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*Make Harmony Between Technology and Nature, and Your Mind will Fly Free as a Bird*
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# LABORATORY SMALL HYDROPOWER PLANT TESTING STAND

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***Abstract**: The paper presents a testing stand for a water turbine assembly consisting of a turbine – a planetary speed increaser and a generator. The experiments allow identifying the functioning conditions and the performances of the small hydropower plant, as well as the monitoring of the input and output parameters. The goal is to see the improvements brought by the planetary speed increaser in the turbine assembly features. The proposed turbine assembly model is made using CAD / CAE software.*
***Key words:** experimental stand, CAD/CAE model, small hydro*

## 1. INTRODUCTION

The paper objective is to design an experimental stand for a water turbine assembly, which allows the monitoring of the input and output parameters in order to identify its performances. The stand is equipped with an interface with the computer that allows developing a data basis of input and output speeds and moments. The testing on the experimental stand is the first step in the development of the small hydro control system in real functioning conditions

The turbine assembly consists of a Turgo turbine, a planetary speed increaser with deformable element that was proposed by the authors (Jaliu, 2009) and a generator. The model of the turbine assembly is made using CATIA and INVENTOR software.

## 2. THE 3D MODEL OF THE TURBINE ASSEMBLY

The 3D model of the Turgo turbine assembly that is proposed to be implemented on a river near Brasov is presented in Fig. 1, a. The assembly consists of the Turgo turbine that was acquisited in the frame of a research project,, a planetary chain speed increaser (Fig. 1,b) and an electric generator. The speed increaser consists of a chain transmission and three parallel connecting rods with bearings (Fig. 1,b) and is proposed by the authors. The transmission is manufactured and will be assembled between the turbine and the generator through two elastic clutches.

## 3. EXPERIMENTAL STAND

In the design of the control system, the following premises were considered (Harvey, 2005, Von Schon, 2007):

- the water turbine is designed for particular values of the water head and flow. Any perturbations of the small hydro input and output parameters has to be compensated by the control system that, closes / opens a valve to maintain the water level in the basin or a constant output power, starts or stops the small hydropower plant.
- The system allows monitoring the input and output parameters for the assembly and, also, for the speed increaser.

Thus, the stand control system has to:

a) Detect the input and output parameters;

b) Maintain the parameters within the limits admitted by the correct functioning;

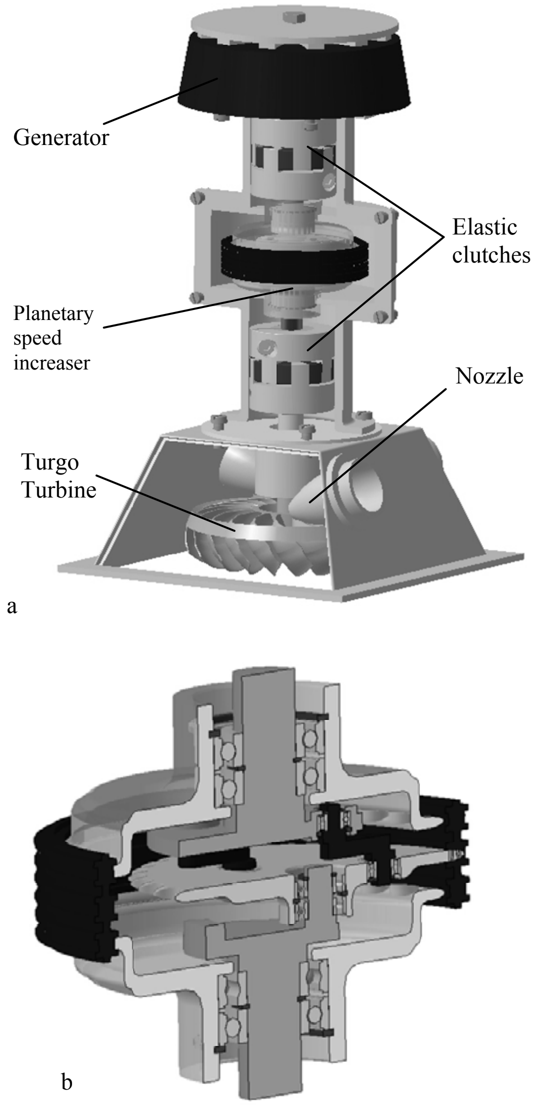


Fig. 1. 3D model of the turbine assembly (a) and the 3D model of the planetary speed increaser (b)

c) Take decision automatically regarding the system start, stop and adjustments;

d) Colect the data necessary in taking operational decisions;

e) Function in an unattended environment, at maximum working regime;

f) Have remote acces.

In the experimental stand, the turbine assembly is used to produce electricity to supply a water heater of 25 l (Fig. 2).

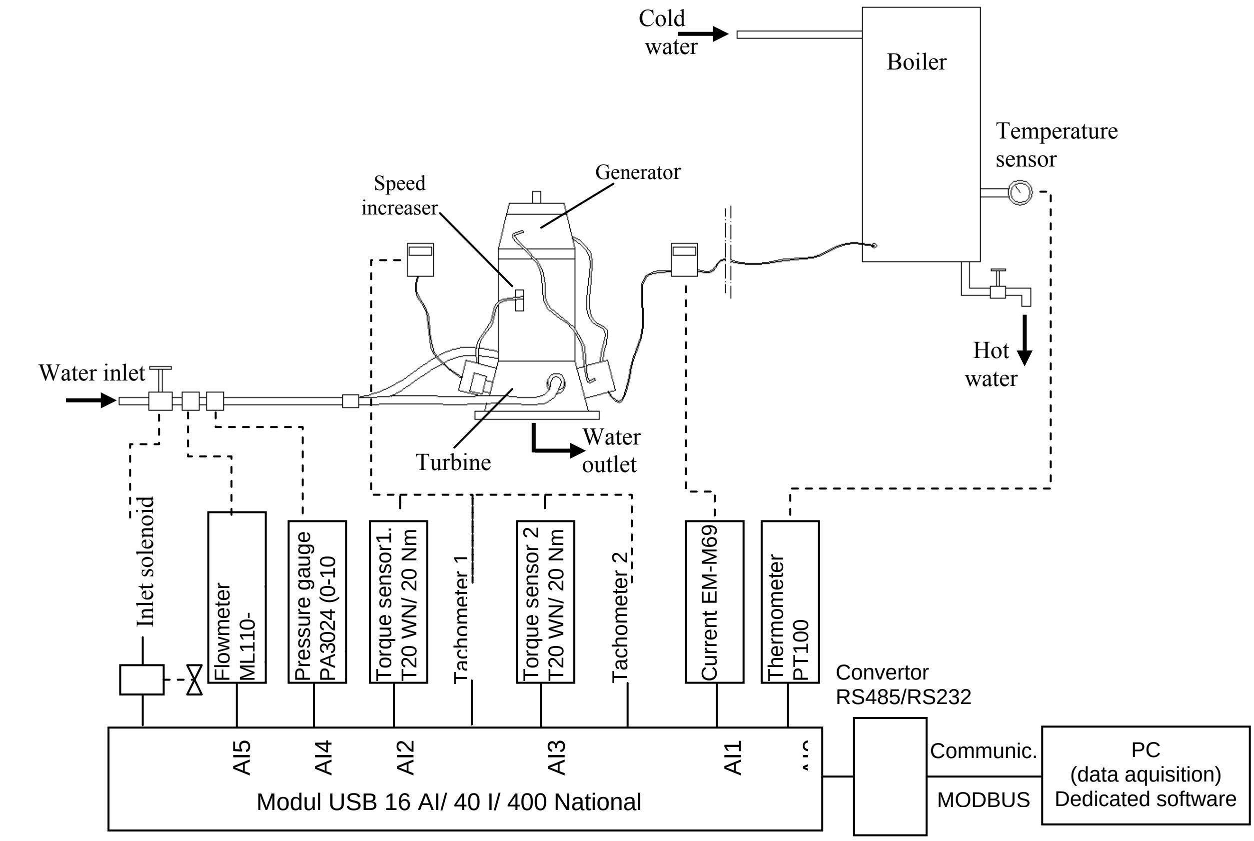


Fig. 2. The scheme of the experimental stand

An electro-valve is used to control the water flow on the turbine and six sensors are used for monitoring the input and output parameters.

The proposed system acquires analogic values of 8 parameters: temperature, voltage, input moment and speed, and output moment and speed, water pressure and flow. The moment sensors include the speed sensor, which gives an impulse for each rotation. The speed is then computed by the PLC software.

The software for data acquisition exports the values to a text file (see Fig. 2).The stand controls the temperature in the boiler, so that the electro-valve is closed and, thus, the turbine is stopped when the water temperature is increasing above a predefined value ($90^0$).

## 4. CONCLUSIONS

An experimental stand was designed by the authors to allow monitoring the input and output parameters of a water turbine assembly and identify its performances. The speed increaser that is part of the assembly is an innovative solution proposed by the authors (Jaliu, 2009). The following aspects can be highlighted from the turbine assembly testing:

1) If the generator load decreases, the turbine tends to increase its speed; by means of a sensor to measure the frequency, control system must enter the preset circuit resistance, thus maintaining the current frequency limits.

2) Usually, micro-hydropower systems use to regulate output power, electronic devices ELC (electronic load controller) (Davis, 2003). The controller automatically compensates any change in load by changing the amount of power dissipated in a resistive load, called ballast load, thus maintaining the overall tasks of the generator and turbine constant. In general, electric water heater is used as ballast. ELC are usually used with synchronous generators.

3) One of the test programs on the experimental stand is meant to determine the system’s electrical response. This involves determining the electrical and hydraulic powers depending on the sensors measurements; thus, the conversion efficiency of the operation in the representative situations can be established. The efficiency of the Turgo assembly: turbine-speed increaser-generator is then compared to the efficiency of the turbine-generator system. This comparison highlights the influence of the speed increaser on the energetic response of the global system.

4) The Turgo assembly is also tested in order to identify its performances for different values of the input parameters (water flow). The study allows identifying the limits within which the system operates in good conditions.

The monitored data will be compared to the numerical simulation results (Jaliu, 2010) in order to validate the theoretical model of speed increaser. The testing results are also useful in the design of the control system for the micro hydropower plant that will be implemented on Poarta River, near Brasov.

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