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MEASUREMENTS OF WATER VELOCITY INSIDE THE MODEL OF THE FLOTATION MACHINE

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Abstract

This paper presents an experimental investigation of the velocity field inside the laboratory model of the flotation machine. The crucial working elements of the flotation machine are stator and rotor. These elements force water flow inside the flotation tank and determine course and effectiveness of the flotation process. Hence, the time-resolved particle image velocimetry technique was applied to capture velocity field inside rotor and stator region and in the close vicinity of these elements. Utilised measurement technique allowed us to capture average water velocity field as well as basic turbulence parameters like turbulent kinetic energy and Reynolds stresses. The aims of this study are experimental determination of the velocity distribution inside the flotation tank and gathering measurement data for validation of the mathematical model of the flotation process.

Key words: flotation process, particle image velocimetry, flow visualisation, stirred tank

INTRODUCTION

Flotation process is commonly used in the material processing industry of natural resources e.g.: cooper or lead ores, coal, mainly to increase their concentration. There are many different constructions of the floatation machines, however the idea of the method is similar in all of them. It is based on the differences in wettability of various materials. The processed material is grinded and placed in the water tank. Then the pressurized air is supplied to the tank which creates great number of small bubbles. Grains of one or more constituents of the processed material stick to the bubbles and they accumulate at the water surface in the form of foam while the rest of constituents fall down to the bottom of the tank. This is very complicated system which operation can't be predicted easily. Hence, any mathematical model of this system needs extensive validation. Therefore, the main aim of this work except experimental investigation of the process is gathering experimental data useful for validation of the mathematical model of the floatation process. For this purpose small scale laboratory model of the flotation machine was built.

MEASUREMENT TECHNIQUE

The schema and picture of the experimental rig are shown in figure 1. The main part of the rig is the laboratory scale flotation machine. The flotation tank and all internal elements i.e. rotor and stator were manufactured from transparent material (plexiglas) to allow undisturbed observation and visualisation of the flow inside. The rotor is propelled by the electric motor with full control of the rotational speed. The rotor rotational speed can be adjusted in the range from 0 up to 2000 revolution per minute. The water velocity distribution in this region of the rotor and stator is crucial for the bubble distribution and mixing of all phases i.e. air bubbles, liquid water and solid particles. Hence, the water velocity distribution was the main area of interest in the presented work. The velocity distribution was measured with time-resolved particle image volocimetry technique (Raffel et al. 2007). At this stage just the water flow was considered, solid grains and air bubbles were absent in the system. The flow was seeded with glass particles with average size 10 μm and illuminated with high power CW DPSS green laser (532nm). The images were recorded with high speed camera Optronis CamRecord 600. The images postprocessing and calculations of the velocity vectors were carried out using the open toolbox written in the MatLab environment (Sveen and Cowen 2004). The measurements were performed at one rotor speed equal to 500 revolutions per minute, at six horizontal planes in the vicinity of the rotor and stator starting from the bottom of the tank and ending in the region above the stator. As a result velocity and turbulence parameters i.e. turbulence kinetic energy and Reynolds stresses fields were obtained at the specified planes.

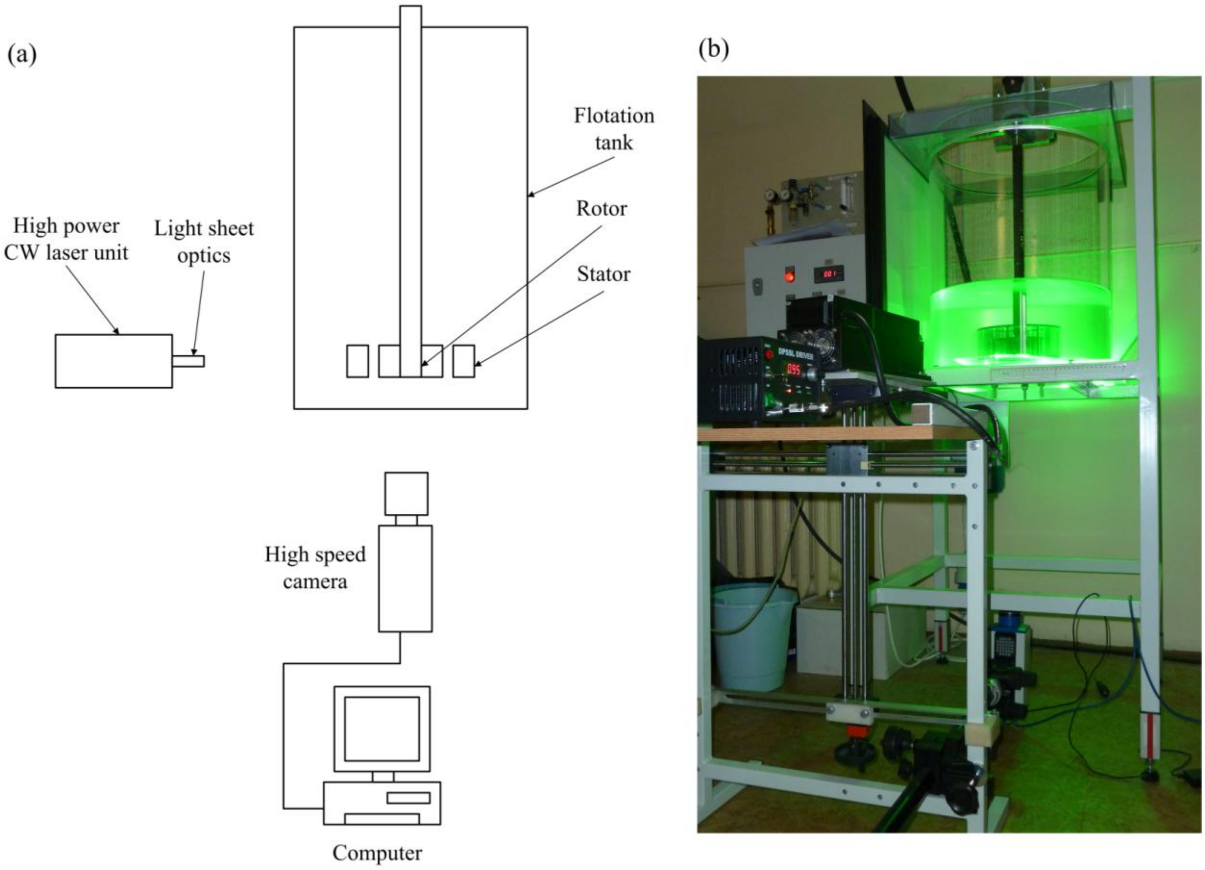

Fig. 1 Laboratory model of the flotation machine: a – schema of the experimental rig, b – picture of the rig.

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