Monitoring the Efficiency of Particular Compressors of the Station

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Introduction

Power supply and chemical companies very often utilize the auxiliary production plants – compressors, supplying the compressed air into the main production. The compressed air distribution must be without any failure and therefore 100% must be guaranteed. It means that more compressors work in compounding in parallel. But in this case it is not possible to monitor exactly the compressors individual time and output loading, and the number of operating hours under the load.

The plant operator endeavour is to maximize efficiency of the operation and minimize the operating and maintenance costs. It can be reached by means of maintenance conditions monitoring, utilizing modern methods of the machine technical diagnostics. The operation of each machine can be characterized by measured parameters, e.g. vibrations, temperature, level of noise, energy specific consumption, power and time use factor, etc. The wear and tear of machines is the result of their loading and overloading.

This contribution should illustrate one of possible utilizations of industrial computer technology for determination of the relative loading of particular compressors at the station. The operator can use the gathered data from the technical diagnostics for assessment of the machine condition and for guarantee of the failure free operation.

Individual Machine Loading Monitoring

At the PLC automaton implemented calculation algorithms process the input signals. These signals are quantities obtained by measurements at the compression station:

- **specific flow q_v** – in the case that output of the compression station is equipped with the measurement of compressed air, the input value is measured flow q_v, expressed in normal cubic meters per second [Nm^3s^{-1}]; if there is no equipment for measurement of output compressed air at the compression station, it is necessary to furnish the station output with the measurement of temperature Θ_v, pressure p_v and the compressed air flow velocity v_v. The volume flow q_v in normal cubic meters per second can be then simply calculated and this algorithm can be implemented into the automaton.

- **temperature Θ_i** , pressure pi of the i-th compressor compressed air output

- **the electromotor current I_i** of the i-th compressor

- **value M_i** – the logical variable of the i-th compressor, giving an information about the state of the power switch

- **value K_i** - the logical variable of the i-th compressor, giving an information about the state of the relief valve

- **Consumed electric power I_{ost}** , eventually the water needed for the central cooling station, intended for all compressors.

Practical Application at the Compression Station

Due to the a.m. close relations between the university and the glass manufacturer AGC Flat Glass Europe. View into compressor station is shown in Fig. 1.

Fig. 1. View into compressor station

The practical installation and measurements were possible at one its establishment Barevka Dubí. Its main production assortment is the flat drawn glass.
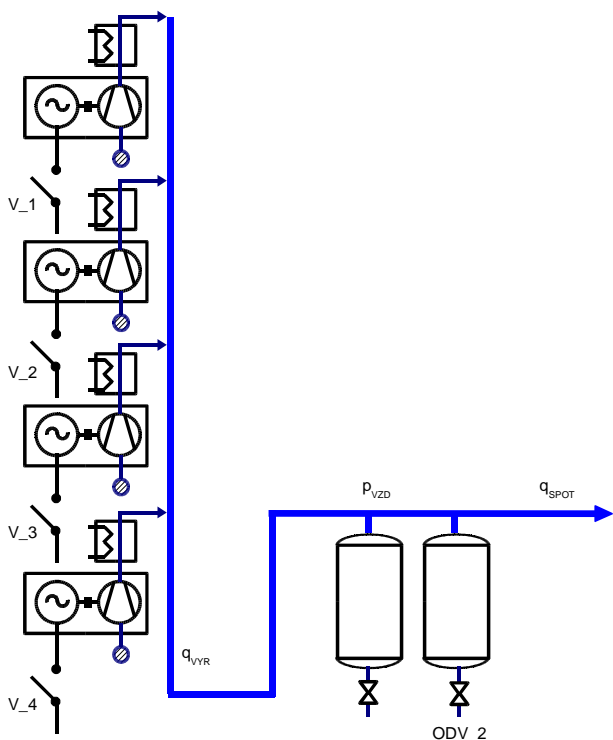

Fig. 2. Compressor Station in AGC

For the main production requirements the compression station, comprising the four compressors of different types (Fig. 2), is operated. There are following compressors:

Atlas Copco GA 90

HAFI 37

HAFI 55

HAFI 90

The compressed air being supplied by a compressor, is dried at the freezing unit, then passed to the common collection conduit and then into the air chambers. From this place it is distributed with pipe manifold to individual compressed air consuming places.

The compressed air flow is not measured.

The Compressor Station Automaton PLC/PAC analyze of the individual compressors efficiency

The automaton PLC/PAC type "Tecomat TC 700", fy Teco Kolín, was selected for both, practical application of algorithms and practical testing at the real plant. The control system generated data are processed on the connected SCADA system.

Each compressor at the station was equipped with the measurement of its power unit electric current. From this measurement the course values of electric current of each individual compressor were obtained. The PLC/PAC automaton then calculated the value of the instantaneous power input for the given instant of time.

The output of the compressor station compressed air was equipped with measurement of flow, temperature and

pressure – all in the frame of this project realization. Installation for measurement of flow, pressure and temperature is shown in Fig. 5.

The compressed air flow was measured by means of integrated orifice gauge,

Deltabar DPO10E fy Endress&Hauser with its output of 4 to 20mA. The compression station output pressure was measured with relative pressure sensor fy BD Sensors, incl. also the electric current output. The compressed air temperature was measured with resistance thermometer PT100 with the current signal transducer.

The PLC/PAC automaton was furnished with newly developed MaR distributing board.

The distributing board scheme is presented in the Fig. 3. The view into the switchboard is presented in the Fig. 4.
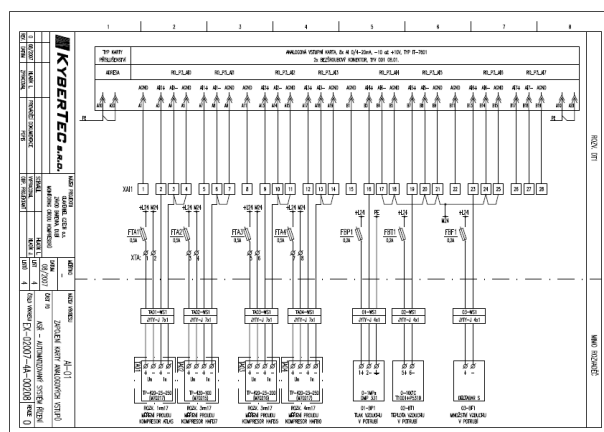

Fig. 3. Scheme of connection

Fig. 4. View into switchboard

The measured values signals of the compressed air flow, temperature and pressure were transferred to the PLC/PAC automaton calculating the supplies of air in normal units, being rated to the normal pressure 101,325kPa and to the normal temperature 0°C.

The graph of measured values of currents, compressed air temperature, pressure and flow is plotted at the Fig. 7.

The individual compressors operating hours were calculated on the basis of measured electric currents. Comparison of operation of all compressors gave a picture about contribution of each machine to the total supply and the new operating hours were calculated, taking into account the real loading of individual machines, as it was mentioned at the theoretical introduction.

Fig. 5. Measurement of flow, temperature and pressure

The all immediate measured and calculated values were saved into database and graphed by means of SCADA interface. The example of operating system is presented in the Fig. 6. The results are possible to be distributed into the company managerial computer net. As it was mentioned, at this project testing stage this net was simulated with a PC desk top computer, being placed just in the compression station.
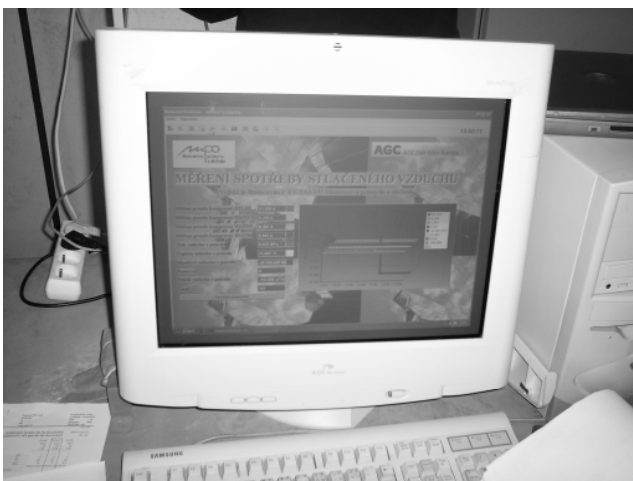

Fig. 6. Evaluation PC

The information about the real operation of the compression station individual compressors has been reached by virtue of the algorithms implemented into PLC/PAC, i.e. the calculated time and power loading of particular compressors, incl. the specific consumptions and their tendencies. This information are the indicators of the machine amortization.
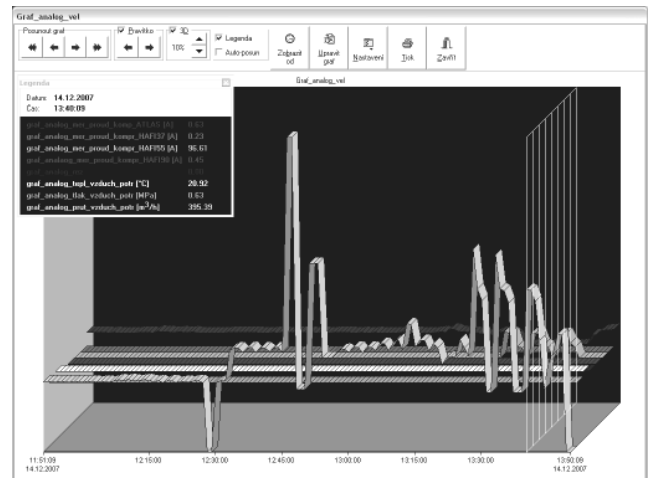

Fig. 7. Graph of measured values

Conclusion

The project "Particular Compressors of the Compressor Station Efficiency Plotting" main topic was the creation of the optimization and diagnostic system, monitoring, analyzing, documenting and optimizing both, the production and consumption of compressed air at the manufacturing company.

There were developed calculating algorithms in the frame of the project, implemented into the standard PLC/PAC automaton, being so created a prototype of diagnostic equipment, monitoring, plotting and documenting the production of compressed air by individual compressors of certain compression station. The particular amortization of compressors has been plotted by means of calculating algorithms, having been implemented into PLC/PAC automaton, being based on the course of loading and overloading of individual compressors. The operating organization has reached so information about individual operation of each machine at the compression station. The calculated time and power loading, incl. specific energy consumptions has become a certain parameter of the machine wear and tear. These information enables the plant operator to optimize and plan their operative maintenance, resulting in prospective savings of maintenance capacities and financial costs.

References

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J. Šípal. Monitoring the Efficiency of Particular Compressors of the Station // Electronic and Electrical Engineering. – Kaunas: Technologija, 2008. – No. 3(83). – P. 67–70.

Results of the project "The Production of Compressed Air of Particular Machines Efficiency Analyze" are presented. This project has been financially supported by the project FT – TA3/155 from the program "Tandem", announced by the Ministry of industry and commerce of the Czech Republic. It is the application of the methods of theoretical informatics in the industrial practice, namely the particular compressor   relative loading determination, which can be used later for diagnosis of the each machine, resulting in fluent service of production plants. The first phase of works was focused in the theoretical part of the project, i.e. the theoretical problems and algorithms procession. The following phases solved an implementation of these algorithms to PLC/PAC and the practical testing on the real equipment, i.e. the realisation on the real automaton and its application at the real surroundings of the compression station. For the purpose of real application in real conditions the PLC/PAC automaton from the Teco Kolín Company, type "Tecomat TC 700" has been selected. The control system calculated data are processed by the connected SCADA system. The results can be distributed also into the company managerial computer net. In the frame of the project tests the system of the company informatics system was replaced with a PC desk top computer, being placed directly at the compressor station. By virtue of the close cooperation between the Jan Evangelisty Purkyně University and the glass concern AGC Flat Glass Europe, both the real installation and practical measurements at its establishment Barevka Dubí was possible. Ill. 7, bibl. 4 (in English; summaries in English, Russian, Lithuanian)

Я. Шипал. Система для анализа нагрузки компрессорной станции // Электроника и электротехника. – Каунас: Технология, 2008 – № 3(83). – С. 67–70.

Представлены результаты проекта «Анализ эффективности машин производства сжатого воздуха». Этот проект был материально поддержан FT – TA3/155 из программы «Тандем», объявленной министерством промышленности и торговли Чешской Республики. Представлены результаты применения методов теоретической информатики в индустриальной практике, а именно, определение специфической нагрузки компрессоров воздуха. Результаты можно использовать для диагностики таких машины. В реальном эксперименте в реальных условиях был использован автоматон PLC/PAC из компании «Teco Kolín» типа «Tecomat TC 700». Данные системе управления вычисляются системой SCADA. Результаты могут быть переданы в компьютерную сеть операторов. Ил. 7, библ. 4 (на английском языке; рефераты на английском, русском и литовском яз.)

J. Šípal. Kompiuterizuota oro kompresorių stoties apkrovos analizės sistema // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2008. –Nr. 3(83). – P. 67–70.

Pateikti projekto, skirto oro kompresorių efektyvumui analizuoti, rezultatai. Projektą finansiškai rėmė „Tandem" programai priklausantis FT – TA3/155. Programą inicijavo Čekijos Respublikos pramonės ir prekybos ministerija. Pateikiami teorinės informatikos metodų pritaikymo pramoninėje praktikoje rezultatai – kompresorių santykinės apkrovos nustatymas. Tai galima panaudoti diagnozuojant šias mašinas. Taip užtikrinamas sklandus gamybos aptarnavimas. Pirmoji darbų fazė buvo skirta teorinei projekto daliai – problemoms spręsti teoriniame lygmenyje ir algoritmams sudaryti. Vėlesnėse fazėse algoritmai įdiegti ir praktiškai išbandyti realioje įrangoje. Eksperimentui buvo pasirinktas „Teco Kolín" kompanijos PLC/PAC tipo automatinas „Tecomat TC 700". Valdymo sistemai duomenis tiekia SCADA posistemis. Rezultatai perduodami į operatorių kompiuterių tinklą. Il. 7, bibl. 4 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).