Parameters monitoring and control for flueric actuators testing system

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Abstract: *A wide range of air supply parameters is needed for the flueric actuators testing in order to find their optimum working regime.*
A system for conditioning these parameters, namely pressure, temperature, mass and volume flow rate has been built for this purpose.
The measured values are continuously stored on the PC hard drive and are checked automatically for keeping them in the normal operating range. In case any of them are going out of this range, this system warns the operator and performs automatic actions for limiting or partially or totally shutting down the system.

Key Words*: flueric actuators, mechanical perturbations, testing system*

1. INTRODUCTION

Flueric actuators are devices designed for increasing the air adhesion on surface of the flaps.

Before to be used on real air planes, these devices need to be tested for checking their parameters such as operating frequency, air pressure and temperature normal operating range. It is needed also to test their stability and response to mechanical perturbations such vibrations and shocks and to inlet air contaminants such as water, oil or sand particles.

For carrying on these tests the flueric actuators needs a system to provide air having similar characteristics as the air from the airplane engines.

2. SYSTEM STRUCTURE

The system which is supplying air has three major parts: the compressing air unit having location in other building than the building where the flueric actuators are tested.

This unit is pumping air into a buffer tank placed outside of the testing area for safety reason. The air is going next into the conditioning air unit which is in the same area as the flueric actuators [1], [3].

The air compression unit contains a compressor skid unit followed by a small buffer tank (Figure 1, section 1).

These units and the outdoor buffer tank (Figure 1, section 2) are designed and manufactured accordingly to all safety regulations [2], [3] and normative directives [4].

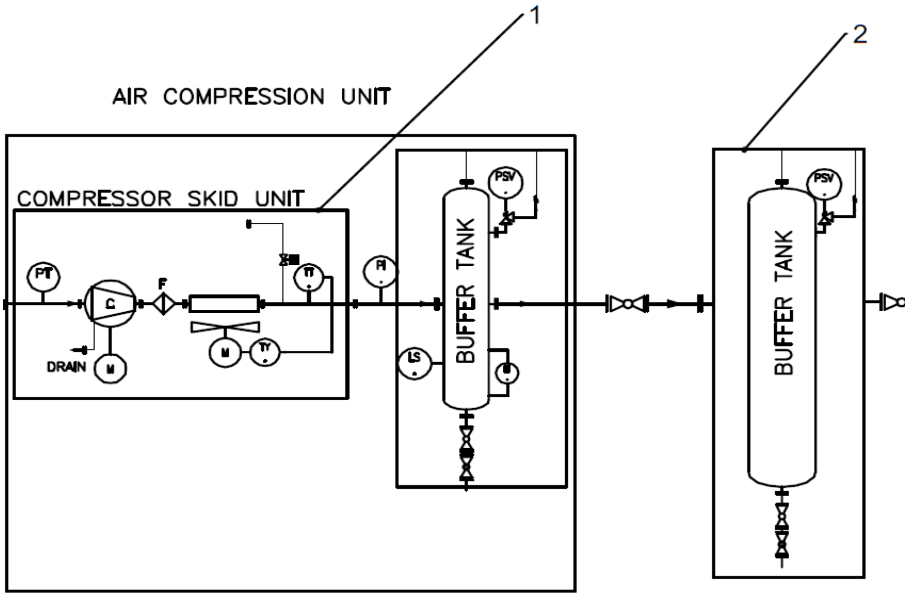

Figure 1. Air compression unit and buffer tank

A general overview of the air conditioning unit is shown in Figures 2 and 3 and its main parts are: the filtering unit, pressure regulator unit, heating unit, air contamination unit and air parameters monitoring units.

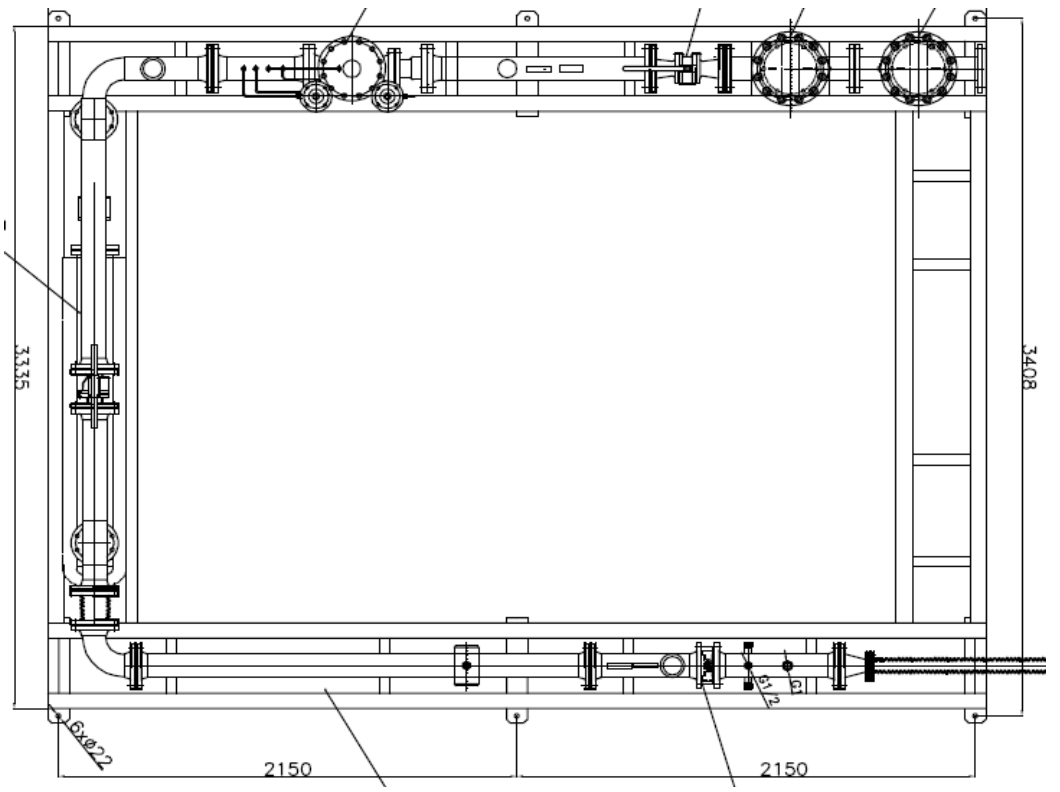

Figure 2. General overview schematics of the air conditioning unit

Figure 3. General overview photo of the air conditioning unit

The air conditioning unit is supplied from the buffer tank on the left hand side of the Figure 4 thru a tap at 10 bar pressure.

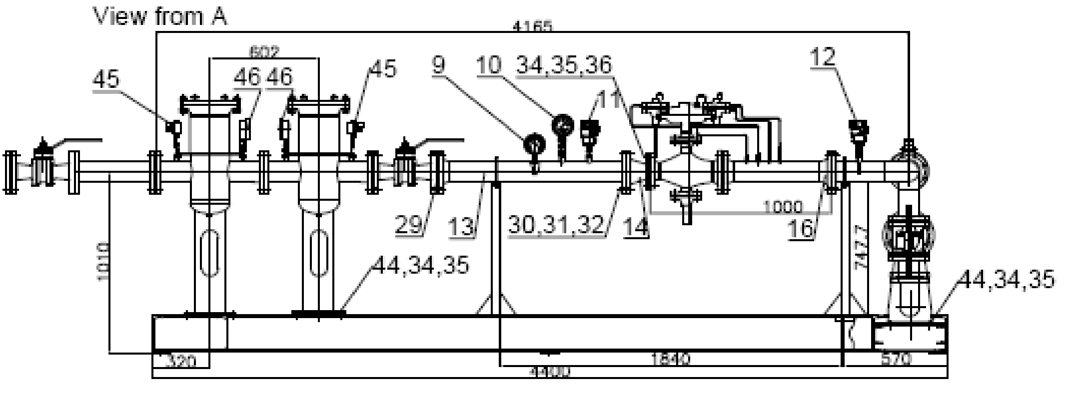

Figure 4. Air conditioning unit - filtering and pressure regulator stages

The first part is the air filtering stage which contains two filters, a coarse one (160 µm) followed by a fine one (20 µm) (Figure 5).

Figure 5. Air conditioning unit – photo of air filtering unit

Each filter is equipped with differential pressure transducers (45) and indicators (46) for checking filter colmatation level. This stage is followed by an air parameters monitoring unit where the temperature and pressure are checked using local indicators or gages (9), (10) and remotely, using specific transducers (11) by sending the measured parameters to a remote data acquisition unit and process computer (Figure 6).

The next stage is the pressure regulator (36) where the air pressure is reduced from 10 down to 0.1 – 1.5 bar adjustable constant pressure (Figure 6).

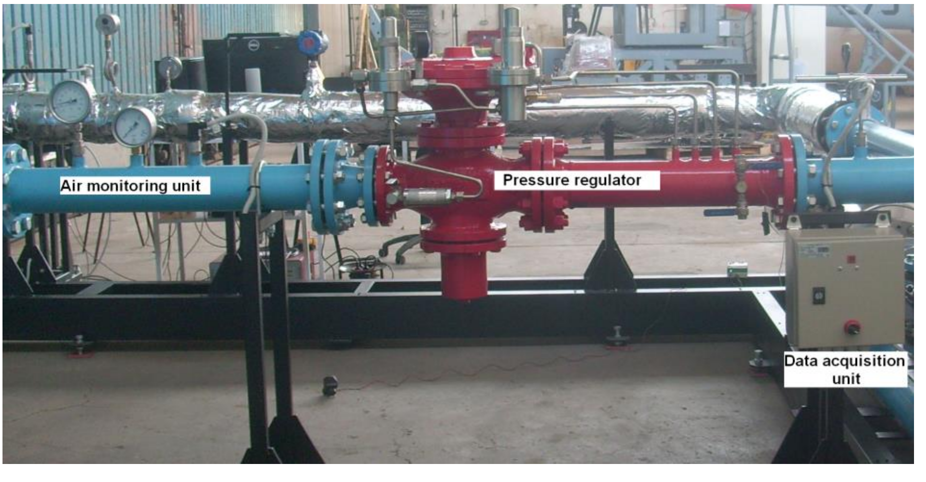

Figure 6. Air conditioning unit – photo of air monitoring, pressure regulator and data acquisition unit

The following stage is the heating unit (Figures 7 and 8) which is a 35kW heater made by Masterwatt Company which rises the air temperature from 0 – 30^{0}C to 50 – 200^{0}C range. The heater can be bypassed using taps (6).

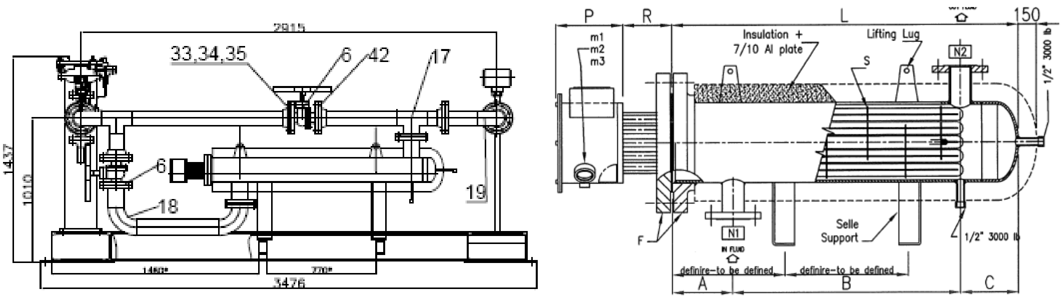

Figure 7. Air conditioning unit – heating unit

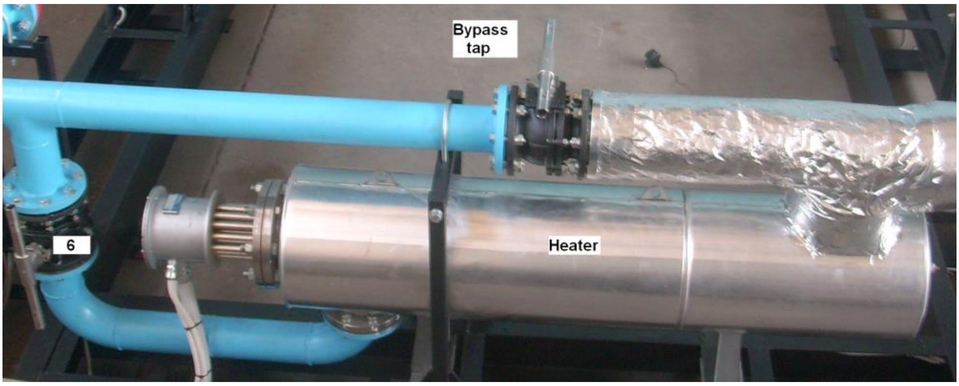

Figure 8. Air conditioning unit – photo of the heating unit

This heating unit is followed by another air monitoring unit shown in Figure 9 (26), (27), (28), (12) which has included a mass flow speed measurement system (15).

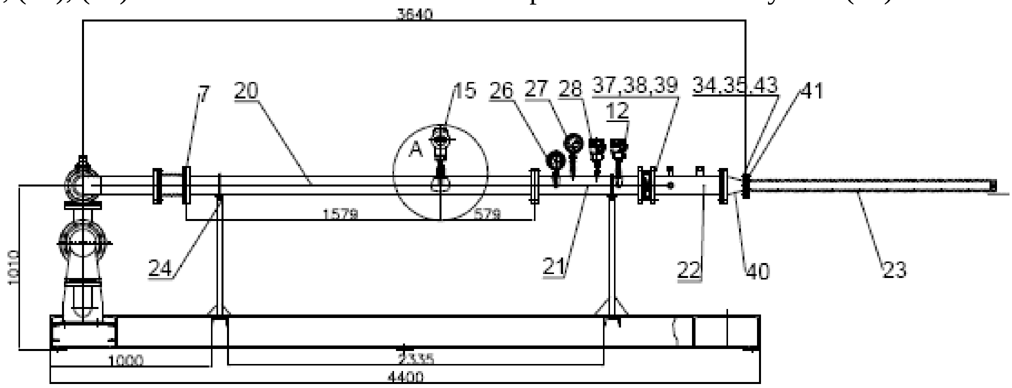

Figure 9. Air conditioning unit – air parameters monitoring and contamination unit

The air contamination unit consists of an inlet (22) into the main pipe where water, oil and sand can be introduced using an injector head supplied by an additional pressurized air system. All the signals from the transducers used in the air parameters monitoring are analog (4-20mA currents or 0-10V voltages) and are applied to Adam 4117 data acquisition module.

This module converts the analog input signals into digital signals which are sent thru RS 485 interface to the process computer where data are analyzed and stored to the PC hard drive [5], [6]. This module together with its power supply is embedded in a box shown in the right side of Figure 6. The heating system is provided with over temperature protection systems: thus, there is a first system assured by Masterwatt and embedded in the main control panel which cuts the heater electrical power if its sheath temperature exceeds a set temperature point (500^0 C); and there is also a second system which is an electronic device which cut the heater electrical power if the output signal from the mass flow meter corresponds to low values of the mass flow or if there is no air flow thru the system [7].

3. SYSTEM TESTING RESULTS

The system pressure stability and the variation of the mass flow rate with air temperature have been tested.

The pressure stability has been tested by starting the data acquisition system before starting the air flow thru the system and acquiring the air pressure values measured near the output of the system by the pressure transducer (28) for 1000 seconds. The air flow has been stopped for few seconds just before stopping the data acquisition process.

The time variation of the output air pressure is shown in Figure 10.

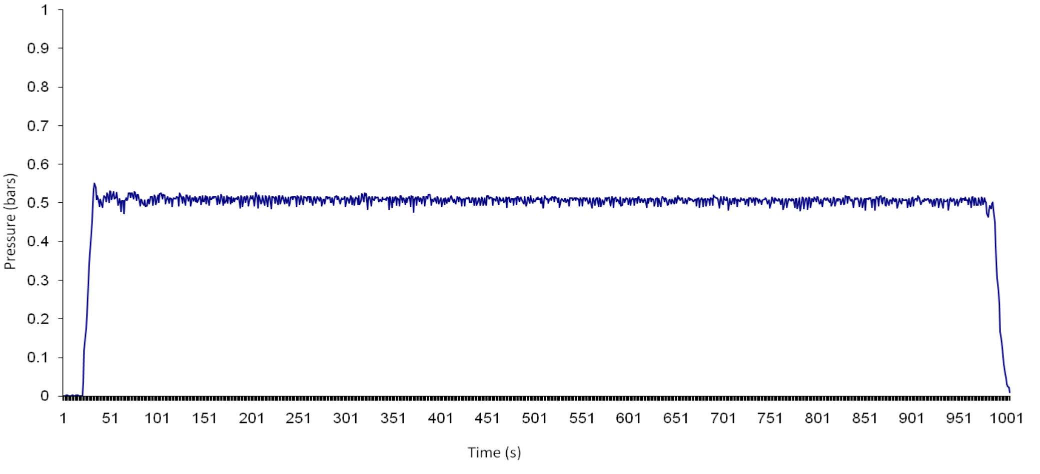

Figure 10. Variation of the output air pressure in time

Because the air density decreases when temperature rises , it is expected that the mass flow decreases with the temperature rising as well. Due to this fact the variation of the mass flow rate with temperature has been tested.

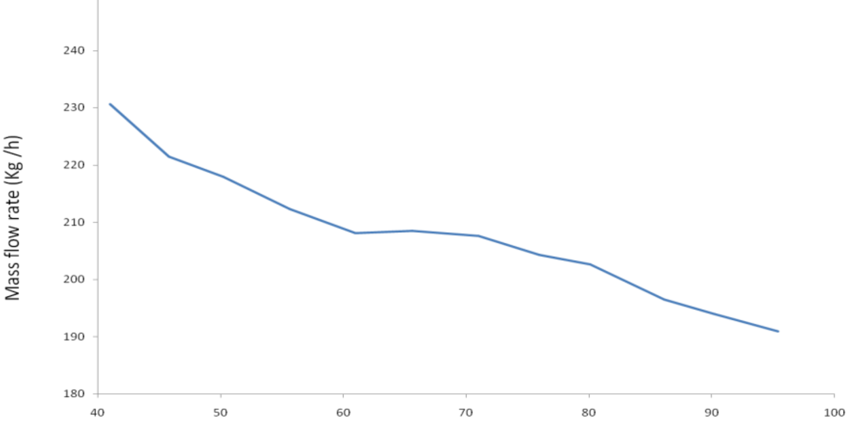

Figure 11. Variation of the output air mass flow with temperature

This test has been performed by maintaining constant the output air pressure and increasing the air temperature from 40^0C to 95^0C. As it was expected, the mass flow value decreases when the temperature increases as shown in Figure 11.

4. CONCLUSIONS

After the first tests performed on this system, the results have proved that it works correctly and the output air parameters are in expected operating range. The air pressure, temperature and mass flow rate values are stable around the set values.

This allows to pass to the next stages, which consist in testing the system to several constant air pressure values and also in testing the system with contaminated air with water, oil and sand.

By its configuration The system allows adding additional devices for improving its functionality. Such a system functionality is the communication between the process PC and the heater control panel for changing remotely the temperature controll process.

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