ISSN 1454 - 8003
Proceedings of 2016 International Conference on Hydraulics and Pneumatics - HERVEX
November 9-11, Baile Govora, Romania

INTERDISCIPLINARY EXPERIMENTAL STAND FOR DETERMINING THE CHARACTERISICS OF A RECIPROCATING COMPRESSOR

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Abstract: *The paper propose is the design of an experimentally stand for students of Thermal Equipment Systems (SET) engineering area within the Alba-Iulia extension of Technical University of Cluj-Napoca. It is desire that the stand to serve several specialized disciplines in the curriculum of the domain. The aim of proposed paper is to develop student's technical knowledge, measurement and control instruments skills, respectively thermal equipment.*

Keywords*: experimental testing stand, reciprocating compressor, pressure, thermal equipment*

1. Introduction

The compressors are thermal generating machines, that carry out gas or vapor pressure increase by consuming mechanical work for different industrial applications. The compressors can be encountered in all industry branches: gas transport, turbine gas, refrigeration, drying, combustion, heat pumps, operating the aggregates, adjustment and control systems, and so on [1]. The incorporated compressor used at experimentally stand is volume piston type, operating in one stage compression and it is powered by an electric engine, electrical energy is converted to potential energy in air pressure [2]. Schematic diagram of the stand that indicated the components and functioning of a reciprocating compressor is shown in figure 1.

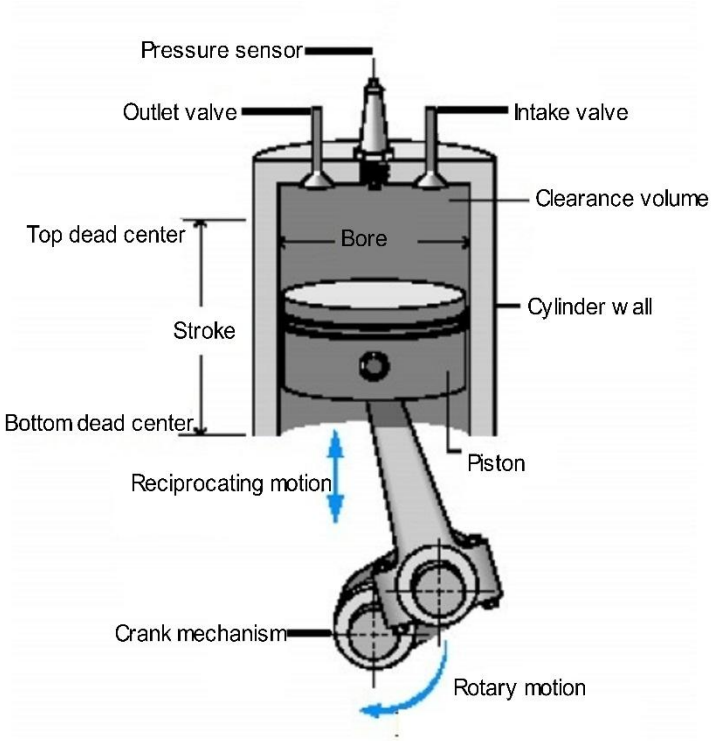

Fig. 1. Schematic diagram of a reciprocating compressor [4].

Moving parts: piston with related rigns and bolt, crank mechanism, intake and outlate valves and crank mechanism, respectivelly the fix parts: cilinder and crankcase were are mounted the two valves: inteke (SA) and outlate (SR) are presented in figure 1 [3]. The ambiantal air is used as thermal agent. The main sizes that caracterised the compressor are shown in figure 2:

- total volume of the cillinder (V_1) is the volume between the cilinder and crankcase, when in top dead center (Pms);
- dead space volume (V_3 or V_m) is the cillinder volume between crankcase and piston, when in bottom dead center (Pmi);
- stroke volume or cylinder capacity (V_c) is the cillinder volume between the two extreme positions of the piston: bottom dead center and top dead center;
- suction volume (V_a) provided by the opening intake valve between points 4 and 1.

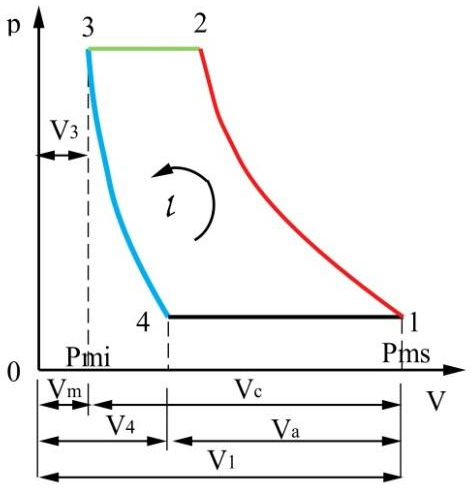

Fig. 2. The operating cycle and the basic characteristics of the compressor [1]

The purpose of this paper consists in designing of an interdisciplinary experimental stand that can be used in order to lead trials determination for disciplines: thermodynamics, compressors and fans, gas dynamics, hydraulics and pneumatics operating. Using this stand in the mentioned disciplines will admit the determination of the following: temperature, pressure, flow rate, compressor power, pressure ratio, the degree of volumetric compression, filling degree, flow rate efficiency, flow rate curve depending on pressure ratio and establishment of maximum work pressure.
The aim to follow in the proposed laboratory work carried out on this stand is students assimilation of theretical concepts regarding the reciprocating compressor, the operating of the used stand, knowledge the measurement instruments that equipe the experimental stand, working mode and procesing procedure and results interpretation.
The proposed and presented testing stand in this paper, give suport for the students, in purpose to develop students technical knoledge, measurements and control instruments utilization skills as well as thermal equipments.
The design theme constitutes in implementation of this stand and the development of practical application designed to monitor the parameters and the characteristics of reciprocating compressor.

2. Experimental setup

From the need to improved student's technical skills regarding the components and compressors functioning in thermal systems field, usage of measurements and control instruments and all so study of heat transfer, respectively the air flow in the cooling system corresponding to compressor, it is submitted the design of this interdisciplinary experimental stand.
Experimental stand will consist of a reciprocating compressor powered by an electric engine, a pressure vessel, a calibrated tank and the following measurements and control instruments:

thermometers, manometers, rotameters, wattmeter, timer, valve, safety valve and discharge valve. The scheme of experimental stand is shown in figure 3.

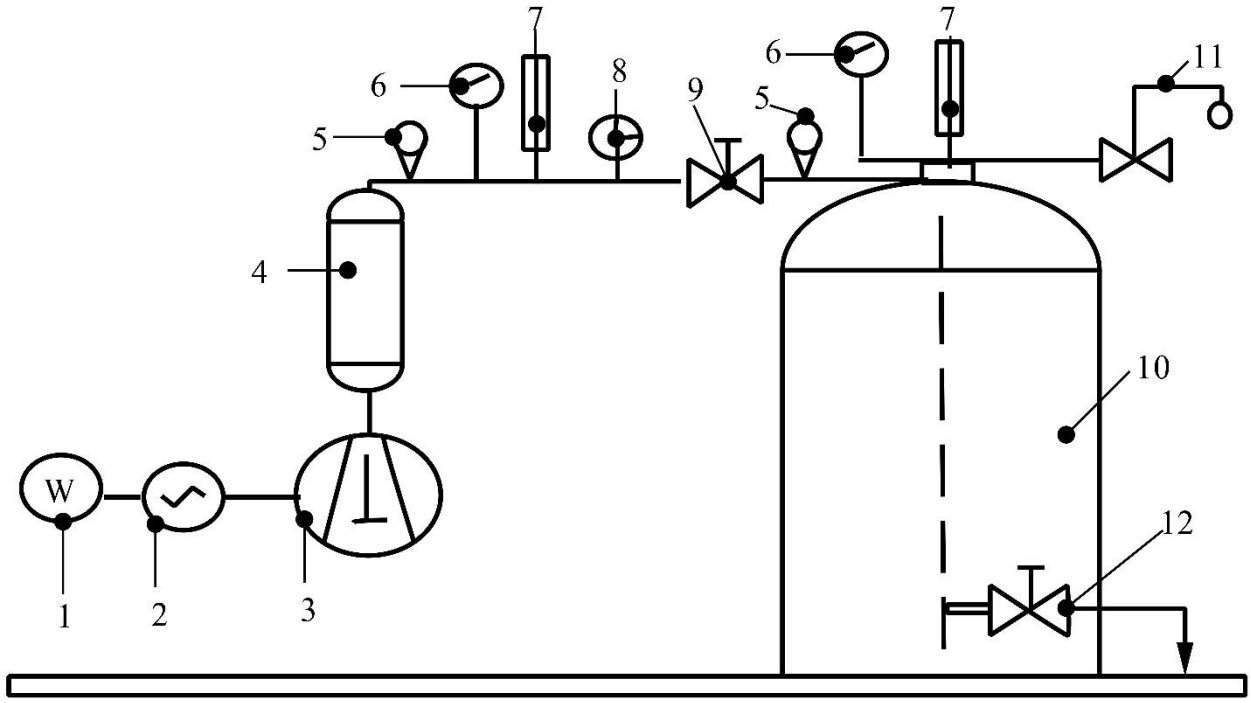

Fig. 3. The scheme of experimental stand
1 - wattmeter; 2 - electric engine; 3 – compressor; 4 - pressure vessel; 5 – rotameter; 6 – manometer; 7 – thermometer; 8 – timer; 9 – valve; 10 - calibrated tank; 11 - safety valve; 12 -discharge valve.

Among the scientific trial works that may carry out on this stand, are presented below two of this:

- ✓ establishment of maximum work pressure for the reciprocating compressor,
- ✓ drawing flow rate curve depending on pressure ratio.

After the compressor is turned on and adjusted to normal standard operating state, the following measurements can be read for both laboratory work:

- ☞ barometric pressure that is equal to the suction pressure;
- ☞ intake air temperature;
- ☞ air fllow rate discharge.

For calibrated tank are established initial and final pressure in order to carried out measurements. It is required that the diferential pressure between calibrated tank and pressure vessel to be at minimum 1 bar. The following parameters are recorded, maintaing a constant discharge pressure in the pressure vessel using the valve.

- ☞ compressor power;
- ☞ initial parameters for pressure and temperature at the inlet of calibrated tank, starting the timer simultaneously;
- ☞ clock until the final value of the chosen pressure is reached, than read the final temperature.

For different pressure values achieved in calibrated tank the measurements are made again, noting each time measured values, mentioned above.

Based on the results are drawn:

- ➢ for the first proposed paper maximum work pressure for the reciprocating compressor (Fig. 4). In order to determine the maximim pressure, for a one stage reciprocating compressor the aspirated volume of gas and volumic coefficient (filling degree) it is imposed to be zero, therefore the flow rate is also zero. It can be noted the gas inside the copressor`s cilinder is compressed and expand by the same curve. Concludes that

the value of discharge pressure (Pr) must be strictly lower than P_{2max}. Increasing the compression ratio respectively, the discharge pressures will modify the operating cycle of the compressor, in order to reduce the volume of suction gas leading to reduction of circulated gas. Decreasing aspirated gas volume due to gas expansion remained occupies a larger quantity performed by the piston stroke [5]. Compression ratio significantly affects the volume coefficient namely filling degree.

- for the second proposed paper flow rate curve depending on pressure ratio (Fig. 5). Note that as the compression ratio increase, air mass flow ratio decrease. Theoretical volume flow rate represents a parameter choice for compressors. So, in order to choose a compressor from producer catalogs must provide a theoretical volume flow rate at least equal to the computed value of this parameter.

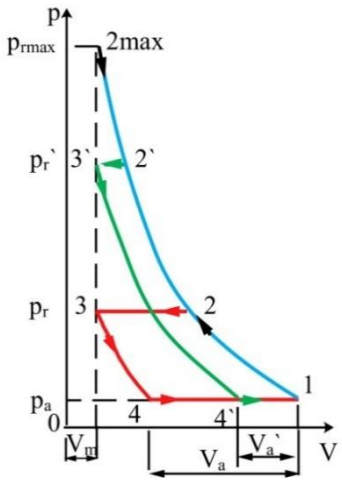

Fig. 4. Establishment of maximum work pressure [1].

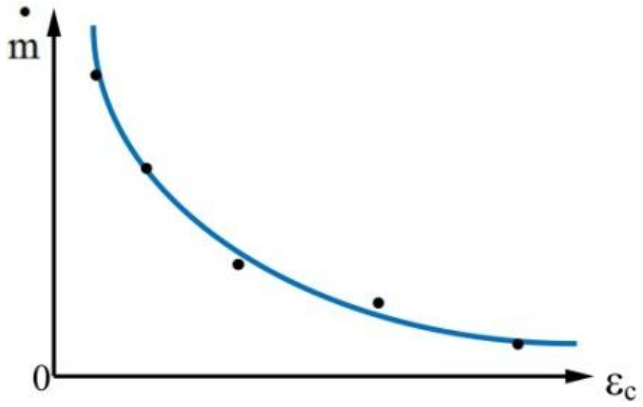

Fig. 5. Mass flow rate curve depending on pressure ratio [1].

3. Conclusions

The interdisciplinary experimental stand aimed to develop the technical knowledge of students from Alba-Iulia extension of Technical University of Cluj-Napoca, major in Thermal Equipment Systems (SET).
The focus is on acquiring theoretical and practical knowledge concerning the reciprocating compressors, the stand designed as well as learning the working principle of measurements and control instruments.
For a better understanding and a proper learning experience for the students of the phenomena of gases flow, as well as covering a larger field from the curriculum, the future interest of the researcher is to improve and extend this experimental stand.

References

[1] L. Socaciu, O. Giurgiu, „Thermodynamics - Laboratory work" (Termotehnică – Lucrări de laborator), Ed. UTPRESS, ClujNapoca, ISBN 978-606-737-089-8, 2015;
[2] http://idd.univ-ovidius.ro/tutorials /cursuri/FIM/ING9/08Compresoare.pdf
[3] A. Plesa „Compressors and Fans – Lecture notes" (Compresoare si ventilatoare – Suport de curs) http://termo.utcluj.ro/
[4] http://aermech.com/wp-content/uploads/2015/03/inline.jpg
[5] http://biblioteca.regielive.ro/download-70507.html