BONDSTAR®

Environmentally Compatible and Effective

BondStar® is a sustainable product achieving excellent results as a dry strength agent in the waste paper processing industry and having no negative impact on the environment. This is confirmed by its successful use worldwide, as well as by extensive series of tests carried out by Lucas Wagner as part of his master's thesis at the Upper Austria University of Applied Sciences to investigate the influence of glyoxalated polyacrylamides on the anaerobic treatment of the waste water generated during the production of corrugated base paper.

About 40% of anaerobic industrial wastewater treatments in Germany are operated in the paper and pulp industry. The process is most commonly used by the manufacturers of packaging papers using waste paper, especially in the production of corrugated base paper, which is produced with low specific amounts of waste water due to the closed loops. As a result of high recycling ratios, the waste paper fibers are becoming shorter and weaker leading to reduced paper strength. To counteract the resulting negative consequences, such as not achieving the required paper specifications or sheet break on the paper machine during the production process, a wide range of chemical additives are added, including dry strength agents.

With the BondStar® product range ACAT has developed synthetic dry strength additives used successfully worldwide. BondStar® is added to the stock suspension early in the wetend. Due to the very good absorption a very high proportion of BondStar® is remaining in the paper and only a very small amount is discharged to the anaerobic stage with the wastewater flow. The product is offered in various concentrations to the market. Glyoxalated polyacrylamides have only a very limited shelf life. To solve the shelf life problem, ACAT has also developed a cost-efficient on-site technology at the paper mill for the production of BondStar®.

The use of BondStar® results in increased dry strength, less breaks, higher paper machine speed and an increased filler content in the end product. Similar to polymer flocculants used in sludge thickening and sludge dewatering in wastewater treatment plants, BondStar® has a cross-linking/ bonding effect between particles oppositely charged to the polymer.

As part of his master's thesis at the Upper Austria University of Applied Sciences, supervised by Dipl.Ing.Dr.nat.techn. Kiril Atanasoff, in cooperation with the Ostwestfahlen-Lippe University of Applied Sciences - Department of Civil Engineering, Laboratory for Urban Water Management, Lucas Wagner investigated the question of whether the use of BondStar® can have negative effects on the anaerobic degradation of the wastewater. To this end, on one hand he carried out extensive batch tests and on the other hand continuous laboratory trials with two parallel operating UASB reactors on a laboratory scale.

UASB reactor 1
made of plastic

UASB-Reaktor
2 made of glass

Batch trials

The batch trials were prepared in 2-liter glass bottles and carried out at a temperature of 37 °C ± 1 °C. In the first series of trials, waste water from the pre-acidification of the industrial wastewater treatment plant of a corrugated base paper mill in Bavaria was used as substrate. In a further series of trials a 0.5 % acetic acid solution with a pH value of 6.5. Pellet sludge from the mill's own anaerobic plant of the corrugated base paper mill in Bavaria was used as inoculation sludge. In the Bavarian mill a 2 % BondStar® solution is used, in a quantity of 66 l/m³ waste water.

It was assumed that different amounts of the dry strength additive remain on and in the end product paper. Conversely, this results in corresponding residual concentrations in the wastewater. These residual concentrations were

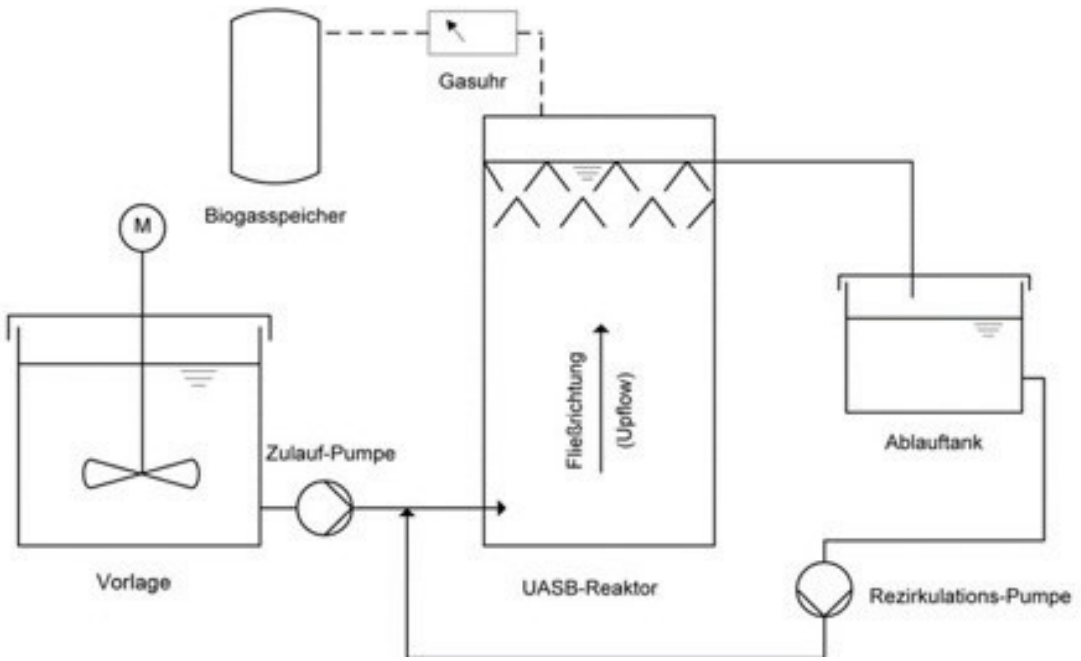
simulated by using different amounts of BondStar® 2 % in batch preparations.

Continuous laboratory trials

The laboratory tests carried out in the corrugated base paper mill were intended to simulate the effects of an incident at the production plant, for example in the case of a pipe burst or a leak in the storage tank. In the event of such an incident, different amounts of 2% BondStar® solution would be discharged directly into the waste water stream and thus into the anaerobic pre-treatment plant. The effects of higher BondStar® concentrations in the wastewater on the anaerobic degradation process in the UASB reactors should be analysed and documented. A continuous trial operation with abnormal high BondStar® addition levels was not carried out, because such an operating condition is far away from the reality and should already be avoided for cost reasons.

The pre-acidified waste water from a corrugated base paper mill's sewage plant was used for the trials. This wastewater already contained small amounts of BondStar® due to the mills operation with BondStar® in their production.

The laboratory reactors for the continuous experiments were borrowed from the Laboratory for Urban Water Management of the University of Applied Sciences Ostwestfalen-Lippe. Various BondStar® concentrations were used to simulate fictional incidents. In the trials it was assumed that a BondStar® inlet pipe would break and a significant amount of BondStar® solution would flow directly into the wastewater treatment plant. In the operation itself, approximately 208.5 ml of BondStar® are added to 5 l pulp suspension of base paper mash.
The assumption was that about 10 % - 100 % of the BondStar® solution is not absorbed by the paper and is in the waste water. In the simulation of the incidents, it was assumed, for example, that a BondStar® feed pipe would break and part or the whole BondStar® (100 %) solution would flow directly to the anaerobic stage.



Schematic test setup of the UASB laboratory plants

The quantities of BondStar® (10 %, 50 %, 100 %) added to the waste water in the tests were intended to simulate that these percentages of the dry strength additive were not absorbed by the paper, but went into the waste water.

The quantity of dry strength additive for the respective incident simulation was always added once to the lab storage tank. The storage tank was filled daily with fresh waste water. The reactor was operated with wastewater without additional BondStar® for about 14 days.

In order to determine the effects of an additional quantity of BondStar® solution in the event of a malfunction, one of the two UASB reactors was operated only with pre-acidified raw wastewater, while a wastewater-BondStar® mixture with the respective BondStar® additives was added once to the second reactor. The two reactors were operated with almost the same COD loads and hydraulic retention times as in the anaerobic unit of the plant. The comparison should show whether and what effects occur in the event of an accident with BondStar®.

The following conclusions can be drawn from the trials:

In her review of Lucas Wagner's master's thesis Prof. Dr.Ing. Ute Austermann-Haun from the OWL University of Applied Sciences came to the following conclusions:

- BondStar® increases Chemical Oxygen Demand (COD) in wastewater. This COD is degraded, recognizable by the higher biogas production. The data show that BondStar® does not inhibit the biogas production, on the contrary, that both the BondStar® trials with pre-acidified wastewater and the BondStar® trials with acetic acid produce more biogas and even the methane concentration increases slightly.
- The batch trials clearly showed that with the increasing addition of BondStar® the COD degradation is delayed, maybe due to the hydrolysis required first. The same effect could not be found in the continuous tests.
- For 87 days the reactors ran in parallel. Reactor 1 was fed four times with wastewater containing high concentrations of BondStar®. Neither the COD elimination performance, nor the biogas production, the biogas composition, the organic acid content or the FOS/TAC ratio were negatively affected by the higher concentration of BondStar® in the anaerobic plant inlet.
- The trials showed that BondStar® is obviously degraded, which is shown by the increase of biogas production.

Result

With the presence of BondStar® in the waste water of a paper mill, no acute or incipient toxicity, no inhibition of biogas production and COD degradation were detected under the conditions described. No acute or long-term inhibition or toxicity occurred. On the basis of the tests, it can be ruled out that the correct use of BondStar® will not lead to any lasting inhibition of methanation, neither during operation nor in the event of malfunctions that may occur repeatedly during paper production.

The last test approach, in which 208ml BondStar® were added directly into the reactor, simulated a very unrealistic scenario. However, it was still carried out to observe and describe possible effects. The addition of 208 ml to 3.75 l reactor volume corresponds to an amount of 55 ml/l corresponding to 55 l/m³ reactor volume.
In real operation, this would mean, for example, for a paper production facility for corrugated base paper, that approximately 70 m³, i.e. more than three tankers of 20 m³ each of BondStar® 2 %, would be added directly to the wastewater

PHOTO: CHRISTINE NESTLER-KENZIAN

Based on the tests, it can be ruled out that BondStar® will lead to a sustained inhibition of methanation.

stream and would immediately reach the wastewater treatment plant and subsequently the methane reactors.

During this experiment Lucas Wagner could observe that the sludge formed a massive floating layer.

In other industrial plants Prof.Dr.Ing. Ute Austermann-Haun has observed that if a too large amount of polymer flocculants is added, the pellets are not able to remove the biogas produced due to the change in viscosity. As a consequence, the biomass floats in this case as well. The microscopic pictures showed massive sticking of the pellets and a binding of fine materials to the pellets. However, the pellets were still functional, i.e. their degradation behaviour was not affected. In summary, it can be said that BondStar® is a sustainable product. Especially using waste paper for the paper production, it improves significantly production conditions.

In the laboratory tests, simulations of malfunctions with large quantities of BondStar® entering the wastewater showed no acute toxic or mid-term negative effects on anaerobic degradation.

Our special thanks go to Prof. Ute Austermann-Haun and Dipl.Ing. Heike Witte from the Technical University of East Westphalia-Lippe, Germany and Dr. Alexander Jäger from the University of Applied Sciences Wels, Austria for their technical and practical support in carrying out the batch and laboratory tests.