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INFLUENT FIJNZEVEN IN RWZI'S

RAPPORT

2010
19

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STOWA 2010 19

ISBN 978.90.5773.477.9

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STOWA rapportnummer 2010-19
ISBN 978.90.5773.477.9

SUMMARY

INTRODUCTION

In most Western countries toilet paper is disposed of together with wastewater to a wastewater treatment plant (WWTP). An average Western European resident uses approximately 10 kg to 14 kg per annum, which represents 30% to 50% of the suspended solids of the influent. In spite of this no research has been conducted into the decomposition mechanisms of toilet paper (cellulose) in the sewage system and the WWTPs. The technology that is used to treat wastewater and sludge may not optimal for this reason. Toilet paper (paper fibre) can be removed from wastewater using fine-mesh screens with a mesh size of less than 0.5 mm.

The purpose of this study is to determine the economic and practical feasibility of fine-mesh sieves as an alternative to the commonly used approach of wastewater sedimentation. This has been examined in relation to the WWTPs in Blaricum which does not have a sedimentation tank and Uithoorn which has a sedimentation tank, and the new WWTP construction project in Weesp. The investment required for a sieve installation has been determined in the case of those plants, along with the WWTP energy balance and the entire sludge treatment process. Prior to this a pilot study was conducted at the Blaricum WWTP during the period from September up to and including December 2008 using two different types of sieves. That study determined the technical operation and separation efficiency rate of the sieves. Extraction possibilities have also been surveyed together with the Energieonderzoek Centum Nederland [Energy Research Centre of the Netherlands] (ECN). Finally, the decomposition of cellulose in an WWTP has been examined.

It is hypothesised that a sieve installation can be paid for from the difference between the cost of current sludge treatment and cheaper extraction of separated materials. After they are compressed, separated materials have a dry material content of approximately 50% and the added advantage that it is possible to treat them more energy efficiently than sludge. In addition, the use of a fine-mesh sieves may also yield operational benefits in the form of reduced thread formation (the intermeshing of hair and fibres), for example. In addition, existing WWTPs without a sedimentation tank may also save on aeration energy.

CONCLUSIONS AND DISCUSSION

Nowhere in the world is there any experience of the use of fine-mesh screens with a mesh size equal to or less than 0.5 mm in the pre-treatment stage of a biological treatment process. Nevertheless, screens are used for the purposes of mechanical treatment in the absence of any subsequent biological treatment. In Norway there are reports of significant efficiencies being achieved on the removal of suspended substances (50% to 80% using a mesh size of 0.35 mm). There experience shows that there is a relationship between efficiency, mesh size, the hydraulic loading of screen filters ($m^3/m^2.h$) and the composition of wastewater. It is not known what impact high efficiencies have on the composition of the separated materials, nor the effect on their processability.

During the pilot study conducted in Blaricum yields of approximately 50% (based on a mesh size equal to or smaller than 0.5 mm) were measured in the case of suspended substances. They are similar to those of a sedimentation tank. Efficiency declines significantly in the case of suspended substances where mesh sizes are larger than 0.5 mm. In the case of the removal

of N and P, using a screen with 50% efficiencies in relation to floating substances, efficiencies are about zero and, as such, are less than in the case of a sedimentation tank.

Where a fine-mesh screen is used, the proportion of cellulose in the sieving product is much greater than in the case of a primary sludge form a sedimentation tank (see Table 1). Its removal occurs at a rate of about 50% in a sedimentation tank and 30% to 70% of the remaining cellulose is broken down in a normal biological treatment process when left for 20 to 30 days.

TABLE 1 CELLULOSE AS A PROPORTION OF DRY MATERIAL CONTENT FOUND IN RESEARCH CONDUCTED BY WATERNET

	Proportion Cellulose/ds
Influent	0.3 - 0.5
Separated materials	0.8
Primary sludge	No more than 0.3
Active sludge	0.1 - 0.15
Fermented sludge	Approx. 0.2

It was found in the course of research that the proportion of inert and gradually degradable COD in screened influent is equal to that of sedimented water. In this respect it should be noted that a limited number of measurements were undertaken and that the findings only apply to the Blaricum WWTP (confined to household wastewater). In such a situation the effect of the AT would be similar in the case of a sieve or sedimentation tank. However, further research is required.

Various options are available for the treatment of separated materials. The heavy metal contents of separated materials are low and more or less comply with the so-called BOOM [Quality and Use of Remaining Organic Fertilising Substances] decree. It is possible to reuse separated materials by drying them and using them as fuel. Acidifying separated materials may be an option. Technically it is possible to use separated materials to produce paper but difficulties may be encountered in relation to social acceptance. In the case of waste treatment the costs of transporting and selling separated materials are relatively limited, because they can be compressed by up to 50%. Treatment costs are in the order of EUR 20.00 to EUR 100.00 per product tonne.

The maximum amount of separated materials which Waternet is capable of producing each year is relatively small compared with other residual biomass streams. This may constitute an obstacle to their beneficial use, because buyers may not find it worthwhile to treat a small amount of separated waste materials. In addition, the legal status of separated materials is not clear at present. The classification of separated materials will need to be determined in consultation with Agentschap NL [NL Agency]. For example, screening materials are currently deemed to be dangerous waste but it is obvious that another form of classification may be possible in the case of separated sieve product. That classification may have an impact on the cost of processing. For this reason the waste classification of separated materials is required before a treatment path can be determined.

In the case of the WWTPs Blaricum (which does not have a sedimentation tank) and Uithoorn (which does have a sedimentation tank) plants, which have been studied, it appears that, when dry weather flow (DWF) is sieved, a fine-mesh sieve installation recoups its outlay in a realistically selected scenario within about 7 -10 years. Where the entire rain weather flow (RWF) to an WWTP is treated, break-even occurs after more than 15 years. A sensitivity analysis reveals that the hydraulic loading of sieves ($m^3/m^2.h$) and surplus sludge production following sieving are decisive for the purposes of breaking even.

Such cases reveal that the time required to break even where a fine-mesh sieve is used in an WWTP which does not have an existing sedimentation tank, is shorter than in the case of an STP which does have an existing sedimentation tank. A variant study was conducted in relation to the entire new construction project in the case of the Weesp WWTP and involved the comparison of a sedimentation tank with a sieve installation. It revealed that no distinction could be drawn between the investments in either system. Investments in a sludge treatment line (digestion and dewatering), where a sedimentation tank is used were disregarded for that purpose. Annual expenses were somewhat less in the case of an WWTP with a sieve installation than an WWTP with a sedimentation tank due to the lower costs involved in treating the separated sieve product.

The use of a fine-mesh sieve in an WWTP also changes the treatment energy balance. More electricity is required for a fine-mesh sieve than for a sedimentation tank, although the collection of the separated materials may cause less aeration. Moreover, separated materials can be dewatered more effectively than sludge, with the result that less transport is required and the caloric value is greater. An energy balance has made it possible to obtain clarity in respect of such changes in the case of the Blaricum WWTP (which does not have a sedimentation tank), the Uithoorn WWTP (which does have a sedimentation tank) and the newly constructed Weesp WWTP. The energy balance included the energy consumption in the WWTP itself, as well as the transport and treatment of sludge and separate sieve product. The underlying assumption is that separate sieve product could be dehydrated by up to 50%, and can be incinerated in a biomass plant.

The energy balance revealed that in the case of all three of the WWTPs the larger the part of the influent that it was possible to sieve, the more energy it was possible to save. It would appear that fine-mesh sieves represent an alternative to sedimentation tanks for energy-related considerations, subject to the proviso that it is possible to incinerate the separated materials with energy efficiencies in excess of 33%. Savings would amount to at least 40% (compared with the reference point without fine-mesh sieving) and may even produce energy on balance in certain cases (energy efficient treatment coupled with the production of large amounts of sludge and separated materials).

RECOMMENDATIONS

The type of sieve that is chosen is important. The findings derived from using sieves in the case of membrane bioreactors (MBRs) cannot be used, because a mesh size in excess of 0.8 mm was used. Attention will need to be given to this explicitly during the design process.

The use of a sieve may constitute one of the possible solutions to ensure the ongoing quality of effluent in the case of those WWTPs whose treatment capacity is too small due to hydraulic or biological limitations.

The cases that have been considered reveal that a sieve installation may recoup its investment and produce major energy benefits especially in the case of those STPs which do not have a sedimentation tank, even if the separated materials are not used to generate energy. The market potential could be clarified in order to encourage the technical development of sieves.

The potential processing of separated materials may be investigated further. Viewed in relation to the concept of 'cradle to cradle' the production of paper using separated materials appears to be a sound solution. After all, the sieving product constitutes about 80% of separated materials. Nevertheless, it is not socially accepted. The production of fatty acids could be a good alternative. It may be possible to tie this in with projects which accord with the bio-based economy concept.

There is a relationship between sieves and the MJA3 energy agreements. The use of sieves will yield savings of no less than 40% in the relevant examples on condition that it is possible to utilise the energy content of the separated materials. In the case of MJA3 energy externally generated must be attributed to the STP concerned. The positive impact on the energy balance that has been forecast would have to be confirmed in a practical study.

Existing WWTPs in which a sieve is installed may sometimes be operated with a very small sludge loading. The effect on the quality of effluent and the production of sludge where the cellulose component is specifically removed is still partly unknown. Because no paper fibres are present after screening, the impact on the dewatering of sludge is a point requiring attention.

A sieve installation will be installed for dry weather flow in the Blaricum WWTP in 2010. There is a need for more practical research. It would be useful if one or more studies were to be initiated in other WWTPs, preferably ones involving completely separate treatment lines.

DE STOWA IN BRIEF

The Foundation for Applied Water Research (in short, STOWA) is a research platform for Dutch water controllers. STOWA participants are all ground and surface water managers in rural and urban areas, managers of domestic wastewater treatment installations and dam inspectors.

The water controllers avail themselves of STOWA's facilities for the realisation of all kinds of applied technological, scientific, administrative legal and social scientific research activities that may be of communal importance. Research programmes are developed based on requirement reports generated by the institute's participants. Research suggestions proposed by third parties such as knowledge institutes and consultants, are more than welcome. After having received such suggestions STOWA then consults its participants in order to verify the need for such proposed research.

STOWA does not conduct any research itself, instead it commissions specialised bodies to do the required research. All the studies are supervised by supervisory boards composed of staff from the various participating organisations and, where necessary, experts are brought in.

The money required for research, development, information and other services is raised by the various participating parties. At the moment, this amounts to an annual budget of some 6,5 million euro.

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