

Abstract Submission

Submission-2428

Topic : / ECCE10 / Fluid separations processes and technologies / process equipment characterisation and design

INVESTIGATION OF VELOCITY FIELD (BY PARTICLE IMAGE VELOCIMETRY) IN TURBULENT FLOW REGIME WITHIN A DYNAMIC FILTRATION MODULE

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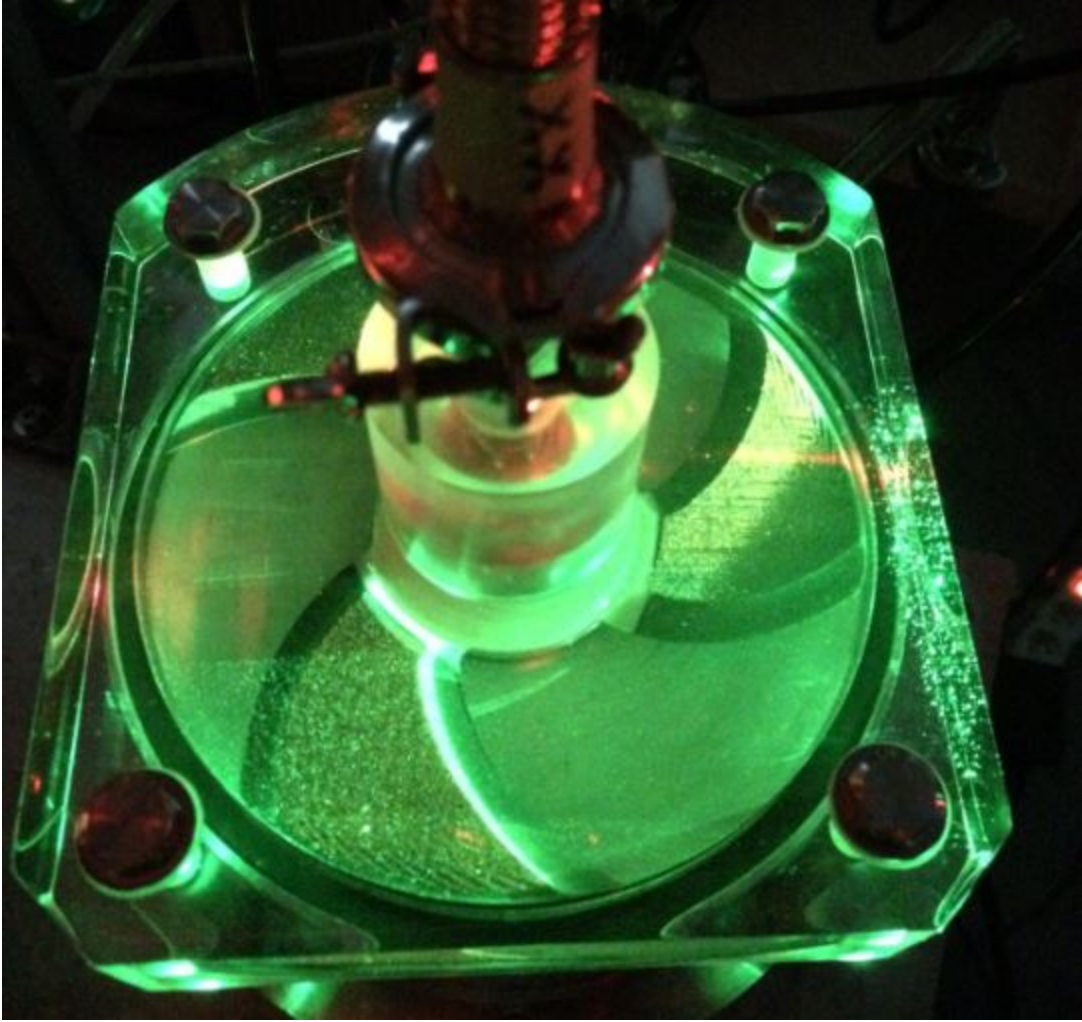
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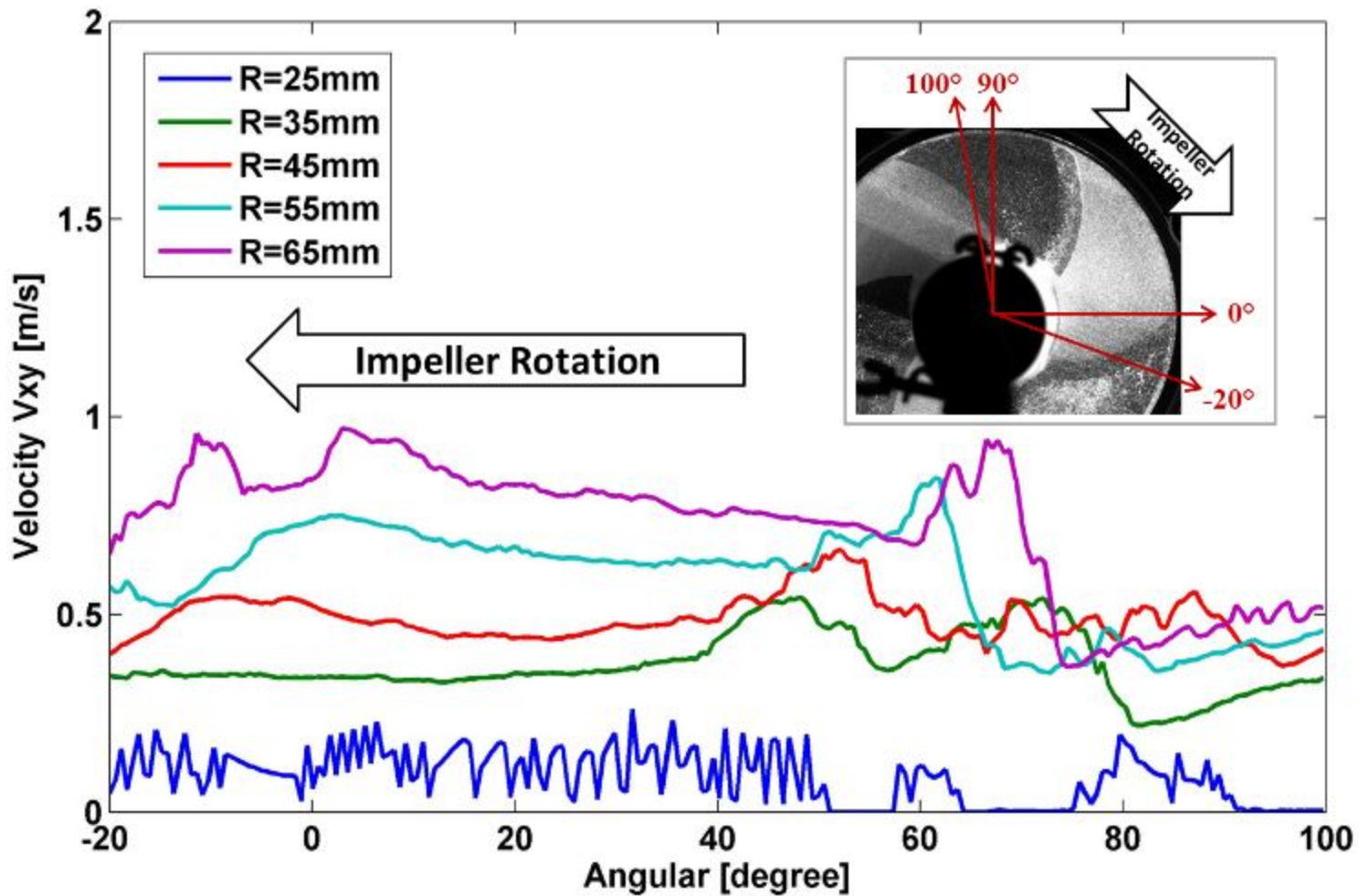
Submit your abstract below (400 words): Dynamic filtration (DF) is an alternative technology to dead-end (DE) and cross-flow (CF) filtration aiming to intensify bioprocess (permeability increase, higher biological productivity by achieving high cell concentration), to reduce environmental impact (low loop volume) and to reduce energetic consumption (uncoupling between retentate flowrate and wall shear rate, working under low TMP). The principle of dynamic filtration aims to generate complex hydrodynamic perturbations (intensity, time dependent) by mechanical movement (rotation, vibration, oscillation) of membrane or another mechanical device close to the membrane. In present paper, a dynamic filtration system, called Rotating and Vibrating Filtration (RVF) module, was designed to treat biological fluids (cell – liquid suspension, viscous fluid). This RVF module consists of two filtration cells in series within a three-flat blade impeller, is driven by a central shaft, continuously rotating (up to 50Hz) between two porous substrate plates (membrane support) which drain the permeate (1).

Both global (pressure drop, power consumption, thermal balance, residence time distribution) and local (radial pressure distribution, velocity field) hydrodynamic approaches are necessary to gain insight in the complex hydrodynamics fields in the DF and subsequently explain the permeability increase and MBR performances. Global hydrodynamic analysis which has been done in previous works (2) indicates that the local variables (shear rate, velocity and pressure) could not be easily estimated in the RVF module. By using Particle Image Velocimetry (PIV), a useful photographic flow-visualization technique, the instantaneous velocity can be analyzed within complex local hydrodynamics under turbulent flow regime. In this aim, a dedicated and fully instrumented experimental set-up has been designed. In a first step, the scrutinized operating conditions were: water, 20°C, $50 < Q < 250$ L/h, $0 < N < 50$ rd/s. Global (thermal balance, pressure drop, power consumption) and local (PIV velocity field) performances are reported and compared to existing literature. PIV enables to demonstrate that local (close to wall) shear stress (or velocity gradient) exhibits high intensity and large magnitude fluctuation. Future works will investigate laminar flow regime, thereafter the results of CFD simulations and experiments will be compared to validate numerical approach and to estimate the best working conditions.

Type of presentation :: Oral

You can add figures:





Highlight 1: PIV has been applied to study local velocity in a specific dynamic filtration module.

Highlight 2: An experimental set-up has been designed to investigate global and local hydrodynamics.

Highlight 3: Future works will study laminar flow regime, results will be compared with CFD simulation.

Reference 1 :: Fillaudeau L., Boissier B., Ermolaev S., Jitariouk N., Gourdon A., "etude hydrodynamique d'un module de filtration dynamique", ind. Alim. Agri., septembre / octobre, 124 (9), 8-16, 2007.

Reference 2 :: Fillaudeau L., Boissier B., Moreau A., Blanpain-Avet P., Ermolaev S., Jitariouk N., Gourdon A., "Investigation of rotating and vibrating filtration for clarification of rough beer", J. Food Engineering, 80, 2007, 206-217

Keywords: Bioprocess, Experimental methods, Filtration, Hydrodynamics