Diffuser Maintenance
Part 1: Flexing & Cleaning of FBDA

The efficiency of new fine bubble aerator mainly depends on the specific air flow rate, but also on shape of aerators (disc, tube, plate), membrane material (ceramics, HDPE, EPDM, silicone, polyurethane, TPE, …) and some plant related factors e.g. tank geometry and water depth. In the last 20 years there were done many investigations, development and improvements.

In general the systems today are designed with a higher number of diffuser and so indirectly lower specific flow rates. Thus oxygen transfer efficiency could be increased for 30% and more.

But operation of fine bubble diffuser with flexible membranes at always low air flow rates can cause subsequently operational problems:

- formation of organic deposits / settlement of bacteria on the membrane surface and related problems with EPS (extracellular polymeric substances), additionally promoted by a lack of oxygen or further nutrients
- formation of organic deposits / settlement of bacteria, which can lead to a loss of components from rubber membranes (so called softener), makes the material harder, flexibility decreases and in worst case membrane can tear up ("biofouling")
- formation of inorganic deposits e.g. lime, promoted by a shift of the lime/ carbonic acid equilibrium closed to the slits [1]
- formation of other mineral deposits containing iron, phosphorus, silicon and other, promoted by low humidity of aeration air, ammonia, nitrate and ferric components in the wastewater [1]

All these processes will lead to growing process problems e.g. clogging of the aerators, worse bubble pattern, decrease in oxygen transfer efficiency, increase of pressure drop of the aeration system. At the end the whole system can fail: blowers can start to surge and/or diffuser membranes can tear up, sludge will enter the air distribution system and so oxygen input into the aeration tank(s) can be interrupted completely.

Therefore there must be carried out special measures from the beginning of the operation of the diffuser system. Because the diffuser are installed on the bottom of the tanks with some meter water on top, the installation of a small retractable diffuser grid with parallel operation to the other diffuser grids is recommended. From time to time this grid can be taken out and diffuser can be visually observed for deposits.

Deposits can be determined by monitoring the diffuser from the test grid and further actions can be started e.g. dosing of an acid into the air stream or cleaning with an alkaline solution. Dosing of acids (usually citric or formic) shall be done as closed as possible to the diffuser. Precise nozzles will form very small drops of the acid which will move with the air stream through diffuser elements. A special ratio acid [l/hr] to air flow rate [Nm^3/h] is applied to achieve highest efficiency. [2]

To reduce biofouling a regular flexing by purging a high air flow rate for a certain amount of time into the system is recommended (details please see manufacturer´s instructions). [2]

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Both maintenance actions shall be done on a regular base. The flexing of the diffuser should be automized in the aeration control system. It must be secured, that always one tank respectively diffuser grid after another is flushed with a specific high air flow rate for a certain amount of time. Low load phases are not recommended in general to use for flexing, because the DO-concentration will rise up quickly and it will take a long time until typical DO-value is achieved again. In the meantime the water with a lot of dissolved oxygen will flow to denitrification zones and will disturb the denitrification process for some hours or stop it completely.

In systems executing a flexible header pressure strategy (based on MOV), header pressure can be too low during low load phases to achieve the required air flow rate. Header pressure can be increased of course, but from energy efficiency point of view this is not economical.

The minimum possible header pressure to achieve required air flow rate must be defined in the controller and must be realized when starting the flexing procedure. Time sequences can ranges from daily to monthly and depend on local situation.

Acid dosing needs to be performed less frequently e.g. 1-2 per year. Preparation of a cleaning cycle (connection of dosing tank, pump and nozzle) is done manually and so cleaning procedure in the aeration controller should be started manually too ("Start now" button and perform a stable air flow rate for a certain amount of time). Even this function requires a minimum header pressure which must be secured for the whole time.

The diffuser system can be monitored in fixed time cycles for permanent increase of pressure drop due to ageing of the rubber membranes and remaining deposits which couldn´t be removed. Based on this information, a decision can be made when diffuser membranes should be replaced. After a flexing cycle a specific stroke is used to measure the actual flow rate. When a threshold is undercut, an alarm is transferred to the PLC.

Literature:

[1] Dr. Wilhelm Frey: Methoden zur Reinigung feinblasiger Druckbelüftungssysteme (EN: Methods for cleaning of fine bubble diffused aeration systems). Conference DWA Teachers and Chairmen Thuringia/ Saxonia, Dresden 2006

[2] DWA-M 229-1: Systems for aeration and mixing in activated sludge plants - Part 2: Operation and maintenance. Beuth Verlag September 2017

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