Caspian Journal of Environmental Sciences

Online ISSN: 1735-3866
Print ISSN: 1735-3033

Wind energy use possibility in LCTM circulation system of a machine-building enterprise

Bulat Faritovich Bairamov*, Albert Rifovich Fardeev

Department of Mechanics and Design, Automotive Department, Naberezhnye Chelny Institute (branch), KFU, Russia

Corresponding author's email: bbairamov@gmail.com

ABSTRACT

In this paper, they considered the process of mechanical processing of parts, during which heat release occurs. High temperatures can lead to reduced tool life, reduced accuracy and processing quality. Therefore, lubricating and cooling technological means (LCTM) are supplied to the processing zone, which reduces friction forces and removes the released heat. LCTM used in machining for cooling and lubrication should be cleaned to a greater or lesser extent depending on the required fluid purity. The fluid temperature must be maintained at a constant level, if necessary. Otherwise, the accuracy of processing needed (surface cleanliness, dimensional stability) will not be achieved. Regeneration of LCTM occurs by their circulation through filters. Pumps are used to ensure circulation. The pumps are driven by electric motors that consume electricity. It is proposed to reduce the costs of LCTM provision by using cheap, environmentally friendly, safe types of energy in the process of circulation and building automatic control systems for LCTM circulation. One of the ways to get affordable energy is to use wind turbines. The article discusses the existing system of LCTM circulation and possible ways of wind energy use in it. The analysis of existing wind turbines and wind power plants has been carried out. The advantages and disadvantages of vane, rotary and orthogonal wind turbines are indicated. It is proposed to create a wind power plant that circulates liquid through filters, which can operate both from a wind engine and from a non-wind engine.

Keywords: Lubricating and cooling technological means, Regeneration, Circulation, Energy, Control system.

INTRODUCTION

Hydraulic control systems are one of the means for automation and mechanization of production processes in mechanical engineering. The energy of a fluid under pressure is used to drive mechanisms and machines, and automatic control systems for technological processes. But the efficiency of energy carrier production means for hydraulic systems is not high enough. Reducing the cost of the process, which increases the fluid pressure is possible by the introduction of cheap, environmentally friendly types of energy in it and the development of automatic control systems for liquid pressure increase. Modern mechanical engineering is a powerful energy consumer. Irreplaceable natural resources are mainly used for their production. At the same time, emissions of heat and fuel combustion products into the atmosphere are high. In this regard, the relevance of power plant use based on renewable energy sources in technological processes increases. Fuel price increases during transportation. The construction of power lines is expensive. The wind does not need transportation. The use of wind turbines should reduce the consumption of fossil fuels. Another comprehension of the essential standards of the GAZ creation framework and their sway on the work measures in the association were proposed, and contends for the need to execute ventures in a number of territories, for example, the presentation of new creation, innovative and strategic cycles, staff preparing, and segment restriction (Kuznetsov *et al.* 2018). Standards of creation and primary instruments of usage of a technique for venture and operational administration for machine-building undertakings are thought of. The technique utilizes the model of the consolidated work process deciding causes and impact connections between measures at phases of a lifecycle of production of the unpredictable specialized framework

Caspian J. Environ. Sci. Vol. 18 No. 5 (Special Issue: Environmental Aspects of Economic and Social Sustainable Development)
pp. 609~614 Received: May 15. 2020 Accepted: Nov. 04. 2020
DOI: Article type: Research

(Lopota *et al.* 2017). For the viability evaluation in the system of big business advancement it is convenient to complete the standard checking of exercises. For that there are should be assessed second records, paces of lists increment. A standard arrangement is under development portraying paces of development of some lists with respect to other people. Quantitative files in successions shaped are set up thinking from the need to guarantee the advancement improvement of an endeavor (Gerashchenkova 2017). The effectiveness of the machine-building undertaking relies upon the productivity of the executives choices at all levels, which influence the usage of creation orders, judicious utilization of creation assets (Medvedev & Aksyonov 2020). Until now, the problems of controlling the operation of a wind turbine have not been studied sufficiently. Therefore, the problems of automatic control system development for technological processes containing wind turbines are urgent. There is a need to improve the wind turbine itself. There are systems for LCTM circulation at machine-building enterprises to ensure the supply of clean lubricating and cooling technological means (LCTM) to metal-working machines (Fardeev *et al*. 2015). Let's analyze the possibility of wind turbine introduction into this system.

MATERIALS AND METHODS

Let's consider the system that is used at many machine-building enterprises to ensure the circulation of LCTM and serves several dozen metal-working machines at the same time. It mainly consists of a system centrifugal pump 1, a centrifugal filtration pump 2, a standby pump 3, a finishing tank 4, a sludge tank 5, a band filter 6, an overflow valve 7 and two pipelines. The liquid is supplied through the first pipeline, from the finishing tank to the metal-working machines and then to the sludge tank. The second pipeline passes the liquid from the sludge tank to the band filter and then to the finishing tank. There are auxiliary devices: oil removal device, liquid aeration device, and condensate removal device. The oil removal device consists of a float 8, an oil separating pump 9, an oil separator 10, an oil container 12 and pipelines. The device for liquid aeration consists of pipelines through which compressed air is supplied from the pneumatic line. The device for condensate removal consists of pipelines, a tank 13 for condensate collection and a pump 14. During system operation, contaminated liquid flows from metal-working machines into a sludge tank. The filtration pump 2 pumps liquid from the sludge tank 5 into the band filter 6. From the filter 6 the purified liquid flows into the finishing tank 4. From the finishing tank, the liquid is pumped by the system pump 1 to the metal-working machines (Fardeev *et al.* 2017; Adib *et al.* 2018; Sobhani & Safarianzengir 2020). The pressure with which the fluid is supplied to the machines must be constant. This provides an overflow valve 7, which drains part of the supply of the system pump 1 into the finishing tank when the pressure in the pipeline increases above the required one. The power of the filter pump 2 exceeds the power of the system pump 1 by 10%. Therefore, the liquid is constantly drained through the overflow channel from the finishing tank 4 into the sludge tank 5. When the band filter is regenerated, the filter pump 2 is turned off, and the supply of clean liquid from the band filter to the finishing tank 4 is stopped. The dimensions of the tank four are chosen so that its volume is sufficient to provide the machines with liquid during filter regeneration. After the end of the regeneration, the filter pump 2 is switched on again and the finishing tank is filled with liquid because the power of the filter pump is 10% higher than the power of the system pump. The contaminated liquid is fed tangentially to the side surface of the sludge tank and taken out from it at the lowest point. Thus, all the liquid in the tank is in constant motion. This prevents large masses of dirt from settling in the tank. If the liquid is heavily contaminated, then such measures are not enough, and the sludge tank is equipped with a scraper conveyor that removes heavy settling dirt in a dried form. We will not consider the case of substantial contamination of the liquid. Let's consider the operation of a strip filter. The strip filter consists of a liquid distribution device, an upper chamber, a lower chamber, a filter cloth, a filter plate, deflection rollers, coilers, a scraper, and a sludge collector. The filter works as follows. From the sludge tank, the contaminated liquid is fed by the filtration pump to the upper chamber through the liquid distribution device. This device is a bath with slots in the bottom, fixed in the upper part of the upper chamber. The liquid flows through a filter cloth from the upper chamber supported by a filter plate into the lower chamber, and then into the finishing tank. Solids are retained by the filter cloth and form a cake on it. When liquid enters the upper chamber from the pipeline, the pressure in it drops due to the high throughput of the filter cloth. The cake formed on this tissue reduces its throughput and the pressure in the upper chamber increases. When a certain pressure is reached, automatic filter cleaning starts. If the pressure does not rise due to the special structure of the cake, the filter cleaning operation is triggered by a clock mechanism or a probe to measure the thickness of the cake. In addition, the start of the filter cleaning process can be done manually.

Caspian J. Environ. Sci. Vol. 18 No. 5 (Special Issue: Environmental Aspects of Economic and Social Sustainable Development)
pp. 609~614 Received: May 15. 2020 Accepted: Nov. 04. 2020
DOI: Article type: Research

The filter cleaning process begins by stopping the filter pump. The liquid stops flowing into the filter. After emptying the upper chamber, the blowing process begins (compressed air is supplied to the upper chamber). After the blowing time has elapsed, the winding left-hand winder draws the used filter cloth together with the dried cake out of the upper chamber. When the filter cloth passes over the deflection roller, the cake is scraped off with a scraper and dumped into the sludge collector. Sometimes, in order to save money, the filter cloth is used several times. For this, cake residues on the fabric are removed with a brush roller, and the cleaned filter cloth is fed back into the filter by the right winder rotation. After cleaning the filter, the filter pump turns on, and the process of filtering the liquid starts again. If one of the pumps (filtration or system) fails, their operation is performed by the backup pump. The connection of a backup pump instead of a filtration or a system pump is made using the valves. The operation of the oil removal device is as follows. There is a float 8 in front of the overflow channel, which sucks out foreign or dropped oils from the liquid. In this case, in addition to oil, the liquid is also captured. The oil mixed with the liquid is supplied to the oil separator ten by the oil separator pump 9. The oil is freed from the liquid in the oil separator and drained into the oil container 12. The liquid is fed from the oil separator into the sludge tank 5.

During the device operation for aerating the liquid, compressed air is supplied from the pneumatic line to the clean and sludge tanks. In this case, the liquid is mixed. The stirring process is necessary to preserve the liquid, and therefore contributes to its prolonged use. When the device for condensate removal is in operation, the condensate formed in the process of circulation and regeneration is removed from the lower part of the clean and sludge tanks by opening the valves and blown out of the pipeline by compressed air into the tank 13 for condensate collection. Condensate is discharged outside by the pump 14 from the tank 13 (upon reaching a certain level). To empty the tanks, the liquid is directed from the finishing tank not to the metal-working machines, but into a special container. The change in the direction of fluid movement is carried out using valves. The most powerful, and, therefore, the largest energy consumers in the considered LCTM circulation system are the system pump 1 and the filtration pump 2. Reserve pump 3 is not considered, since it is not used generally. Therefore, it makes sense to replace the pumps 1 and 2 with wind pump units. The pump will be replaced only for a certain period of time. This refers to the operating time of the windpump units in the mode of liquid circulation provision by the windpump unit and in the mode of the accumulator discharge. The system pump 1 pumps the purified liquid. Therefore, it can be replaced from time to time with a mechanically driven wind pump unit with a vane pump. The filtration pump 2 pumps contaminated liquid, so it can be replaced from time to time with a hydraulically driven wind pump unit with a centrifugal pump. If the wind speed did not drop below a certain level, then it would be possible to replace the pumps 1 and 2 with wind pump units. Since the wind speed is constantly changing (sometimes decreasing to zero), then it is necessary to use automatic Control to connect the pump 1 and 2, or wind pump installation for a particular time. A machine is called a windpump unit, the engine of which is a wind turbine, and the executive body is a pump (Jagadevlah & Smith 1975). To facilitate the choice of a wind turbine, we will consider the designs of existing wind turbines.

RESULTS AND DISCUSSION

A wind turbine is a mechanism that converts the kinetic energy of the wind into mechanical energy of shaft rotation. The working body of the wind turbine is the wind receiving device. There are the following wind collectors: rotor, drum, and wind wheel. The rotor is a shaft on which the blades are fixed. The rotor rotation axis is vertical. The drum differs from the rotor only in the following: its axis of rotation is horizontal. The wind wheel is a hub on which the blades are fixed at a certain angle to the axis of hub rotation. This angle is called the angle of attack. The wind turbines in which a rotor is used as a working body are called rotary or carousel. The wind turbines in which the drum is the functional body are called a drum. The wind turbines with a functioning body in the form of a wind wheel are called vane. This name is because the blades of a wind wheel are sometimes called wings. Rotary and drum wind turbines work as follows: the force of wind pressure acts on the blades located on one side of the drum rotor rotation axis, a torque arises, and the rotation of the wind turbine shaft begins. To prevent the force of wind pressure on the blades located on the other side of the drum rotor rotation axis, they are closed with half-cylinders.

If the blades of a rotary wind turbine are concave, then the rotor rotates even without the closing half-cylinders, since the force of wind pressure on the concave side of the blade is much greater than the pressure force on the

Caspian J. Environ. Sci. Vol. 18 No. 5 (Special Issue: Environmental Aspects of Economic and Social Sustainable Development)
pp. 609~614 Received: May 15. 2020 Accepted: Nov. 04. 2020
DOI: Article type: Research

convex side. Guides can be installed around the rotor in rotary wind turbines. They direct the airflow along regular to the blade surface at the pressure point. The principles do not require orientation in the wind direction. Wherever the wind is blowing, it will always hit only one side of the rotor. Thus, the use of concave blades or the installation of guides makes it possible not to use the downwind orientation system (Bairamov & Mardamshin 2008). The disadvantage of rotary wind turbines is their slow speed. But the low rate of the rotary wind turbine gives one advantage: the rotary wind turbine is silent. This advantage allows it to be located in close proximity to residential and industrial buildings. Drum wind turbines are not widely used in the modern world. Vane-type wind turbines are widely used now. This is due to the high utilization of wind energy in these wind turbines and the high angular speed of the wind turbine rotation. The wind energy utilization factor ξ is the ratio of the power N (Nikitin 1990) developed by the wind turbine to the wind power N_B :

$$\xi = \frac{N}{N_B}.$$

The high angular speed of the wind turbine rotation allows the shaft of the wind turbine to be connected directly to the shaft of a widespread high-speed generator of electric current. The rotation axis of the propeller-driven wind turbine is located horizontally, and a system is required that continually changes its position in the horizontal plane so that the propeller rotation axis is directed along with the wind speed. There are various orientation systems. The easiest way is to equip the wind turbine head with a stabilizer wing, which works on the principle of a weather vane. Due to the automatic adjustment of the attack angle of a high-speed vane wind turbine blades, its power is limited. The same system of automatic adjustment of the blade attack angle reduces the increasing angular velocity of the propeller at low load. This prevents the wind turbine from breaking. The high utilization rate of wind energy is the reason for the widespread use of vane wind turbines. But despite the low utilization of wind energy, it makes sense to manufacture rotary wind turbines. This is due to the following advantages: low tower height, quiet operation, the possibility of positioning the machine executive bodies on the earth surface due to the vertical axis of rotation, and the absence of a downwind orientation system. Among other things, these advantages reduce the cost of the rotary wind turbine, which is of great importance for their industrial production increase. Previously, rotary vane-type wind turbines were considered, when the blades use the force of wind pressure. There are rotary wind turbines with blades that use lifting power. In this case, the blades have a wing profile and are parallel to the axis of rotation. Since the axis of rotation of such wind turbines is located orthogonal to the wind direction, they are called orthogonal.

CONCLUSIONS

The advantage of orthogonal wind turbines over rotary ones is the increased utilization of wind energy ξ. But they also have a drawback. The rotor of an orthogonal wind turbine must first be untwisted, and only after that, the lifting force applied to its blades will create a torque. A wind power plant (WPP) is a machine designed to convert wind energy into some other type of energy. Like any machine, a WPP consists of an engine, a transmission and the machine executive bodies. The WPP engine is a wind turbine at a given time, or another non-wind engine (usually an internal combustion engine or an electric motor powered by an external electrical network). The transmission can be mechanical, electric, pneumatic or hydraulic drives. The executive bodies of the wind turbine can be generators of electric current, pumps, mills, and so on, or a power take-off shaft. The WPP differs from other machines in that it has two engines of different types. When the wind speed is equal to or higher than the design speed, the operation of the executive bodies is provided by the wind turbine. If the wind speed is lower than the design speed, then a non-wind motor acts as the engine of the machine. At the same time, if the wind speed allows the wind turbine to generate energy, then the wind turbine continues to operate, but the energy generated by it is stored in various batteries. Accumulators can be hydraulic, pneumohydraulic, electrochemical and so on. After sufficient energy has been accumulated, the energy from the battery is used instead of the energy generated by the non-wind motor.

SUMMARY

To connect or disconnect a wind turbine, non-wind motor and battery, a control system is required (Bairamov & Bairamov 2018). It should operate automatically (Peiffer & Rouche 1969) depending on the wind speed and the

Caspian J. Environ. Sci. Vol. 18 No. 5 (Special Issue: Environmental Aspects of Economic and Social Sustainable Development)
pp. 609~614 Received: May 15. 2020 Accepted: Nov. 04. 2020
DOI: Article type: Research

state of the battery charge. In addition, the control system must regulate the joint operation of an engine and the executive bodies of the machine (Yoshizawa 1966) under changing operating conditions. To use wind energy in the LCTM circulation system, it is necessary to create a wind power plant that circulates liquid through filters. In connection with the wind speed variable, it is also essential to control the operation of the wind turbine and the entire wind power plant (Fardeev & Abdullina 2016). It is desirable that this Control is automatic.

ACKNOWLEDGEMENTS
The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

REFERENCES

Adib, A, Oulapour, M & Chatroze, A 2018, Effects of wind velocity and soil characteristics on dust storm generation in Hawr-al-Azim Wetland, Southwest Iran, *Caspian Journal of Environmental Sciences*, 16: 333-347

Bairamov, FD, Bairamov, BF 2018, About hybrid system stability with distributed and concentrated parameters. *HELIX*, 8: 2493-2498.

Bairamov, FD, Mardamshin, IG 2008, Investigation of operation of hydraulic systems with wind pumping units", *Russian Aeronautics*, 51: 314-320.

Fardeev, AR, Abdullina, AM 2016, Joint operation of a hydraulically driven wind pump unit and a pipeline when the wind speed and the number of consumers are changed. *Scientific and Technical Bulletin of the Volga Region*, 1: 33-36.

Fardeev, AR, Bayramov, FD, Bayramov, BF 2015, Modernized system of lubricating and cooling technological means supply for metal cutting machines and research of its dynamics. *Scientific and Technical Bulletin of the Volga Region*, 5: 125-128.

Fardeev, AR, Fardeev, AA, Abdullina, AM 2017, The operation of the hydraulic valve of the manipulator, when they control technological processes of forging and hot stamping. Modern technologies in mechanical engineering: a collection of articles of the 21th International Scientific and Technical Conference, Penza, December 2017, ANOO "Privolzhsky House of Knowledge" – Penza, 28-32.

Gerashchenkova, T 2017. Approaches to the evaluation of the effectiveness of innovative development of the machine-building enterprise strategy. In: SHS Web of Conferences, EDP Sciences, Vol. 35, p. 01119.

Jagadevlah, TS, Smith, RT 1975, Generation schemes for wind power plants", paper presented in the 10th Intersociety Energy Conversion Engineering Conference (IECEC), Newark.: Delaware, August.

Krainev, AF 1987, Dictionary-reference book on mechanisms. Moscow, Mechanical Engineering, 560 p.

Kuznetsov, VP, Garina, EP, Romanovskaya, EV, Kuznetsova, SN and Andryashina, NS, 2018. Organizational design and rationalization of production systems of a machine-building enterprise (by the example of the contract assembly workshop). *Espacios*, 39: 25.

Lopota, AV, Tsyrkov, AV & Tsyrkov, GA 2017, Methods and tools of project-operational management of a machine-building enterprise. In 2017 International Conference on Quality Management, Transport and Information Security, Information Technologies (IT&QM&IS), IEEE, pp. 544-547.

Medvedev, S & Aksyonov, K 2020, Development of a method and decision support system for distributing orders of a machine-building enterprise. In IOP Conference Series: Materials Science and Engineering, IOP Publishing, Vol. 971, No. 4, p. 042097.

Nikitin, NN 1990, The course of theoretical mechanics. Moscow Higher School, 608 p.

Peiffer, K, Rouche, N 1969, Liapunov's second method applied to partial stability. *Journal de Mécanique*, 8: 323-334.

Sobhani, B and Safarianzengir, V 2020, Monitoring and prediction of drought using TIBI fuzzy index in Iran, *Caspian Journal of Environmental Sciences*, 18: 237-250

Yoshizawa, T 1966, Stability theory by Lyapunov's second method. Tokyo: Mathematical Society of Japan, 223 p.

Caspian J. Environ. Sci. Vol. 18 No. 5 (Special Issue: Environmental Aspects of Economic and Social Sustainable Development)
pp. 609~614 Received: May 15. 2020 Accepted: Nov. 04. 2020
DOI: Article type: Research

امکان استفاده از انرژی باد در سیستم گردش LCTM یک شرکت ماشین‌سازی

بولات فاریتوویچ بایراموف*، آلبرت ریفوویچ فردایف

دانشیار گروه مکانیک و طراحی، گروه خودرو سازی، موسسه نبرازین چلنی، KFU ، روسیه

(تاریخ دریافت: ۹۹/۰۲/۲۶ تاریخ پذیرش: ۹۹/۰۸/۱۴)

چکیده

در این مقاله، به بررسی فرایند پردازش مکانیکی قطعات که در طی آن آزاد سازی گرما رخ می‌دهد، پرداخته شده است. دمای بالا می‌تواند موجب کاهش عمر مفید ابزار، کاهش کیفیت پردازش و صحت شود. بنابراین، ابزارهای فناورانه روانکاری و خنک سازی (LCTM) در قسمت پردازش استفاده می‌شوند و باعث کاهش نیروی اصطکاک و گرمای آزاد شده می‌شوند. LCTM مورداستفاده در ماشین کاری برای خنک سازی و روان کاری، باید بسته به خلوص مایع مورد نیاز، پاک شود. دمای مایع یا سیال باید در صورت لزوم ثابت باشد. در غیر این صورت، دقت پردازش مورد نیاز (تمیزی سطح، پایداری ابعادی) حاصل نخواهد شد. بازتولید LCTM از طریق گردش آن‌ها به روش فیلتراسیون صورت می‌گیرد. پمپ‌ها برای اطمینان از گردش استفاده می‌شوند. پمپ‌ها توسط موتورهای الکتریکی کار می‌کنند که برق مصرف می‌کنند. این روش برای کاهش هزینه‌های LCTM با استفاده از انواع انرژی‌های ارزان، سازگار با محیط‌زیست و ایمن در فرایند گردش و دستگاه‌های کنترل خودکار برای گردش LCTM پیشنهاد شده است. یکی از شیوه‌های تولید انرژی ارزان، استفاده از توربین‌های بادی است. در این مقاله در مورد سیستم فعلی گردش LCTM بحث شده و شیوه‌هایی را برای استفاده از انرژی باد ارائه می‌کند. تحلیل نیروگاه‌های انرژی بادی و توربین‌های بادی انجام شد. مزایا و معایب توربین‌های بادی پره‌ای، روتاری و ارتوگونال ارائه گردید. پیشنهاد می‌شود تا یک دستگاه بادی برای گردش مایع در داخل فیلترها با استفاده از موتور بادی و غیر بادی، استفاده شود.

*مولف مسئول

Bibliographic information of this paper for citing:

Faritovich Bairamov, B, Rifovich Fardeev, A 2020, Wind energy use possibility in LCTM circulation system of a machine-building enterprise, Caspian Journal of Environmental Sciences, 18: 609-614

Received: May 15. 2020 Accepted: Nov. 04. 2020
DOI:
Article type: Research