6. Positioning

6.1 General description

The correct positioning of mixers and flowmakers in the biological treatment zones of a wastewater treatment plant is very important for the efficient operation of the plant. Non-compliance with positioning principles and guidelines may create problems caused by vibrations, and result in wear.

6.2 Positioning principles, mixers

6.2.1 Positioning of mixers in general

The mixer should be submerged as deep as possible, however, no deeper than the tip of the propeller blade is 20-40 cm above the bottom of the tank, see Fig. 14:

$$H_{MIN} = 20 \text{ to } 40 \text{ cm}$$

where H_{MIN} = Minimum height from the tank bottom to the propeller tip.

The distance from the propeller tip to the liquid surface should be minimum half the propeller diameter.

The minimum height of the liquid above the bottom of the tank (H_{LIQUID}) can be calculated according to the following formula:

$$H_{LIQUID} \geq H_{MIN} + 1.5 \times D_{PROP}$$

where D_{PROP} = propeller diameter.

The minimum length of free flow towards the propeller (L_{MIN}) should be twice the propeller diameter:

$$L_{MIN} \geq 2 \times D_{PROP}$$

This is normally not a problem, as the length of the motor and motor bracket is usually more than twice the propeller diameter.

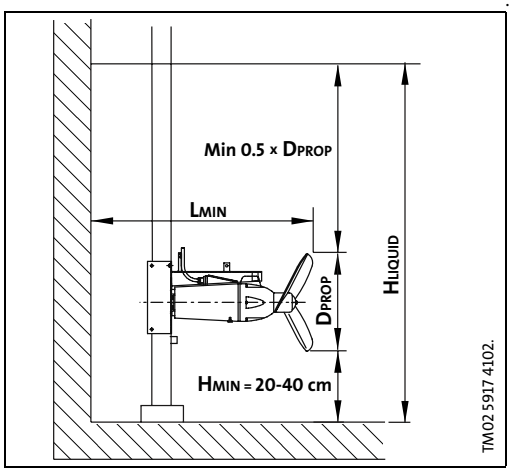

Fig. 14 Positioning of mixers

Mixers should not be installed after aeration zones in the tank, as air bubbles cause a strong reduction in mixer performance.

It is recommended to distribute the required flow performance on two or more mixers. This will generate a more homogeneous flow.

Formulas:

$$H_{MIN} = 20 \text{ to } 40 \text{ cm}$$

$$H_{LIQUID} \geq H_{MIN} + 1.5 \times D_{PROP}$$

$$L_{MIN} \geq 2 \times D_{PROP}$$

where:

H_{MIN} = Minimum height from the tank bottom to the propeller tip
H_{LIQUID} = Minimum height of the liquid above the bottom of the tank
D_{PROP} = Propeller diameter
L_{MIN} = Minimum length of free flow towards the propeller.

6.2.2 Positioning in circular tanks

A mixer in a circular tank should be positioned in such a way

- that a steady, circulating flow is generated, preventing sedimentation of solids (see Fig. 15), or
- that the deposited solids are mixed with the liquid (see Fig. 16).

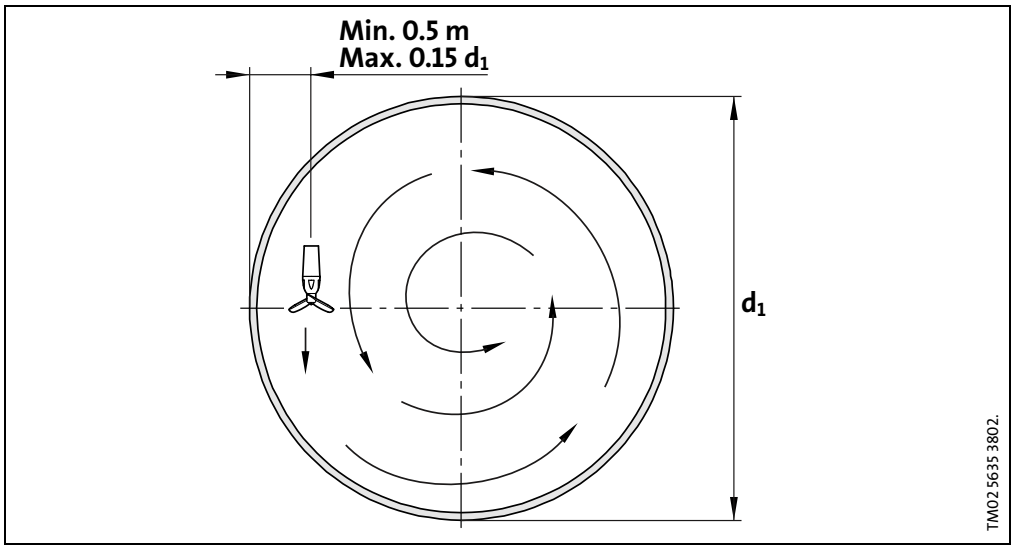

Fig. 15 Solids are kept suspended in the liquid of a circular tank

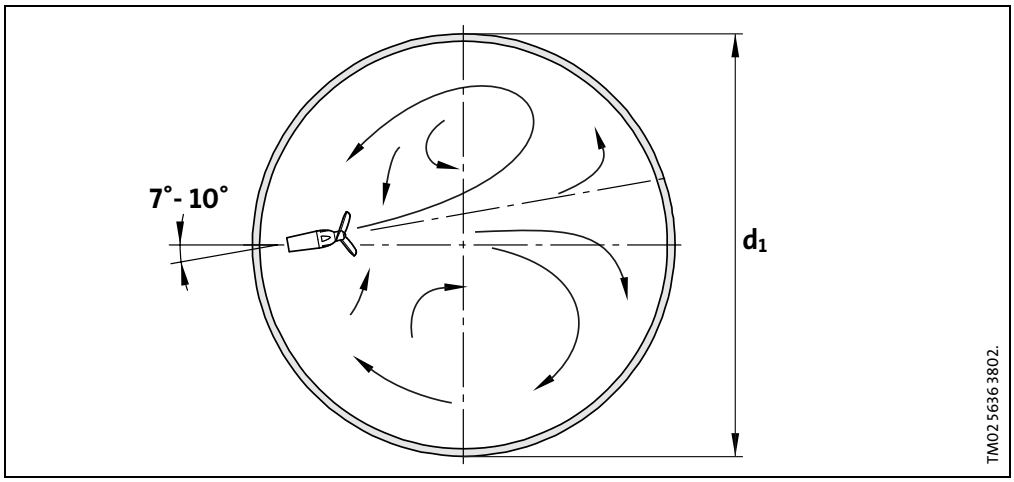

Fig. 16 Deposited solids are mixed with the liquid of a circular tank

6.2.3 Positioning in rectangular tanks

A mixer in a rectangular tank should be positioned in such a way

- that a steady, circulating flow is generated, preventing sedimentation of solids (see Fig. 17), or
- that the deposited solids are mixed with the liquid (see Fig. 18).

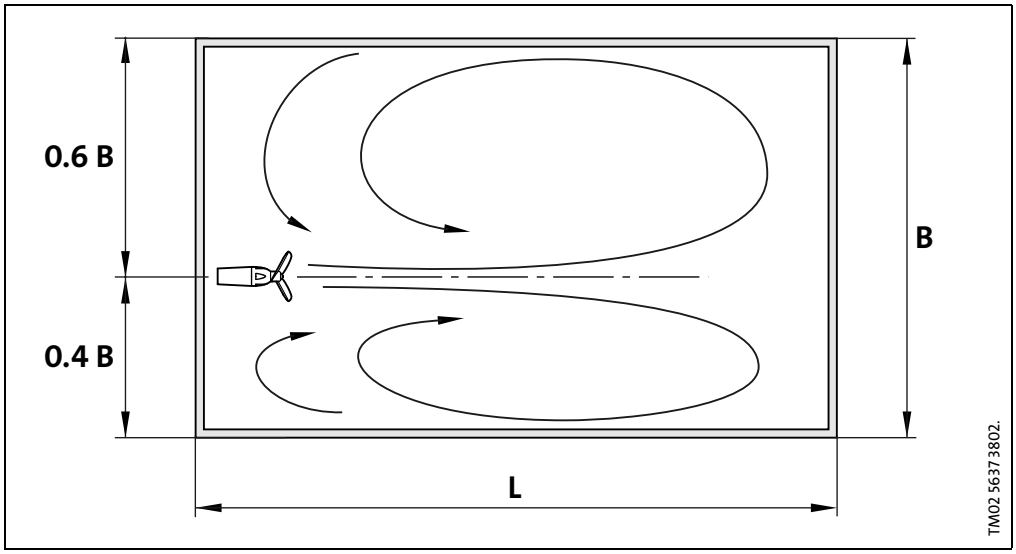

Fig. 17 Solids are kept suspended in the liquid of a rectangular tank

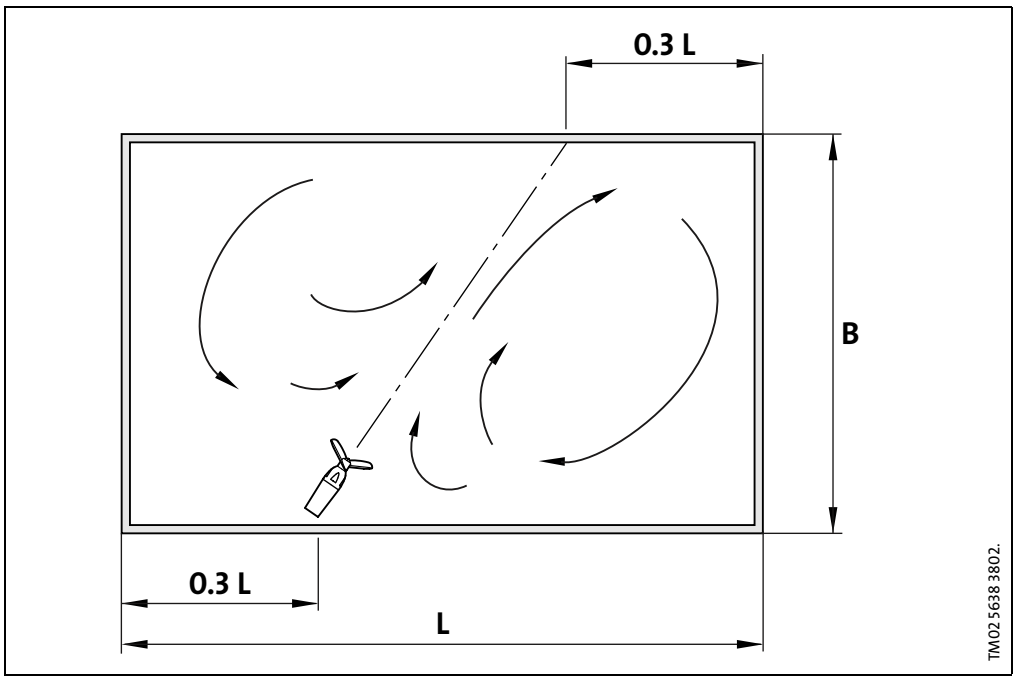

Fig. 18 Deposited solids are mixed with the liquid of a rectangular tank

6.2.4 Positioning two or more mixers in square or rectangular tanks

Position two or more mixers in the same tank in such a way that the mixers do not generate opposite flows, which may result in vibrations and loss of energy, see Fig. 20 and Fig. 19.

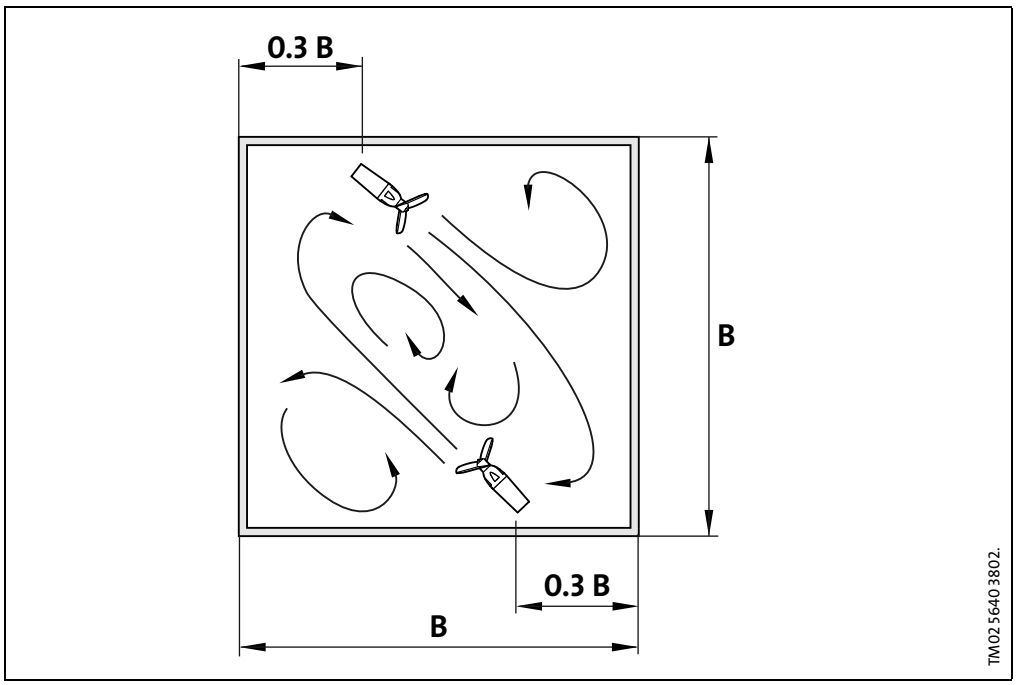

Fig. 19 Positioning two or more mixers in a square tank

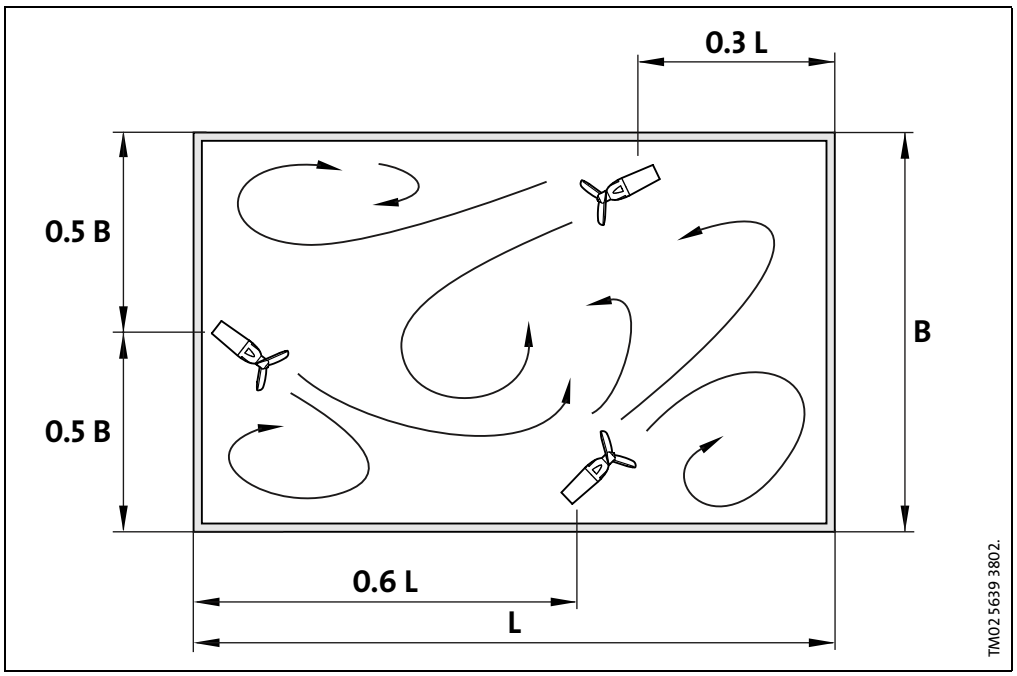

Fig. 20 Positioning two or more mixers in a rectangular tank

6.3 Positioning principles, flowmakers

6.3.1 Positioning of flowmakers in general

The distance from the propeller tip to the surface of the liquid is very important to prevent the flowmaker from generating vortices.

As a rule, the distance from the propeller tip to the liquid surface should be minimum 75% of the propeller diameter.

The minimum height (H_{MIN}) from the tank bottom to the propeller tip should be 0.4-0.5 metres, see Fig. 21:

$$H_{MIN} \geq 0.4 \text{ to } 0.5 \text{ m}$$

The minimum height of the liquid above the bottom of the tank (H_{LIQUID}) can be calculated according to the following formula:

$$H_{LIQUID} \geq (0.4 \text{ to } 0.5) + 1.75 \times D_{PROP}$$

where D_{PROP} = propeller diameter.

The minimum length of free flow towards the propeller (L_{MIN}) should be twice the propeller diameter:

$$L_{MIN} \geq 2 \times D_{PROP}$$

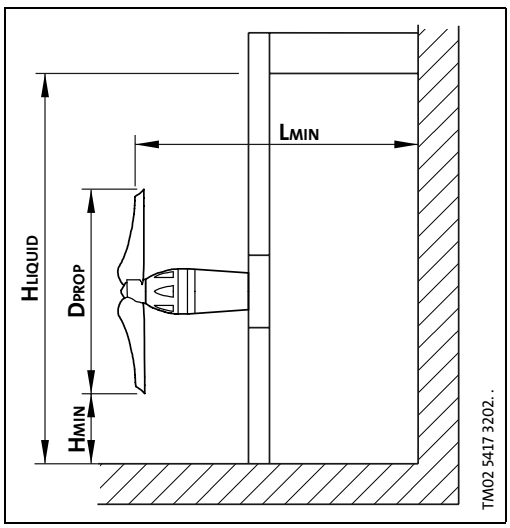

Fig. 21 Minimum liquid level

Formulas:

$$H_{MIN} \geq 0.4 \text{ to } 0.5 \text{ m}$$

$$H_{LIQUID} \geq (0.4 \text{ to } 0.5) + 1.75 \times D_{PROP}$$

$$L_{MIN} \geq 2 \times D_{PROP}$$

where:

H_{MIN} = Minimum height from the tank bottom to the propeller tip
H_{LIQUID} = Minimum height of the liquid above the bottom of the tank
D_{PROP} = Propeller diameter
L_{MIN} = Minimum length of free flow towards the propeller.

6.3.2 Two or more flowmakers positioned in parallel

Positioning of two or more flowmakers in parallel, should be made according to the principles shown in Fig. 22. Instead of positioning the flowmakers with a space of S_{FM} between the propeller tips, the construction of a wall between the flowmakers is recommended.

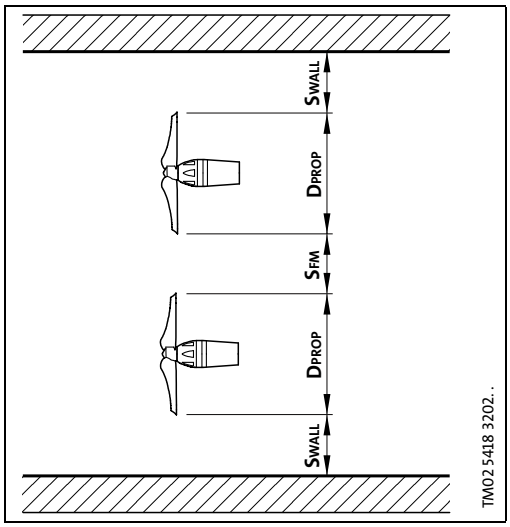

Fig. 22 Two or more flowmakers positioned in parallel

Formulas:

$$S_{FM} \geq 0.5 \times D_{PROP}$$

$$S_{WALL} \geq 0.5 \text{ m}$$

where:

S_{FM} = Minimum space between propeller tips
D_{PROP} = Propeller diameter
S_{WALL} = Minimum space between propeller tip and wall.

6.3.3 Positioning in “racetrack” tanks

In a racetrack tank, a flowmaker should be positioned as follows:

Do not position the flowmaker immediately after the bend. Being very turbulent in this area, the flow will cause vibrations in the flowmaker.

Position the flowmaker at a distance from the bend corresponding to 30-50% of the rectangular length (L_{RECT}) of the tank, see Fig. 23.

$$L_1 = 0.3 \text{ to } 0.5 \times L_{RECT}$$

The distance from the bend to the propeller should be at least twice the propeller diameter (D_{PROP}). This length (L_1) allows the flow to stabilize after the bend.

$$L_1 \geq 2 \times D_{PROP}$$

For a proper flow to develop on the other side of the flowmaker, the length (L_2) of approximately one to three times the propeller diameter is required.

$$L_2 \geq (1 \text{ to } 3) \times D_{PROP}$$

The average flow velocity in a racetrack tank should be 0.25 to 0.30 m/s.
If this velocity is not reached, sedimentation may develop. If this velocity is exceeded, the excess energy generated results in undesired vibrations and wear.

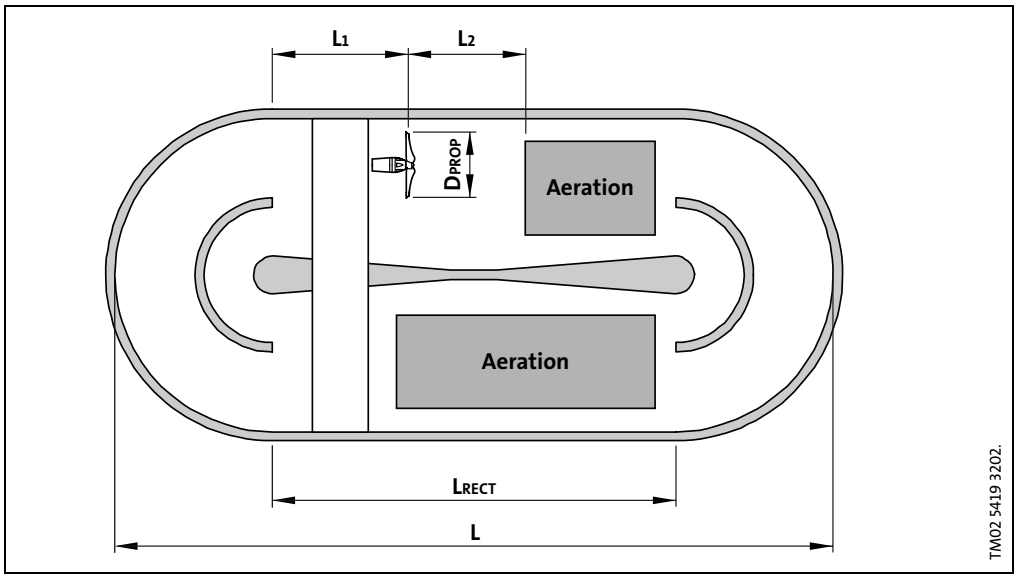

Fig. 23 Positioning of flowmaker in a racetrack tank

Formulas:

$$L_1 = 0.3 \text{ to } 0.5 \times L_{RECT}$$

$$L_1 \geq 2 \times D_{PROP}$$

$$L_2 \geq (1 \text{ to } 3) \times D_{PROP}$$

where:

L_{RECT} = Rectangular length of the tank
L_1 = Length from the bend of the tank to the propeller
D_{PROP} = Propeller diameter
L_2 = Length required for a proper flow to develop on the other side of the flowmaker.

6.3.4 Positioning in racetrack tanks with asymmetrically positioned deflectors

In racetrack tanks it is often observed that the flow velocity at the far end is higher than closer to the middle wall.

To reduce or eliminate this effect, it is recommended that deflectors are placed asymmetrically in the tank. This creates a more homogenous flow, causing less vibrations in the flowmakers.

Position the *deflectors* asymmetrically according to the principles shown in Fig. 24, where W = distance from the middle wall to the outer wall of the tank.
Thus, the distance 0.54 W and 0.46 W means 54% and 0.46%, respectively, of the distance W.

Position the *flowmakers* at a distance of W/2 from the outer or middle wall, see Fig. 24:

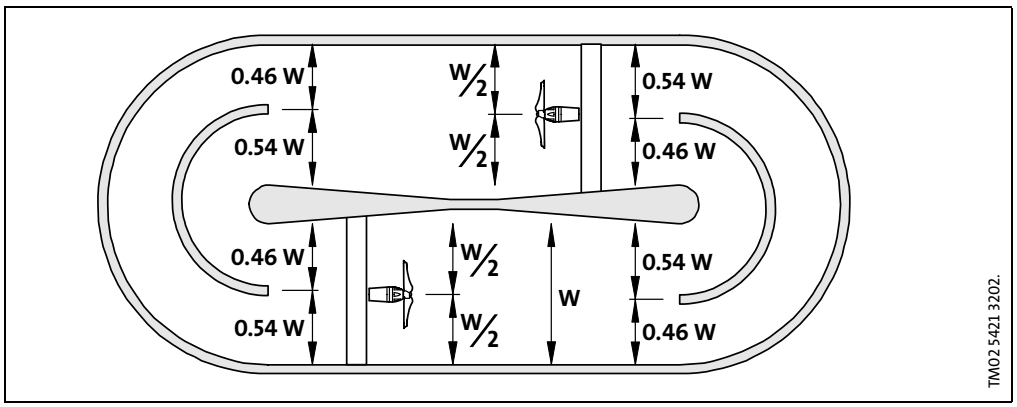

Fig. 24 Positioning of flowmakers in a racetrack tank with asymmetrically placed deflectors

6.3.5 Positioning in serpentine tanks

In serpentine tanks, flowmakers should be positioned as follows, see Fig. 25:

Position the flowmakers in the middle of the tank. The minimum space between propeller tip and wall should be 0.5 metres on either side of the flowmaker.

$W_{CHANNEL}$ = distance between channel walls.

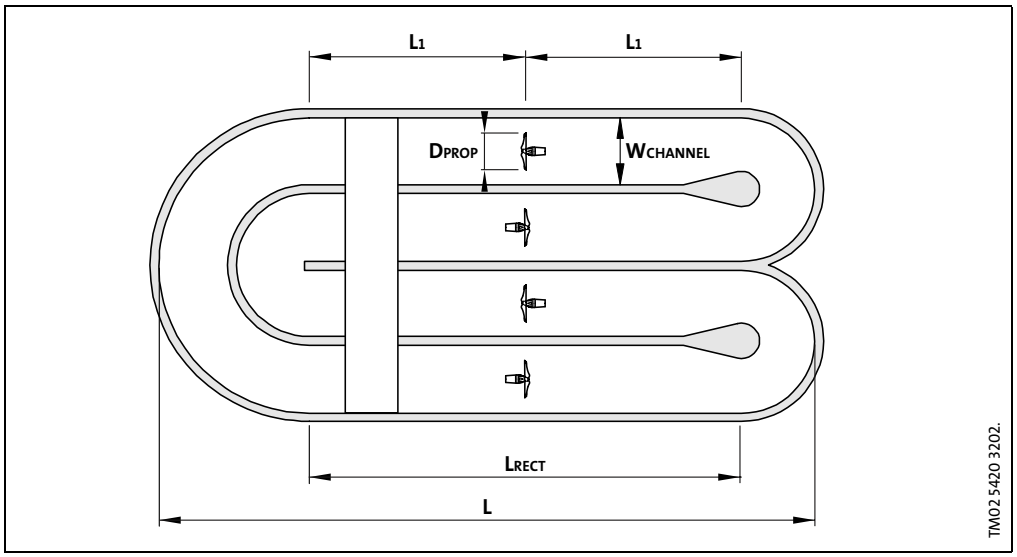

Fig. 25 Positioning of flowmakers in a serpentine tank

Formulas:

$$L_1 = 0.5 \times L_{RECT}$$

$$D_{PROP} \leq W_{CHANNEL} - 2 \times S_{WALL}$$

$$S_{WALL} \geq 0.5 \text{ m}$$

where:

L_1 = Length from the bend of the tank to the propeller
L_{RECT} = Rectangular length of the tank
$W_{CHANNEL}$ = Distance between channel walls
D_{PROP} = Propeller diameter
S_{WALL} = Minimum space between propeller tip and wall.

6.3.6 Positioning in circular tanks

In circular tanks, the flowmaker should be positioned at a distance of 0.7 x R_{TANK} from the middle of the tank (R_{TANK} = radius of tank), see Fig. 26. Turn the flowmaker 25° towards the middle of the tank.

$$R_{FLOWMAKER} = 0.7 \times R_{TANK}$$

where $R_{FLOWMAKER}$ = distance from centre of circular tank to flowmaker.

The propeller diameter must not exceed 15% of the tank diameter:

$$D_{PROP} \leq 0.15 \times 2 \times R_{TANK}$$

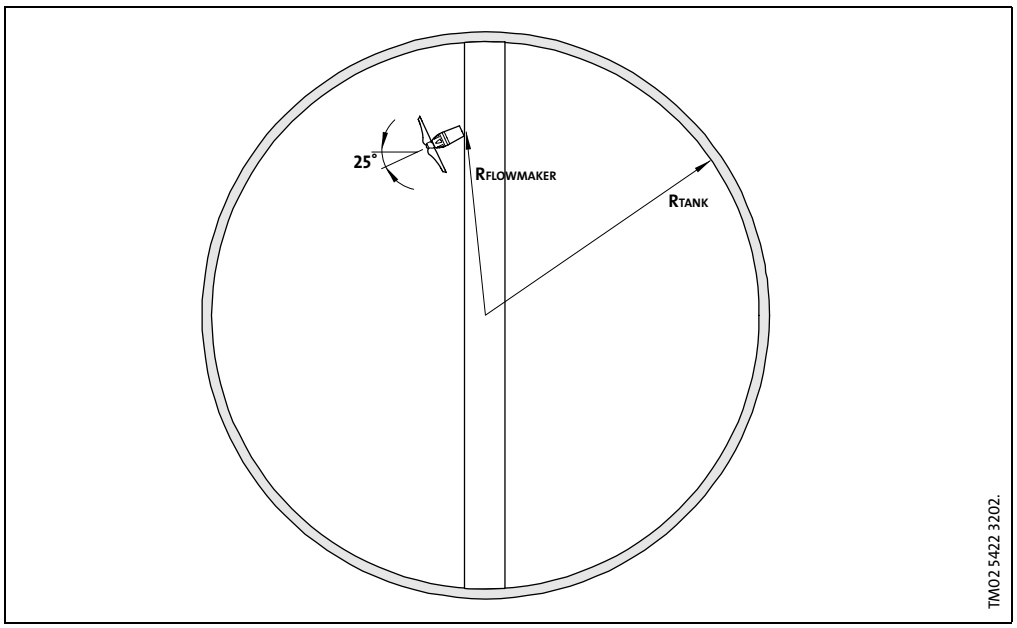

Fig. 26 Positioning of flowmaker in a circular tank

Formulas:

$$R_{FLOWMAKER} = 0.7 \times R_{TANK}$$

$$D_{PROP} \leq 0.15 \times 2 \times R_{TANK}$$

where:

$R_{FLOWMAKER}$ = Distance from centre of tank to flowmaker
R_{TANK} = Radius of the tank
D_{PROP} = Propeller diameter.

6.3.7 Positioning in annular tanks

In annular tanks, the flowmaker should be positioned in the middle of the channel, see Fig. 27. The tangent is turned 10° towards the middle of the channel.

The minimum space between propeller tip and channel wall (S_{WALL}) should be 0.5 metres on either side of the flowmaker, see also section 6.3.5 Positioning in serpentine tanks.

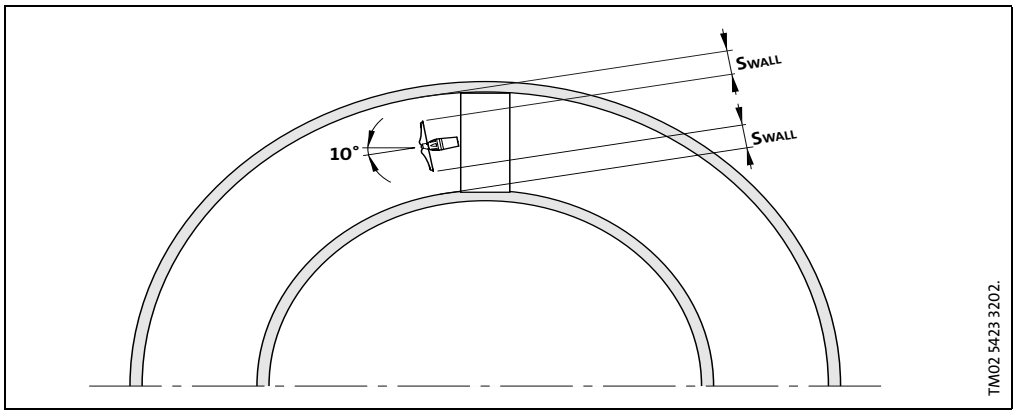

Fig. 27 Positioning of flowmaker in an annular tank

Formulas:

$$D_{PROP} \leq W_{CHANNEL} - 2 \times S_{WALL}$$

$$S_{WALL} \geq 0.5 \text{ m}$$

where:

$W_{CHANNEL}$ = Distance between channel walls
D_{PROP} = Propeller diameter
S_{WALL} = Minimum space between propeller tip and wall.