



Technical Paper

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The Protist *Euglena gracilis* as a Biological Indicator for the Deteriorating Effect of Flow in Pumps and Piping Systems on sensitive biological process suspensions

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Summary

In order to evaluate the deteriorating effect of different kinds of flow in pumps and piping systems *Euglena gracilis* can be applied as a biological indicator. This organism is already utilised for the detection of the water quality because of its sensitive reactions towards chemicals. In the same way it responds to mechanical strains like pressure or shear stress. These macroscopic reactions could be detected with a special device developed by the Institute for Plant Ecophysiology of the University Erlangen Nürnberg. This is an automatic bio test system (ECOTOX, Real Time Computer, Möhrendorf, Germany) that analyses the movement behaviour, the shape and for this reason also the activity of the cells.

During experiments, *Euglena gracilis* will be exposed to certain mechanical loads:

- Pipe flow
- Couette flow.

Combinations of all these and further strains occur in pumps especially in the following types:

- Oscillating displacement pump
- Rotating displacement pump

So far fundamental experiments for pipe flow, Couette flow and for pulsating pressure were performed. Pressure pulsation experiments conducted through the cooperation of the Institute for Plant Ecophysiology and the Institute for Process Technology and Machinery emphasise the sensibility of the cells and the monitoring system. Pulsations with amplitude of $\pm 3.5 \cdot 10^{-4}$ MPa and varying frequencies could be detected by a change of the r-value during the strain. The relaxation time depended on the frequency of the pulses. Concerning the pipe flow the pipe length was varied between 0.5 m and 2 m combined with diameters of 5 mm and 10 mm and laminar as well as turbulent flow at Reynolds numbers of about 1020 and 3565 were examined. For all tests a tendency towards an increase in the r-value (precision of orientation) as well as in the upward value could be detected. With increasing Reynolds number, diameter and pipe length the precision in upward orientation increases. A rheometer with a double-slit Couette geometry and a gap of 500 μm was used to regulate the shear rate from 100 s^{-1} over 500 s^{-1} , 1000 s^{-1} , 2500 s^{-1} to 5000 s^{-1} . Up to 500 s^{-1} most of the measured values improved. With increasing shear rate the inactivation increased also. While the up value and the compactness are increasing further the speed and the percentage of motile cells tend to lower inhibitions for shear rates of more than 2500 s^{-1} .