LUNG VENTILATORS PARAMETERS DETERMINATION

Bogdan Marius CIUREA[1], Doru-Dumitru PALADE[2], Sorin KOSTRAKIEVICI[3]

Se dezvolta un sistem de testare unitar cu ajutorul caruia se determina automat parametrii ventilatori furnizati de echipamentul de ventilatie pulmonara. Pentru determinarea automata a parametrilor ventilatori se utilizeaza diversi senzori montati prin intermediul unei placi de achizitie de date la un calculator pe care are instalat software-ul LabView. Cu ajutorul software-ului Labview se dezvolta un program care poate extrage automat parametrii ventilatori.

An integrated test unit that can automatically determine the ventilators parameters provided by pulmonary ventilation equipment is being developed. Several sensors mounted to a computer via a data acquisition card are used for automatic determination of the parameters. A program that can automatically extract the ventilator's parameters is developed using the LabView software.

Keywords: Ventilation parameters, Test system.

1. Introduction

The ventilators automated testing system should automatically extract the ventilation parameters values. For this it must determine the pressure values of (p_{max}- maximum pressure, $p_{plateau}$ - plateau pressure, PEEP - Positive End-Exhale Pressure, VT_i - inhale tidal volume, VT_e - exhale tidal volume, f - respiratory rate, t_{insp} – inhale time, t_{exp} - exhale time, t_1 – the part of inhale time in which gas is introduced into the lung, t_2 - the part of inhale time in witch the lung volume remains constant (do not enter gas), F_iO_2 - inhale O_2 concentration etc.) For this purpose a program is developed in LabView to process the electric signal collected from the sensors [3] through a data acquisition card and display the pressure and flow diagrams and, also, the values of the ventilation parameters.

For testing purpose the system should extract ventilating parameters for different ventilation modes.

2. Ventilation parameters values determination

[1] Eng., Dräger Medical Romania, e-mail:bmciurea@yahoo.com
[2] Prof., National Institute of Research & Development for Mechatronics and Measurement Technique, Romania
[3] Prof., Dept. of Bioengineering and Biotechnology, University POLITEHNICA of Bucharest, Romania

The variation diagrams of pressure, flow and oxygen concentration versus the electric power voltage supplied by the sensor were determined.

The characteristic equations of these parameters are:

$$p = 15.54 + 34.54 \cdot U \tag{1}$$

$$\dot{V} = -18.23 + 32.63 \cdot U \tag{2}$$

for $\dot{V} > 0, U > 0.56$

$$\dot{V} = -26.35 + 47.06 \cdot U \tag{3}$$

for $\dot{V} < 0, U < 0.56$

$$FiO_2 = 1.25 + 1316.67 \cdot U \tag{4}$$

where p is the pressure,
U - the electrical voltage,
$\dot{V}$ - the gas flow,
FiO_2 – the oxygen concentration.

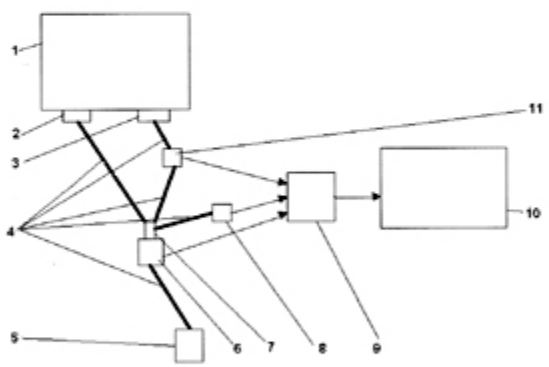

Fig. 1. Test system diagram. 1. ventilator, 2. exhale block, 3. inhale block, 4. connecting hoses, 5. lung simulator, 6. flow sensor, 7. Y piece, 8. pressure sensor, 9. data acquisition card, 10. computer, 11. oxygen concentration sensor.

Using the LabView software [5], a computer program has been developed to extract data from pressure, flow and oxygen concentration sensors using data acquisition card USB 6009 produced by National Instruments. For sampling, the rate was settled at 1000 Hz. This value was chosen because this system can test the ventilation equipment used in neonate area, where respiratory frequencies are high (30-100 breaths / minute).

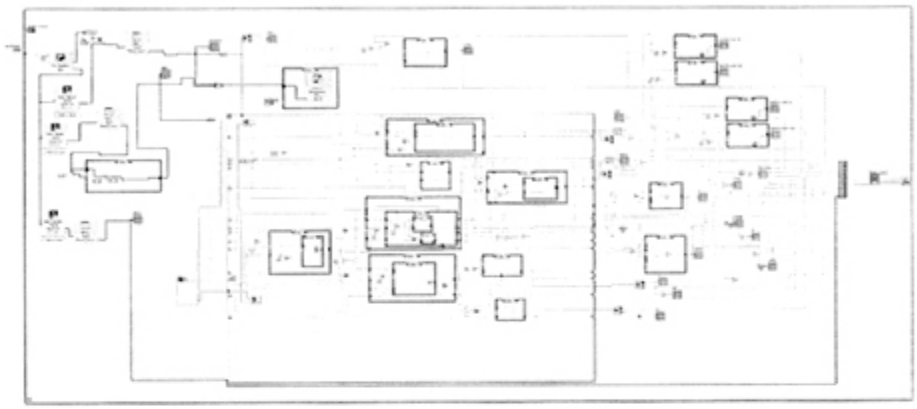

Fig. 5. Software in LabView for viewing ventilation parameters

The pressure and flow diagram are visualized. Check whether the shapes of these diagrams are similar to the classic ones for the chosen ventilation mode.

The ventilation parameter's values are read and compared with the values preset for the test equipment.

Data gathered by the system presented in this paper are saved in a spreadsheet file format where it can be easily printed or processed.

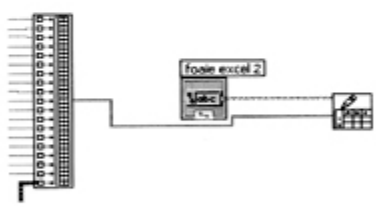

Fig. 6. Copy data in spreadsheet file format

Fig. 7. Data in spreadsheet file format

Table 1

Summarizing the set and measure parameters

p_{max} set	p_{max} measured	PEEP set	PEEP measured	VT set	VT measured	f set	f measured	t_{insp} set	t_{insp} measured
15	14.2	0	1	400	375	12	11.95	1.8	1.83
32	32	5	5.4	400	378	12	11.94	1.8	1.85
32	32	5	4.5		376		14	1.8	1.78
25	25.3	5	5.2				18		
		7	7.43				20		

REFERENCES

[1]. *F. Rittner, M. Döring*, Curves and loops in mechanical ventilation, Dräger Medical, Germany
[2]. *R. Rathjen* , Mandatory ventilation, Dräger, Lubeck, 1995.
[3]. *R. Chatburn*, Computer Control of Mechanical Ventilation, Respiratory care, **vol. 49**, no. 5, may 2004.
[4]. *R. Chatburn*, Fundamentals of Mechanical Ventilation, A short course on the theory and aplication of mechanical ventilators, Manu Press Ltd., Cleverland Heights, Ohaio, 2003.
[5]. *S. Pasca*, Instrumentatie virtual (Virtual instrumentation), Cavallioti, Bucuresti, 2007.