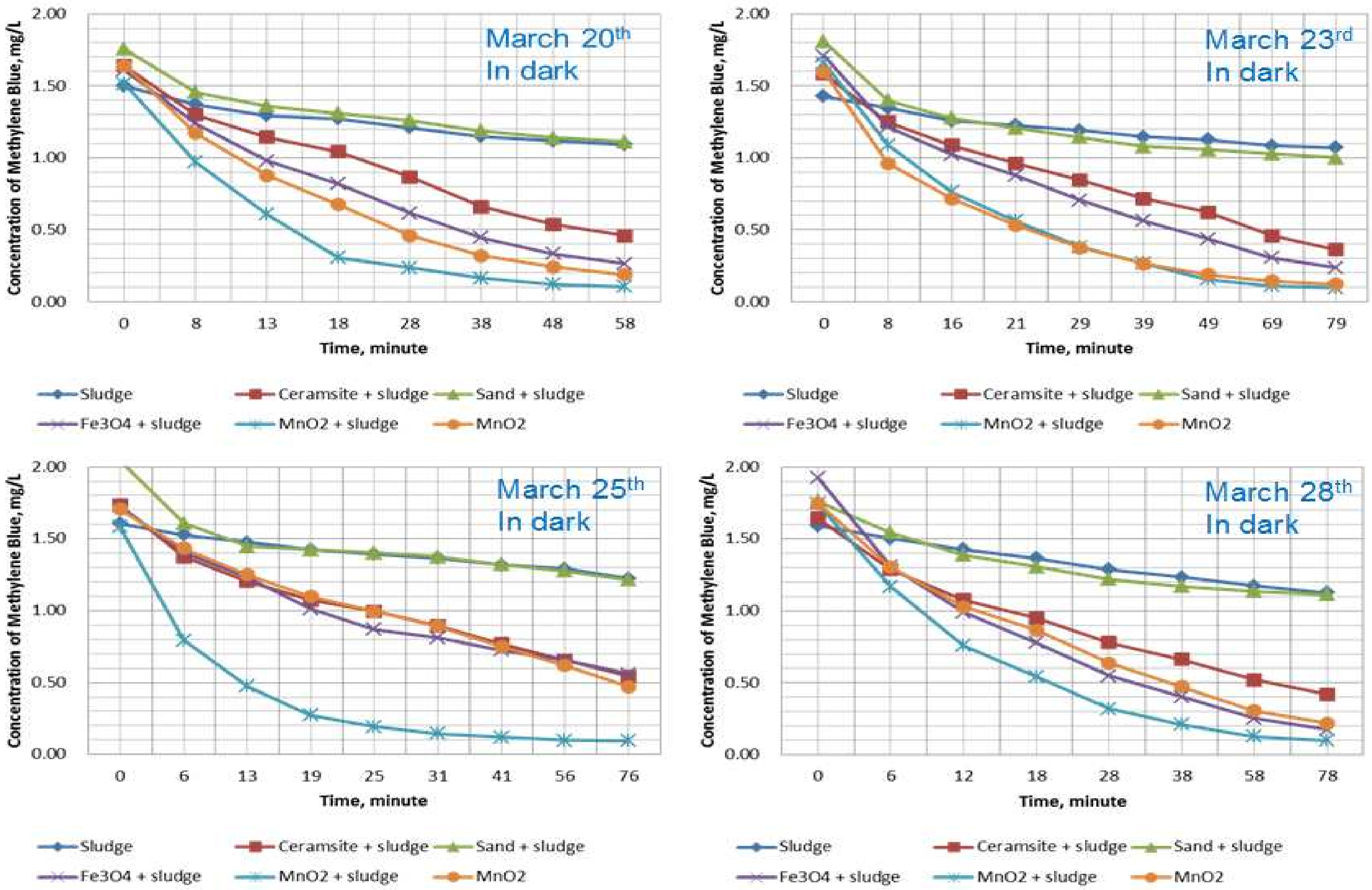
In 10minutes of the experiment Decomposition of Methylene Blue with minerals and aeration

March 11th
Exposed to lamp

In 60minutes of the experiment Decomposition of Methylene Blue with minerals and aeration



The experiment Decomposition of Methylene Blue with minerals and aeration with exposed to lamp



The experiment Decomposition of Methylene Blue with minerals and aeration without exposed to lamp

Appendix III. Plan of approach of thesis (Peng Dong1)

Plan of approach of final thesis
The New Way to Treat Wastewater under SLIK/PILLS Project

Vitens in Zwolle

Wageningen UR

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Introduction

I am doing my thesis research from February to July at Vitens Zwolle. The project is about the waste water treatment of hospital under SLIK/PILLS (pharmaceutical input and elimination from local sources). SLIK stands for “Sanitaire Lozingen Isalaklinieken”. The PILLS is an EU-project that focuses on finding solutions for pharmaceutically burdened waste water directly at the source. Project Pills is embedded in project SLIK by the waterboard Groot Salland. The goal of the SLIK project is to build and operate the first full-scale wastewater treatment plant for the treatment of sewage from the Isala hospital in Zwolle, containing rests of medicines and hormones to gain more insight in the treatment steps, operational aspects and costs to be able to improve to water quality in and near Zwolle.

During this time there is a SLIK project started at Wageningen UR in the cooperation with Vitens and drafted by Dr. Jun Zhai named “Mineral Catalyzed bio-degradation of Pharmaceuticals from Hospital wastewater under SLIK/PILLS project”. The Progect will develop new process of waster water treatment and test in the plant of Isala hospital in Zwolle.

The main research question is:

Which mineral(s) or a combination of some minerals can enhance the treatment of waste water better?

Sub-questions:

How to test the effect of waste water treatment in different reagent?

What's the different of the result of waste water treatment in different reagent?

What's the better combination for waste water treatment?

The objective of this research is:

Compare the different process (including the new one developed in WUR) in plant of Isala hospital in Zwolle and find out which one is low cost, low healthy risk and easy operation.

Plan of work

The beginning of the research starts at the office in Vitens Zwolle and the plant in Isala hospital. And then the project of "Mineral Catalyzed bio-degradation of Pharmaceuticals from Hospital wastewater under SLIK/PILLS project" will start the in WUR from 28th February to the end of April. And after the research of WUR the result will be test in the plant of Isala hospital in Zwolle.

During the research in WUR and the test in Isala hospital the sub questions will be answered gradually. After the sub-questions answered the different of difference process can find out. The cheapest cost, the less pollutant and the easiest operation will be find out. The objective will be achieved by the research questions.

Most of time in Wageningen will be laboratory work which could help to answer the questions. It will take 2 to 3 months in Wageningen. After the research finished in Wageningen the result which is the new process of waste water treatment will be test in treatment plant in Isala hospital for more than 1 month. During this time I will start the report in mean time. If the test in plant will take longer than one month the new result will be show in the presentation at the end of June.

The deadline of draft report is on 20th May. And the Final report will be finished at 9th June. The final presentation will be at the last week in June.

Results

The finial result will be a thesis report under 40 pages. The report will include introduction of my thesis, the goals, research questions, and experiment and treatment plant test. Also the important part: Result and some important data during the experiment.

Organization schedule

	February	march	April	May	June
Introduction					
Plan					
learning background					
Experiment					
Test					
Result					
Draft report					
Final report					

Vitens WUR

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Reference

http://www.pills-project.eu/index.php?id=126

http://www.pills-project.eu/index.php?id=156&lang=uk&from=135