UME Gas Flow Rate Measurement Systems and the New Wind Tunnel with LDA

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Abstract

National Metrology Institute of Turkey, UME, has partially completed the new gas flow velocity and gas flow rate measurement systems. In this article UME primary and secondary gas flow measurements systems for air at atmospheric conditions will be explained briefly.

In the new gas flow laboratories, velocity measurements and anemometer calibrations are realized with a 2D Laser Doppler Anemometer .Two dimensional velocity measurements up to 40 m/s can be done in two different tunnels that have dimensions 500 X 500 mm and 250 X 250 mm.

The wind tunnel system is constructed parallel to a gas flow measurement system. This turbine gas meter test rig is designed for a maximum flowrate of up to 19500 m3/h with an uncertainty less than 0,5 %. Another gas meter test rig for air at atmospheric conditions is designed and constructed to operate parallel with a sonic nozzle test rig. This system will be used for gas flowrate calibrations in the range of 50-5000 m3/h. Until the planned sonic nozzle test rig is added to this system, the uncertainty can be declared as 0,3%. Primary standard Bell Prover and the low flow secondary standards Wet gas meter and Bubble Generators completes the traceability chain for gas flow at atmospheric conditions.

Key words: LDA, wind tunnel, test rig, flow velocity, flow rate, calibration, and traceability.

1.INTRODUCTION

The new gas flow rate and velocity measurement systems have been added to the current systems to cover the full range of industrial need of the country. One of the main concerns while realizing this was the treceability chain. Treceability chain for gas flow rate measurements at atmospheric conditions from 1 ccm to 19500 m^3/h and velocity from 0,1 m/s to 40 m/s has been realized at UME Gas Flow Measurement Laboratories with seven main systems, namely; LDA, Bell Prover, PVTt, Wet Gas Meter, Bubble Generator, Reference Flowmeter and Test Rig High Flow Test Rig. Figure 1 shows the hierarchically organized system of standards to realize the treceability chain at UME Gas Flow Labs.

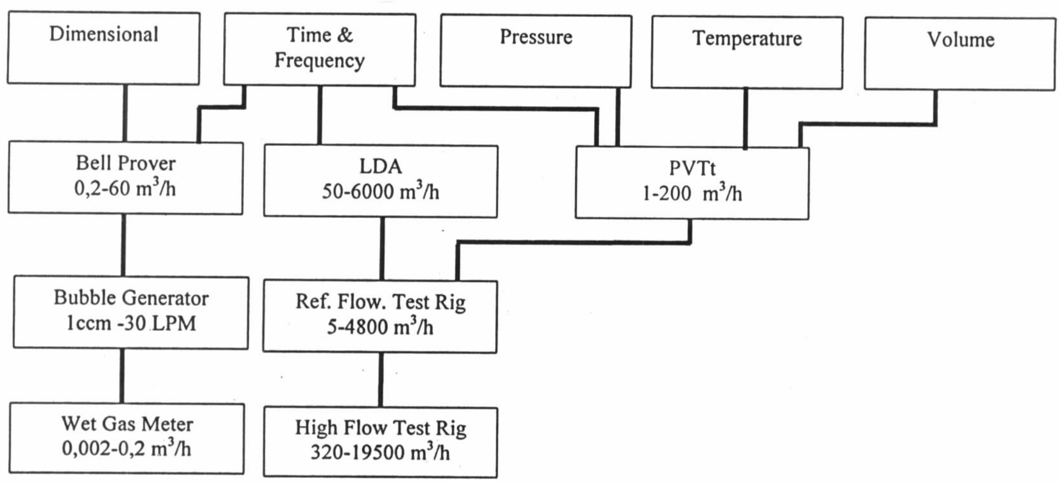

Figure1. Treceability chain at UME Gas Flow Measurement Labs

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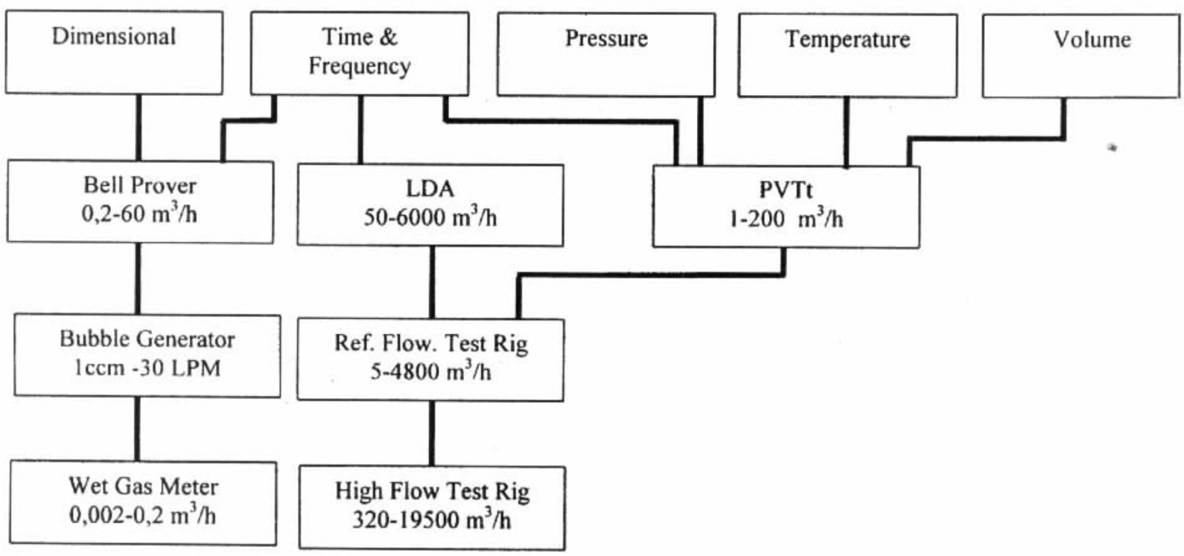


Figure1. Treceability chain at UME Gas Flow Measurement Labs

2. THE NEW WIND TUNNEL WITH LDA

2D LDA has been started to use for air velocity measurements up to 40 m/s with a new wind tunnel design at UME. Test section is rectangular and depending on the desired velocity range, two different measurement rooms of dimensions 250x250 and 500x500 mm can be chosen. By using these flexi glass measurement rooms, also the cross-sectional average velocity can be easily obtained to calculate flow rate for reference flow meter calibrations.

2D LDA is a product of Dantec and its processor is BSA F80. Frequency processing up to 180 MHz is possible. 5W Argon-Ion laser is used to have different colours at 514.5 nm, 488 nm and 476,5 nm.

The velocity at the centre region of the test section is determined by using the 2D LDA system and anemometers are calibrated against this velocity. Figure 2 shows the schematic diagram of the wind tunnel. The wind tunnel is an open-circuit suction type, and consists of the main body, test section and the blower. The air is sucked from the room and exhausted out of the building. There is a reference pitot tube placed at the downstream of the test section to check the velocity calculated by LDA so that any misalignment of the laser can be detected if the difference in velocities is noticeable.

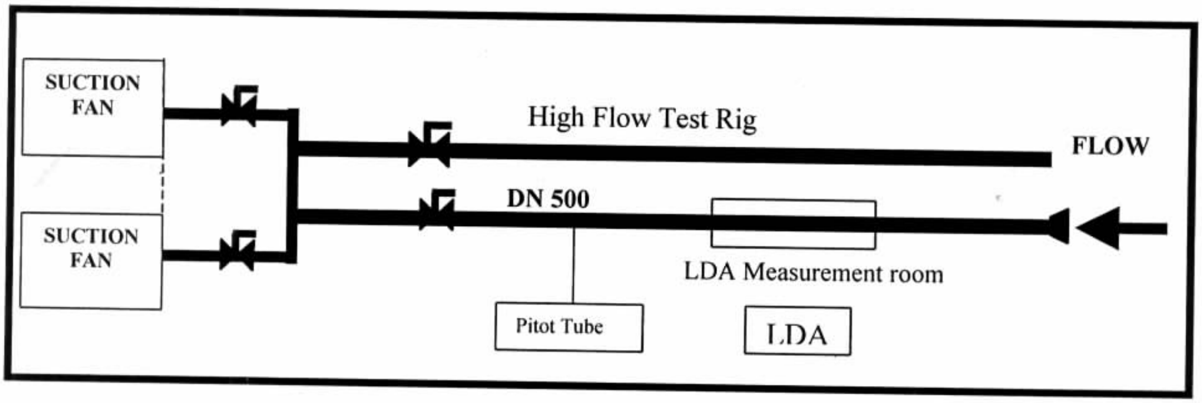


Figure 2. Schematic diagram of the Wind Tunnel

3. BELL PROVER

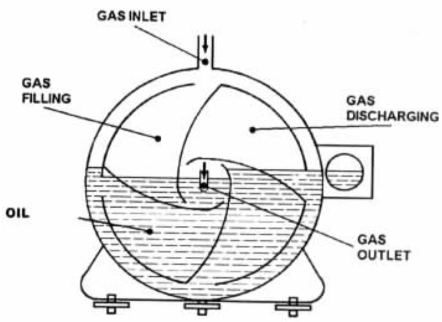
UME national standard for gas flow rate measurement is the Bell Prover. Gas flow rate in the range of 0,2-85 m^3/h is measured by this system with an uncertainty of 0,2 %. It is the starting point of the treceability chain. It is calibrated at UME Dimensional and Time &Frequency Laboratories with primary standards so the other low and high gas flow standards are traceable to the Bell Prover.

4.BUBBLE GENERATORS

Three different size of Bubble Generators are used for low flow calibration in the range of 1ccm-30 LPM with an uncertainty of 0,4 % [1] and these bubble generators are traceable to UME Bell Prover. Bell Prover calibrates the largest buble generator and it is used to calibrate the middle one and the middle one is used to calibrate the smallest one.

Bubble generators are also compared with the reference Wet Gas Meter.

5.WET GAS METER



The reference Wet gas meter is being used for gas flow meter calibration in the range of 0,002-0,2 m^3/h with an uncertainty of 0,2 % .It is calibrated by PTB and compared with the Bell Prover traceable Bubble Generators at UME.

6.MEDIUM REFERANCE FLOWMETER TEST RIG

Reference flow meter Test Rig is designed to operate in the range of 5-4800 m^3/h for gas flow meter calibrations. It consists of a fan, reference flow meters and valves. There are pressure-actuated ball valves upstream and downstream of the flow meters. Besides measuring the time and counting the electric pulses [3], also pressure and temperature is measured upstream of each flow meter. All data is collected in a flow computer and the software is designed at UME. Reference flow meters are traceable to NMI (Netherlands Metrology Institute) but when the UME PVTt system is completed, these flow meters will be traceable to PVTt and LDA systems. The uncertainty of the system is 0.3 for k=2. Schematic diagram of the Reference Flow meter Test Rig is shown in Figure 3.

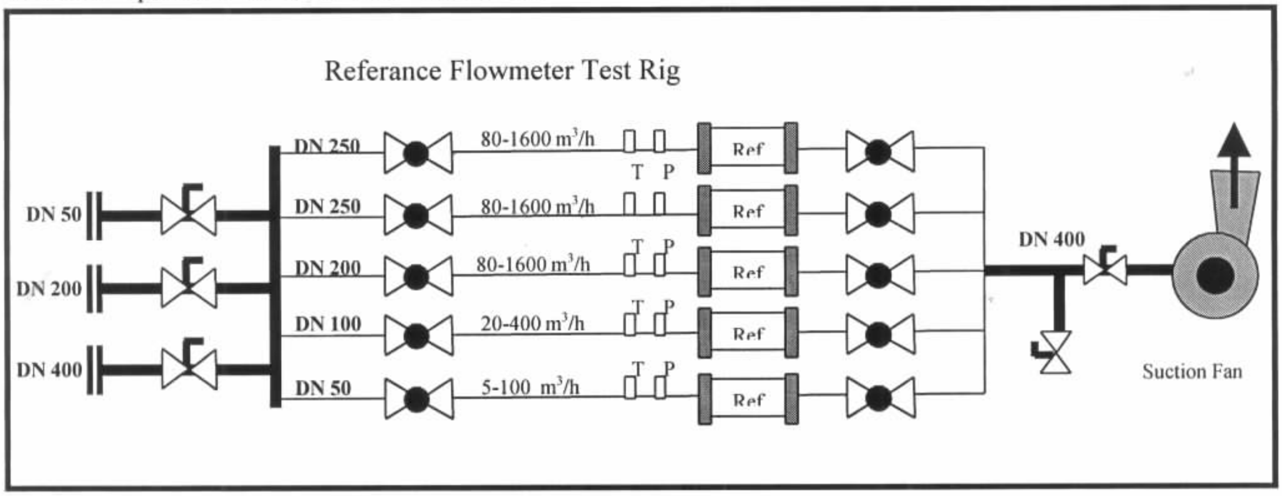


Figure 3.Schematic diagram of the Reference Flow meter Test Rig

7.HIGH FLOW TEST RIG

High Flow Test Rig consists of two suction fans, three G4000 reference flow meters [4] and pressure actuated ball valves. It operates in the range of 320-19500 m^3/h for gas flow meter calibrations. The same type flow computer is used with this system as Reference Flow meter Test Rig. Reference flow meters are also traceable to NMI and will be traceable to UME PVTt system in the future. The uncertainty of the system is 0.35 for k=2. Schematic diagram of the High Flow Test Rig is shown in Figure 4.

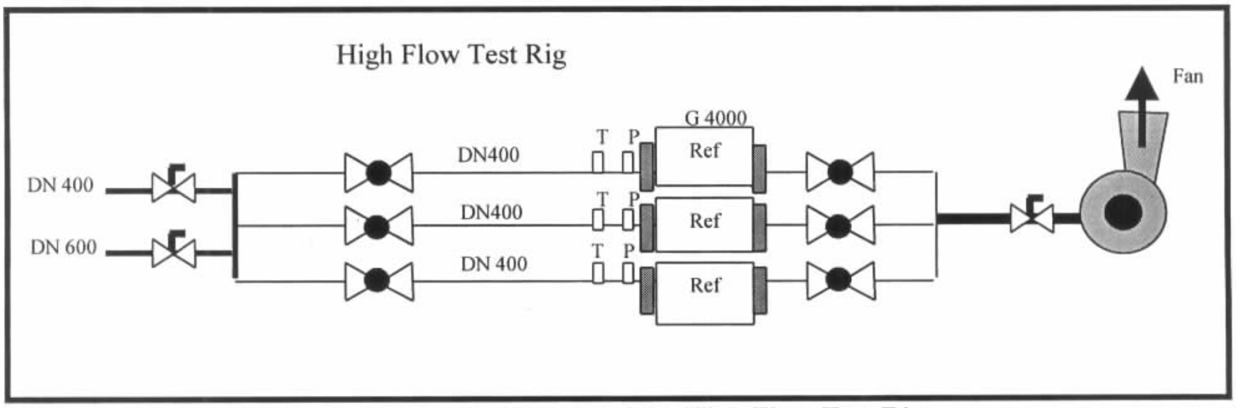


Figure 4.Schematic diagram of the High Flow Test Rig

8.PVTt SYSTEM AND HIGH PRESURISED TEST RIG

PVTt system consists of a compressor, pressurized tank, valves, three regulators, G650 reference flow meter and main measurement volume tank. Pressurized tank's volume is 7,5 m^3 and full of air at 30 bars. The measurement volume tank is 4 m^3 and maximum inlet pressure 6 bars. Reference flow meter is traceable to NMI but planned to be traceable to other UME reference standards in the future. This system is also used for calibration of flow meters up to G650 for pressures to 20 bars. Schematic diagram of the PVTt System is shown in Figure 5.

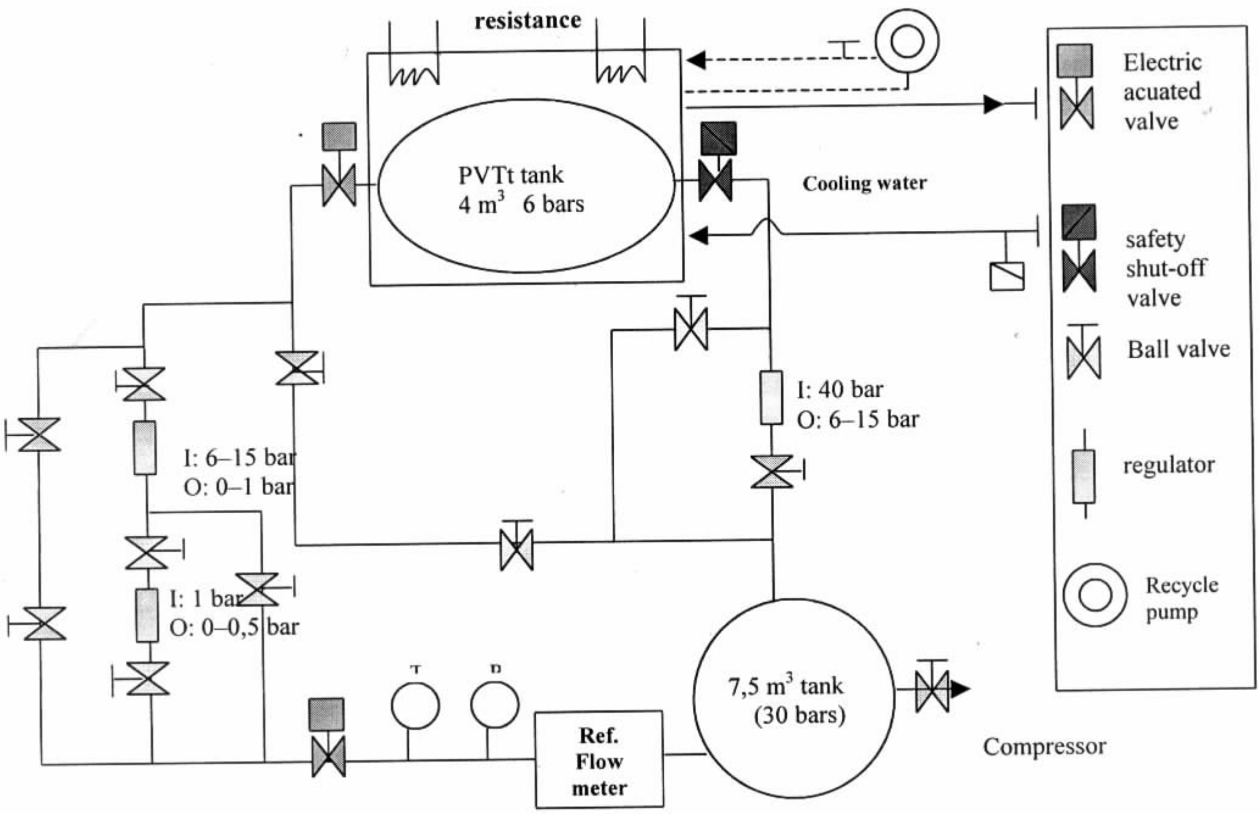


Figure 5.Schematic diagram of the PVTt System is shown in

8.CONCLUSIONS

The new gas flow measurement systems of UME are briefly explained in this paper. The Wind Tunnel with LDA will be used both for velocity measurements and flowrate measurements and so an important part of the treceability chain. PVTt system is still under construction and after it is completed and all tests are done, it will serve as a national standard.

9.REFERENCES

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[4] David Spitzer, Industrial Flow Measurement, (Instrument Society of America), 1990

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