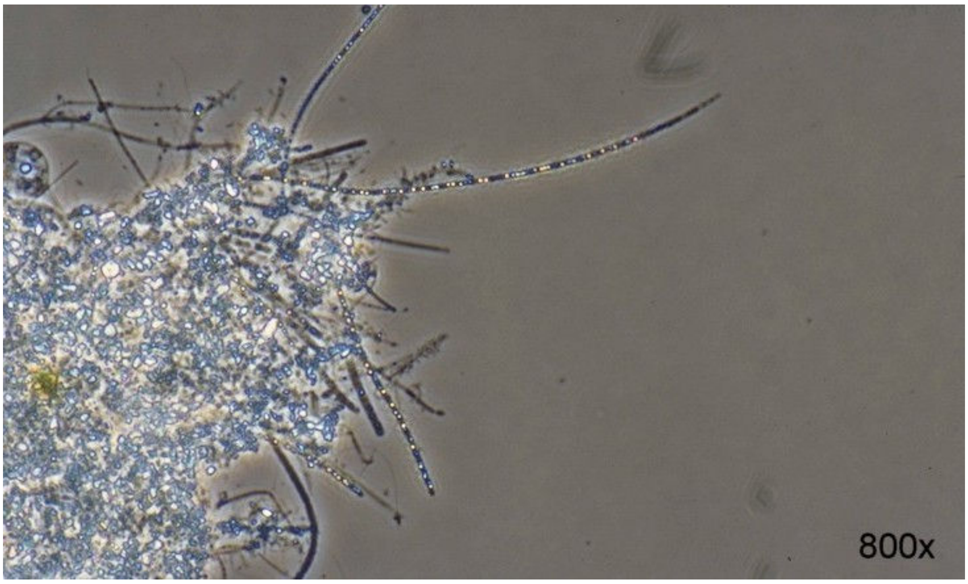
Thiothrix-1

Resembles: -
Probes: class specific Gam42a [10] and group specific G123T [7] and TNI [16]
Frequency occurrence (200 samples; 175 WTPs):

- observed with a FI ≥ 1 in 15 samples
- observed with a FI ≥ 3 in 4 samples



Characteristics

- straight, bent or somewhat twisted filaments;
- filaments frequently protruding from or attached to the flocs; occasionally attached to other filaments;
- often tapering of the filaments;
- filament length variable;
- filaments not branched;
- not motile;
- cell diameter may vary from 0.6 µm (tip filament) to 1.2 µm (basal cells);
- sheath absent;
- without attached growth;
- septa only visible in thicker filaments and when S granules are missing;
- rectangular cells;
- often already *in situ* sulphur granules; fast storage of granules with the S-test;
- Gram negative;
- Neisser negative.

Remarks
All *Thiothrix* morphotypes belong to the *Gammaproteobacteria*; class specific probe: Gam42a [10].. G123T and TNI are group specific probes. A number of classified *Thiothrix* species might occur in WTPs [1, 4, 7, 8] and probes are available by which various subgroups can be distinguished [7]. However, additional FISH tests, aimed at further identification of the morphotypes observed by applying such subgroup specific *Thiothrix* probes, were not carried out during the Dynafilm project.

Thiothrix-1 includes *Thiothrix*-3 and 5, two previously distinguished separate morphotypes [3].

Physiology
Most classified *Thiothrix* species use low molecular compounds, such as short chain fatty acids and often also sugars for their growth and they also derive energy from the oxidation of reduced sulphur compounds such as H_2S or thiosulphate. It has even been demonstrated that acetate is taken up under anoxic or anaerobic conditions by some *Thiothrix* strains if thiosulphate is present [13]. Some *Thiothrix* strains absolutely require reduced sulphur compounds for their growth.

References for further reading about the physiology of *Thiothrix*: 1, 5, 11, 12, 13, 14, 17 and 18.

Occurrence in activated sludge
Thiothrix-1 was often observed in WTPs treating wastewater from pulp & paper industries and on occasion also in plants receiving wastewater from chemical, dairy and food industries. Thus, it is not possible to correlate this morphotype with a specific industrial branch. However, it is very likely that growth of *Thiothrix*-1 will mainly occur in plants treating wastewater rich in reduced sulphur compounds.

Control strategies
The common possibilities aimed at solving a bulking problem are listed below (1-7). Selectors or two step configurations are often effective methods to control filamentous species using low molecular compounds for their growth. If sulphur is stored very easily and in massive amounts by the *Thiothrix* morphotype present, reduced sulphur compounds, supplied with the influent, most likely play a decisive role in the competition of that Thiothrix sp. with other sludge bacteria. Reduced sulphur compounds can be removed in an aerated, highly loaded first stage (option 3). Other low molecular compounds, also stimulating growth of *Thiothrix* sp., will be largely removed simultaneously.
It is always recommended to start with a pilot scale experiment before a selected control method is applied on full scale.
References for further reading about process control: 2, 6, 9 and 15.

1. Good "House-keeping"
2. Remove deficiencies: $O_2 > 2$ mg/l and BOD:N:P =100:5:1.
3. Two step configuration (aerobic/aerobic or anaerobic/aerobic), in order to remove most of the easily degradable influent fraction before this enters the aeration tank.
4. Aerobic selector.
5. Anoxic zone if sufficient nitrite/nitrate is available for removal of the dissolved fraction from the influent through denitrification.
6. Anaerobic zone if a combination with a Bio-P process is an option.
7. Controlling symptoms, viz. applying physical or chemical methods aimed at destroying the filaments or at improving the settling velocity of the flocs by increasing their weight.

References

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Slide show images

- 1-3: low magnification; filaments often attached to the floc or to other filaments
- 4-6: diameter variable (often tapering)
- 7: occasionally more twisted filaments
- 8-20: examples S-storage, *in situ* or after applying the sulphur deposit test.
    - 10: *S. natans* does not store S
    - small S granules are almost black
- 21-22: FISH images with probe TNI