System instrumentation and data acquisition for TurboRiver-RB7

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Abstract: *The technical evolution of the industrial groups involving hydropower turbines, determined by the request of increased efficiency and reliability, imposes the control through modern command and control automation systems. The paper presents a quick view of a possible system for instrumentation and data acquisition for an electric-generating system based on kinetic water turbine. There are presented some details about overall configuration, temperature and pressure measurement as well as an advanced system for water flow investigation in different location of the assembly.*

Key words: *instruments, automatic, measurement*

INTRODUCTION

The dynamic characteristic of a hydropower turbines represents the multitude of regimes for which the gas turbine has a stable working, its utilization being extremely helpful in finding solutions for hydropower turbines connected problems.

The dynamic characteristic describes the dynamic properties of the hydropower turbines as a free system, unconditioned by any system law. In practice, only certain working regimes are necessary, depending on requests. In order to answer to these requests, the hydropower turbines are fitted with automatic control systems accomplishing the command and control functions.

OBJECTIVE

The paper presents a system of instruments and data acquisition for the main parameters, necessary in the process of monitoring and controlling a hydro–electric turbine installed on a river, such as the preliminary design TurboRiver-RB7 presented in Fig.1.

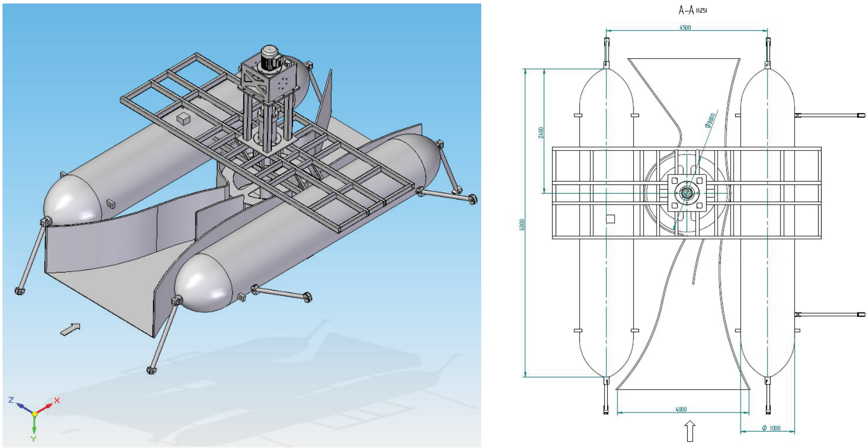

Fig. 1. TurboRiver-RB7 electro-generating system

Nowadays systems of instruments, data acquisition and automatic adjustment are required to solve the main criteria of performance and safety, necessary and specific to each type of operation.

The classical solutions for monitoring and controlling hydro-energetic turbines can no longer fulfil their need of performance, they need to be replaced with new systems of last generation, with a high level of intelligence, capable of communicating very fast with the Programmable Logic Controller (PLC) from the automation of the aggregate and to ensure the unitary and precise control of the parameters of the turbine in all operating conditions.

THE STRUCTURE OF THE SYSTEM

In order to execute a new system of instruments and data acquisition for monitoring the hydro-energetic turbine, the classical solutions have been replaced with new concepts of last generation and interconnected systems, capable of communicating with the PLC of the system of adjustment and control, to ensure a good operation and monitoring of the hydro-energetic turbine with performance.

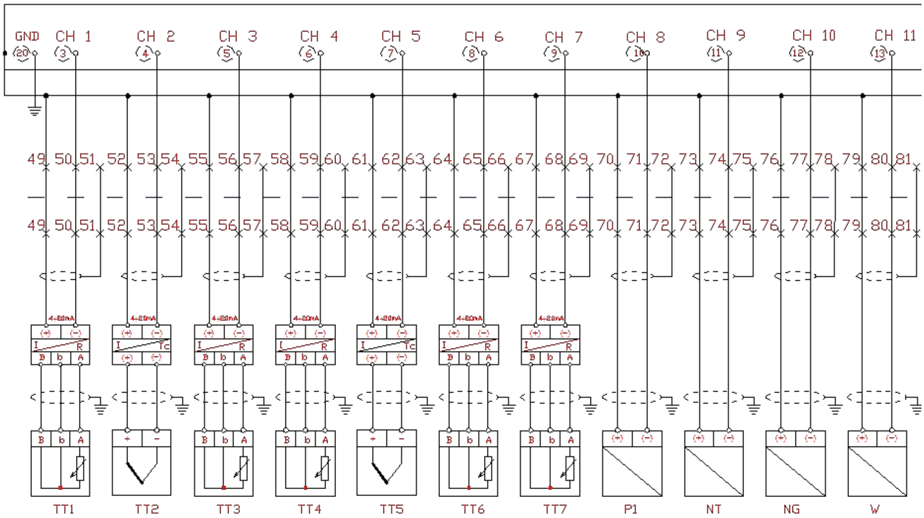

Fig. 2. PLC general architecture

System structure is based on a simple and compact architecture, respecting rules and ensuring maximum energy performance in monitoring and acquiring parameters of interest in hydroelectric turbine control.

Automation control system design has been focused on the areas where significant problems usually occur, not investigating speed, pressure and differential pressure control and monitoring issues. The Programmable Logic Controller's general architecture has been defined in order to operate monitoring and control sequences for hydroelectric turbines.

The Programmable Logic Controller is equipped with analogue and digital inputs and analogue and digital outputs. The analogue input modules are built on 16 bits with a precision of 0.05 in continuous current. The choice of the central unit module has been based on its processors' performances, the possibility of floating point calculation due to its all-in mathematical co-processor, the integration of logarithmic, trigonometric and exponential functions and the "flash" high capacity memory. (www.gefanuc.com 2012)

TEMPERATURE MEASUREMENTS

Heat resistance temperature transducers operate based on the property of metals to modify their electrical resistance as a result of sudden changes in temperature. Electrical resistance variations are read by an adapter that converts the electrical signal output into variations of electric current to be read by the PLC. The temperature measurements are achieved using heat resistant rigid construction with protective sheath, made of platinum sensor, with a precision of 0.1%.

PROGRAMMABLE ADAPTER TO CONVERT SIGNALS

The device is designed to be used as a system of temperature sensors adapters installed in potentially explosive areas. This equipment must be installed in electrical panel, outside the Eex area, without the necessary protection circuits such as power supplies, Eex or barriers Eex certified. The diagram in Fig. 3, right, shows the different ways of connection different adapters for temperature sensors installed in potentially explosive environments. It can be observed that the adapters chosen for this application do not require Eex certified safety barriers. These adapters have signal terminals for 3 or 4 wire connection, with an output signal of 4-20mA, have good electrical isolation, can be supplied at a voltage of 8 ... 36 VDC and have an accuracy of 0.2%.

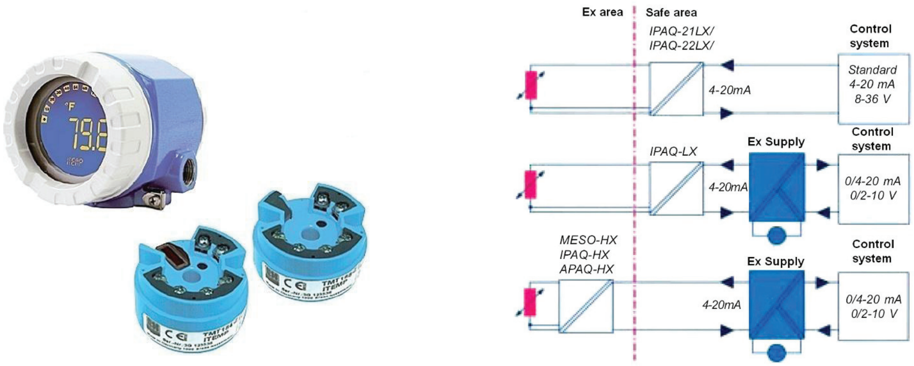

Fig. 3. Signal adaptors

PRESSURE MEASUREMENTS

SMV 3000 Smart metering technology extends and uses piezo-resistive sensor technology with implanted microprocessor-ion, sealed in the body of the instrument. This capsule contains three piezo-resistive sensors in one component resulting a differential pressure sensor, an absolute pressure sensor and a relative temperature sensor. Applied process pressure transducer diaphragm is transferred from the fluid to the sensor.

In this manner of operation, SMV 3000 can achieve an output signal that is stable and fully compensated for changes in process pressure and ambient temperature within a very large operating range. The microprocessor electrically coupled to the sensor produces an interval of very good accuracy/relative accuracy. These pressure transducers have a unified signal output of 4 ... 20 mA, and voltage between 11 ... 45 VDC. The analogue precision mode is 0.075% and 0.05% in digital mode and it shows a departure point from 0 to ± 0.003% of maximum measurement.

SPEED AND DIRECTION OF FLOW MEASUREMENTS

Multi-hole probes are fluid mechanics instruments designed to determine the flow velocity and pressure through direct measurement of the pressures at the probe tip which can be installed in different locations of the assembly such as: inlet, outlet, in front of just after the blades etc.

These probes measure flow velocity and pressure by interfering (as little as possible) with the flow in a particular and consistent manner. The probes are calibrated at multiple flow angles in an water or airstream of constant and known speed.

In an unknown test flow, the measured port pressures are compared to the calibration map by sophisticated pressure-to-velocity reduction software, which returns the total and static pressures at the probe tip, as well as the flow angles. Using thermodynamic data (reference pressure and total temperature) provided by the user, the unknown velocity vector, as well as the total and static pressure at the measurement location may be determined. Such a system, developed by Aeroprobe U.S.A., is presented in Fig.4.

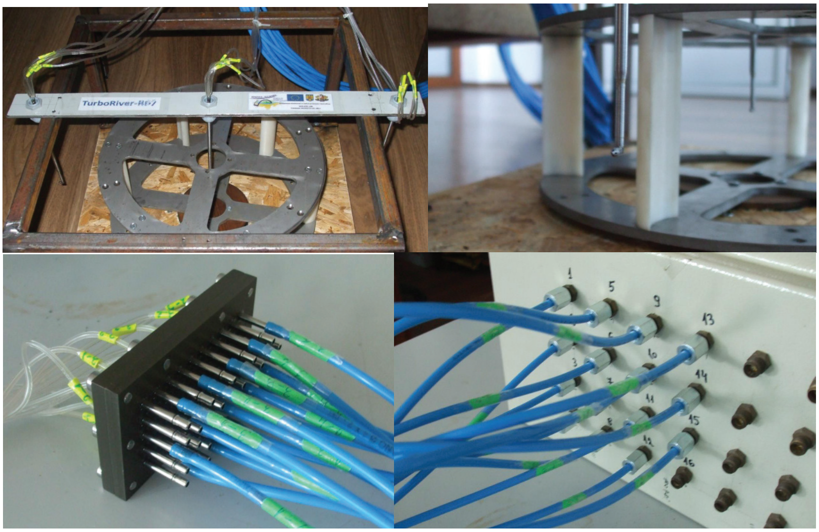

Fig. 4. Speed and flow measurement probe and complete system

These are amplified by the AP3KAX Sensor Amplifier, providing signals to the data acquisition system. AeroAcquire software enables the user to acquire the probe signals, manipulate the time-series of pressures to account for the acoustic attenuation / amplification due to the probe pneumatics (by integration of the ARC software), and perform the reduction to velocity magnitude and flow angles (by integration of the Multiprobe software).

CONCLUSIONS

The monitoring, command and control systems for complex installations, require a high level of intelligence, capability of extremely fast communication with the installation and the auxiliary equipments and precise and unitary control of turbine's parameters for all working regimes.

The modern systems, such as the automation system described in the present paper, involves high number of measurement lines – both analogue and digital inputs and outputs, high speed for parameters' acquisition and execution elements command, high accuracy for all temperatures, pressures and mass flow rates measuring lines. The instrumentation and data acquisition system can be used only for maintenance and monitoring of the turbine but also for scientific work which may lead to improved designs in terms of efficiency, reliability etc.

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The paper is reviewed.