EXHAUST GASES MEASUREMENT PREPARATION

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Abstract

The paper deals with the measurement preparation for the exhaust gases measurement. The measurement is carried out within the project of basic research. The aim of the project is the research of the influence of an unconventional charging intercooling on the selected ecological and economical parameters of a turbocharged compression ignition internal combustion engine in the specific operational conditions. The paper gives the information about the types, numbers, specification and position of the sensors used. The measuring scheme with the connection of sensors and connector blocks is also shown. The details about the single parts of the measuring chain are given. The paper also shows the view on the sensors through the photographs. Some results from a testing measurement are also shown and the results from the selected sensors can be compared. The two different intercoolers are used for charging air cooling. The first intercooler is the air/air type equipped with a ventilator, the second intercooler is the water/air type without a ventilator. The total displacement of an engine is 7.6 l. The measurement itself is aimed mainly to acquire information regarding the influence of the low temperatures of charging on the amount of NO_x. Also the influence on the amount of particulate matter is examined through the mentioned measurement.

Keywords: *measurement preparation, sensors, measuring scheme, measuring card, data acquisition*

1. Introduction

The measurement is aimed mainly to acquire the information regarding the influence of the low temperatures of charging on the amount of exhaust gases emissions mostly the amount of nitrogen oxides. But also the influence on the production of CO and CO_2 and particulate matter is going to be examined through the measurement. There are two intercoolers in the way of the boosted air. The engine which the measurement is going to be carried out on is the four stroke compression ignition engine with the engine displacement of 7.6 l. The first intercooler is air to air type and the second intercooler is liquid to air type.

2. Sensors

There are temperature and pressure sensors used to acquire the parameters of the charging air. There are used two types of the temperature sensors. The first type is the resistive temperature detector (RTD) type 112 705 707 from ZPA Nova Paka – Pt100, four wire, temperature range -70 to +180°C, cable length 16 m. This sensor is for taking the air temperature before the charger, the air temperature after the charger, the air temperature after the intercooler 1, the air temperature after the intercooler 2, the inlet engine coolant temperature and the outlet engine coolant temperature. Fig. 1 shows the RTD sensors. The second type of the temperature sensor is the thermocouple (TC) J type from ZPA Nova Paka, temperature range -40 to +700°C. This sensor is used to take the exhaust gases temperature after the turbine (see Fig. 2), the inlet coolant temperature and the outlet coolant temperature.

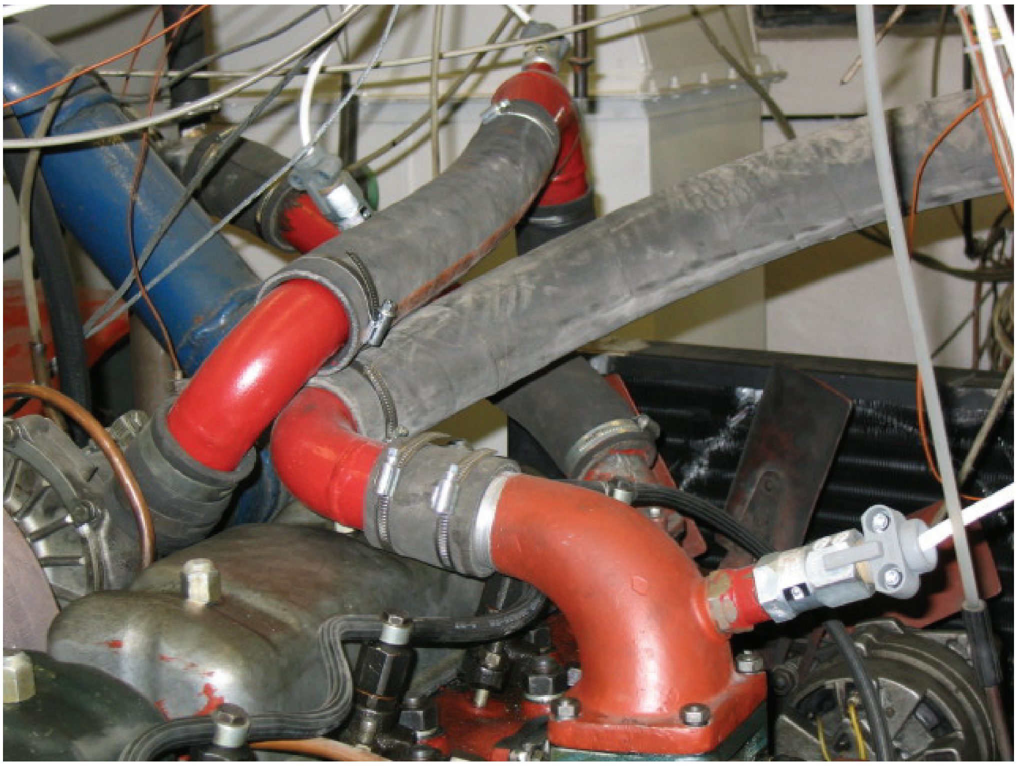


Fig. 1. RTD sensors for the air and engine coolant temperatures

Fig. 2. TC sensor for the exhaust gases temperature after the turbine

There are absolute pressure sensors of three types used for the measurement. The first is the pressure sensor DMP 331 111-1601-3-2-100-800-1-006 from JSP Jicin – absolute pressure sensor, measuring range 0 to 160 kPa, voltage output 0 to 10 V DC, three wire, temperature compensation -20 to +50°C. This sensor is used to take the air pressure before the charger. The second is the pressure sensor DMP 331 111-2501-3-2-100-800-1-006 from JSP Jicin – absolute pressure sensor, measuring range 0 to 250 kPa, voltage output 0 to 10 V DC, three wire, temperature compensation -20 to +50°C. This sensor is used to take the air pressure after the intercooler 2. The last sensor is the pressure sensor DMP 331 111-4001-3-2-100-800-2-006 from JSP Jicin – absolute pressure sensor, measuring range 0 to 400 kPa, voltage output 0 to 10 V DC, three wire, temperature compensation -20 to +50°C, which is used to take the exhaust gases pressure before the turbine. Fig. 3 shows the pressure sensors mentioned.

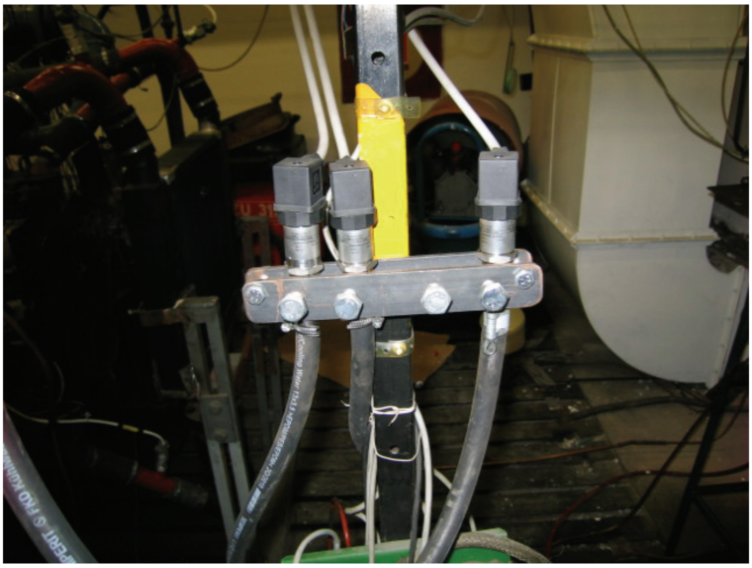


Fig. 3. Pressure sensors

3. Data acquisition system

The temperature sensors are connected to the universal transmitters PREASY 4116, voltage output 0 to 10 V DC, which are connected to the two SCB-68 noise rejecting, shielded Input/Output connector blocks corresponding to the measuring card National Instruments NI PCI-6225 M series , 80 Analog Inputs, 24 Digital Inputs/Outputs, 2 Analog Outputs. The software used is LabVIEW Academic Premium Suite from National Instruments. Fig. 4 shows the part of the measuring system.

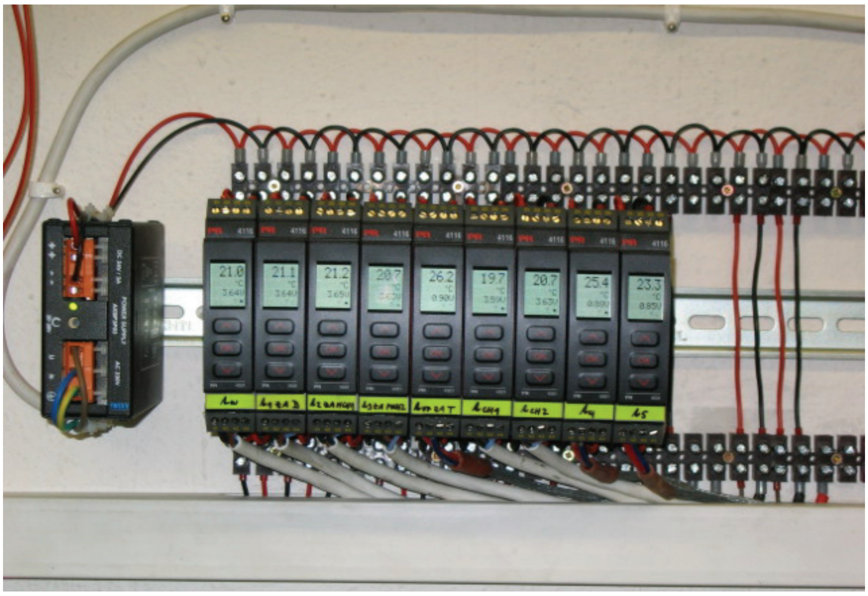


Fig. 4. Universal transmitters – the part of the measuring system

4. Exhaust gases measurement

For the exhaust gases measurement is used the AVL Dicom 4000 (see Fig. 5) and for the measuring of the amount of particulate matter the UVMV MT120 (see Fig. 6).

Fig. 5. AVL Dicom 4000

Fig. 6. UVMV MT120

The measuring scheme can be seen in Fig. 7 and the sensors arrangement and their connection to the connector block in Fig. 8.

Some results from the testing measurement can be seen in Tab. 1 where also the results from the sensors can be compared. Fig. 9 shows the view on the measuring system.

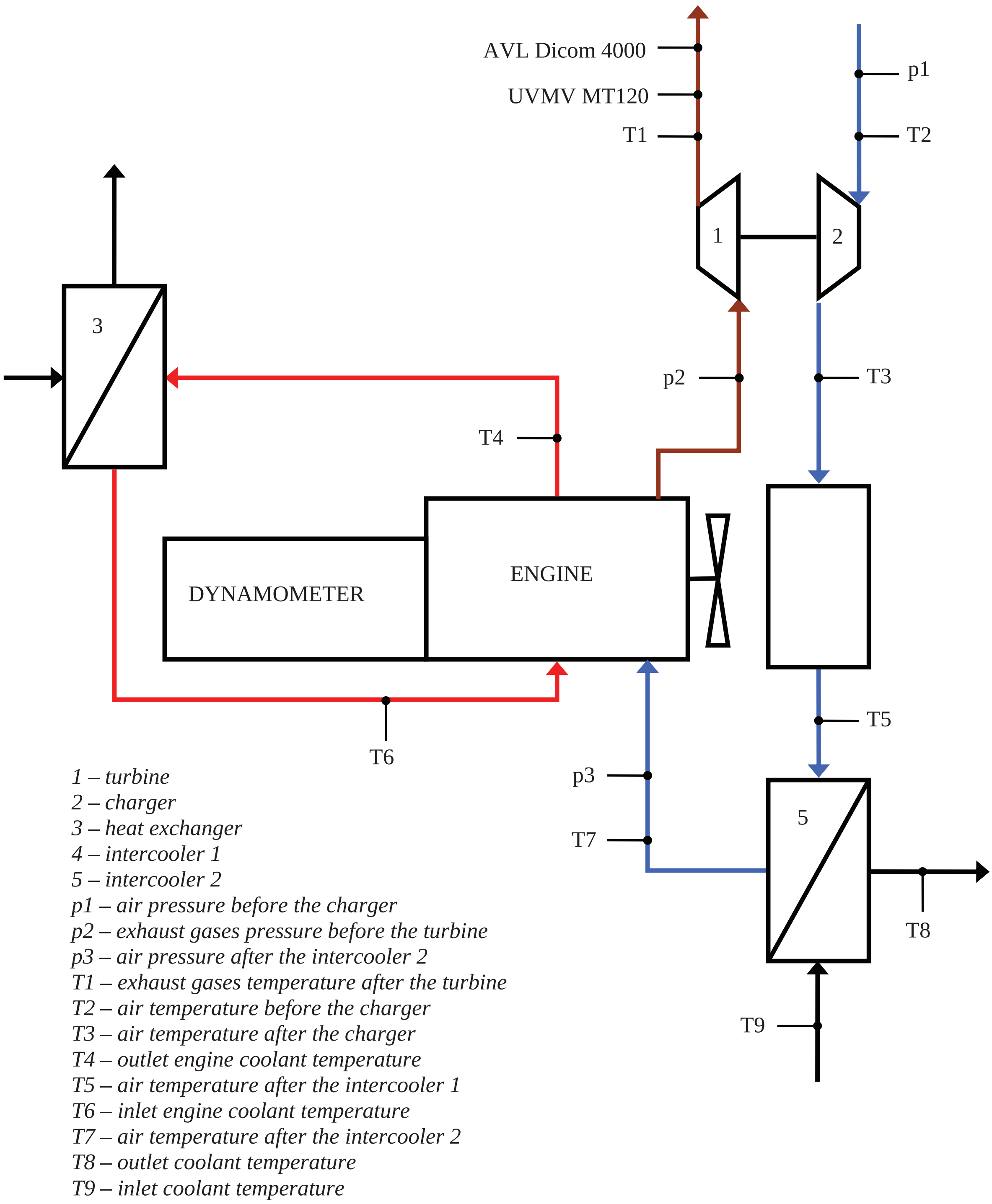
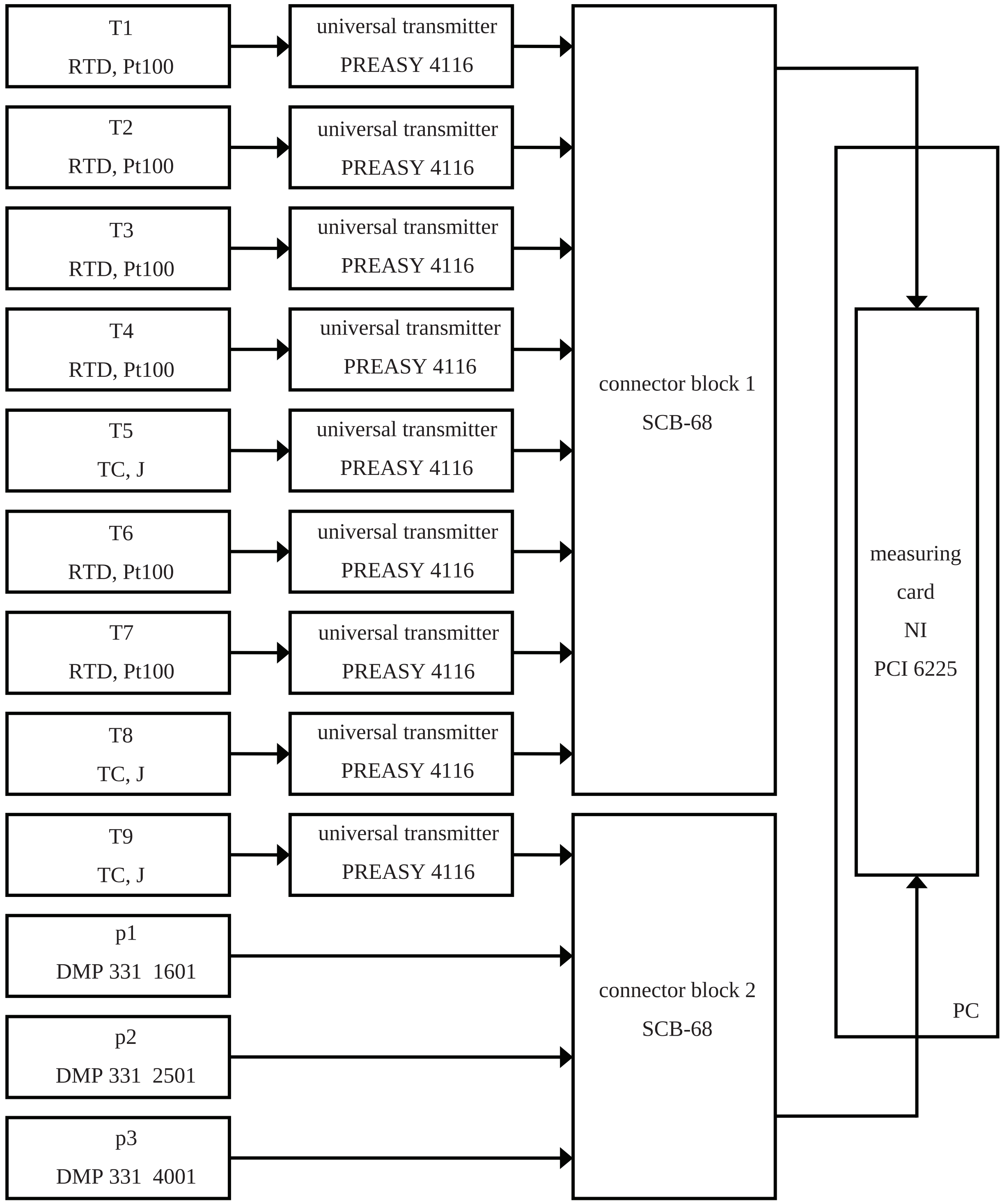


Fig. 7. The measuring scheme

5. Conclusion

The paper deals with the exhaust gases measurement preparation for the research project which is focused on the influence of the boosted air temperature on the exhaust gases emissions production mainly the production of nitrogen oxides. The sensors and other parts of the data acquisition system together with the measuring scheme are described. The measuring system was verified by the testing measurement which results are also provided in the paper.



p1 – air pressure before the charger, p2 – air pressure after the intercooler 2, p3 – exhaust gases pressure before the turbine, T1 – air temperature before the charger, T2 – air temperature after the charger, T3 – air temperature after the intercooler 1, T4 – air temperature after the intercooler 2, T5 – exhaust gases temperature after the turbine, T6 – inlet engine coolant temperature, T7 – outlet engine coolant temperature, T8 – inlet coolant temperature, T9 – outlet coolant temperature, RTD – resistive temperature detector, TC – thermocouple

Fig. 8. Sensors and their connecting to the connector blocks

Tab. 1. Testing measurement (t1 – air temperature before the charger, t2 – air temperature after the charger, t3 – air temperature after the intercooler 1, t4 – air temperature after the intercooler 2, t5 – exhaust gases temperature after the turbine, t6 – inlet engine coolant temperature, t7 – outlet engine coolant temperature, t8 – inlet coolant temperature (without coolant), t9 – outlet coolant temperature (without coolant), p1 – air pressure before the charger, p2 – air pressure after the intercooler 2, n – engine speed, M – engine torque)

Parameter	Measurement								
	1	2	3	4	5	6	7	8	9
t1 (°C)	17.5	18	18.7	18.8	19.2	18.2	18.9	20	19.3
t2 (°C)	17.7	21.7	31.2	34.9	45.4	60.3	95.2	33.6	27.2
t3 (°C)	17.8	20.1	24.8	27.1	32.4	39.9	60.7	28.3	23.7
t4 (°C)	17.4	18.1	21.2	23	25.3	32.1	49	43.1	31.7
t5 (°C)	16.9	128.7	230.4	275.9	355.3	466.7	526.6	218.5	124.6
t6 (°C)	15	17.7	34.4	38.1	42.1	71.9	76.8	73.6	68.2
t7 (°C)	17.7	20.2	37.6	41.7	45.9	76.2	81.5	76.7	66.2
t8 (°C)	15.9	19.2	21.5	21.8	22	20.7	21.4	22.6	22.9
t9 (°C)	15.2	17.6	19.5	19.7	19.9	19.4	20	21.6	21.3
p1 (kPa)	99.04	100.32	101.6	101.6	101.92	102.72	103.2	103.68	103.84
p2 (kPa)	99	95.75	100.5	100.75	107.75	124.75	143.5	99.75	104
n (min^{-1})	0	1220	1635	1625	1770	1770	2200	1220	0
M (Nm)	0	0	167	196	290	456	417	23	0

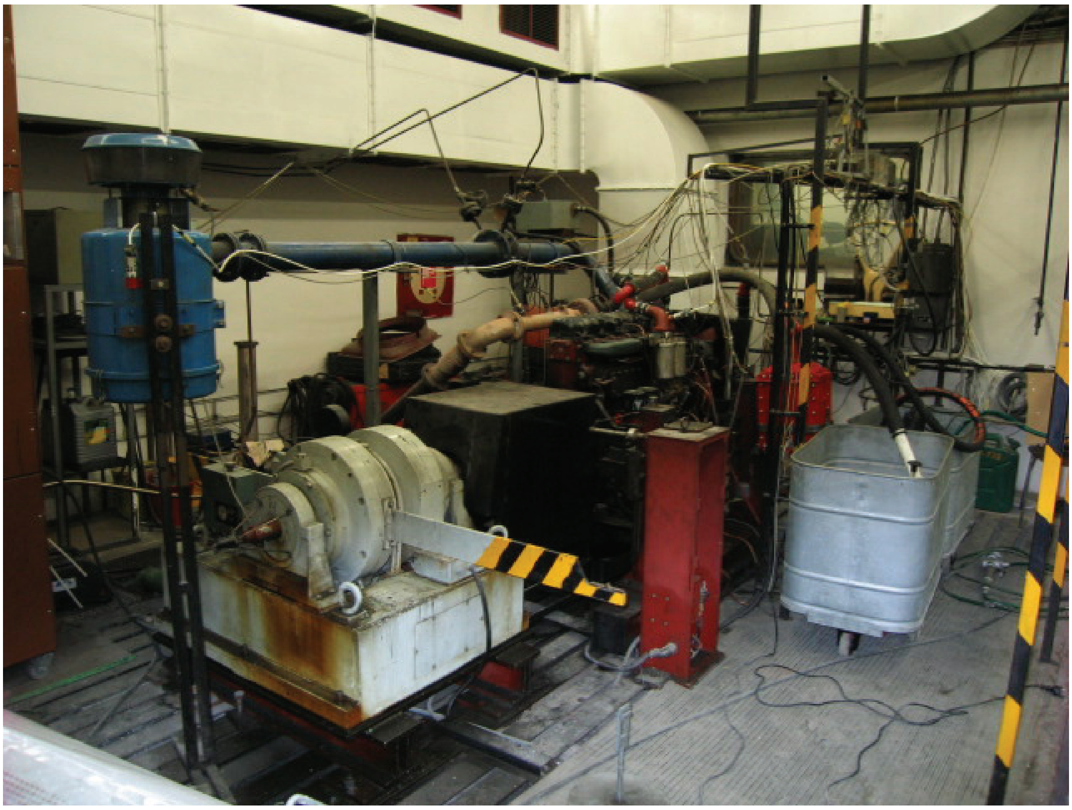


Fig. 9. View on the measuring system

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