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Effiziensteigerung im Klärprozess

White Paper

Dewatering in the Wastewater Treatment Process – the Key to an Efficiency Improvement of up to 30%:
Floc Forming

Technology, Expertise and Amortisation

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Introduction

The optimization of the wastewater treatment process is the permanent job of all plant managers and their teams. New metrology and a growing experience in the process helps to fullfill this challange. The parameter OEE, Overall Equipment Effectiveness, relevant for producing process industries, could be applied to waste water treatment plants and will become more and more important. Technical, legal and social pressure on the operator is rising. The agricultural use of sewage sludge face less acceptance, thus, the demand for the expensive combustion of sewage sludge will increase. Consequently, the costs for polymer consumption, sludge transport and disposal will rise. These three cost factors were targeted by scientists of the German research institute CUTEC GmbH, when they analysed the sewage sludge dewatering process. The result was a highly effective possibility to reduce costs significantly in a short term, often with payback periods less than one year. This could be realize by a compact plant module which is easyly installed into the existing plant and pre-treats the sewage sludge before dewatering. For polymer initiated flocforming processes, this new two-step conditioning unit could taylormade the floc structure for any dewatering process. The new conditioning unit has been applied in the waste water treatment, landfill leacheate treatment and sewage sludge dewatering so far. Combining conventionell separation units with this new conditioning unit will lead to an improved separation efficiency as well as to a significantly reduced polymer consumption.

To summarize: a higher dewatering efficiency is possible by forming optimized flocs!

The Prozess

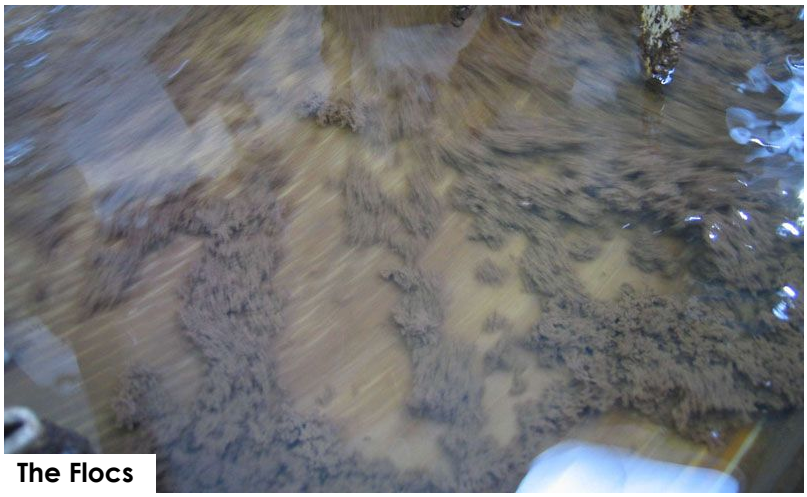
In the waste water treatment technology polymer initiated thickening and dewatering steps are state-of-the-art and well known for many years. Lately, other industrial sectors are more and more interested in an application in order to separate specific ingredients, e.g. in the pulp and paper industry. Traditionally, the focus of interest and innovation was – and still is - on the separation apparatus itself, not on the precedent forming of the optimized floc structure for this apparatus. Conventionell one-step or static mixers could not control the floc development in a satisfying way, thus, the reproducable forming of a targeted floc structure is hardly possible. This suboptimal floc structure is widely compensated by polymer overdosages, which causes high polymer costs.

The efficiency of any separation process, e.g. filtration or sedimentation, is influenced by the separation unit itself as well as by the conditioning of the media. Conditioning means the preparation of the media by e.g. chemicals to enhance the separation characteristics. Organic flocculation agents are often used for the conditioning of waste water or sewage sludge. The addition of these polymers cause the flocculation of the colloids in the media. The resulting floc structures highly depend on the way of insertion of the polymer into the sludge.

A novel two-step floc forming reactor was developed in cooperation with CUTEC GmbH in order to counteract theses disadvantages and to produce a targeted and reproducable floc structure. Besides the specific process requirements the plant has to excel by a compact and modular design.

High Separation Efficiency by the `Right` Floc

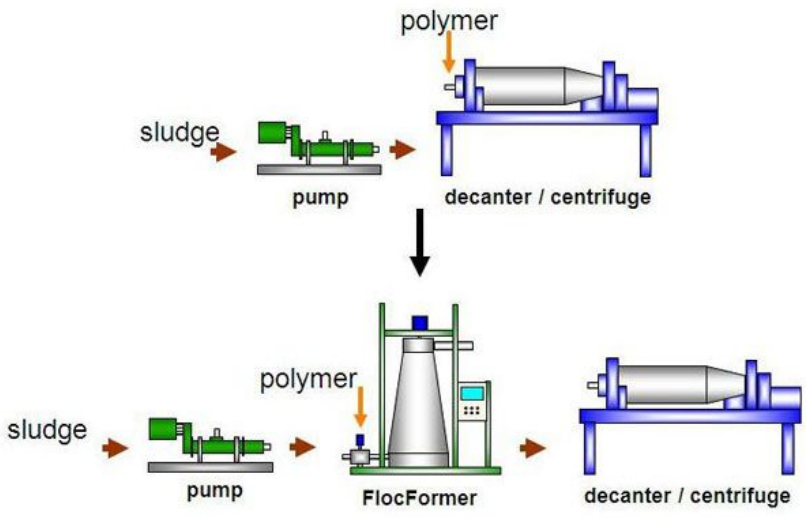
The pre-condition for a high separation efficiency is to completely merge the colloids and to form mechanically resistant floc structures with good filtrability characteristics. Particular attention is necessary to include even the smallest particles during the floc forming process. Conventionel condition technique is rarely possible to meet this demand. The addition of the polymer using inline or static mixers is ineffective because of little or absent control elements. e.g. only the rotation speed is variable at inline mixers. Thus, the simultaneous influence on size, structure and stability is impossible. Static mixers are even less adaptable, as the energy input is directly connected to the actual flow rate.



The Flocs

Up-to-date flocculation engineering is able to influence the process parameters in a purposeful way, e.g. retention time, energy input or the polymer consumption – if necessary in separate sub-steps. The new two-step flocculation process provide omtimized process parameters for the two separate sub-steps floc genesis and floc forming.

The Floc Forming Reactor – how Does it Work?



The floc forming process is realized in a two-step reactor with four degrees of freedom. In the first step, a rapid mixer with turbulent flow regime disperses the concentrated polymer solution homogeneously in the incoming media. Total flocculation is required, forming voluminous aggregates with less sheer stability. In the second step, these voluminous flocs flow through a pelleting zone of a cone-shaped stirring reactor where compact flocs are obtained. An inner cone is rotating in a cone-shaped housing, resulting in a gap, where pelleting takes place. The frazzled flocs are rolled up between the cone and the housing and local mechanical forces press on indentations and compacts the floc.

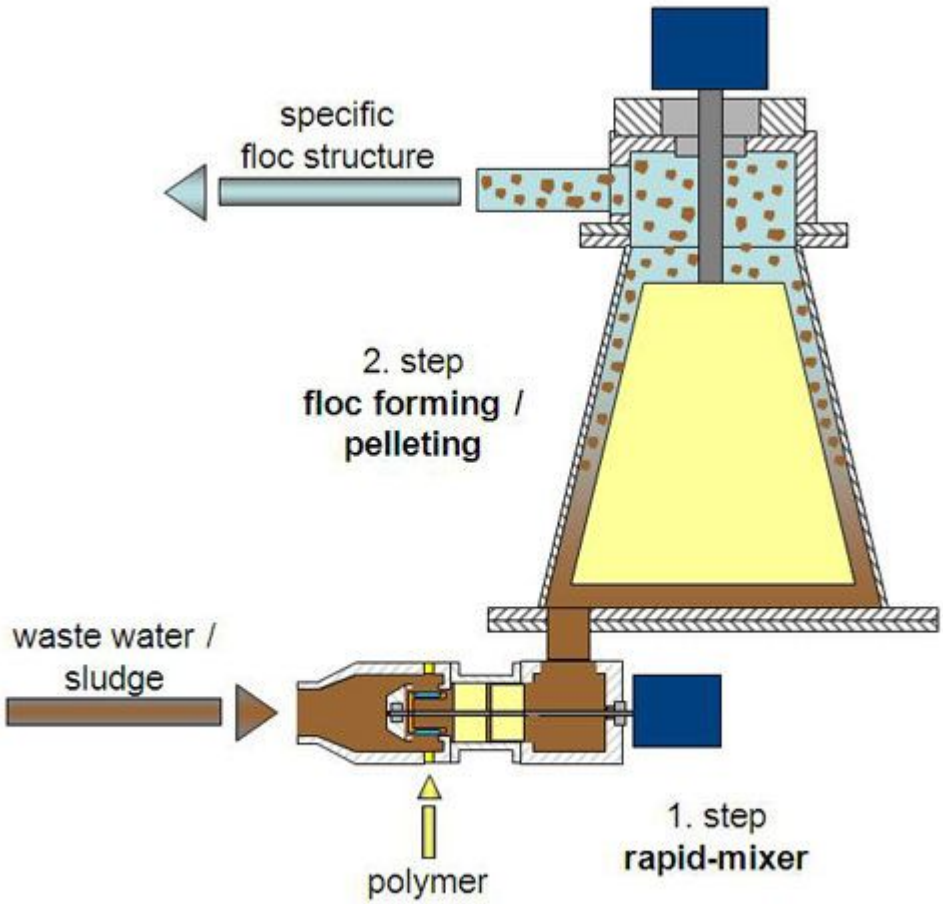
FlocFormer

Additionally, the inner cone is adjustable along the axis resulting in a steplessly variable gap size. The flow regime inside this gap is not constant along the axis. At the base of the cone the periphal velocity is higher than at the apex leading to laminar as well as laminar-cellular flow regimes in one apparatus. The transition from one flow regime to another is an important condition forr the process and is

influenced by the rotation velocity and the radiuses in the gap. By controlling these two parameters, the rotation velocity or the gap size, the operating point could be easily adapted to e.g. changing flow rates. The optimal operation of the floc forming unit and the generation of the targeted floc pellets are achieved. These floc pellets are easy to separate or to dewater.

Because of the four degrees of freedom, a wide range of floc structures could be generated, specific for various separation machines or media. Because every separation machine-media combination demands for an other optimal floc characteristic.

Optional, there is the possibility to implement a floc sensor for an online analysis of the floc structure. This photo-optical sensor correlates the optical characteristics of the flocs with dewaterability parameters of the media and allows the online-controlling of the process.

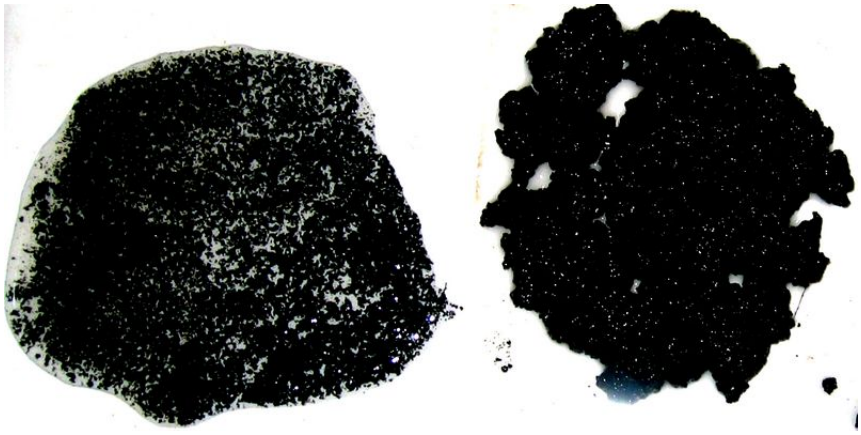


Waste Water / Sludge Flow (Schematic of the 2-step flocculation)

The Results

The separation efficiency of machines such as belt filter presses, rotation drum sives, filter presses, screw presses or decanter centrifuges is significantly increased by the specific two-step conditioning. Because of the compact floc pellets, the primary filtration is enhanced. The high mechanical stability of the flocs allows the release of water even under high mechanical stress during the filtration or pressing process.

The second effect is a decrease in polymer consumption. The condition reactor with its preliminary rapid mixer is inserting the polymer in the optimal way. The polymer could develop its full properties, an over-dosage is not anymore required. Thus, polymer costs are minimized.

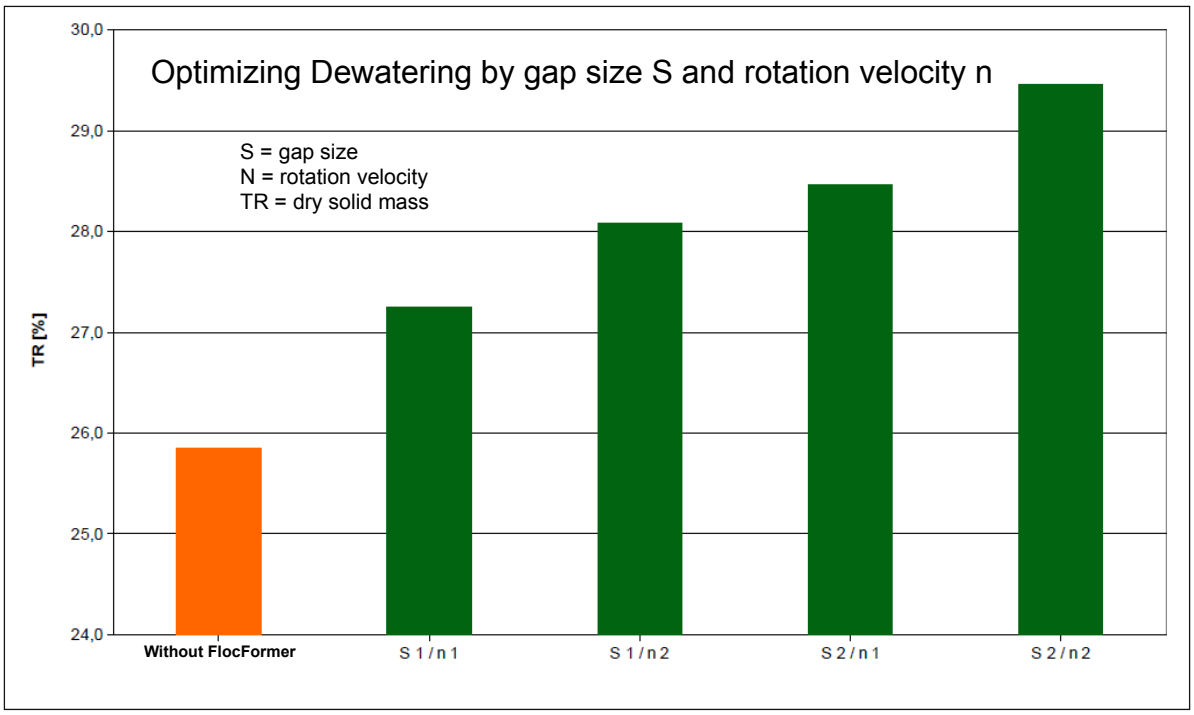


Waste Water before Separation (incl.Polymer):
without **with FlocFormer**

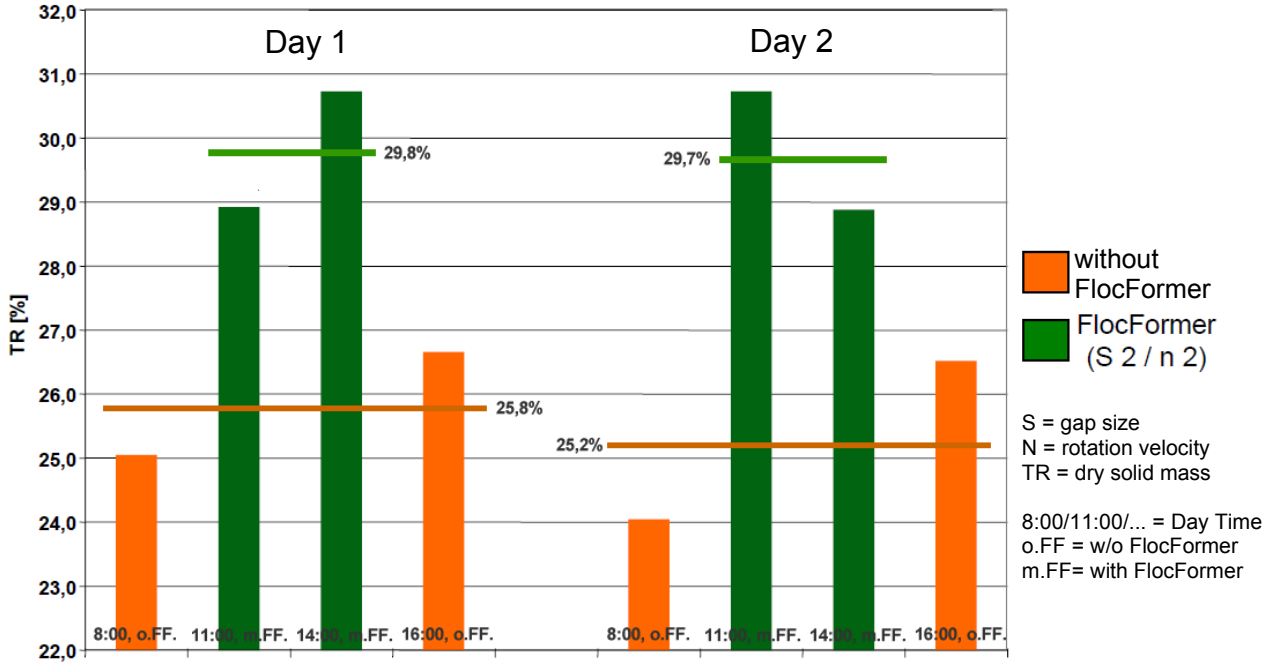
The filtration with belt filter presses could examplify the advantages of the optimized floc structure. During belt filter press dewatering, initial gravity filtration and afterwards different pressure zones take place. When the flocs are floating in the gravity zone, the liquid phase drains off rapidly to a large extent due to the good preconditioning. Thus, the belt velocity could be reduced aiming at higher retention times in the press zones. Supported by the high floc stability, the increased retention time leads to an improved dewatering result.

The separation efficiency of decanter centrifuges is enhanced by the external preceding conditioning, too. The high stability necessary for decanter centrifuge dewatering is one of the great advantages of the new process.

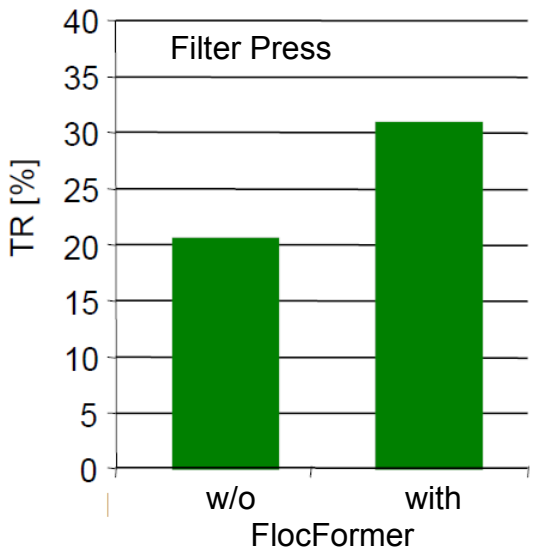
Dewatering results with FlocFormer (by gap size S and rotation velocity n)

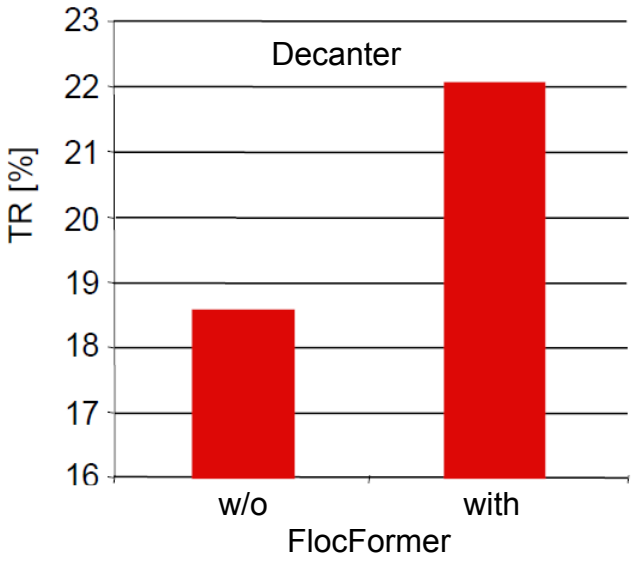


Dewatering Results on two different Days (with and without FlocFormer)



Expl. Dewatering results for Filter Press and Decanter



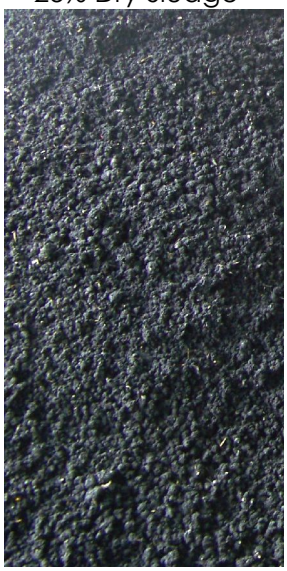


Just a glance at the dewatered sludge shows the difference (Waste Water Treatment Plant in Goslar/Germany):

20% Dry Sludge

24% Dry Sludge

25% Dry Sludge



without FlocFormer (Initial)

with FlocFormer (+20%)

with FlocFormer (opt) (+25%)

The Result:
Depending on the specific application, the separation efficiency could be **improved by 10 up to 30%** using FlocFormer technology. Simultaniously, the polymer consumption could be **reduced by 25%**. Because disposal costs are – besides the energy costs – the major matter of expense for the plant operator, an implementation of the new conditioning reactor FlocFormer could raise the Overall-Equipment-Efficiency OEE in a double-digit range.

Expertises of Waste Water Experts

„Since we use the FlocFormer we have optimized our Sludge Dewatering in the Decanter. The Technology is great and saves us a lot of money."

Joerg Hinke
Plant Manager
EURAWASSER
Subsidiary Goslar / Germany

„The FlocFormer Technology helps us to decrease the cost of the Cargol Filter Stages significantly. The Process runs stable now since 2.5 years."

Martin Sieloff
Department Director
Osterode County / Germany
Waste Disposal Site Hattorf

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FlocFormer Installation in a Plant

The new conditioning process has standed the test in more than 40 pilot scale runnings. The main focus of activities has been in the area of wastewater treatment. In municipal sewage sludge dewatering, the efficiency of chamber filter presses, rotation drum sieves, scew presses, belt filter presses, Bucher-presses and decanter centrifuges has been improved. As a rule, the polymer consumption decreased significantly in addition to the improvement of the separation efficiency.

The additional value for the environment:

- Sewage sludge incineration: because of the increased solid content of the sludge, the energy yield is rising significantly according to less drying-energy.
- Transportation: sewage sludge tonnage on the road decreases about one-fifth (aprox. 3 Mio. t sewage sludge/anno have to be carried by truck in Germany, this results in possible tonnage savings of 0.6 Mio t/anno or 30.000 less truck-movements)

These over-all advantages relieve the environment in a calculable way.

An other application has been realized in lanfill leachate treatment, leading to a very economic solution for this task. A huge part of the organic and oxidable components (so called COD) could be separated by the two-step flocculation process.

Further employment are possible in any polymer initiated separation processes, such as

- pulp and paper industry,
- fruit juice production,
- any food production,
- wastewater treatment,
- any sludge dewatering tasks,
- thickening.

Amortization „Process Benefit with FlocFormer“

The cost reduction potential „Reduction of Sludge mass“ und „Reduction of the Polymer application“ is calculated in the following in a real application with an initial dry Sludge Value of 22%. With FlocFormer 27% were reached. Even with initial values of 30% TS significant potentials are run in.

The financial Results:

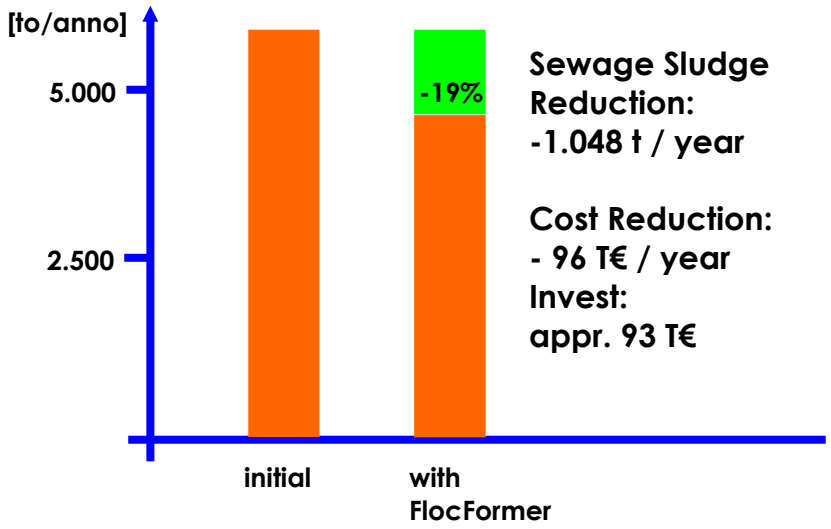
With a minimum lifetime of the FlocFormer of 8 years an average annual interest of the used capital of 102% is realized.

The capital value of the investment of 93.5 Teuro gives, discounted at a rate of 10%, a cumulated cash flow of **417 TEuro** in the remaining 7 years after installation.

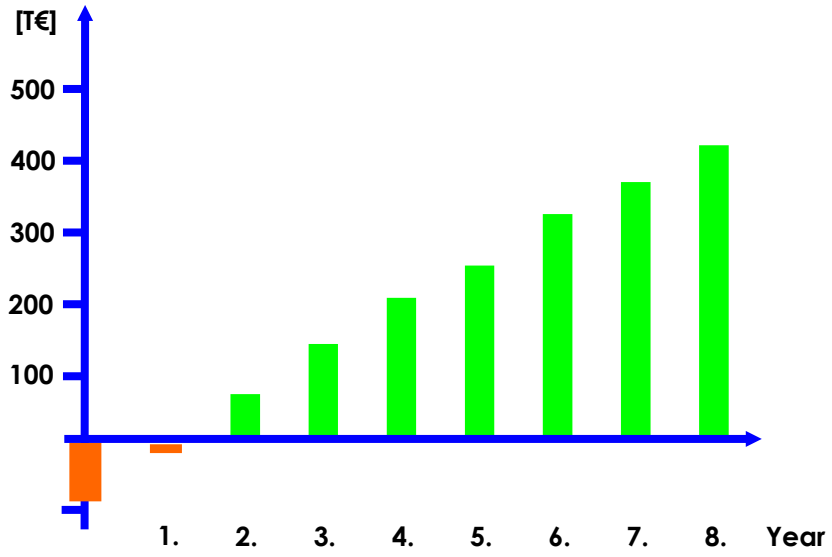
Summary: The Return of the Investment ROI (before interest deduction) is 102 % per year!

The Graphics

The Results



The Cash Flow (cumulated)



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The Calculation

(for a realized additional drainage performance of from 22% to 27%.
Even at installed Plants with initial best performance of appr.30% a significant approvement will run.)

Name	Value	Dim.
Maximum Volume	36	m3/h
Dry Substance Inflow	1,92	%
Dry Substance Mass	0,69	t/h
Present Drainage	**22,00**	**%**
Currently Mass	3,15	t/h
Drainage with FlocFormer	**27,00**	**%**
In future Mass	2,56	t/h
Mass Reduction	**0,59**	**t/h**
Operation Period per Year	1.768,00	h/a
Annual Reduction	**1.047,67**	**t/a**
Disposal Expenditure	90,00	Euro/t
Reduction Disposal	**94.290,30**	**Euro/a**
Polymer saving	**1,00**	**kg/t**
Annual Mass mud	1.222,04	t/a
Polymer mass	1.222,04	kg/a
Polymer Cost	4,00	Euro/kg
Reduction Polymer Expenditure	**4.888,17**	**Euro/a**
Reduction Disposal and Polymer	**99.178,46**	**Euro/a**
Operating Expenses, Services	3.400,00	Euro/a
Net Expenses Reduction	**95.778,46**	**Euro/a**
Net Investment	85.000,00	Euro
Installation Cost	8.500,00	Euro
Investment	**93.500,00**	**Euro**
Calculation Interest rate	6,00	%
Return on Investment (ROI)	**0,98**	**Year**

With pleasure we count on your initial datas.

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