Study of the functionality of a wastewater treatment plant during a prolonged period without inflow

In response to a request to verify the functionality and efficiency of the wastewater treatment plant (hereinafter WWTP) during a prolonged period without inflow—caused in realistic conditions, for example, by seasonal operation and a lack of inflow during the winter months—we conducted a four-month test. During this test, we monitored microorganism activity during the shutdown, oxygen conditions in the tank, and activated sludge sedimentation. After the WWTP returned to normal operating conditions, we also analyzed samples of treated wastewater until the biological functionality of the WWTP was stabilized.

Condition of the WWTP prior to the start of testing

The WWTP selected for the tests was located at the test site of the municipal wastewater treatment plant in Brno-Modřice, which had been in operation for the previous two months while testing the effect of air volume on the plant's functionality. The wastewater source consisted of effluent from the Brno sewer system, with inflow characteristics corresponding to the following average parameters:

BOD5= 365 mg/L

COD = 835 mg/L

SS = 290 mg/L

$\mathbf{N}_{TOT}$= 85 mg/L

With these inflow parameters, the WWTP achieved the following average effluent values:

BOD5= 14 mg/L

COD = 58 mg/L

SS = 29 mg/L

$\mathbf{N}_{NH4+}$= 2,2 mg/L

Centrifugal pumps were used for the influent to the wastewater treatment plant, pumping wastewater into the plant's influent chamber at a flow rate and volume corresponding to the testing of wastewater treatment plants as specified in standard EN 12566-3+A.

Picture 1 Tested WWTP

Testing procedure

Testing began on November 5, 2025, by disconnecting the wastewater treatment plant's inflow from the wastewater source and setting the initial aeration mode for the activated sludge tank to a cycle of 15 minutes on and 4 hours off. At the start of testing, the activated sludge sediment concentration in the activated sludge tank was 340 ml/L.

The WWTP was inspected regularly once a week, during which the oxygen level in the WWTP's activation tank was measured and a sedimentation test was performed. During the first week of the influent shutdown, no significant changes in activated sludge sedimentation were observed, and the oxygen level remained stable at around 10 mg/L even with intermittent blower operation.

Picture 2 Data from the oxygen probe

Picture 3 Sedimentation test 1.12.2025

By the second week of the influent shutdown, there had already been a noticeable decrease in activated sludge volume, with a value of 160 ml/L achieved during a standard 30-minute test. After another week without inflow, a further decrease in the volume of settled sludge was recorded, down to 120 ml/L. Due to the still high oxygen level in the activation tank, the blower operating ratio (aeration/rest) was further reduced to a 10-minute run/6-hour (360 minutes) pause cycle. After a total of two months of WWTP operation, the activated sludge volume decreased to 100 ml/L and remained at this level until the end of the four-month test period. During this period, oxygen levels remained consistently around 9–10 mg/L.

Start-up of the WWTP

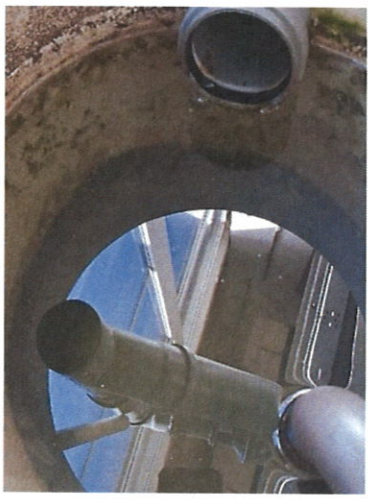
After a four-month shutdown of the influent flow, the influent pump to the WWTP was restarted, and the influent flow rate and volume were set in accordance with the testing requirements of EN 12566-3+A2. On the very first day after commissioning, the activated sludge sediment from the activation tank was measured, which immediately rose to 150 ml/L; at the same time, samples of the effluent were taken, which showed the following values:

BOD5= not measured mg/L

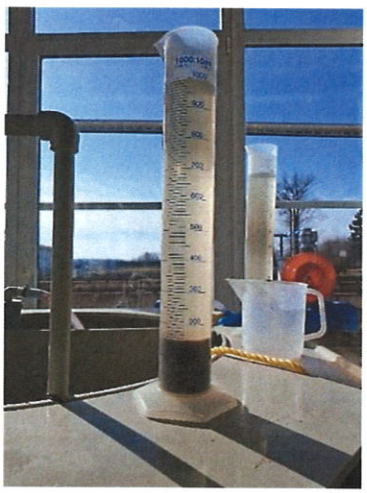
COD = 94 mg/L

SS = 74 mg/L

$\mathbf{N_{NH4+}}$= 0,1 mg/L



Picture 4 Treated water in inflow tank



Picture 5 Sedimentation test 2.3.2026

The water in the drainage structure was visually clear, with no leakage of undissolved substances.

On the second day of observation, there was a noticeable increase in activated sludge volume, reaching 340 ml/L, and effluent samples were collected, giving the following results:

BOD5= 41 mg/L

COD = 106 mg/L

SS = 71 mg/L

$\mathbf{N}_{NH4+}$= 20,5 mg/L

Picture 6 Sedimentation test 3.3.2026

On the third day of observation, there was again a slight increase in activated sludge volume, this time to 350 ml/L, and effluent samples were collected, giving the following results:

BOD5= not measured mg/L

COD = 96 mg/L

SS = 36 mg/L

$\mathbf{N}_{NH4+}$= 20,8 mg/L

Picture 7 Sedimentation test 4.3.2026

On the fourth day of observation, there was again a slight increase in activated sludge volume, reaching 360 ml/L, and effluent samples were collected, showing the following results:

BOD5= not measured mg/L

COD= 66 mg/L

SS = 22 mg/L

$\mathbf{N_{NH4+}}$= 8,8 mg/L

Picture 8 Sedimentation test 5.3.2026

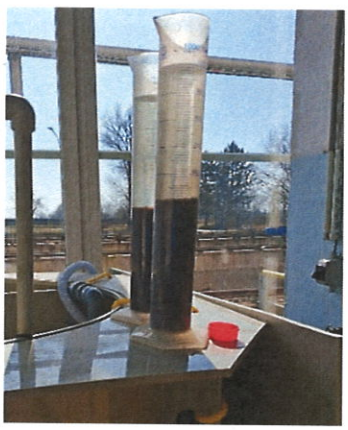
On the fifth day of monitoring, a slight increase in activated sludge volume was again observed, reaching a value of 390 ml/l. At the same time, samples of effluent were collected, yielding the following results:

BOD5= 27,4 mg/L

COD = 52 mg/L

SS = 18 mg/L

$\mathbf{N_{NH4+}}$= 0,8 mg/L



Picture 9 Sedimentation test 6.3.2026

A validation check was then performed after another three days of operation; the measured activated sludge sediment reached a value of 490 ml/L, and the following effluent values were measured:

BOD5= not measured mg/L

COD = 41 mg/L

SS = 6 mg/L

$\mathbf{N_{NH4+}}$= 0,02 mg/L

After another two days, another test was conducted; the activated sludge concentration reached 600 ml/L, and the effluent values were as follows:

BOD5= not measured mg/L

COD = 89 mg/L

SS = 68 mg/L

$\mathbf{N_{NH4+}}$= 1,8 mg/L

Unfortunately, this result was negatively affected by an incorrect sample collection, so it was decided to perform another validation sample collection, which was carried out during the next inspection two days later. During this inspection, the activated sludge sediment already showed a stable volume of 600 ml/L, and the effluent values were as follows:

BOD5= 9,3 mg/L

COD = 58 mg/L

SS = 24 mg/L

$\mathbf{N_{NH4+}}$= 0,2 mg/L

Picture 9 Sedimentation test 13.6.2026

Summary of treated wastewater quality results following the transition to normal operating conditions at the wastewater treatment plant:

CHECK & ANALYSIS	Sediment (1000ml)	Oxygen	BOD	COD	N-NH4	SS
05.11.2025	340					
10.11.2025	340	10,6				
19.11.2025	160					
03.12.2025	120					
13.01.2026	100					
02.03.2026	150	-	-	93,7	0,111	74
03.03.2026	340	9,39	41,1	106	20,5	71
04.03.2026	350	7,83	-	95,9	20,8	36
05.03.2026	360	7,18	-	65,6	8,82	22
06.03.2026	390	7,6	27,4	52,1	0,849	18
09.03.2026	490	6,82	-	40,9	0,024	6
11.03.2026	600	1,66	-	88,7	1,76	68
13.03.2026	600	8,28	9,3	58,1	0,024	24

Evaluation of the tests and conclusion

Operational tests of the wastewater treatment plant during periods without influent flow have demonstrated that, when the activation tank is operated in a 10/360 aeration mode, this is sufficient to maintain the activated sludge in good condition, ensuring that the plant's startup after influent flow resumes is smooth and rapid.

Based on the measured values of the effluent from the treated wastewater following the restart of the influent, it can be clearly stated that, as early as the third day after restart, the WWTP exhibited values consistent with a normal, well-functioning WWTP, including for the ammonia nitrogen parameter. This demonstrates sufficient activity of nitrifying bacteria, which was also confirmed in subsequent validation tests conducted after seven and eleven days.

It has thus been demonstrated that, by operating the WWTP under appropriate conditions during periods without inflow, the activated sludge can be maintained in a state that allows for a rapid and safe restart of the plant once wastewater inflow resumes.

In Brno, 2.4.2026

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