Contribution to the study of the choice of training rotors of a pilot unit of production of micro-algae.

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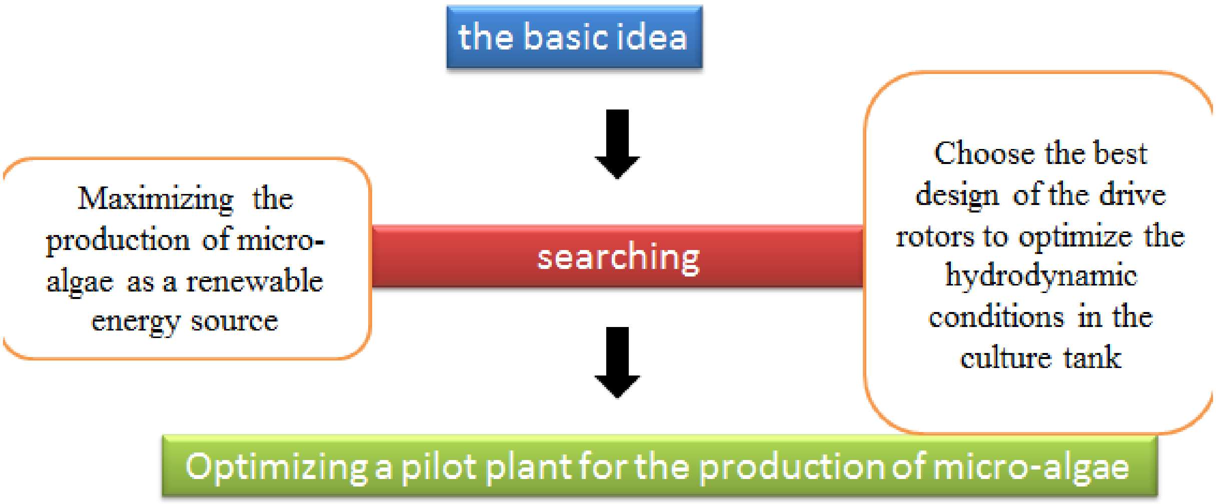
Abstract:

The basic idea is based on developments in research to improve the production of microalgae under better conditions from micro-algae production units. A test bed is manufactured using commercial CAD and CFD software. After this, we propose to carry out a series of experiments to test different types of training rotors. The work we propose to develop in this thesis will therefore allow the sizing of the training rotor of the pilot crop unit and the improvement of the productivity work of the micro-algae.

Keywords: micro-algae; training rotors; test bench; digital approach

1 Introduction

The idea to use microalgae in energy purposes emerged in the late 50's in the United States, decade after the discovery that numerous species were capable of synthesizing important quantities of lipids under certain conditions of culture. Aquatic Species Program demonstrated the technical feasibility to use microalgae for the production of fuel. Microalgae comprise a vast group of photosynthetic, heterotrophic organisms which have an extraordinary potential for cultivation as energy crops. They can be cultivated under difficult agro-climatic conditions and are able to produce a wide range of commercially interesting byproducts such as fats, oils, sugars and functional bioactive compounds. The idea of this thesis was born with the following observation: in oceans, lakes or industrial raceways, there is an essential need to study the coupling between hydrodynamics and biology, as many phenomena are directly influenced by it carbon fluxes, eutrophication, migration or growth of many biological species. Because of the multiscale properties of the system and the use of sophisticated models and method for its numerical simulation, the coupling is delicate to handle. It also requires the joint efforts of mathematicians, biologists or oceanographers. That is why I choose to design in my thesis a hydrodynamic test bench focusing attention on the choice of rotor allowing a better operation of agitation and production of micro-algae.



2 Design of the production unit:

2.1 Calculation and sizing:

The purpose of this project consists in studying and in designing of training rotor for a microalgae production unit that could be convertible into a hydrodynamic test bench. In this section, we will look at the study of various possible technological solutions. For the optimal choice of solutions, we will consider factors related to the proper functioning of the machine and the availability of parts in the market. The proper solution is one that provides the best compromise between these two criteria.

In the following, we will choose the suitable solutions to the following mechanisms:

- Tank shape,
- Mixing mechanism,
- The tank holder,
- Choice of the rotational guiding system.

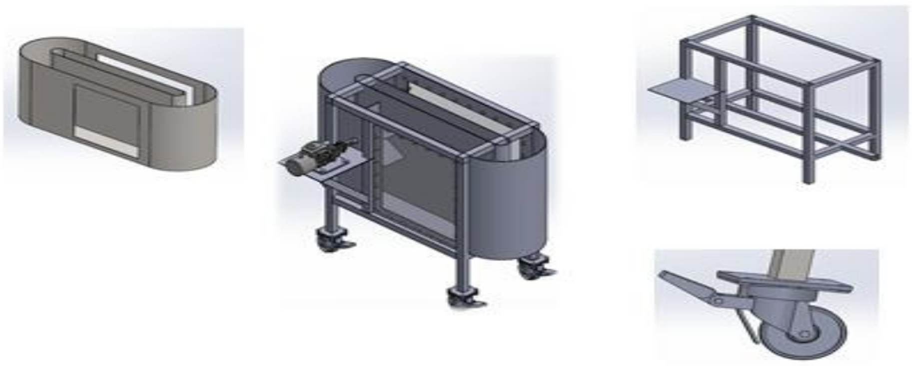


Figure 1: *Test bench views*

2.2 Simulation:

After presenting the different designs, we have chosen the third one according to these criterias:

- The design simplicity: its fabrication doesn't need a skilled workforce,
- Economic: Less quantity of materiel used. In fact we just need steel rods and steel angles,
- Non-bulky: it has an easier removal then others,
- More stability for the generator maintenance: it differs from the others in concentration stress areas.

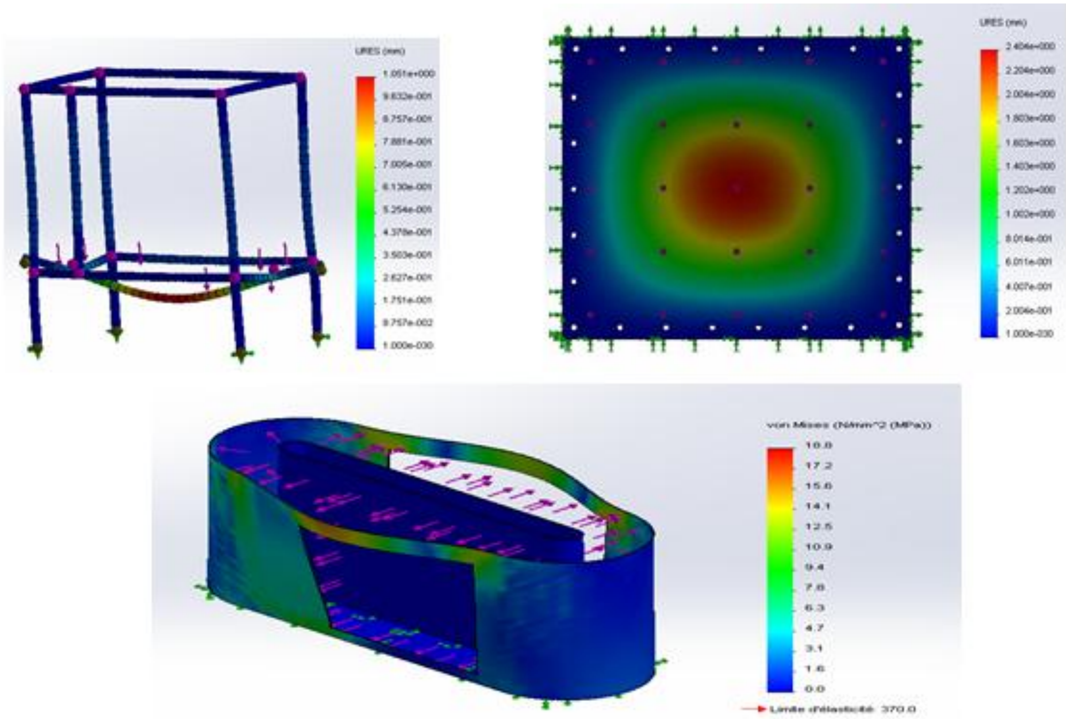


Figure 2: Digital study

2.3 The choice of training rotors:

Agitator systems exist in large varieties, it differs from the manual and speed performance, loads and friction coefficients it gives. In this section, we will study three systems following guides:

- Paddlewheels,
- Rushton Turbines,
- Propeller Turbines.

2.3.1 Paddlewheels:

Figure 3 presents the Paddlewheel agitator which is a form of waterwheel or impeller in which a number of paddles are set around the periphery of the wheel.

This solution has the following advantages:

- The flow of water is perfectly linear and without vortex
- Easy manufacturing,

- Low cost,
- Simple system.

However, the disadvantages of this solution are:

- Low efficiency.

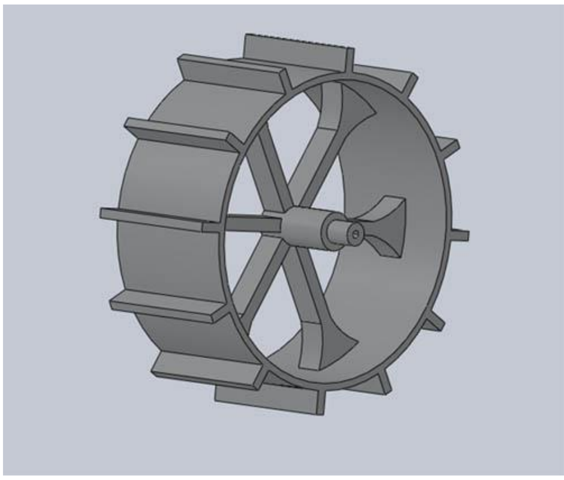


Figure 3: *Paddlewheel agitator*

2.3.2 Rushton Turbines:

Figure 4 presents the Rushton turbine which is a classic design that provides a simple radial flow pattern that moves material from the center of the vessel outward where it flows along the outer walls of the tank.

This solution has the following advantages:

- The flow of water is perfectly linear and without vortex,
- Easy manufacturing,
- Simple system.

However, the disadvantages of this solution are:

- Low efficiency,
- High cost.

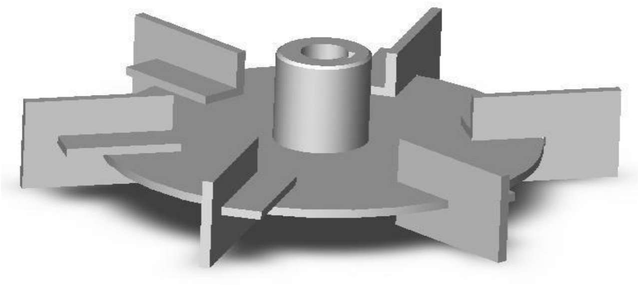


Figure 4: *Rushton turbine*

2.3.3 Propeller turbines:

These turbine create a fluid motion in an axial direction and provide a major fluid flow. However, some mobile exhibit, in addition to the predominant axial component, a radial component.

This solution has the following advantages:

- Rapid mixing,
- Multi-directional water flow.

However, the disadvantages of this solution are:

- The rotation of the agitator creates vortex,
- Hard manufacturing,
- Complicated system,
- High cost.

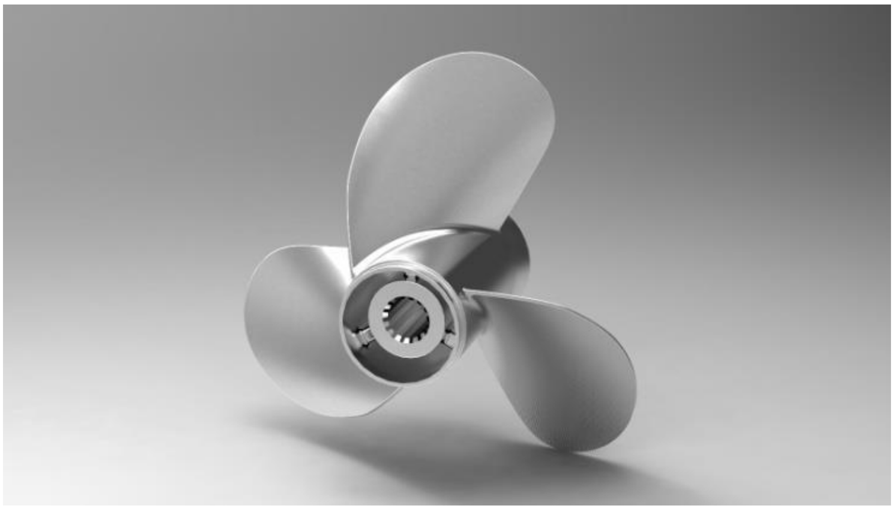


Figure 5: *Propeller turbine*

2.3.4 Chosen solution:

After studying the effect of geometric and numerical parameters on rotors Training; we were chosen the paddlewheel agitator.

This mobile provides a parallel flow to the stirrer shaft. Indeed, they are used for turbulent flow. The radial flow is created by a horizontal movement towards the walls of the basin, provided the water by the rotation of the agitator

3 Conclusion and perspectives:

The production cost of microalgae is very cheap comparing to agriculture product. The product is 100% natural and without any added value which increases the customer demands. The price of microalgae is always high, but our customers can afford to buy it. The potential customers of microalgae are international companies of food, cosmetic, pharmaceutical industries. Laboratories can be included in our partners list in order to convert microalgae to biofuel or to provide us by new strain of microalgae.

In this context, we are interested in the to choose the best design of training rotors to optimize hydrodynamic conditions in the micro-algae culture tank.

We still have to conduct a series of experiments to test different types of training rotors and confront them with our numerical results

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