Annals of the University of Petroşani, Mechanical Engineering, 25 (2023), 169-174 169

ESTABLISHING THE HOURLY AND OPTIMAL ENERGY BALANCE FOR THE KAESER BSD 81.45 KW HELICAL SCREW COMPRESSOR

DAN CODRUT PETRILEAN[1], ANDREEA CRISTINA TATARU[2]

Abstract: In the article, the real and optimal hourly thermal energy balance of the helical compressor was designed. Through a technically feasible measure, the specific consumption of the helical compressor was reduced, and the effective heat recovered was then calculated.

Keywords: energy efficiency, real and optimal balance heat, helical screw compressor, specific consumption

1. INTRODUCTION

The energy balance is a practical way of expressing the principle of energy conservation and highlights the equality between the energy input and output from the analyzed circuit for a certain period of time.The purpose of the article is to achieve a real and optimal energy balance sheet to improve energy specific consumption. The realization of the real hourly energy balance allows the assessment of the actual state of the compressor's operation. By proposing feasible measures to reduce energy consumption, an optimal hourly balance is then achieved.

The utility of the article resides in the fact that by generating energy savings, the electricity and heat bill for the consumer is reduced. In the specialized literature, there are concerns in this field, especially to be able to design and justify measures to reduce the consumption of electricity and thermal energy at the consumer [1], [2], [3], [4].

2. RESULTS

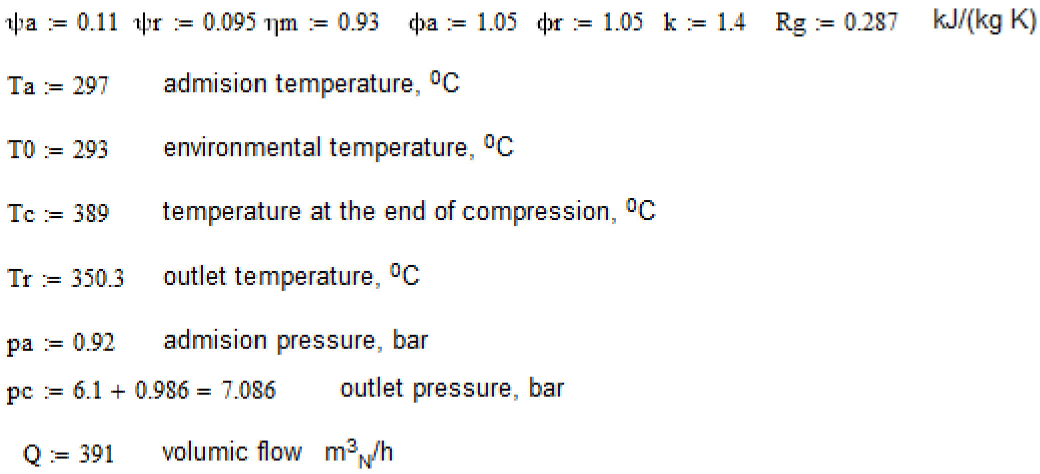
In the article, the problem of reducing the specific energy consumption of a helical compressor is raised. The method we will use refers to the realization of the real

---

[1] *Professor, Ph.D. Eng., University of Petrosani, danpetrilean@upet.ro*

[2] *Lecturer, Ph.D. Eng., University of Petrosani, andreeatataru@upet.ro*

and optimal hourly energy balance for the analyzed helical compressor. Most of the input values were obtained by "in situ" measurements, and a small part was taken from the literature and others were calculated. The input data obtained by measurements and calculations are presented as follows in Mathcad:



$\psi a := 0.11$ $\psi r := 0.095$ $\eta m := 0.93$ $\phi a := 1.05$ $\phi r := 1.05$ $k := 1.4$ $Rg := 0.287$ kJ/(kg K)

$Ta := 297$ admision temperature, ^0C

$T0 := 293$ environmental temperature, ^0C

$Tc := 389$ temperature at the end of compression, ^0C

$Tr := 350.3$ outlet temperature, ^0C

$pa := 0.92$ admision pressure, bar

$pc := 6.1 + 0.986 = 7.086$ outlet pressure, bar

$Q := 391$ volumic flow $m^3{}_N/h$

Based on the specific relationships from the specialized literature, the real hourly heat balance for the helical screw compressor was achieved. The obtained results are presented in value and percentage in summary in table1:

Table 1. **Summary table of the real hourly balance KAESER BSD 81 compressor, 45 kW**

EXERGY ENTERED INTO THE CONTOUR			**EXERGY OUT OF THE CONTOUR**		
Name	**kWh**	**%**	**Name**	**kWh**	**%**
Exergy at the compressor shaft	35.08	100	USEFUL EXERGY		
			The exergy of the compression process	24.11	68.73
			LOST EXERGY		
			Losses through suction lamination	1.38	3.94
			Losses due to lamination during discharge	1.18	3.36
			Heat loss during compression	3.2	9.13
			Heat losses during discharge	0.77	2.19
			Heat losses in isobaric cooling	1.99	5.67
			Mechanical losses	2.45	6.98
			Total losses	**10.97**	**31.27**
TOTAL	**35.08**	**100**	**TOTAL**	**35.08**	**100**

A more suggestive representation of these values was obtained by drawing up the Sankey diagram in figure 1.

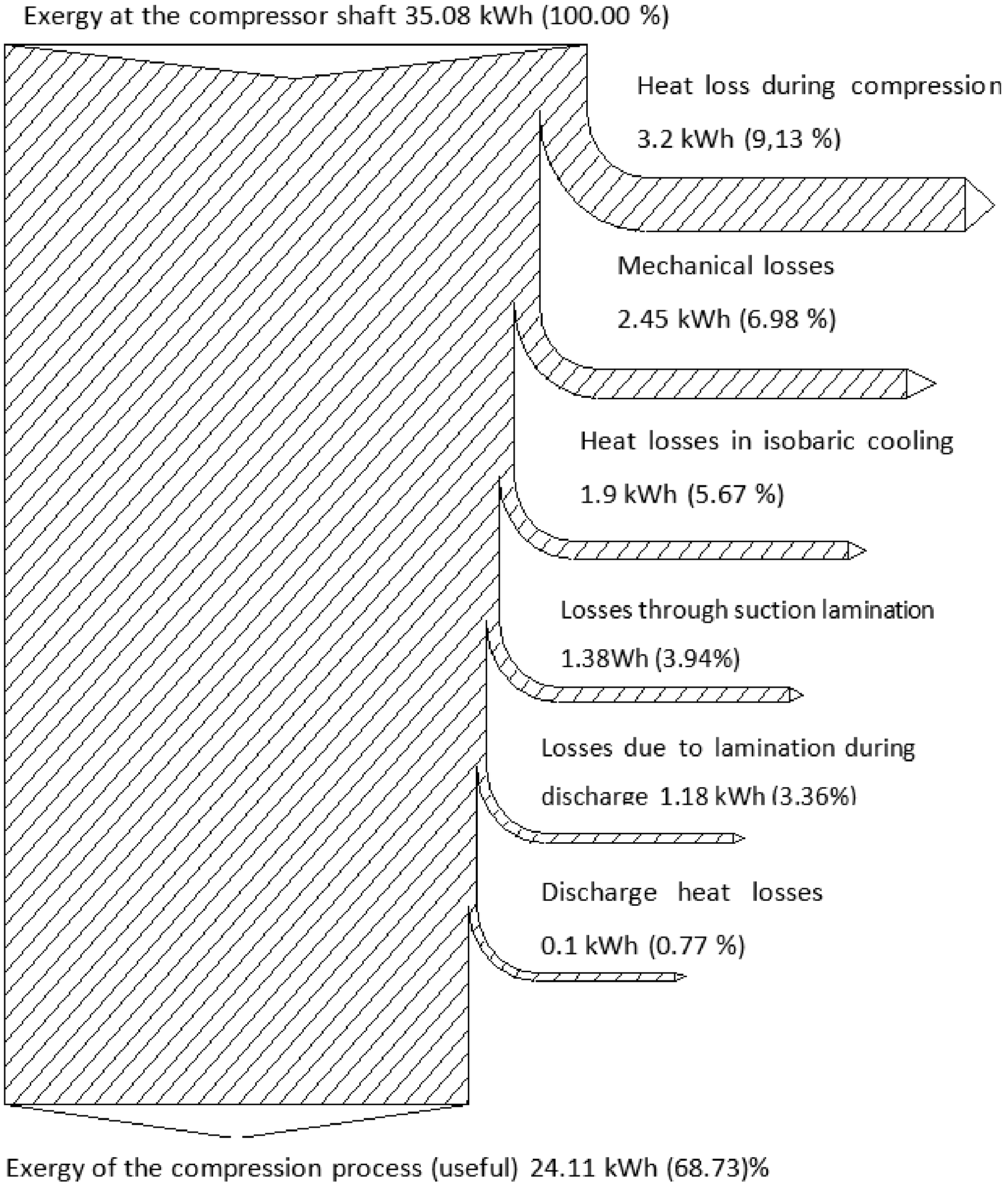


Figure 1. SANKEY diagram of the actual hourly balance for the KAESER BSD 81 compressor, 45 kW

Real specific consumption:

$$C_s = \frac{\textit{Energy at the compressor shaft}}{\textit{The hourly volume flow}} = \frac{35.08}{391} = 0.0897\frac{\mathrm{kWh}}{\mathrm{m_N^3}} = 332.92\frac{\mathrm{kJ}}{\mathrm{m_N^3}} \tag{1}$$

Specific consumption according to technical specifications:

$$C_{st} = \frac{45}{489} = 0.092\frac{\mathrm{kWh}}{\mathrm{m_N^3}} = 331.2\frac{\mathrm{kJ}}{\mathrm{m_N^3}} \tag{2}$$

Accepting the real possibility of recovery of 0.6% [5], of the heat losses during compression, of the heat losses during recharging and of the heat losses during isobaric cooling, the optimal balance will be determined in the following (table 2).

Table 2. **Summary table of optimal hourly balance KAESER BSD 81 compressor, 45 kW**

EXERGY ENTERED INTO THE CONTOUR			**EXERGY OUT OF THE CONTOUR**		
Name	**kWh**	**%**	**Name**	**kWh**	**%**
Exergy at the compressor shaft	35.08	100	USEFUL EXERGY		
			The exergy of the compression process	24.11	68.73
			Exergy related to the heat recovered from the cooling air	2.46	7.01
			LOST EXERGY		
			Losses through suction lamination	1.38	3.94
			Losses due to lamination during discharge	1.18	3.36
			Heat loss during compression	1.88	5.36
			Heat losses during discharge	1.17	3.34
			Heat losses in isobaric cooling	0.45	1.28
			Mechanical losses	2.45	6.98
			Total losses	**8.51**	**24.26**
TOTAL	**35.08**	**100**	**TOTAL**	**35.08**	**100**

By recovering the heat from the cooling air of the compressor, the exergy consumption can be reduced by 35.08-32.62 = 2.46 kWh, the specific consumption becoming:

$$C_s^{op} = \frac{32.62}{489} = 0.066\frac{\mathrm{kWh}}{\mathrm{m_N^3}} = 237.6\frac{\mathrm{kJ}}{\mathrm{m_N^3}} \tag{3}$$

The temperature of warm air discharged at the hood was determined experimentally:

$t_{airwarm} = 62\ ^0C$; warm air flow $D_{airwarm} = 0.3049$ kg/s; the specific enthalpy of warm air is 89.9 kJ/kg; the specific enthalpy of the ambient air takes 37 kJ/kg.

Recoverable heat per hour (τ = 1 h):

$$\begin{aligned} Q_{rec} &= (D \cdot (i_{acald} - i_{a)} \cdot \tau = 16.13\,\mathrm{kWh_t} = \\ &= 16.13 \cdot \left(1 - \frac{T_0}{T_{acald}}\right) = 16.13 \cdot 0.152 = 2.46\mathrm{kWh_e} \end{aligned} \qquad (4)$$

Accepting a recovery factor $f_r = 0.58$ [6] for the heat exchanger, we obtain:

$$Q_{rec}^{efectiv} = 2.45 \cdot 0.58 = 1.421\ \mathrm{kWh_e} \qquad (5)$$

3. CONCLUSIONS

Through the proposed feasible technical solution, the specific energy consumption was reduced, obtaining a significant hourly electricity saving.

REFERENCES

[1]. **Petrilean, D.C., Preda, L., Marinescu, D.C.,** Real and optimum exergetic balance sheet of helical screw compressor, ATLAS COPCO GA 30 CF to reduce energy consumption, 15th International Multidisciplinary Scientific, GeoConference SGEM 2015 Proceedings, pp. 425-432, Albena, (2015).

[2]. **Dosa I.,** Energetics of Pneumatic Installations, Tehno-Art Publishing House, Petrosani, 2003.

[3]. **Petrilean, D.C** The study of Energy Losses through Case Helical Screw Compressor, Bulletin of the Transilvania University of Brasov, Proceedings of the internationally attended national conference on thermodynamics, 235-241, 2009.

[4]. **Irimie, S.I., Radu, S.M., Petrilean, D.C., Andras, A.** Reducing the environmental impact of a gas operated cogeneration installation. In Matec Web of Conferences (2017, Vol. 121, p. 10005). EDP Sciences. DOI: 10.1051/matecconf/201712110005.

[5]. **Irimie S.I., Petrilean, D.C**., Environmental Impact Assessment for Dismantling an Energetic Complex Using Thermodynamic Concepts, 9th International Conference on ENERGY, ENVIRONMENT, ECOSYSTEMS and SUSTAINABLE DEVELOPMENT" (EEESD '13), Lemesos, Cyprus, 76-81, 2013

[6]. **Dumitrescu I., Itu R.B., Marc B.I**., Design and implementation of a milling machine with numerical control along three axes, Annals of the „Constantin Brancusi" University of Targu Jiu, Engineering Series, No. 2/2020.

This page intentionally left blank.