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« Investigation of possibility of transformation of heat environmental energy into electric energy by means of vortex process »

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Note: Text of English version is prepared in 2015 by the author, with additional comments and clarification.

ABSTRACT

The report contains 58 pages, 26 figures, 1 table, 1 graph. The report use 15 references to other publications. Keywords: energy conversion, centrifugal energy converter.

Object of study in this paper is method of converting of dissipated environment heat energy. Also we plan to calculate parameters of energy converter, operating according to this method. The objective of the work is determination of principles of conversion of environmental heat energy mechanically, by means of compression-decompression of elastic working body and to design autonomous fuel-less power source.

The methodology of the project: Considering main known technical solutions in this field of research, the author offered theoretical model of calculation of main parameters of the process. Then set of design documentation can be created to produce experimental energy converter. Testing of this experimental model will allow adjustments of the theoretical model. The result of this work should be develop up to workable concept of energy conversion, which must be proved by experimental way.

There is no open information about this object of research in Russia and abroad. Some analogues are discussed in this report.

Practical development of this research is autonomous fuel-less source of mechanical energy and propulsion force. This machine can be used to be electric power source to provide electricity power in 10 kW - 10 MW level.

Importance of this technology for industrial needs can be evaluated by analyzing fuel component of any industrial production process. This fuel component reduces efficiency of all kinds of transport and

increases production costs of any product, including agricultural products. The proposed technical solution eliminates this costly fuel component.

At this stage (R & D) the design documentation is developed to produce experimental device only. Development of research is future stage allows build prototype of power converter and organize mass production of autonomous power sources.

CONTENT

NORMATIVE REFERENCES

This research report use references to Russian standards of documentation:
1. General requirements and rules of design documentation must correspond to Russian Standard GOST 2.105-95 "Unified system of design documentation. General requirements for textual documents " (approved by resolution of the Russian State Standard at August 8, 1995 № 426).

DEFINITIONS

Present report use following terms with corresponding definitions:

1. **The converter** means centrifugal vortex converter of environmental heat energy into electric power.
2. **Low-potential heat** means scattered thermal energy of environment, in particular, energy of air.

3. **The heat pump** means device to transfer heat energy from low-potential source of heat energy (with a low temperature) into energy of more hot heat carrier. Thermodynamic describe heat pump as reversed refrigerator.

4. **Working liquid, liquid working mass, working mass** – it is water, oil or other liquid substance to be used in centrifugal vortex converter of energy. Important property of this “working liquid” is its inertial mass (rest mass). It is necessary to use it in inertial processes, for example, in rotation or accelerated movement.

5. **Elastic working body** is aerated working liquid, i.e. liquid mixed with some amount of air. Property of elasticity in this case is essential to accumulate potential energy in form of elastic deformations.

6. **Working mix** is elastic mix of liquid and gases.

7. **Aerated mix or aerated liquid** is stream (flow) of liquid including air bubbles.

8. **Coefficient of increase of power** is ratio of kinetic energy of stream of working liquid at the outlet from nozzle of rotor pipe to kinetic energy, which was spent to create rotation of working liquid in the rotor.

9. **Laminarization of a stream of air or liquid** is reduction or full elimination of turbulence of this stream. It is reduction of entropy of this stream, i.e. alignment of speed vectors of molecules in one direction.

10. **Aether** is universal gaseous environment media. It consist of particles. The particles have some mass, it is much less than mass of hydrogen atom. More detailed description is presented in article [1] by Prof. Mendeleyev's definition of aether. Aether is connected with particles of matter, and aether is reason of its rest mass (inertial effects). This connection is demonstrated as inertial effect in case of accelerated motion of any massive body. Aether can be described with real physical properties, including elasticity of Aether.

SYMBOLS AND TERMS

TERM		SYMBOL	
Acceleration of gravity	-	g	(m/c^2)
Normal acceleration	-	a	(m/c^2)
Length of accelerated movement way	-	h	(m)
Angular speed of rotation	-	ω	(rad/c)
Rotation per minute speed	-	n	(rpm).
Linear velocity of motion	-	V	(m/)
Velocity of stream of liquid	-	υ	(m/c)
Energy	-	E	(J)
Power	-	P	(Watt)
Power of first turbine	-	P_1	(Watt)

Power of second turbine	-	P_2	(Watt)
Power of third turbine	-	P_3	(Watt)
Input power	-	P_{in}	(Watt)
Expenses of liquid volumetrical	-	N_1	(m^3/c)
Expenses of liquid mass	-	N_2	(kg/c)
Density of working liquid	-	ρ	(kg/m^3)
Kinematic viscosity of water	-	ν	(m^2/c)
Axial length of way of liquid in rotor	-	X	(m)
Angle of inclination of the screw	-	α	(degrees)
Angle of blade	-	β	(degrees)
Section of pipe	-	S	(m^2)
Diameter of pipe	-	D	(m)
Radius of rotation	-	R	(m)
Average critical velocity	-	$(V_{ave)critical}$	(m/c)
Mass	-	m	(kg)
Factor of hydraulic friction	-	λ	
Factor of resistance to the flow	-	C_d	
Pressure	-	p	(N/m^2)
Reynold’s critical number	-	$Re_{critical}$	

INTRODUCTION

Let’s describe current state of this scientific and technical problem. Power sources have various applications and we can determine two main areas: house power supply or industrial power sources, and also transport power sources. Relevance of present research is great demand in power sources. Modern power engineering is based on hydro carbonic fuel, for example, gas-turbine power plants and internal combustion transport engines. It can't provide growing needs in high-quality development of civilization. Demand grows more quickly than offer. Fuel – based power engineering is not unique solution in modern World. It is necessary to change fuel concept of power engineering industry. Modern technologies must provide low cost and ecologically clean solutions. This process already is demonstrated in new transport technologies (hybrid and electric cars), wind, solar and heat pump power sources.

In Russia and abroad, some experiments were made to obtain additional kinetic energy from molecules of water flow or molecules of air (transformation of environment heat energy), but we do not know about organizing efforts to create production facilities and start manufacturing of autonomous energy converters. Experimental converters of centrifugal - vortex type are shown in point 3 of this report.

Novelty of presented here technical idea is special part of rotor, which play role of centrifuge. Also novelty is explanation of factor of elasticity. It is important property of working mix of gas and liquid in this technology of energy transformation. Purpose of the centrifuge is considered in point 8, where you can see some calculations of power of the energy converter.

The proposed technical solution allows to get self-acceleration of rotor to apply this technology for wide range of power plants and transport propulsion units. This solution include method of creation of conditions of acceleration of motion of working liquid in the rotor, special elements of design to provide transfer of kinetic energy of liquid stream into kinetic momentum of rotor that leads to increase of its torque, and also condition of transfer of kinetic energy of liquid stream after exit from nozzle of rotor to the rotor, that allow to create additional increase of torque of the rotor.

There are three types of turbines in the rotor: screw turbine, jet turbine and turbine with blades. There are no known analogs of this design of the device.

The basis of this scientific Report is Contract No. 1 of January 11, 2011 between JSC Faraday, Tula, Russia and Customer JSC “Vortex heat energy converters”, Kurgan, Russia. Several sketches of the design are part of this report, but complete set of design documentation must be produced according to Russian standard GOST 2.105-95 and it was provided to the Customer separately.

Theoretical researches in this topic can't give us completed answer to all questions about transformation of environment thermal energy into useful mechanical work. Several factors in theoretical model cannot be exactly calculated. It is necessary to organize Research Project, to design, build and to test experimental model, then to organize measurements to modify the theoretical model, and then to get more detailed understanding of parameters of all processes. After this stage it will be possible to design commercial level prototype of the energy converter.

This Research Project is planned only to calculate parameters of design of experimental level model of energy converter, and after its testing we can come to new level of researches. It is necessary to check all parameters of theoretical model by means of experiments.

The main technical characteristics of the offered experimental model are following:

- The dimensions were set by Customer.

- The rotor of the converter has spiral pipes filled with moving liquid.

- In the centrifuge, by means of mixing of liquid and air we can create cavitation effects, so this aerated gas-water mix will demonstrate required physical properties, especially important property of elasticity of working body.

- Start (beginning of rotation of the rotor) is caused by moving liquid mass in the rotor. The external centrifugal pump is used for this purpose.

- The liquid outlet (exit from the rotor) is organized through tangential nozzles of rotor pipes, and this outlet of mass will provide torque of the rotor.

- After the rotor will be accelerated up to nominal speed of rotation, then working difference of pressure will provide self-motion of the liquid to inlet (suction inflow). After this point, the start pump can be switched-off, and it will be possible to connect electric generator to the shaft to get electrical output power.

Technological features of experimental design are following: main parts of the device are made of stainless steel, bronze and copper (pipes). There are no some special materials here. Bearing are standard type parts also.

The main parameters of experimental model are following:

- Calculated output mechanical power is planned to be 10 kW, for speed of rotation n = 3000 rpm.

- Time of operation is unlimited (non-stop).

- It is planned to use water, but in some tests it is planned to try investigate other types of working liquid, for example, oil.

Patent information are presented, in particular case, Victor Shauberger's patents are considered here [12, 13]. The analysis of patents allows to plan real practical application of this Research Project.

Metrological equipment is necessary here: tachometer, manometer-vacuum gage, thermometer. Measurement of rotation speed is from 10 rpm up to 5000 rpm. Measurements of pressure in the pipeline are from 10^4 up to $5 \cdot 10^6$ (N/sq.m). Temperature limits of liquid are from + 10 Celsius up to 180 Celsius.

MAIN PART

1 Description of subject of research

1.1 Decision of direction of research

This general research problem is placed in area of technical solutions of autonomous power sources. The offered project consider recommendations of the Customer about possible methods of realization of transformation of environmental heat energy into electric power by means of creation of vortex processes in centrifugal mechanical device. This choice of direction of research allows to use industrial facilities of the Customer to organize innovation and manufacturing process.

1.2 Analysis of the problem

At the present time there are two main directions of practical application of low-potential environmental heat energy.

The first direction is widely known: heat pumps can provide transfer and concentration of heat energy. This technology use classical compression-decompression cycles of working gas (the low-temperature boiling liquid). Modern heat pumps can spend 1 kW of electric power to transfer into the house 4 kW of heat energy. Primary source of heat energy is air, water or earth, i.e. we must provide heat exchange with environment media. For example, American company Razer Technology (Raser Technologies) can create low-temperature geothermal power plants in places where is no natural sources of hot water or steam. This technology includes drilling of 150-200 meters depth wells with circulating hydrochloric liquid. Temperature of this heat-carrier is about 75-80 degrees Celsius that is enough to provide operation of low-temperature turbine and to rotate electric generator with this turbine. For example, this company built 11 MW power plant at Alaska area, where are no natural geothermal sources of water and steam.

Development of heat pumps will allow creating self-running autonomous sources, but this technical solution is complicated by low-temperature turbine. These devices are high cost, stationary and cannot be designed for small power level.

We have to note advantages of environmental heat conversion method. A positive ecological result of innovation of this energy conversion technology was shown in 1952 by Russian Professor K. A. Putilov in his “Physics textbook” [2]. He wrote about innovation of technology of absorption of environment heat: “Simple calculations demonstrate that if we could to use environmental energy conversion for all auto cars in all countries of the World then only after 1700 years we will notice decrease of water temperature of World Ocean in 1/100 of degree".

The second direction of development of technologies are devices of direct transformation of environment heat into electric power or into mechanical work. Let’s consider main methods of this direction of environmental heat conversion technologies.

1.2.1 Photo inversion of energy.

We know properties of some substances (luminophors) to re-radiate incoming photons. Re-radiated photons have increased wavelength (it is “Stokes luminescence”). There is also other process: reduction of wavelength of the reradiated light (it is increase of energy of photons) in the case of reflection from a luminophor (it is “anti-Stokes luminescence”). The additional energy of photon is result of transformation of inner heat energy of the luminophors matter into energy of luminescent radiation. **Due to capture of heat energy of luminophors matter, the matter become more cold, and then decrease of its temperature is compensated by inflow of heat energy from environment.**

Therefore, there is real increase of power of luminescent radiation due to concentration of environmental heat energy. This additional energy can be very significant. Theoretically, it can reach 160% efficiency, i.e. luminophor can give out 60% excess energy. There are several practical applications of this effects: cooling of objects, luminescent maser, luminescent power photo multiplication.

1.2.2 Chemical inversion of energy.

Open energy systems of catalytic process demonstrate property to accumulate energy and exist in non-equilibrium thermodynamic state. This process is possible due to combination of exothermic reaction with participation of some catalyst and endothermic reaction (cooling) of the catalyst. These chemical reactions are capable to be self-running in the case of absorption of dissipated environment heat energy. It allow us to consider perspectives of new technological processes.

There are modern galvanic cells using endothermic reactions. Energy to provide the reactions is absorbed from crystal lattice of atoms of matter of this device. During operation of this galvanic cell its case become more cold. Here is continuous inflow of environment heat energy to surface of this device (we can say “energy is concentrating” in this case). Therefore, electric energy output of this chemical power source is partially provided by absorption of environment heat energy.

1.2.3 Mechanical inversion of energy.

There are several ways to use kinetic energy of air molecules, heat energy of water or other source of low-potential heat. The devices can be passive or active. The devices using jet (stream) technologies are

active devices. The object of researches of this Project is **one of methods of mechanical inversion of environmental heat energy by means of special stream of working liquid. We’ll consider it later.**

1.2.4 Gravitational inversion of energy.

Gravitational field make environment to be non-uniform, i.e. it create some “distortions” in all thermodynamic processes. It lead to increase of entropy. This circumstance was noted by Maxwell and Russian Professor Ziolkovsky. They proposed an idea about vertical gradient of temperatures in the atmosphere. This gradient must be result of gravitational field. Ziolkovsky also assumed that this specified temperature gradient must depend on molecular composition of gas (air).

Modern theory of this process is developed by Professor V. F. Yakovlev. He calculated dependence of gradient of temperatures on molecular composition of gas. Mr. E. G. Oparin and Professor V. F. Yakovlev offered an idea of new type of power source, which consisting of two vertical pipes filled with different gases. Temperature of two different gases in top part of pipes must be significantly different due to gravity field. This gradient of temperatures between two pipes can be used to generate electric power, for example, by means of thermocouples.

1.2.5 Thermo-inversion of energy.

Example of this method is piston engine using compressed gas. In this device there is injection of some nonflammable liquefied gas (nitrogen, helium) in chamber. Pressure of this extending gas will move the piston, thus cylinder of the engine will be cooled, and environmental heat energy will inflow into this device. Output power of this engine mainly is made by extending gases and **some additional power will be provided due to absorption of environmental heat energy.**

1.2.6 Electro- inversion of energy.

One of the most perspective methods is solid state semiconductor converter of heat into electric power. There are also other methods besides semiconductors. Mr. N. E. Zayev patented several methods of concentration of environmental heat energy. He used properties of nonlinear electric capacitors and nonlinear ferromagnetic materials. He demonstrated possibility of excess output energy in nonlinear cycles of charge – discharge of capacitors, or in non-linear cycles of magnetization – demagnetization of ferromagnetic materials. It is also direct transformation of environment heat energy into electric power.

2. Justification of physical principles of energy conversion

2.1 Conception by Professor Ziolkovsky

Russian Professor Konstantin E. Ziolkovsky was famous except in area of rocketry. He also was interested to discover principles of Universe, considering it to be some type of "heat transformation machine". He and other scientists assumed that orthodox classical physics concept of Universal Law of dispersion of heat (ideas about unidirectional increase of entropy in the Universe) is very strange and doubtful concept.

In the article "Second Beginning of Thermodynamics" [3], he refers to Klauzius’s postulate about heat: "Heat **can't be transferred itself** from cold body to more warm body" [4]. Keyword here is “itself”, i.e. without special conditions. From this remark, Ziolkovsky draws a conclusion about existence of possibility of capturing of environmental heat, but it is necessary **to provide special conditions** for this heat transfer from cold body to warm body.

This remark give us some basis to look for a ways of transformation of environment heat in the Nature, in particular, we must to study special vortex processes in liquids and gases. In some case, conversion of environment heat energy can be discovered in Natural processes.

Further, considering energy of gas molecules placed in area of gravity field action [3], Ziolkovsky showed that this potential field is sufficient condition to create in vertical column of gas **the special non-equilibrium conditions of pressure and temperature.** So, useful work and power can be provided here without expenses (for free). It is necessary to note: in proposed Project **we plan to build design of centrifugal converter of energy using similar principle. The difference is following: instead of gravitational field of the planet we will use more powerful centrifugal force field.**

Ziolkovsky wrote: “… it is impossible to deny possibility of second type perpetual mobile since the Universe doesn't deny it". The “second type perpetual mobile” is physical term introduced by Professor Ostvald. This device is machine, which work due to reduction of environment media entropy, i.e. due to absorption of environment heat energy.

Conclusions: We completely agree with Ziolkovsky's ideas, and we offer here real technical solution in this field of researches.

2.2. Theory by Mr. Gennady N. Buinov

Mr. Gennady N. Buynov in his scientific publications [5 – 9] showed analytical regularities of closed cycles of gases, for open physical systems (i.e. inflow of environmental heat energy is possible in

open systems). He noted important aspect of concept of “entropy”: This notion is not something real with some physical sense, ***it is just a mathematical function*** that is useful for calculations. From this point of view, function of entropy can be non-continuous, i.e. it can be broken and it can “have a gap”. Mr. Buynov proved possibility of self-organization of processes in open physical systems in the case of **spontaneous reduction of entropy**. So, there is possibility of free increase of energy in real technical devices, if we will provide heat exchange with environment.

Mr. Buynov calculated and designed several types of industrial power stations: industrial concentrator of environmental heat energy using cyclic conversion of titan hydride, cyclic heat energy converter using water-ammonia mix with standard steam-turbine, heat turbine power plant working with closed-loop processes based on four-oxide of nitrogen.

Conclusions: Technical projects by G. N. Buynov use non-equilibrium conditions of gases and mixes of gases. This topic is placed out of area of our present mechanical inversion project. Nevertheless, his theoretical conclusions are very useful to make analysis of processes of transformation of environment heat to provide useful work.

2.3 Concept of conversion of energy by Pavel K. Oshchepkov

Conversion of environment heat energy was developed in Russia by scientists P. K. Oshchepkov, A.F. Okhatrin, E.G.Oparin and other researchers. Professor Pavel K. Oshchepkov mainly was top-level designer and expert in Russian radar systems. In 1967 Professor Oshchepkov created Public Institute of Energy Conversion (non-profit organization) to develop research on energy conversion in Moscow, with State Committee on rational use of material resources.

Professor Oshchepkov wrote: “The most attractive dream of mankind is mastering of processes of natural circulation of energy. Energy cannot be destroyed, as well as energy cannot be created… therefore there are two paired natural processes of dispersion of energy and natural processes of concentration of energy. There are people who claim that this idea contradicts with the Law of thermodynamics. It is incorrect. The second law of thermodynamics is correct law in closed system, and this second law is confirmed in thousands and thousands real examples, it is solution of many scientific and technical tasks. It is senseless to challenge justice of second law for these **closed systems**. But in reality **there are no absolutely closed systems**. The world is infinite in space-time, and interaction between material substances is described by more complex laws than second beginning of thermodynamics. Future science will discover these new laws. Use of process of natural circulation of energy in the nature will reduce threat of overheating to provide heat balance of our planet. Also conversion of environmental heat is not

related with radioactive danger or atmosphere combustion products. It open for us abundance of energy, it create main basis of life... It is very timely to find solution for practical use of natural energy circulation”.

Professor Oshchepkov introduced notion “kessor”. This term means “concentrator of environment heat energy”. In some Russian publication we can see term “C-kessor” for the case of electric Capacitor. Converter of environment heat into electric power, for example, can be designed on the basis of properties of non-linear electrical capacitor (technology by N. E. Zayev).

Scientific ideas by Professor Oshchepkov are more interesting than standard concept of heat pumps. He wrote: “The power sources in future times, to my opinion, will be special electronic devices. This electronic devices must take heat from surrounding space and transform it into electric power. In this technology I see greatest scientific and technical task. Scientific, engineering and designer experts must try to find ways to solve this problem”.

Oshchepkov’s “Public Institute on energy inversion problem” created theory, made calculations and designed several electronic devices to provide electric output power by means of transformation of environment heat energy.

Professor Oshchepkov wrote in 1967: “Today we see expensive economics… Many years it spends irreplaceable natural resources of coal, oil and gas. One problem is exhausting resources but also the resources are excellent valuable raw materials for chemical industry. They are burned in fire chambers of power plants, polluting the atmosphere and lead us to catastrophical “greenhouse effect”, which is more dangerous than thermonuclear catastrophe. There is one more paradox of traditional power engineering: huge amount of energy is produced in one place to be transferred by expensive and not-reliable power lines in other place for thousands of kilometers to the consumers of energy... for example in the apartment to electric bulb. Isn't this way too difficult and wasteful? Everything can be organized by different way, with more simple and cheap way, more reliable, with more efficiency. Let’s allow standard powerful power engineering systems with power transmission lines to provide electric power for large industrial plants. But many small consumers, especially in rural areas of North of Russia and Siberia, can use small energy converters of environment heat (one or two kilowatt of electricity). It is enough to provide one apartment with energy for lighting, heating and other needs. The volume (size) of this power source is about standard desk lamp. If mankind wants live in harmony with environment, it is necessary to make everything to learn methods of receiving energy from environmental heat without breaking of ecological equilibrium of the Nature”.

These words by Professor Oshchepkov are very timely today.

3 Analysis of scientific and theoretical basis

3.1 To the history of the problem

Considering centrifugal machines based on reactive jet effect, we have to note ideas of famous inventor and scientist Heron from ancient city-state Alexandria. In his treatise “Pneumatics” (about 120 years B.C.) Heron described various devices using compressed air or steam to move (rotate) due to reactive jet effect. Drawing is shown in Fig. 1.

Fig 1. Steam turbine invented by Heron.

Heron's turbine use vapor pressure received from burning fuel. In the same ancient way today, all modern steam and gas-turbine machines work. The cycle “burning – heating – pressure” is simple but this technology demand fuel consumption, i.e. it require expenses of resources. There is no novelty here if we will replace one type of fuel to another one, for example, we can burn hydrogen instead of coal.

“Pressure of vapor” are most important words for any power engineering experts. They know only one main Law: it is necessary to spend fuel to heat water and to get high pressure steam, then turbine can rotate the electric generator. The same idea was main conception in heads of drivers of old steam locomotives… There is no difference in this conception today.

Let me say some important news for these “experts”: there is other method of creation of pressure**. It is centrifugal pressure, it can be created without fuel.** Some input power is necessary to start rotation of mass due to its inertial weight, but rotation can be organized in self-running mode. It is already was known thousands years ago, and periodically, this simple technology must be re-invented once more time for benefit of humanity.

Let me note that approximately in 1760, Johann Andreas von Segner invented engine based on reactive jet effect of out-coming stream of water. Segner didn't think about self-running autonomous operation of his device. He applied this method to apply centrifugal force for acceleration of water-mill

rotor, which produces some useful work using water stream. In this machine it is possible to create big pressure of outgoing stream, since pressure is increasing due to action of centrifugal force. The pressure grows with increase of speed of rotation of the turbine. Many machines use general principle of “Segner’s wheel”, presented according to scheme at Figure 2.

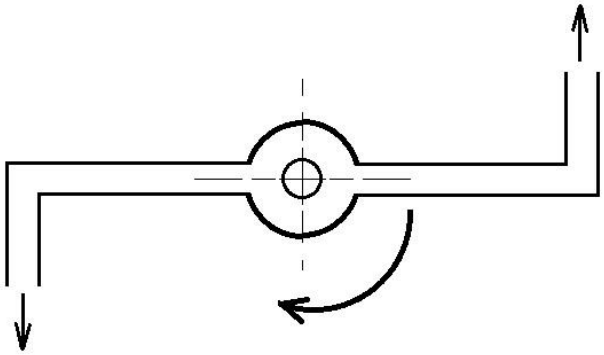

Fig. 2. Segner’s rotor. Inlet of water is axial. Outlet is tangential.

If we can provide unlimited axial income of water, then this rotor will be rotating due to reactive jet effect. Also it must be accelerating rotation, if water is coming free of losses or losses are small. Let’s note that in center (along an axis) water flow moves with a small velocity therefore section of axial pipe must be more than total section of all tangential pipes. Also let’s note that besides torque and rotation, in this design there is paired force effect: inflow of water provide axial reactive propulsion force.

So, we have new formulated task: it is necessary to create acceleration of water under action of centrifugal force. It let us possibility of increase of water kinetic energy and we can get additional kinetic energy for free. Then we can use blades of turbine or some other method to use this additional kinetic energy for transformation into torque of the rotor.

For this purpose**, it is necessary allow water to be accelerated during its motion under action of centrifugal forces**. Thus, an optimum trajectory of its movement is **logarithmic spiral of variable radius shown in Figure 3.**

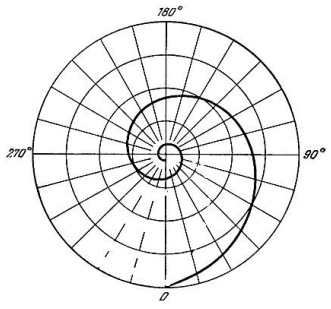

Fig. 3. Logarithmic spiral of variable radius

Some modern centrifugal water pumps and air fans already use similar design of its blades to provide optimal trajectory of motion of liquid or air. In simple words, motion of water along any flat or conical spiral of increasing radius will allow water to be accelerated, that will create additional torque for this rotor. Use of air as working mass is also possible. It is much lighter than water therefore speed of rotation of air turbine must be much more than speed of rotation of water turbine to provide the same output power. It demands high quality production facilities to manufacture some rotating parts and also to polish some parts of the casing.

3.2 Viktor Shauberger

Let’s consider example of self-rotating energy generator that was invented by Viktor Shauberger. This author also developed a very interesting designs of propulsion units for aerospace, but this Report don't include consideration of new propulsion methods. Viktor Shauberger inventions practically are very useful for development of new power engineering technologies. However, we can note following: all similar devices demonstrate both components of driving force: the axial propulsion force and the tangential force to get rotation. This aspect allow to use centrifugal machines both as power source and also as active (not reactive) propulsion unit, for example, for airspace craft, sea, river, auto or railway transport.

On photo, Figure 4, you can see original device made by Victor Shauberger. This device provided his house with electric power and heat energy during several years.

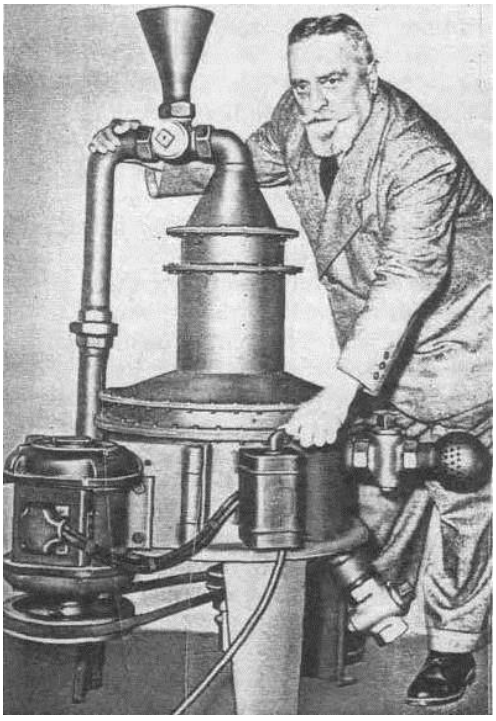

Fig. 4. Viktor Shauberger and his “home generator”

Let’s note, at Figure 4, in the right lower part of this machine, there is **spherical air filter** connected with crane. Let’s assume it is necessary to adjust input of air into the system. At the left side, in lower part of the photo, you can see electric generator connected by belt drive to shaft of this centrifugal-vortex device. Above there is funnel, it can be used for filling the device with water. It is connected to pipeline where is water circulation.

Some models of Shauberger’s generators and original parts of his devices are stored in museum, Austria. Figure 5 demonstrate open view of the device.

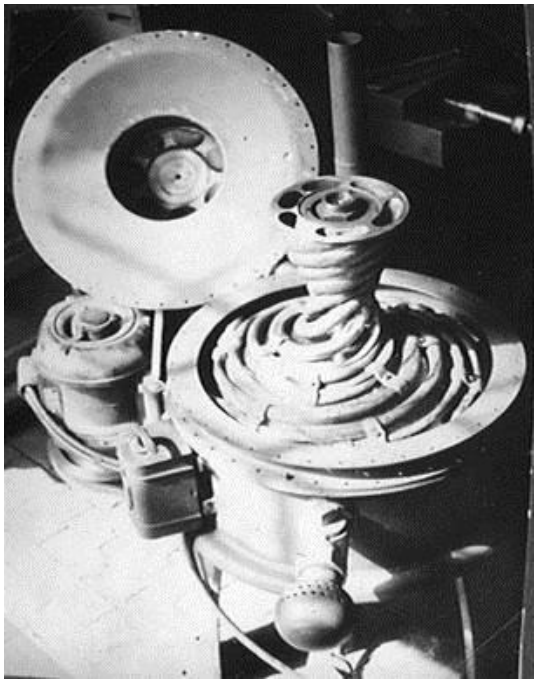

Fig. 5. Design of the rotor. Photo provided from Austrian museum.

The rotor includes several copper pipes which are bending around a cone. The input of water into the pipes occurs from the top (narrow part of the cone). Description of operation of this machine include understanding of important aspect: **besides water, in the copper pipes always there is some small amount of air.** This condition is considered to be important part of design to provide successful operation of this device. Start of this machine require some adjustment process: it is necessary to provide correct ration between amount of water and amount of air in the mixture of water and gas in the pipes.

Second interesting feature of this device is special design of nozzle. In fact, it is micro-turbines which doesn't rotating but it creates rotation of out-going stream of water. Figure 6 demonstrate design of the nozzle and Shauberger's micro-turbine. It is described in patent [13].

Fig. 6. Nozzle and micro-turbine.

This technical solution has wide application in modern technical devices to increase velocity of motion of jet stream at the exit from the nozzle.

There are some interesting facts: Shauberger's device demonstrated self-rotation mode, but also it created powerful axial (vertical) force. One of Shauberger's devices flew up and destroyed roof of the building. Victor Shauberger's photo and photo of his devices in this report are published with permission of Shauberger's family (letter to Alexander V. Frolov dated January, 2011).

Conclusions: Victor Shauberger solved problem of hydrodynamic losses by means of his special micro-turbines, also he used elastic working substance (air and water mix), that is important aspect of this design. We will use it in our present project.

3.3 Clem’s experimental motor

We can consider one more interesting example of technical device. It is Clem's motor. This machine also use centrifugal force to create self-rotation mode. In 1972 Richard Clem was worker - operator of heavy road machinery in Dallas, USA. He discovered that rotating sprayer of hot asphalt can continue rotation after switch-off, and this rotation can be very continuous (about one hour). The design of this equipment is simple: the axis of this machine is vertical and its rotor has a conical form.

Mr. Clem do not knew theory and Shauberger’s results, but he empirically studied the problem to build self-rotating “Clem's motor”.

Figure 7 is schematic diagram of Clem’s generator.

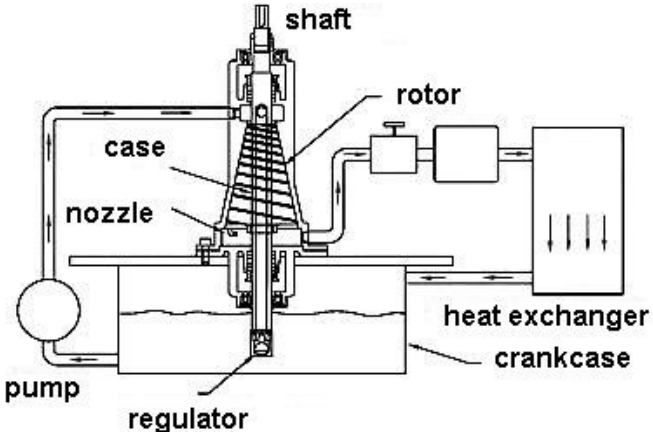

Figure 7. Principal scheme of Clem’s device

This device also use centrifugal force and motion of liquid in special conical extending trajectory to increase torque of rotor. It is just an idea in general, according to general information, without real sizes and details, it wasn't tested experimentally. We will note here important aspect: heat exchanger with environmental is presented in this case.

Figure 8 demonstrate scheme of similar device and possible form of the rotor. The conical rotor is placed inside of conical case. There are several spiral channels on the surface of the rotor. These channels must provide motion of liquid along cone surface. The liquid is coming to the end of cone and moving out of the channels through several nozzles.

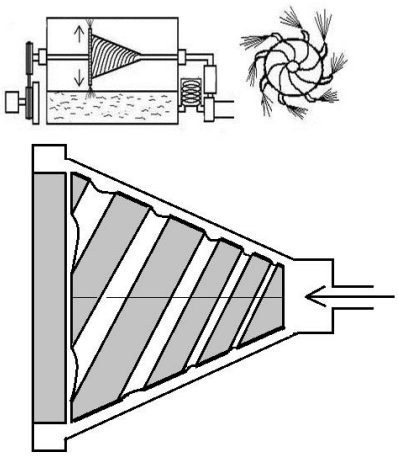

Fig. 8. Version of Clem’s device.

There is recommendation on similar designs and we already reported about this aspect: it is necessary ‘to allow acceleration of moving liquid” since it is moving by action of centrifugal force. For this purpose, the spiral channels must have increase of step with increase of radius, and also it can be useful to provide variable cross-section of channels (it must be increasing as approaching to nozzle).

There are several important aspects of this design of rotor. Segner’s reactive effect produce torque and rotation but it is not only reason of rotation. Acceleration of moving liquid along spiral trajectory and interaction of this liquid with rotor must provide to this rotor additional torque. In point of inlet (entrance to rotor) velocity of liquid is equal to speed of rotation of this rotor. In last part of trajectory (near of the nozzle) **the liquid is moving quicker than rotor**. The increase of velocity of liquid is caused by centrifugal effect, it is clear analogy of accelerated falling of a body in gravitational field. Thus, the **rotor is accelerated by interaction with the liquid if it is moving more quickly than the rotor.** At some speed of rotation, external primary drive can be switched-off, and device can be used in self-running mode of energy generator. It is possible also to use kinetic energy of stream after it will exit out of the nozzle. For this purpose it is necessary to apply inclined reflectors on the rotor, i.e. blades of turbine.

Thus, in this design there are three key aspects:

A. Aacceleration of liquid is possible if we allow possibility of increase of its radius of motion. This motion is accelerated due to centrifugal force. If the liquid can move more fast than the rotor, some additional torque can be created.

B. The jet (reactive) Segner’s effect provide acceleration of the rotor.

B. Additional torque can be provided by interaction of out-going water stream and blades of turbine, which is fixed on the rotor.

We have to note important aspect: Richard Clem used food oil Mazola. The working liquid during operation was heated up to +150 degrees Celsius. Water in this case will boil, so oil is better idea. Also we suppose the oil is more elastic than water.

There is small information about real Clem’s device: liquid was forced in hollow shaft with pressure about 2.10^6 (N/sq.m), then liquid moves across spiral canals of cone and then it leaved the rotor through nozzles. It forced the cone rotor to rotate. Speed of rotation reached 2300 rpm. Heat exchanger (radiator) was used to cool the liquid (oil).

It is known that first version of Clem’s motor was failed. Clem made second version of engine to be more strong. Some parts are shown at Figure 9, photo at the left. This version is 250 kW motor, its weigh was about 90 kg. Clem installed this motor on auto car and demonstrated its work on a trips. The accumulator in the car was used only for start of the Clem’s motor and to provide lights of the car. Inventor said about his motor following: “I designed seven-step pump and converter”. The pump was used to “supply oil under pressure from storage in the converter, where energy was converted in sufficient force to rotate the rotor”.

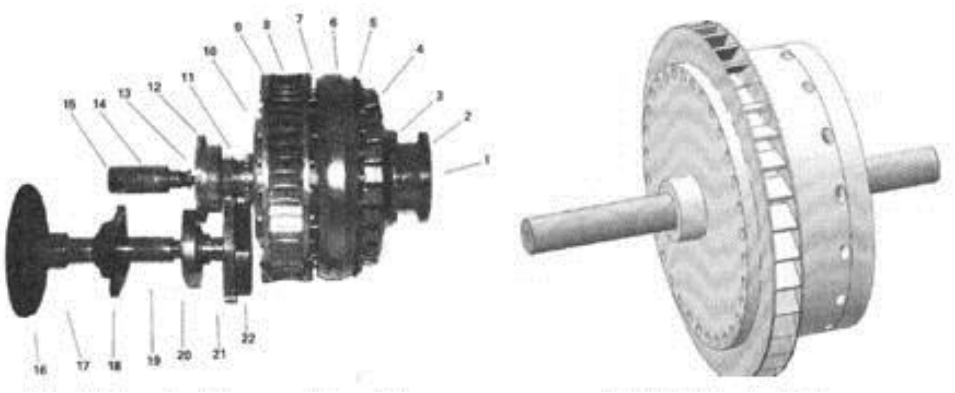

Fig. 9. Left side: photo of original parts. Right side: 3D model

So, we can describe mail principles of operation of Clem’s motor: working liquid (oil) passed across several canals in accelerated mode. This process provide increase of torque of the rotor. Then the liquid (oil) came back to collector tank, from the tank it came to heat exchanger and then the cycle of motion of liquid is started again. This energy converter operated like turbine, but Clem said “it wasn't the turbine in usual sense of this word”.

Clem's engine was tested by Bendix Corporation. The test consisted in dynamometer measurement of generated output power in self-rotation mode. The engine was tested with 250 kW real load, continuously 9 days. It was successful tests, and Clem signed contracts to produce several generators for coal company, but these production plans weren't realized.

Conclusion: special features of Clem’s device (what we know now) show an important role of form of rotor. Also heat exchanger is important for compact power unit of transport application.

3.4 Scheme by Leopold Scherjau

One more attempt to create centrifugal-vortex converter of energy was made by Leopold Scherjau, his scheme is presented at Figure 10. This device wasn't successfully tested. There are significant problems of this design. This scheme is very similar to Richard Clem's device but here is no conical rotor (there are rotor spiral pipes but radius of rotation of the liquid is very small and it is constant value). To my opinion, this aspects is important and cone rotor is necessary in this device. We can see at the left part of Figure 10 air inflow adjustment crane and also air filter. Main part of rotor here has constant radius, therefore working liquid has no opportunity for accelerated motion (here is no increase of radius of rotation). In lower part of this rotor, moving liquid leaves pipes in radial direction and comes to tangential nozzles. The small torque can created but here but we cannot get additional torque since here is no conical rotor.

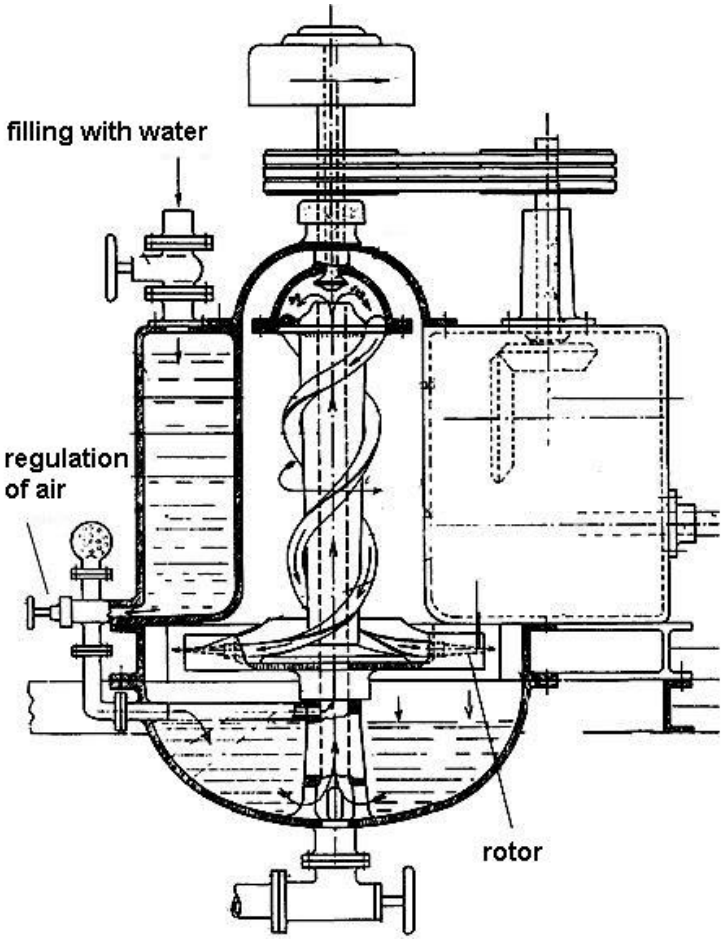

Figure 10. Scheme by Leopold Scherjau

Conclusions: optimization of design of this machine require to provide special trajectory of movement of liquid. Radius of rotation must be gradually increased. Optimal form is trajectory of logarithmic spiral. It gives maximum freedom for moving liquid to increase its radial component of speed due to centrifugal force.

3.5 Yuri S. Potapov’s conception

We can consider practical achievements in area of self-running devices on example of “quantum heat power plants” by Yuri S. Potapov. Scheme of this power plant is shown at Figure 11. Here is heating of moving liquid. Electric power is generated for customer but part of this output power is necessary to use for pumps.

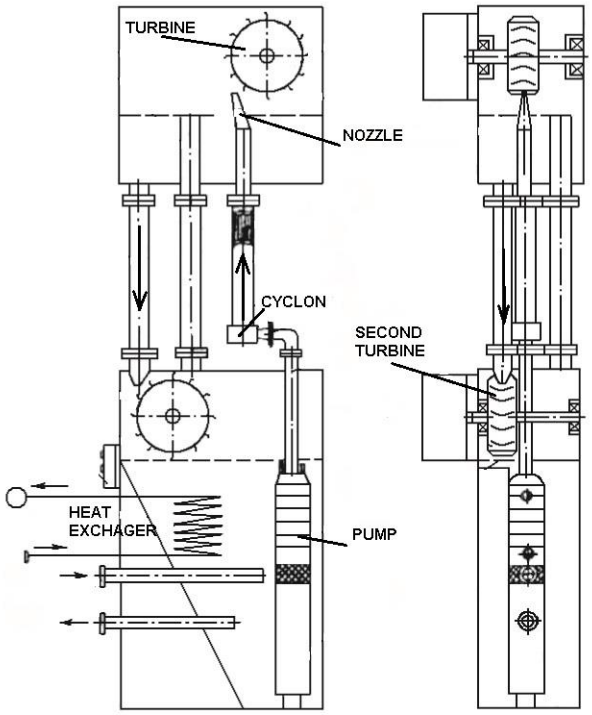

Figure 11. Scheme of two-stage electrical power plant by Yuri Potapov

Principle of action of this power plant is following: pump push water in special device to produce vortex turbulences (cyclone). After acceleration of water in cyclone it comes through nozzle to water-wheel (turbine). The turbine is connected to electric generator. In lower tank there is second water-wheel turbine, also this wheel is connected with electric generator. Temperature of working liquid is about 70 - 100 degrees Celsius, pressure is about 8 - 10 Atm in area of the nozzle. This stream of water provide operation of the first turbine. Second turbine is placed in lower tank. It works due to falling water stream. Thus, this device produce heat energy and electric energy without expenses of fuel, and this technology is environmentally clean. We have not information about manufacturer, test reports and operating experience of this equipment.

Conclusions: in this Potapov's scheme we see both heat generation effect and excess kinetic energy produced by centrifugal machine. Special feature of this scheme is two-cascade transformation of kinetic energy of water stream.

3.6 Hardy's Self-running Water Pump

Let’s consider one more perspective direction of research in area of autonomous power supply. Figure 12 is photo and scheme of experimental turbine. Author James D. Hardy patented this idea [10]. Design is very simple, it is “home made” device.

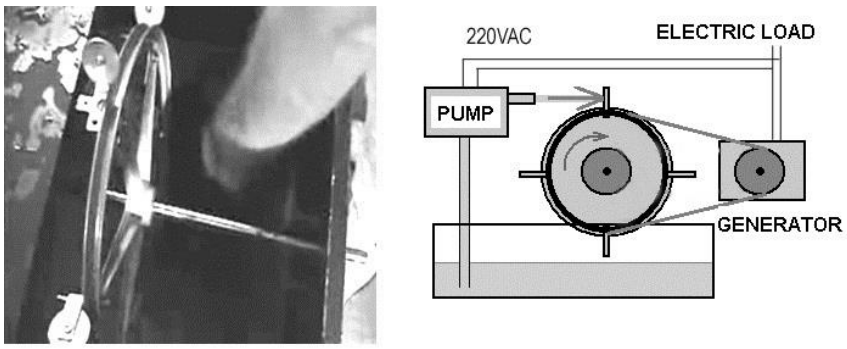

Figure 12. Hardy’s experiment

There is some information about parameters of this pump: it is high pressure pump, standard application is compact automobile high pressure sink, power input is 220VAC. Pressure of water stream is about 10^7 (N/sq.m).

Productivity of pump in Hardy’s experiment was about 350 - 600 liters of water per hour. Consumption power was about 1 kW/hour. Output power provided by turbine is corresponding to kinetic energy of water flow and it is equal about 25 kW. So, according to experimental data reported by the author, he was succeeded to receive autonomous mode (self-running process). In this mode the electric generator connected to turbine must provide power for the pump and also extra-power for several lighting lamps (useful load).

We can note that speed of rotation is slow in the case of direct axial connection between generator shaft and turbine, i.e. it cannot provide correct speed of rotation of electric generator. To increase speed of rotation shaft of turbine use flywheel of big diameter and belt drive to provide connection to generator shaft of small diameter.

Conclusion: we can assume that Hardy’s device proves possibility of obtaining of excess kinetic energy of stream of liquid in the case of centrifugal pump and very high pressure.

3.7 Bogomolov’s centrifugal energy converter

Mr. Vyacheslav Ivanovich Bogomolov invented centrifugal converter of energy, he worked in St.-Petersburg, Russia. The experimental device was created and tested in Faraday Ltd company, 2003. The scheme of this simple device is shown in Figure 13 (in this case the spring is free, i.e. it is non-compressed). In Figure 14 the energy converter is demonstrated in position of compressed spring.

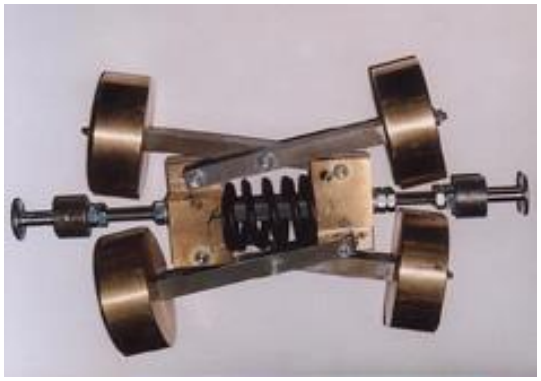

Figure 13. Bogomolov’s converter of energy

Figure 14. Bogomolov’s energy converter in position of compression

Design is simple: during rotation two loads (inertial masses) are displaced on bigger radius of rotation and due to this motion of loads they compress the spring.

The essence of this invention is energy transformation method: during first stage, centrifugal forces compress the spring (or other elastic body), rotation can be provided by electric motor-generator. Then, in second stage the loads are rotating by inertia, and the spring is straightened. This process means transferring of the loads to smaller radius of rotation. Potential energy of compressed spring is converting into kinetic energy, that increasing torque of shaft and electric motor-generator, which in this phase of cycle works in generator mode.

This device was tested experimentally, for the case of movement down and up, in gravity filed (vertical direction). Figure 15 show scheme of this experiment.

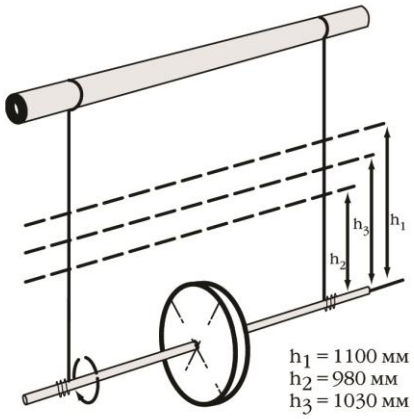

Figure 15. Bogomolov’s experiment

In initial state, two threads are wound on an axis of the device shown in Figure 15, and the device is placed on initial height level h_1. After release, device is moving down with acceleration, from initial height level h_1 to lower point. After it will be stopped, then due to inertia it will begin movement up. Sure it cannot reach position of initial height h_1. There are some losses of energy. It can reach position on level h_2 or h_3.

During experiment, initial level and stop-point are the same, but levels h_1 and h_2 were measured and compared. We have to note that motion of the device up and down was organized with rotation, and centrifugal forces provided compression of the spring.

In first version of this experiment the spring was fixed by strut. The device fall down from height of 1100 mm, after passing of the lower point, the device rises again up to height of 980 mm. In case the spring was fixed by strut, i.e. it was not compressed by centrifugal forces. In second version of experiment the spring was compressed by centrifugal forces in stage of falling, and the spring was straightened during motion up. In this part of cycle, **potential energy of compression was transformed to rotor torque (kinetic energy).** In this case, after falling from the same height of 1100 mm, after passing of the lower point, the device reached level of height 1030 mm. The difference between 1030 mm and 980 mm proves existence of effect of transformation of energy in second version of experiment (using the spring compression by centrifugal forces of rotation).

This experiment was repeated many times to collect statistical data. Accuracy of measurements was about 10 mm. Figure 16 show the experiment. In more details, you can read about Bogomolov's projects in magazine New Energy Technologies [11].

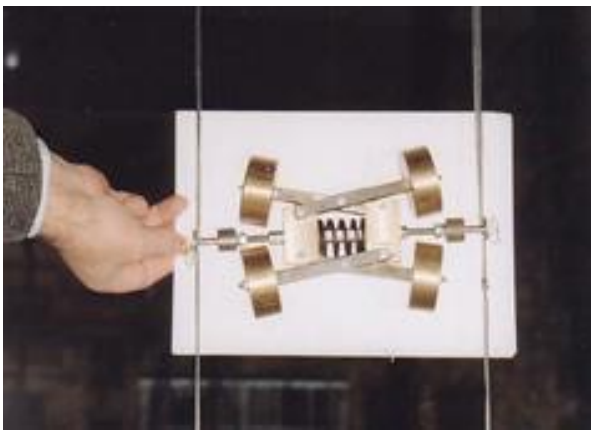

Figure 16. Bogomolov’s experiment

Conclusions: The method proposed by Mr. Bogomolov is very important for designing of centrifugal and vortex energy converters. Elasticity is important property of working matter of converter. Elasticity allows to collect potential energy of compression of elastic matter placed in area of centrifugal force field, and then to release it during de-compression of elastic matter. Gas or mix of gas and water can be used as elastic matter.

3.8 Professor Alexandrov’s discovery

Professor Alexandrov, Russia is author of discovery registered in USSR, Discovery #13, October 30, 1957. It is discovery of effect of transformation of potential energy to kinetic energy and it is interesting for us to consider application in the present research work. Professor Alexandrov demonstrated a very simple experiment: steel ball falls from some height, it falls with acceleration, and in the lower point of its trajectory the ball is reflected from a steel plate, then the ball is moving up. Professor Alexandrov demonstrated fact: after reflection the ball can rise above the position of its start, if it began the movement down with zero kinetic energy. This fact seems strange as this ball falling down, after collision with a plate, it can get some additional energy to reach point above the point of start.

Explanation of this effect wasn't made before and here we can offer some ideas. It is possible to assume that this effect is result of elastic deformation of the ball in process of collision. Reason of excess energy is some hidden energy in form of compression of metal of the steel ball. Really, after several impacts, the ball partially loses elastic properties and the effect gradually decreases.

Conclusion: In this example, stages of accumulation and transformation of energy, are useful for us to design centrifugal-vortex converters. It is important to use property of elasticity of matter to store energy and then to transform stored potential energy of compression into kinetic energy of motion.

3.9 Experiments with air molecular motor

Let’s consider project of 2004-2005 by Faraday Lab Ltd company, St.-Petersburg. This project was named “molecular engine”, by Mr. Yury S. Potapov. The term “molecular” is related with kinetic energy of air molecules, that depends on temperature. We know that air molecules are chaotically moving but vector sum of all molecules in some volume of space is equal to zero. We can transform their energy into useful work, at least partially, **if we will create their directed movement (stream laminarization).** In this case vector sum of kinetic energy in volume of air will not be equal to zero.

Subcontractor in this research project was Degtyarev’s factory (Kovrov, Russia). They designed, developed and produced main part of test bench for this experiment, named UKS-37. Faraday Lab Ltd company (St. Petersburg) was customer of this project. Theoretically, it was planned to produce excess electric power. 37 kW electric generator was rotated by helicopter turbine. The turbine was powered by air stream from fan. Power of air inflow (its kinetic energy) must be sufficient to provide functioning of fan electromotor and also provide some power in useful electric load. There is special cylinder-pipe between air fan and turbine. Some special conditions was created in this pipe to “take off” part of kinetic energy of molecules of air and then to transfer this additional energy to the turbine. The photo of this device is shown at Figure 17.

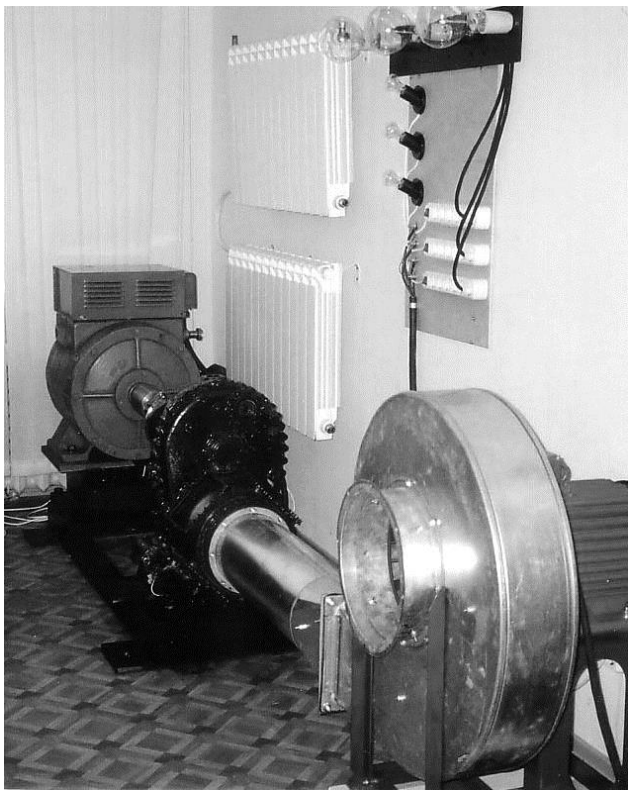

Figure 17. Experimental device in Faraday Lab ltd, 2004.

We already considered similar case in point 3.6 of this report: excess kinetic energy is created already by centrifugal fan, due to elastic compression of air under the influence of centrifugal forces. Next stage is energy transformation of potential energy of compressed working body into its kinetic energy, then we must transfer this additional kinetic energy to the rotor. Also we must develop some methods of reduction of losses, that can be experimentally investigated. These methods of optimization consist in installation of passive elements (reflectors) of air flow. These reflectors create vortex effect without energy consumption from an external source.

In other words, reflectors provide **transformation of pressure of air stream into kinetic energy of rotation of molecules of air.** This air flow make turbine to rotate. The turbine is helicopter gas-turbine GTD-350, with its standard gear box. Maximum electric power of electric generator GS-250 is 60 kW. Initially, source of air was centrifugal VPZ fan, diameter of its rotor was about 1 meter, consumption was about 7 kW, manufacturer is plant in Chudovo, Russia. Later, fan unit was replaced with other centrifugal fan: VDS-5 type, manufactured by LISSANT (St. Petersburg).

It was planned to reach autonomous mode of operation of the UKS-37 device and demonstrate about 37 kW of output electric power.

History of development of this project is following: Potapov's concept was true, undoubtedly. There were organizational and technical difficulties to get autonomous mode of operation. Stage of production of experimental device was delayed by subcontractor. After production of this experimental setup, first tests in Kovrov city did not demonstrated autonomous self-running mode. After Subcontractor reported to the Customer (Faraday lab ltd) about problems, we discussed possible development of the project. Customer did not received workable device but Subcontractor transfer to the Customer the experimental test bench for further stage of experimental research. This work was organized in Faraday lab ltd, St.-Petersburg by Mr. Alexander Vladimirovich Frolov and Mr. Igor Anatolyevich Pogonyaylo.

The experimental device was received from subcontractor with broken fan. Due to this reason, the fan was replaced with new centrifugal VDS-5 fan, productivity is about 800 cubic meter per hour, electricity consumption is about 5 kW/hour (nominal).

Self-running autonomous mode in this design was impossible: VDS-5 fan can not provide sufficient kinetic energy of air stream to overcome losses in low efficiency of turbine and electric generator. Consumption power of fan was about 5 kW/hour, so electric generator can provide about 3 kW/hour power. Attempts to increase electric load lead to decrease of quality of electric power: decrease of speed of rotation of electric generator and power voltage level. Technical solution was simple: we tried

to increase volume and pressure of working air mass. For this purpose we planned to use new AF53 compressor (air pressure was 10 times more, than pressure of VDS-5). Estimated results were about 30 kW/hour of output electric power, for input power about 10 kW/hour.

Due to lack of financing and also after technical problems with gear box of the turbine this project was stopped in 2005. The experimental test bench was sold to other company, placed in Moscow. We do not know about some value results of experiments with this device after 2005.

During this experiment, some important aspects of optimization of this device were studied and proposed by Faraday Lab ltd. At first, it is reflectors placed on inner surface of cylinder pipe. The cylinder have 400 mm diameter and 1000 mm length. This cylinder was installed between the centrifugal fan and the turbine. The reflectors on inner surface of the pipe created vortex, i.e. “screw rotary process” of air motion. In this case output power in load of electric generator was increased by 5-7% in comparison with experiment without reflectors (rectilinear movement of air from the fan to the turbine).

We can say it is free addition kinetic energy since rotation of air flow was provided by means of passive inclined reflectors. This increase in output power was created without increase of input power, due to change of a trajectory of the air flow in the pipe. By this way we can use part of potential energy of compressed air but main part of this free energy is transformed into kinetic energy after outlet from the device that is not useful for torque.

Conclusions on this project: concept of use of centrifugal machine is correct if we will use elastic working matter (for example, air) and we can hope to get self-running mode of operation in this case. It was possible to provide about 3 kW of output power (load was standard electric lamps with tungsten filament), and connection of this load to generator was not related with increase of consumption power.

It is especially important to note that it was possible to increase output power of electric generator exit by means of passive reflectors, i.e. with vortex motion of air.

(Please note: vortex motion is sum of linear and rotation motion… here is centrifugal force, so here is additional compression of elastic matter).

3.10 Information about air turbine designed by Mr. Haskell

There is some information about self-running air turbine of 1960th years, USA, author is Karl Haskell. Developing of this project was organized by Ron Rockwell. There is no information about patent

but it is possible to note some parameters of this self-running turbine: speed of rotation is about 100 000 rotation per min. One more aspect: there is high electric potential due to air ionization.

Conclusions: We can assume that ionization of air will reduce friction in environment air, by this way we can reduce losses. This method can be applied for designing of centrifugal-vortex machine using air as working body.

3.11 Information about energy converter «EF9»

Other example of research project is area of our interest is EF9 Energy Systems company. They investigated technology of transformation of environment (air) heat energy into useful work. The scheme of this generator (3D model of 2011) is shown here, Figure 18.

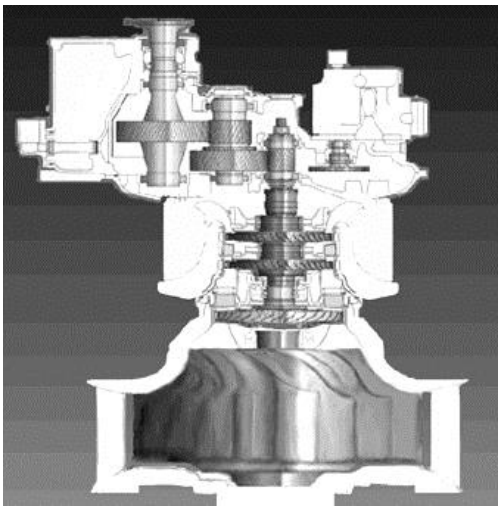

Figure 18. Scheme of EF9.

Authors don't provided description of principles of operation of this device. They believe that main role in transformation of energy here is “Bernoulli's effect”. The purposes of the EF9 Energy Systems company is creation of 50kW generator for houses and also compact energy generator (drive) for transport.

Conclusions on point 3.11: In analysis of processes of transformation of energy, for the cases of gases and liquids, we can use classical formulas and physical concepts, including Bernoulli's formula of calculation of total pressure of a stream.

4 Comparative analysis, advantages and disadvantages of methods

Let’s consider advantages and disadvantages of several methods of creation of centrifugal-vortex converters of energy.

Advantages of Shauberger’s device is simplicity of manufacturing. From the other side, vertical axial arrangement of rotor cannot be applied for some vehicles. Important feature of this technology is elastic working body (mix of liquid and air), and also special vortex micro-turbines to decrease hydraulic losses (patents [12] and [13]). Useful aspect of this technology is “pair effect”, i.e. axial propulsion force and torque force is created in pair.

Scherjau proposed device without conical rotor, therefore motion of water is organized here along spiral of constant radius. This motion doesn't provide transfer of its kinetic energy to the rotor. We can use this scheme for information about configuration of parts of centrifugal energy converter.

Simple experiment by Hardy demonstrated possible technical solution of transformation of energy. It is stationary device therefore we must develop this design for other applications including transport. Advantage of this method is standard high pressure pump. Additionally it is necessary to design turbine and general configuration of parts. Critical view on this device is following: the pump can create high pressure but this pressure must be used to compress some elastic working body, according to presented here conception. If so, the pump-turbine-generator setup can be self-running power plant.

We considered here air converter. It can also provide self-running operating mode. Application of this technology can be more practical than liquid centrifugal-vortex energy converters. Advantage of this technology is working body (air). It has important physical property of elasticity.

Clem's design is optimal scheme of converter. It use liquid. Original schemes aren't available for open consideration but basic principles can be reproduced according to available data. It will allow to use this scheme and design centrifugal-vortex converter of energy. It is especially important to note the fact: working liquid in Clem’s device is oil, i.e. elastic working body. Device creates torque of rotor and also heat energy. Oil technologies allow working with more high pressures and temperatures than water technologies. Also the oil is no corrosive liquid that is important for metal parts of the device.

5 Determination of goals of research work

Purpose of present research work is development of engineering approach to idea of high efficient transformation of environment heat energy into electric power. It must be reliable, simple and low cost in manufacturing process.

In theoretical part of this research work, we must consider method of calculation of main parameters of the process of transformation of energy, including calculation of losses of useful power and ways to minimization of the losses.

Calculation can be made by dynamic method, considering accelerated motion of body in field of action of centrifugal force for the case of rotating liquid in the rotor. For this purpose, it is necessary to show conditions of this accelerated motion of the liquid, and then to calculate average normal acceleration for cases of several different angular speeds of rotation of the rotor.

Further, it is necessary to show efficiency of centrifugal-vortex converter of energy and make approximate calculation of hydraulic losses (losses of pressure on length of pipes). In addition, it is necessary to calculate losses in backup pipeline (return of liquid to start point).

It is necessary to consider influence of difference of atmospheric pressure between area of rotation of the rotor and other part of hydraulic system. This device can work in hermetic or non-hermetic case.

To make verification of data that is calculated by dynamic method it is necessary to calculate value of power output by other method, for example, by calculation of pressure difference in the system. Comparison of two results will allow us to see value of error of the calculations.

6 Justification of choice of optimum design

Considering several analogical designs in point 3 of the report, it is possible to make proposal about optimal design of device to test theoretical concept of centrifugal-vortex converter. The following parts must be provided: conical rotor, spiral channels (pipes) for motion of working liquid along trajectory of increasing radius, tangential outlet of working liquid and backup pipe to return liquid in start point by external pipe. The form of pipes (channels of motion of liquid) has to provide optimal transfer of kinetic energy of liquid to rotor. This form is variable step and radius of the spiral pipes. In initial part of rotor, the step of spiral is maximum and radius is minimum. Near of nozzle, spiral step is minimum and radius is maximum.

It is planned to use water as working liquid, and, if necessary, to try with oil. In this regard, in a design it is expedient to apply oilproof glands.

The most important is elasticity of the working body, in particular, air and liquid mix. This mix will provide accumulation of potential energy in form of elastic compression of the mix. Further it will be possible to transform this potential energy to kinetic energy of motion of liquid and to torque of the rotor, then the rotor will make electric generator shaft to rotate. Creation of air and liquid mix is [planned in area of centrifuge. Here are conditions for cavitation of liquid and formation of bubbles. Also here is compression of elastic water-gas mix under influence of centrifugal forces.

7 Description of principle of operation of the converter of energy

Theory of mechanical centrifugal machines which can provide self-running mode demands serious study of concept of rest mass and inertial properties of matter bodies. In general, it is possible to say that centrifugal force and other inertial effects are aether-dynamics phenomenon. It is similar to aerodynamics in air environment: if we can create gradient of pressure in aether or in air then we will obtain lifting or propulsion force, and in some cases, both components of force. In simplified view, centrifugal force creates increase of potential energy of a body for free. This additional energy can exceed expenses of energy of primary source that is necessary to provide rotation of working liquid. Engineers and designers must “release” working liquid to allow it to be moving along line of action of centrifugal force. By this way the liquid will get maximum acceleration and effectively use its kinetic energy. This engineering project is very interesting commercial project also since for the level of mass production centrifugal – vortex converters of energy can become simple, reliable and inexpensive power sources for many practical applications (home, industrial, transport).

The sketch of design is Figure 19. Let’s consider principle of operation of this centrifugal-vortex converter of energy.

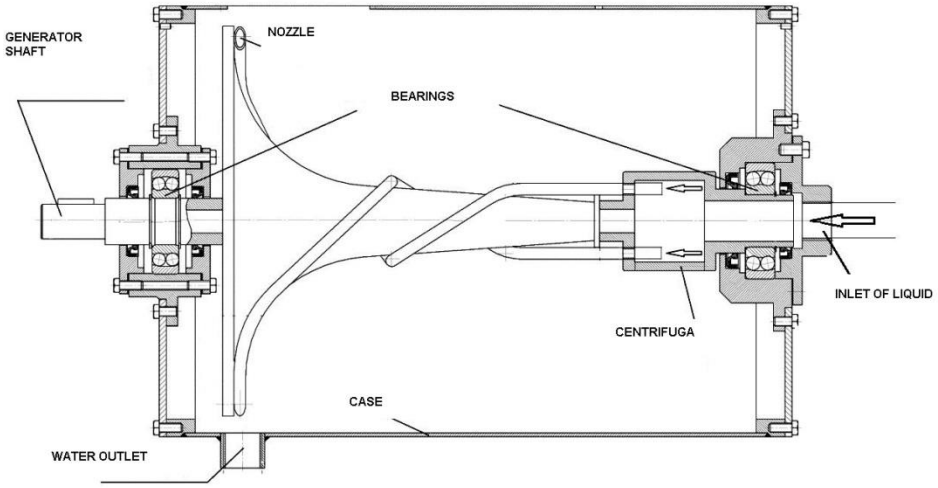

Figure 19. Sketch of centrifugal-vortex converter of energy

Water, or other working liquid, comes to branch pipe (on the right side of Fig.19). The pipe is fixed on flange of external case. It should be noted that working liquid has some rest inertial mass. This mass provides its inertial properties in rest and in motion. We can not develop theory without clarification of theory of matter and its physical properties. We need understanding of principles of operation of centrifugal-vortex converter of energy, since it uses inertial properties of liquid working body. We have to understand following: aether is connected with matter particles of body and it is property of physical system including a body and aether environment. This physical system is open system and we can organize energy transformation in this system. We will especially note that aether is considered in the our concept to be elastic medium, on this level of energy. Russian Professor Dmitry Mendeleyev [1] explain properties of matter in simple words: “... **aether can be defined as weightless and elastic liquid**, filling space and related with all bodies. Aether is recognized by physics as reason of light, heat, electricity and so on. It is possible to say that aether is similar to gas … Calling aether as gas, we must consider a fluid in general sense, as elastic fluid which doesn't have coupling between its particles".

For understanding of physics of the considered processes it is important to see role of **concept of mass of particles of matter, including aether.** Faraday [14] wrote: “The matter is presented everywhere, there is no intermediate space which isn't occupied with it... Means, the matter will be continuous everywhere and considering mass of the matter we shouldn't assume some distinctions between its atoms and any intermediate space. Forces round the centers provide to these centers property of atoms of a matter”.

So, **inertial properties of mass are provided by aether**, which is connected with particles and is placed between atoms. Therefore, accelerated motion and centrifugal force are effects of elastic interaction of a body with surrounding elastic aether environmental medium. From this point of view, additional energy and excess torque (kinetic momentum) can be obtained in technically closed physical system. In this case, it can be caused only by transformation of energy of environment, i.e. elastic deformations of the environment and thermodynamic changes in it. **We can observe deformation of aether as absorption and emission of heat.**

More deep consideration of this process question, for example analysis of physical mechanism of elastic interaction of bodies is out of frames of this Research Work. Let’s note in short that essence of phenomena of elasticity is electromagnetic interactions of atoms, we can design and test some mechanical device but we have to remember about aether and electromagnetic nature of any matter.

Let’s consider parts of design of centrifugal-vortex converter. So-called “centrifuge” provide rotation of liquid if rotor is rotating. Later we’ll calculate value of input power to be spent for initial acceleration of working mass (to change its orbital velocity).

At the beginning of cycle, working liquid arrives in branch pipe under pressure from pump, and then it passes area of centrifuge with rotation. It creates conditions of cavitation process and provides aeration of working liquid and its elastic properties. Further, working liquid is moving towards a nozzle inside of several pipes (there are fixed on surface of the rotor). In this design it is planned to use eight identical pipes placed symmetrical. Figure 19 shows only two pipes of total eight pipes.

At the beginning of work the rotor is motionless. Liquid comes in pipes of the centrifuge, then it passes into spiral-screwed pipes and it is moving to wide part of conical rotor, then it leave pipes through nozzles. Velocity of motion of the liquid, at the initial stage is depending of pressure of pump, this pump is necessary to start. Increase of speed of rotation is result of reactive jet effect (Segner's effect).

Further, rotation leads to acceleration of orbital motion of liquid in centrifuge and also to acceleration of linear motion of liquid in pipes. The pipes are made in form of screw spiral of variable step and variable radius. In start (on minimum radius of rotation of liquid) the spiral has big step, it means that axes of pipes are located at small angle to axis of rotation of a rotor, it is almost axial position of pipes. This part of rotor creates for liquid condition of accumulation of additional potential energy (compression) without possibility of its transformation to kinetic energy. In process of motion of liquid to nozzles, angle of spiral is increasing and this change of position means possibility of accelerated motion of liquid in field of centrifugal forces. Here is decrease of static pressure and expansion (increase in volume) of air bubbles of water-gas mix, that is process of conversion of potential energy. As velocity of liquid is increasing, dynamic pressure also is increasing and static pressure in pipes is decreasing.

Let’s note that acceleration of liquid in process of motion in pipes towards a nozzle creates vacuum (decompression) in area of centrifuge and inlet branch pipe. The pump can be switched-off if speed of rotation of the rotor will reach critical number of rpm, that is necessary to overcome hydraulic losses and power of initial acceleration of incoming liquid. Theoretically, it will be calculated in point 8 of the report, losses on friction are about 10% of total kinetic energy of flow of liquid. So, the device can be self-running.

Further, rotation of rotor will be possible in autonomous self-running mode. Increase of speed of rotation of rotor depends on several aspects of transformation of kinetic energy of stream of liquid to the rotor torque. It will be considered in following point of the report (calculations and results).

Some notes: in the case, at left, on Figure 19, you can see hatch to provide service access to elements of rotor. It is possible to regulate angle and position of reflectors of third turbine. For sealing of the case, the hatch must be used with rubber laying on all perimeter of the hatch. Shaft to connect electric generator is provided in left part of the rotor. Electric load must be switched on after the rotor will reach nominal

speed of rotation. Electric generator is standard and its nominal is 3000 rpm. Theoretically calculated power is 10 kW on nominal speed of rotation. The general scheme of circulation of liquid will be shown later, Figure 26. There is also crankcase to collect liquid after exit from nozzles. In self-running mode (nominal speed of rotation) liquid will moves from crankcase under influence of pressure difference (without pump).

8 Method of calculation of main parameters of energy converter

8.1 Conditions of accelerated motion of working liquid

There is main condition of accelerated motion of the working body in this design: working liquid must have elastic properties. Incompressible liquid can't be accelerated as continuous stream and due to the incompressibility flow of this liquid will have gaps and strong turbulence.

The reason of movement of liquid in rotor pipes is gradient of pressure. The movement is directed towards smaller static pressure (maximum dynamic pressure) which is created in wide part of cone rotor. Thus, due to form of the rotor and its elements, in this device we can create reactive jet effect (outlet of liquid from nozzle), and also conditions of transformation of kinetic energy of stream to rotary motion of rotor. To provide this condition, pipes are made in form of screw spiral.

Description of principles of operation was made in point 7 of the report, but now we consider detailed transformation of energy in the design.

Hydrostatic pressure in liquid is analog of potential energy, and it can be transformed into kinetic energy. An example of this case is falling body. It is moving with acceleration of gravity “g”. BY similar way, we can consider potential energy of rotating liquid, which can't increase its rotation radius (for example this radius is limited by the rotor case). In our design of rotor, there is part of rotor with spiral pipes to collect liquid in some volume. This volume is area of centrifuge. Here is stored potential energy of working liquid.

Let’s note following: in this part of device, due to rotation, exist conditions of increasing of potential energy of working water-gas mix. In this part, influence of centrifugal pressure creates elastic compression of working body. This process (starting rotation of incoming liquid into centrifuge) demands some expenses of energy (input power) to overcome inertia of body (liquid) and accelerate it. Ratio of expenses of power (input power) and output power allows calculate efficiency of converter.

In process of rotation of liquid, there is shift in radial direction if radius of rotation is increasing. This shift is provided by gradient of centrifugal force. This motion of liquid in pipes is accelerated, i.e. here is

increase of kinetic energy of liquid. Thus, total energy of unit of volume of working liquid in outlet (point of exit from nozzle) can be much more than total energy of the same unit of volume of working liquid in point of inlet to the rotor. This additional energy is provided for free due to centrifugal force.

Let’s note again: additional energy in this physical system can be explained considering open system. Inertia, in this case, is considered to be property of environment media (aether), but it is not property of working body. Rotation of inertial mass body demonstrates centrifugal effect. This effect is caused by gradient of pressure of elastic medium (aether). Potential energy, in this case, can be transformed in kinetic energy in stage of relaxation (decompression) of working elastic body. Thus, in elastic environment (aether) there is some thermodynamic process. Value of this process is equivalent to output power and this process in aether manifest itself in changes of temperatures of the environment air.

Other useful effect is possibility to receiving torque and axial propulsion force. Let’s draw mechanical analogy: Some massive load compress vertically installed spring. This spring is installed on some support. There is work to act against elastic forces of compressed spring and this work is performed by gravity (weight of the load). We can transform potential energy of this spring to kinetic energy if we will turn this spring in horizontal direction. Decompression of spring will push away the load, and spring will receives opposite direction momentum of motion. The same process we can observe in the device: centrifugal forces and elastic forces are counterbalanced in area of centrifuge. In process of motion of liquid, it moves to other physical conditions, which are determined by geometry of the case (radius and angle of spirals). These conditions are necessary for transformation of potential energy of compressed elastic working liquid to its kinetic energy, and, at the same time, this geometry create in the case effect of axial propulsion force. In this physical system we can observe example of reactive effect: torque of rotor is corresponding to axial propulsion force.

8.2 Calculation of acceleration and power

Let’s consider accelerated motion of working liquid in rotor pipes. Similar case is process of falling of body (mass “m”) from some height “h” in the field of gravity. For our case, instead of the acceleration of gravity “g” we use centrifugal acceleration “a” in formulas. Height “h”, in this case, is equal to difference in radiuses of the cone rotor (one point is inlet of liquid in the pipe and other point is center of nozzle). Kinetic energy is increasing according to square of speed function. Static pressure also will be decreasing according to square of speed function. This dependence of pressure of liquid on the speed of its flow is described by Bernoulli's law. External atmospheric pressure is not significant value here therefore in our consideration there are only static and dynamic pressure.

Let's make some notes: at horizontal arrangement of an axis of the rotor, on small speed of rotation, normal acceleration of liquid in pipes is comparable with acceleration of gravity. So, it will be noticeable that each turn of rotor have two half-period: half of cycle of rotation "down" the liquid will receive more acceleration than in other half-period of "up". It is result of summation or subtraction of normal acceleration of rotation and acceleration of gravity. In this situation, there is non-compensated vertical mechanical momentum in device (vibrations). So, it is preferable to use vertical arrangement of an axis of rotor. However, for nominal speed of rotation the arrangement of rotor is not matter since normal acceleration will exceed acceleration of gravity.

Let's calculate normal acceleration for several values of speed of rotation by formula (1):

$$a = V^2/R \quad (1)$$

where a – acceleration, V – linear velocity of motion, R – radius of trajectory.

The linear velocity of motion V along trajectory of radius R can be calculated by formula (2):

$$V = \omega R \quad (2)$$

where ω – angular velocity of rotation (Rad/sec), formula (3)

$$\omega = \pi n/30 \quad (3)$$

where n – rotation speed (rpm).

Working liquid moves in pipe. Its acceleration is variable and it is depend on radius of rotation. Radius is changing during the liquid is approaching the nozzle. Let's use data on angular speed of rotation for five operating modes, and we will find normal acceleration in point of start, in radius of the centrifuge, ($R=5\ 10^{-2}$ m), then we will find normal acceleration of liquid in central point of nozzle. This point is rotating on radius $R=1{,}4.10^{-1}$ (m). Then we will find their average value, for each mode. Results of calculations are shown in Table 1.

Table 1. Calculation of average normal acceleration for various speeds of rotation.

Speed of rotation n (rpm)	100	500	1000	1500	3000
Angular velocity ω (Rad/sec)	10,46	52,33	104,67	157	314
Linear velocity V (m/s) $R=5\cdot10^{-2}$ (m)	0,52	2,61	5,23	7,85	15,7
Acceleration a (m/sec^2) $R=5\cdot10^{-2}$ (m)	5,4	136,2	547	1232	4930

Linear velocity V (m/sec) $R=1,4\cdot10^{-1}$ (m)	1,46	7,32	14,65	21,98	43,96
Acceleration a (m/sec^2) nozzle $R=1,4\cdot10^{-1}$ (m)	15,2	382,7	1533	3451	13804
Average acceleration a (m/sec^2)	10	260	1040	2341	9367

Work of centrifugal force to create accelerated motion of body depends on value of acceleration. Let’s calculate value of work per unit of time to calculate power.

In simple case, motion of liquid in pipe is started from central point of axis towards nozzle, in radial direction of flat Segner’s rotor, Figure 20

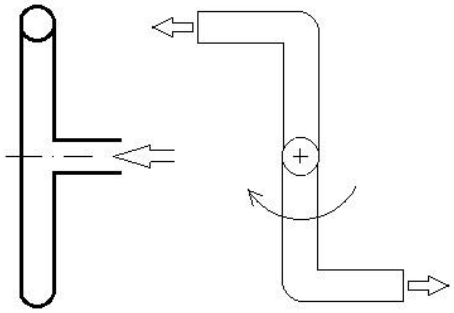

Figure 20. Scheme of motion of liquid in flat Segner’s rotor.

Calculations in this case are similar to example of vertical falling body in gravity field. In cone rotor screw spiral pipes there is also axial shift of liquid due to influence of centrifugal force. Therefore, it is necessary instead of vertical falling body to consider analogy with accelerated motion of body on inclined plane surface. This physical task is classical and its solution is known, the scheme is shown as Figure 21.

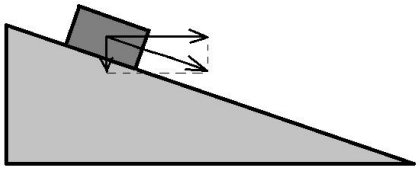

Figure 21. Accelerated motion of falling body on inclined plane surface.

Let’s find final speed of motion of liquid in the pipe at point of nozzle. We can use formula (4)

$$V= (2\ a\ X\ \sin\alpha)^{0.5} \qquad (4)$$

where V - velocity of liquid in point of outlet, a – average acceleration, X – length of accelerated motion trajectory, α - angle of inclination of turn of spiral to axis of the spiral.

In present device, X is about $3 \cdot 10^{-1}$ (m), angle α is about 30 degrees in wide side of the cone rotor. Average acceleration for speed of rotation n = 3000 (rpm) according to Table 1 is equal to a=9367 (m/sec^2). Result: value of velocity of liquid in area of nozzle is about V = 53 (m/sec).

Let's note: designing require optimization of parameters X and sinα in formula (4). Value X depends on number of spiral turns. Angle α depend of form of rotor (inclination of spiral turns to axis of rotation).

Further, power is work per unit of time. Calculation of power require to set value of expense of liquid per second. Calculation of expense of liquid is possible by following method: Let's find area of section of pipe (diameter is 10^{-2} m) formula (5)

$$S = \pi D^2/4 \quad (5)$$

Result is $S=7,85 \cdot 10^{-5}$ (m^2). For velocity V = 53 (m/sec) there is flow of liquid through this section. Let's name this expense of liquid N and calculate it by formula (6)

$$N_1 = VS \quad (6)$$

For speed of rotation n = 3000 (rpm) in one pipe we can estimate expense of liquid $N_1 = 4 \cdot 10^{-3}$ (m^3/sec). This mass of water N_2 can be calculated by formula (7)

$$N_2 = N_1 \rho \quad (7)$$

where ρ – density of liquid (kg/m^3).

In this case, N_2 = 4 (kg/sec). For other type of liquid it is necessary to consider other density. We assumed here that cavitation will slightly decrease density and we do not take this decrease into account.

Expense of liquid for all 8 pipes and nozzles equal to 32 (kg/sec), for speed of rotation 3000 (rpm).

Kinetic energy of moving body can be calculated by formula (8):

$$E = 0,5 (mV^2) \quad (8)$$

In our case we see flow of mass, i.e. we know expense of liquid N_2 "mass m per second" and we can calculate power. Let's use formula (8) but replace "m" with N_2 to calculate power by formula (9):

$$P = 0{,}5\, N_2 V^2 \qquad (9)$$

where N_2 – expense of liquid (kg/sec), V – velocity (m/sec).

Power P=11 (kW) if speed of rotation n = 3000 (rpm), N=32 (kg/sec), V = 53 (m/sec).

Explanation of calculations: Speed of motion of liquid in pipe, for purposes of this calculation, can be average value. This speed is variable during motion: after outlet from centrifuge, speed is increasing up to point of nozzle. Initial speed of stream in point of inlet to centrifuge is variable. It is depend on speed of rotation of the rotor. For purposes of calculation we can accept it to be equal to zero, i.e. we will calculate minimum power. Real power can be more high since liquid is coming to centrifuge with some nonzero speed. In correctly designed return pipeline we can see significant axial component of speed of incoming liquid that will bring significant addition in creation of torque.

So, considering zero speed of incoming liquid, average value velocity (half of maximum) equal to $V_{average}$ = 26,5 (m/sec). Expense of liquid is N=32 (kg/sec), so by formula (9) we can calculate power P = 11 (kW). This power of flow of liquid was provided by process of rotation in centrifuge. We can transform this energy in kinetic from in point of exit from the nozzle. Part of this power can be transformed in electro-energy, considering friction losses, hydrodynamic losses and efficiency of reactive jet turbine, efficiency of third turbine (reflector blades) and efficiency of electro-generator. We do not consider here power of pump, i.e. kinetic energy to start rotation in stage before self-running mode. This calculation was made for self-running more, and pump here is switched-off. In this mode liquid is circulated due to gradient of pressure between inlet and outlet.

Let's calculate power if speed of rotation is 1500 (rpm). In this case, expense of liquid is twice less and equal to N_2=16 (kg/sec). Average velocity is a=2341 (m/sec^2). According to formala (4), we can calculate velocity in the end of trajectory of accelerated motion V = 26,5 (m/sec), that is twice less than for speed of rotation equal to 3000 (rpm). So, velocity of outflow of liquid is linear function of speed of rotation. In the case of speed of rotation n = 1500 (rpm) we can calculate average velocity of motion of liquid in pipes. It is V_{cp} = 13,25 (m/sec). According to formula (9) we can calculate power of flow of liquid P = 1,4 (kW).

Conclusion: Increase of speed of rotation in two times, from n = 1500 (rpm) up to n = 3000 (rpm) lead to increase of power in 8 times from 1,4 (kW) up to 11 (kW). This factor is product of two factors in

formula (9): expense of liquid in increased linearly in 2 times and average acceleration is increasing by square law, i.e. in 4 times.

So, power depend of speed of rotation in cubic function. Increase of speed of rotation in 3 times will lead to increase of power in 27 times and so on. For example, let’s calculate power for high speed of rotation. For speed n = 4500 (rpm) factor is 3 in comparison with n = 1500 (rpm), so power will be increased in 27 times to be about 37,8 (kW). If we will increase speed of rotation in 4 times from n = 1500 (rpm) up to n = 6000 (rpm), then power will be increase in 64 times, from 1,4 (kW) up to 90 (kW). Figure 22 demonstrate how power (kW) is function of speed of rotation (rpm).

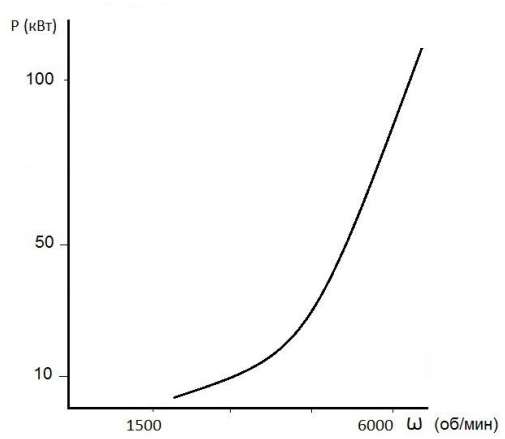

Figure 22. Function power of rotation speed.

Let’s note other factors: consumption of working liquid is depending on diameter of pipes (section), diameter of centrifuge and diameter of rotor in its wide part of cone. Any change of proportions of sizes of rotor will lead to change of angle of inclination of spiral. It will change parameters of first (screw) turbine.

Conclusions: power level about 10 (kW) can be theoretically obtained in the proposed here design.

Real results can be different from theoretical calculations of power. Increase of speed of motion of liquid in rotor pipes is related with big friction losses and hydrodynamic losses. Nevertheless, these problems can be solved by means of real technical methods. Creation of compact centrifugal converters of energy for transport, power industry and various equipment seems to be possible in range from 10 (kW) to 10 (MW). It is real engineering task.

8.3 Efficiency of operation of centrifugal-vortex energy converter

Let’s consider efficiency. It is important question of theory of centrifugal-vortex converter. We will note existence of three reactive jet turbines in this design. The three turbines have different principle of operation, different efficiency and ways of increase of efficiency.

8.3.1. First turbine

The first turbine consist of pipes placed on the rotor. Liquid is moving inside of the pipes. The pipes are bent in form of screw spiral. It creates conditions of transfer of kinetic energy of stream of liquid to rotor. Axial component of speed of movement of working liquid provide dynamic pressure of stream upon inner surface of the pipes, since they are placed at some angle to stream speed vector. So, by this was some torque is created (analogy is any propeller). Average efficiency of modern screw turbines reaches 75% but we must take low efficiency to see low limit of power. Therefore we will set efficiency of transformation of kinetic energy of stream of working liquid to rotor torque at level of 50% that correspond to law of conservation of momentum in this first turbine.

Calculation of heat friction losses in the pipe will be made in point 2.8.4. of this report. It is about 10% of kinetic energy of liquid in the pipe length.

So, according to formula (9), for speed n = 3000 (rpm), power of flow of liquid is P = 11 (kW), so 10% losses are about 1.1 (kW). It is value of heat losses and part of this energy will be transformed in heating of the working liquid.

Taking into account heat losses, in our consideration remains about 9.9 (kW). We can assume 50% of this power will be transferred to rotor shaft, i.e. according to the law of conservation of momentum P_1 = 4,9 (kW).

8.3.1 Second turbine

The second turbine works due to reactive jet effect. It is similar to principle of Segner’s wheel. Kinetic energy of liquid stream (outgoing flow from the nozzle) is transferred to rotor, according to Newton Law. Therefore, power on shaft is equal to half of power of the liquid stream in point of exit from the nozzle. In calculations we must use relative speed of movement between nozzle and liquid, for example, for n = 3000 (rpm), velocity of liquid stream at point of exit from nozzle is equal V = 53 (m/s), and velocity of movement of the nozzle is V = 44 (m/s). So, relative velocity is equal to $V_{relative}$ = 9 (m/s). Thus, outgoing stream of working liquid provide to rotor acceleration and the rotor can rotate with the

increasing angular speed, if load is not connected to the shaft. Speed of rotation will be increasing until friction losses or temperature of working liquid will reach critical value.

Let’s calculate additive of power provided by second reactive jet turbine. This power can be calculated by formula (9), taking into account the relative speed of liquid stream and speed of rotation of rotor. For n = 3000 rpm, N=32 (kg/s), $V_{relative}$ = 9 (m/s), so power is equal to P_2 = 1.3 (kW).

8.3.2. Third turbine

Further, there are blades on the rotor to transform kinetic energy of liquid stream into mechanical power on shaft. We will consider its work and calculate estimated efficiency.

The third turbine here is eight separate reflectors of stream of working liquid. Reflectors are installed at angle about β ≈30 of degrees, everyone is placed near one nozzle. This turbine transfers to rotor about half of kinetic momentum of free stream of working liquid, after this flow of liquid exit from nozzle. Contribution of this turbine to operation of device is very significant. Considering reflector is rotating together with rotor, it is moving towards to free stream of liquid leaving nozzle. Their vector speed are shown at Figure 23.

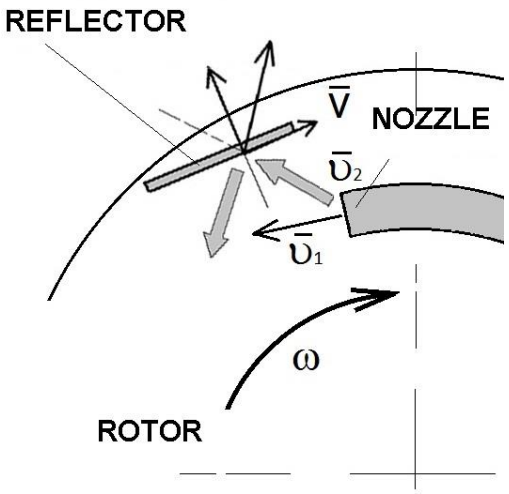

Figure 23. Vectors of forces in third turbine.

Let’s note, result of action of radial centrifugal force is radial component of vector of stream υ_2 after exit of liquid from nozzle. So, vector υ_2 doesn't coincide with tangential vector υ_1. The optimal angle β is about 30 degrees. This angle can be established by adjustment of turn of reflector in relation to axis of stream.

Calculation of power of the third turbine can be made by formula (9), but it is necessary to use relative speed of interacting bodies (free moving liquid and moving reflector). This relative velocity is sum of speeds of stream and speed of rotor, but taking into account sinβ between them.

So, we can calculate power by formula (10)

$$P_3 = 0{,}5\sin\beta\ N\ V^2 \qquad (10)$$

where N is consumption of water (kg/s), V is relative speed (m/s), β is angle between vector of stream and the plane of reflector in point of their interaction.

According to calculation for n = 3000 (rpm), N=32 (kg/s), V = 53 (m/s), and β ≈30 degrees, power of third turbine is P_3 = 22.4 (kW).

8.3.3. Total power

Total power is sum of power of all three turbines by formula (11)

$$P = P_1 + P_2 + P_3 \qquad (11)$$

For n = 3000 (rpm), total power is P = 4,9 + 1,3 + 22,4 = 28,6 (kW).

Let’s consider efforts to make liquid rotating, i.e. we will find input power that is necessary to overcome inertia forces of liquid, which inflow into the rotor. We can use law of energy conservation: to make liquid rotate with some speed, it is necessary to spend power, which correspond to created kinetic energy of liquid.

In initial part of rotor, for these purposes there is centrifuge. R radius is 5.10^{-2} (m). Kinetic energy of liquid in centrifuge can be calculated according to formula (8). It is necessary to spend this amount of energy E_{input} to make liquid rotate. With formula (9), taking into account value of speed of motion of rotating liquid in centrifuge, it is possible to find input power P_{in}.

Let’s find value of input power P_{in} by formula (9) for n = 3000 (rpm), N=32 (kg/s) and linear velocity of liquid in centrifuge on R radius = 5.10^{-2} (m) V = 15.7 (m/s).

Calculations show following: initial acceleration of working liquid in centrifuge up to velocity V=15.7 (m/s) require power $P_{in} = 0.5\ NV^2 = 4$ (kW).

Total power by formula (10) is P = 28,6 (kW) and taking into account losses P_{in} = 4 (kW) of initial acceleration of incoming liquid we can estimate power on shaft about P = 24,6 (kW). Electric generator will provide transformation of this mechanical power to electric power with efficiency about 85%.

Conclusion: We have to take into account total power of three turbines, friction losses and input power to start rotation of liquid in the centrifuge. Result is 20 (kW) of electric power at n = 3000 (rpm).

8.4 Calculation of hydraulic losses

Above calculation of maximum power was made without consideration of hydraulic losses, which depend on material of pipes and mode of motion of liquid in the pipes.

Choice of material of pipes require comparative analysis of resistance coefficient C_d. If pipe is made by drawn (brass, lead and copper) this coefficient is about $C_d = 2.10^{-3}$. For high-quality seamless steel pipes, it is equal to $C_d = 2.10^{-1}$. For pig-iron pipes, this coefficient is approximately equal to $C_d = 1.0$.

Conclusion: it is good idea to use copper or brass drawn pipes.

Then, let’s consider briefly theory of streams of liquid to find ways of decrease of hydrodynamic losses of working liquid stream kinetic energy.

There are two types of hydraulic losses of energy: friction losses on length of pipelines and local losses caused by elements of pipelines. In this element due to change of size or configuration, there is change of stream speed. The stream become separating from inner surface of the pipe and vortex is created. In present design of device there is not this element of pipes. The beginning of pipe is connected to centrifuge without joints and transitions, then the pipe comes to the end with nozzle. There are no sharp bends and soldering, it isn't required here.

Sudden expansion or narrowing of stream create losses of pressure (kinetic energy). In this places there are vortex formations, i.e. separation of steam from inner surface of the pipe with organization of continuous rotary motion of liquid. In present design of device (on all length of rotor pipes) there are no expansion or narrowing of stream diameter. It must reduce hydrodynamic losses significantly.

Hydrodynamic resistance depend on mode of motion of liquid. Fundamental experiments in this field of research were made by Reynolds in 1883. He considered two modes of motion of liquid: laminar mode and turbulent mode.

Laminar mode of liquid flow is layered current without hashing of particles of liquid, without pulsation of speed and pressure. Laminar current of liquid in a direct pipe of constant section we can observe that all lines of current are directed parallel to pipe axis, thus here are no cross movements of liquid particles. Turbulent mode of liquid flow is current with intensive hashing of liquid, with pulsations of speeds and pressure. In this turbulent flow there are main longitudinal movement of liquid, cross-motion and rotary motions of separate volumes of liquid. Intensive turbulence considerably increases friction coefficient.

Transition from laminar mode to turbulent mode is observed at critical speed of motion. Value of this speed in function of kinematic viscosity of liquid and diameter of pipe, by formula (12).

$$(V_{cp})_{кр} = (Re_{кр}\ \nu) / D \qquad (12)$$

where $Re_{critical}$ Reynolds critical number, D – pipe diameter, ν - kinematic viscosity of water.

Let's calculate average critical velocity $(V_{av})_{critical}$. Kinematic viscosity of water $\nu = 1{,}007 \cdot 10^{-6}$ (m^2/s) for t =20 ^{0}C temperature, diameter of pipe is $D = 10^{-2}$ (m). Let's take into account lower critical number of Reynolds $Re_{critical} = 2300$.

Calculation shows that in this case $(V_{ave})_{critical} = 2.310^{-1}$ (m/s).

Conclusions: In calculations of velocity of motion of liquid in rotating rotor pipes by formula (4) we see values of velocity in 100 – 200 times more than critical velocity. For example, maximum velocity for speed n = 3000 (rpm) is equal to V = 53 (m/s) that is 200 times more than $(V_{ave})_{critical} = 2.3\ 10^{-1}$ (m/s).

Obviously that, without special technical adaptations, mode of motion of liquid will be high turbulent, i.e. there are big losses here.

Let's find coefficient of hydraulic friction by Blazius's formula (13):

$$\lambda = 0{,}316 / Re_{critical}^{0{,}25} \qquad (13)$$

where λ is hydraulic friction coefficient on the length.

On low limit $Re_{critical} = 2300$ hydraulic friction coefficient is $\lambda = 4{,}5 \cdot 10^{-2}$.

It is necessary remember difference between hydraulic system pressure caused by acceleration of gravity "g" and acceleration of motion of liquid in rotating rotor pipes. Value of average acceleration "a" for various speed of rotation we already calculated, data is Table 1. Darci-Weisbach formula (14) let us to find friction losses of pressure p on length of L. In our case $L = 3.10^{-1}$ (m).

$$\Delta p = \lambda (L/D)(V^2/2)\rho \quad (14)$$

where L is length of pipe, D is diameter of pipe, V is velocity of stream, ρ is density of liquid.

Result of calculation: for speed of rotation n = 3000 (rpm), density of liquid is about 10^3 (kg/m^3), and average velocity of stream V = 22 (m/sec), losses of pressure of pipe length is about $3.2\ 10^5$ (N/sq.m).

Conclusions: hydraulic friction losses considerably affect efficiency. In point 8.6 we’ll calculate working pressure difference. After this step we’ll see percentage ratio value of reduction of working pressure difference due to friction losses. This reduction corresponds to losses of power on shaft. Once time again, let’s note that these losses correspond to heat power, it is necessary remove this heat from working liquid by means of heat exchanger.

8.5 Calculation of static pressure difference

Let’s calculate difference of static pressure in air that is created by in process of rotation of the rotor. We can consider movement of nozzle in environment as relative movement. This motion creates changes in balance of static and dynamic pressure of air on open end of the nozzle. Bernoulli's law is formula (15):

$$p_{atm} + p_{stat} + 0{,}5\rho V^2 = \text{const} \quad (15)$$

where p_{stat} is statical pressure of air on nozzle, p_{atm} is atmosphere pressure, ρ is density of air, V is relative velocity on the nozzle in environmental.

We know value of atmosphere pressure, so formula (15) can be presented in formula (16)

$$p_{stat} = 1{,}01 \cdot 10^5 - 0{,}5\rho V^2 \ (N/m^2) \quad (16)$$

Atmosphere pressure of air is the same for both ends of pipe for motionless rotor, but in the case of rotation, it decreases by value of dynamic pressure.

In rotating pipe, there is pressure difference between nozzle and other end of the pipe. We can calculate this difference by formula (17)

$$\Delta p = 0{,}5\rho V^2 \ (N/m^2) \quad (17)$$

where Δp is pressure difference in pipe, ρ is density of air, V is relative velocity of the nozzle in environmental (air).

For n = 3000 (rpm), relative velocity is V = 44 (m/sec). Density of air is about $\rho = 1{,}2$ (kg/m^3). Pressure difference is $\Delta p_{stat} = 1{,}1 \cdot 10^3$ (N/m^2), for this speed of rotation.

Further, considering this energy converter we have to take into account closed cycle of liquid motion, Figure 24. So, there is gradient of atmospheric pressure for working liquid. In crankcase of device (if device is not sealed hermetically) there is atmospheric pressure on surface of liquid but for rotating nozzle there is reduced static pressure of air. Difference is about $\Delta p_{stat} = 1{,}1 \cdot 10^3$ (N/m^2).

Thus, due to existence of atmospheric pressure, there is some additional power. The working liquid will get additional acceleration by difference of static pressure of environment.

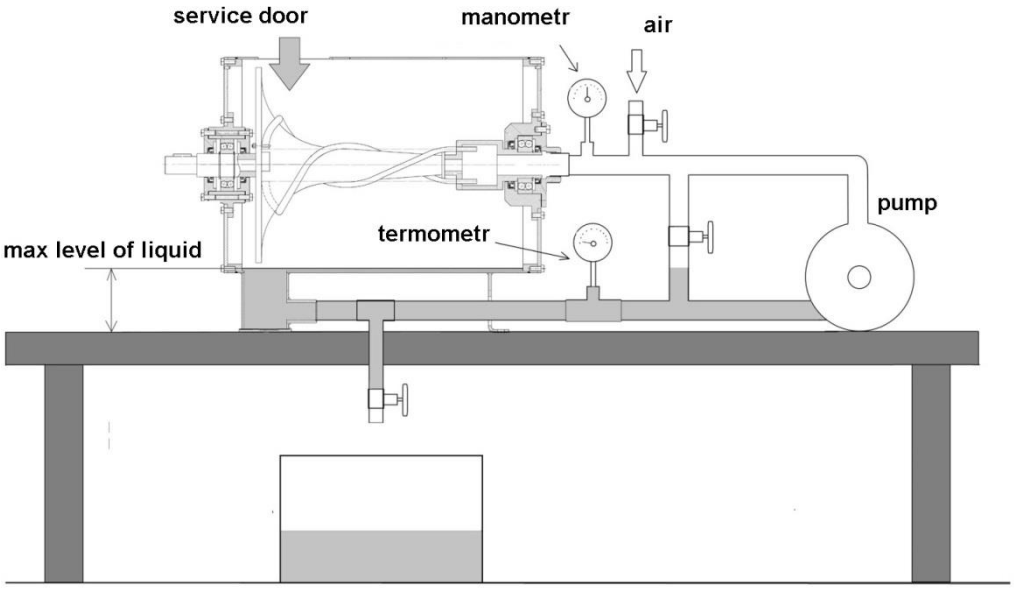

Figure 24. Scheme of liquid circulation.

Let’s calculate this additional power. Surface of the nozzle can be calculated by formula (5) It is equal to $S = 7{,}85 \cdot 10^{-5}$ (m^2). Surface of all 8 nozzles is $S_8 = 6{,}2 \cdot 10^{-4}$ (m^2).

On this surface act force F, for pressure difference $\Delta p = 1{,}1 \cdot 10^3$ (N/m^2) formula (17). The force F can be calculated by formula (18)

$$F = \Delta p \, S_8 \qquad (18)$$

From our calculation $F = 7 \cdot 10^{-1}$ (N).

Let’s calculate torque of rotor, considering force F act in the point place on radius $R = 1{,}4 \cdot 10^{-1}$ (m). Torque can be calculated by formula (19)

$$M_{torq} = F \cdot R \tag{19}$$

Result of calculation is $M_{torq} = 10^{-1}$ (N m)

For n = 3000 (rpm), i.e. angular velocity $\omega = 314$ (Rad/sec), we can calculate power by formula (20)

$$P = M_{critical}\ \omega \tag{20}$$

This value is additional power on shaft of rotor. It is result of air pressure difference P = 31 (W).

Conclusion: this additional power is not significant, therefore, hermetical sealing of device isn't necessary condition. Let’s note that this method of calculation of power of working liquid stream use method based on pressure difference, and it can be useful in other cases.

8.6 Calculation of power based on pressure difference

To check calculations and possible value of error, there is known technique of double solution of the same task by various methods. In point 8.3 of the report, value of power was found in dynamics, by determination of kinetic energy of stream. This energy is result of accelerated movement in pipes from centrifuge to nozzle. Let’s find power on shaft by different way, considering liquid movement as result of pressure difference in tubes that is created by rotation of rotor. From value of pressure difference, we will find force, torque and power. After that, we will estimate friction losses.

Let’s find difference of full pressure in the beginning and at the end of trajectory of movement of liquid in pipe. There is Bernoulli's formula (20)

$$0{,}5\rho V^2 + \rho g h + P_{atm} = Const \tag{21}$$

where ρ is density of liquid, V is velocity of stream of liquid, g is acceleration of free falling in gravity field, h is height.

In case of accelerated movement of liquid in pipes of rotor, the formula is (22)

$$0{,}5\rho V^2 + \rho a R + P_{atm} = Const \tag{22}$$

where ρ is density of liquid, a is normal acceleration, R is radius of rotation, V is velocity of liquid stream.

To calculate pressure difference we can use formula (23)

$$\Delta p = (0{,}5\rho V_2^2 + \rho a_2 R_2) - (0{,}5\rho V_1^2 + \rho a_1 R_1) \quad (23)$$

Where $V_1 = 15{,}7$ (m/s), $a_1 = 4930$ (m/s^2), $R_1 = 5 \cdot 10^{-2}$ (m) are velocity, acceleration and radius, $V_2 = 53$ (m/s), $a_2 = 13804$ (m/s^2), $R_2 = 1{,}4 \cdot 10^{-1}$ (m) are velocity, acceleration and radius in the end of the pipe (at nozzle). The values were calculated and presented in Table 1.

Value of working pressure difference is calculated by (23) $\Delta p = 2{,}93 \cdot 10^6$ (N/m^2).

Let's compare this value with data of point 8.4 about hydro dynamical friction losses in pressure: $\Delta p = 3{,}2 \cdot 10^5$ (N/m^2). Conclusion: hydro-dynamical losses are about 11% of working pressure difference. It was mentioned in point 8.3.

So, taking into account hydro-dynamic friction losses we can estimate value of working pressure difference $\Delta p_p = 2{,}6 \cdot 10^6$ (N/m^2). We can note that similar value of pressure was used in the Clem's device.

Atmosphere pressure difference was considered in point 8.5. It is not significant value $\Delta p_{stat} = 10^3$ (N/m^2), so we can do not take it into account for calculations.

Let's note that increase of working pressure difference can be created by means of reduction of radius of rotation of liquid in the centrifuge, and also by increase of radius of rotation of nozzle. We can not reduce radius of centrifuge since centrifugal pressure is created in this part of device and it is useful effect to provide compression of elastic working body. So, to increase power we must increase radius of wide part of the conical rotor.

We know the pressure difference $\Delta p_p = 2{,}6 \cdot 10^6$ (N/m^2), so we can calculate force F, according to formula (24)

$$F = \Delta p_p S_8 \quad (24)$$

Square of 8 nozzles is $S_8 = 6{,}2 \cdot 10^{-4}$ (m^2), so force is $F = 1{,}61 \cdot 10^3$ (N).

This force of total stream from 8 nozzles, due to the pressure difference. Let's assume we make this stream to work in turbine with 50% efficiency, that is Newton law of transfer of kinetic momentum between stream and blades of turbine. Radius of turbine is $R = 1{,}4 \cdot 10^{-1}$ (m), so we can calculate torque on shaft according to formula (25).

$$M_{torque} = F \cdot R \tag{25}$$

Result of calculations is $M_{torque} = 2{,}25 \cdot 10^{2}$ (Nm).

For n = 3000 (rpm), angular speed is $\omega = 314$ (Rad/sec) and we can calculate power by formula (26)

$$P = M_{critical}\ \omega \tag{26}$$

Power is P = 70 (kw). Considering efficiency is 50%, power is about P = 35 (kw).

Also we have to take into account 11% friction losses, so power **is P = 31 (kw).**

We already made calculations of power according dynamic model by formula (11), it was **P = 28 (kw).**

Conclusion: calculations of value of power of centrifugal energy converter were made by two different methods **and both results are very close, with accuracy about 10%.**

8.7 Proposals on reduction of losses

In this device it is planned to operate with over-critical velocity, so it is necessary to use in design of the device special methods of reduction of losses. Size of device and diameter of pipes can not be increased and it must correspond to planned values.

First idea on reduction of hydro dynamical losses is decrease of viscosity of working liquid. We will use aerated liquid, i.e. it is not continuous flow of liquid but water-gas mixture. Viscosity of this mixture is less than viscosity of water. It is necessary to use special methods to provide aeration of liquid, in opposite case cavitation will change continuous state of liquid flow to change it in vapor-gas mixture (gas and vapor bubbles inside of liquid flow). In standard equipment, the cavitation is negative effect and designers try to avoid cavitation in pipes of water systems. In our case, the cavitation can be useful to decrease viscosity of liquid and also to provide elastic properties to working liquid (it is necessary to collect potential energy in state of elastic compression). In the proposed here device, the cavitation is organized in area of centrifuge. Ends of the pipes are inserted in area of centrifuge (30 mm part of pipes).

One more proposal is special helical mode of motion of liquid in the pipes (laminar-vortex trajectory of motion of liquid), so we can name this device as “vortex” energy converter.

Vortex motion can be self-organizing process by means of rotation of flow around if its axis. It is possible if the flow of liquid can move with acceleration, but friction forces on surfaces try to stop this accelerated motion. In reality, any stream of liquid moving down with acceleration will start rotation. Central part of the stream is moving with more high velocity than periphery of the stream. Friction create micro-vortexes in periphery part of the stream since here is maximum of friction. The micro-vortexes provide minimum of friction and allow acceleration of the stream. So, this self-created vortex processes reduce resistance to motion of the stream in periphery area the stream. So, motion of liquid is helical vortex trajectory.

Physical basis of this effect is simple: rotation of liquid around axis create centrifugal force, and this force push liquid to walls of the pipe. Due to this force, transverse oscillations of particles (i.e. turbulence) in the liquid flow is reduced or totally eliminated.

Conclusion: It is necessary to provide vortex rotation of liquid around axis of motion, by means of special elements of design. We offer several technical solutions: helical relief on inner surface of the pipes, and also micro-turbine in the end of the pipe. Experimental testing of this method was made with air and described in point 3.9 of this Report. Victor Shauberger described this method in patents [12] and [13]. Figure 25 demonstrate his technical idea of special pipe.

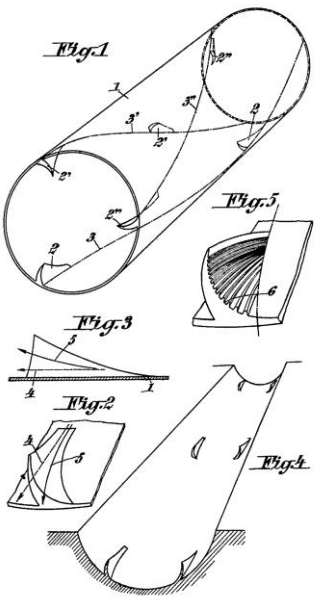

Figure 25. Shauberger’s idea of special pipe to create vortex.

Acceleration of liquid here is provided by twisting of mainstream flow of water inside pipe by means of special blades. In area of low pressure (along axis of rotation) there is mainstream of liquid, main mass transfer of working body. Velocity of motion along axis of the pipe is increased in area of low pressure. Area of high pressure is periphery of the flow; there are micro-vortexes in this area of the flow. This area of high pressure play role of “balls of bearing”.

We can see analysis of helical (vortex) liquid flows in publications by Prof. Milovich [15]: “Helical motion of liquid is special motion. In this motion each particle of liquid is moving linear along its trajectory and also it is rotating around axis of this trajectory. Result of this rotation is shift of layers in normal direction (perpendicular) in relation to linear velocity. This shift creates motion of all mass of the liquid in flat, which is normal (perpendicular) to main direction of motion. It creates rotation of flow around axis of motion. Kinetic energy of this motion is equal to kinetic energy of linear stream.”

There is important conclusion: increase of kinetic energy of mainstream by means of reduction of hydro dynamical losses is possible only in the case of technical possibility of increase of kinetic energy of rotation, i.e. design of rotor of the device must allow this increase of kinetic energy of rotation.

So, we offer to use in this research project copper pipes, that allow rotation. Other idea, for example, rectangular (square) channels cannot provide rotation of the liquid flow.

Additional element of design is helical relief (groove) on inner surface of the pipes, with big step (3-7 radius) in the beginning of the trajectory of liquid will provide conditions of rotation of liquid.

In next stage of research projects it can be useful to calculate and design micro-turbines by Shauberger’s method demonstrated in patent [13]. This design is demonstrated at Fig. 26.

Figure 26. Shauberger’s micro-turbine

Please note: Figure 6 shows micro-turbine is placed at the end of pipe, in nozzle. Please note diameter of section of nozzle is decreased with micro-turbine. **So, this part of device will provide increase of pressure in liquid, which is moving in the pipes. Pressure is important to provide compression.**

Also it can be interesting to install the micro-turbine in the beginning of the pipe. From the other side, this additional dynamical element of design will reduce its reliability and increase its cost. Passive elements of design, i.e. helical relief (grooves) on inner surface of the pipes allow reducing hydro-dynamical losses in device.

Let’s note importance of section size and length of the back-way pipeline. Value of losses depends on the section diameter and length. Increase of section of the pipeline will reduce velocity of motion of liquid and losses. Calculation of losses of pressure for n = 3000 (rpm), by formula (14) in backway pipeline of two-inch diameter $D = 5 \cdot 10^{-2}$ (m), with length L = 1,2 (m), for velocity of motion V = 18 (m/s) let us value of losses of pressure about $\Delta p = 1,7 \cdot 10^5$ (N/m^2), that is about 7% of working difference of pressure. So, it is recommended to make back-way pipeline as short as possible, also it is necessary use gradual (not-rectangular) changes of trajectory of liquid. It is not recommended to use corrugated hosepipes.

Total losses in this hydraulic system is about 18% for n = 3000 (rpm). This energy is heat and it is necessary to remove this heat energy by means of external heat exchanger.

9 About necessity in experimental research

In point 8 it was noted about experimental proof of the theory and calculations. Main aim of experimental work is proof of concept, method of calculation of power and losses. The third turbine provide main part of total power and torque on shaft of electro-generator, so main experimental task is obtaining of real experimental data about optimal parameters of the third turbine. It is planned to investigate efficiency of different forms of blades of the turbine, and also to find optimal angle of the blades. Possibility of regulation of this angle is provided in the design of experimental device.

Also in experiments it is planned to obtain experimental data about real efficiency of Shauberge’s method of reduction of hydraulic losses.

Also in experiments it is planned to investigate operation of the device with helical relief (grooves) on inner surface of the pipes and compare results with device, where standard pipes are used. Different value

of step of helical grooves can be tested (from 3 up to 10 diameters of the pipe) to get experimental data about most efficient value of the step.

10 Estimated results

Main planned result of this research work is proof of possibility to build workable centrifugal-vortex energy converter. Theoretically, after start with external motor or pump, the rotor must rotate with acceleration up to nominal speed of rotation and it must provide power (torque) on shaft. This power must be sufficient to get 10 kw electro-energy for n = 3000 (rpm). Also it is planned to detect some axial propulsion force.

CONCLUSION

Calculation of design of experimental energy converter was presented in this research work. This converter transforms environmental heat energy into mechanical work. This research work will be completed after experiments will prove possibility of self-running mode of operation and theoretical data about power will be confirmed. Power must be function of speed of rotation. After this stage of research it will be possible to design powerful fuel-less machines for industrial application. Accuracy of calculation is about 10%, that is related with average value of acceleration of moving liquid. This method reduces result of calculation, i.e. real power must be more than theoretical value of power. Reliability of theory will be proved by experiments.

Conclusions are following: it is doubtless that reactive effects (Segner’s type rotor) will provide torque of rotor. Also we can conclude that it is possible to provide self-running mode of rotation of the rotor if we will make correct design of the machine. Important conditions are: collection of potential energy in compressed working body, and then transformation of this potential energy into kinetic energy, and then to transfer this kinetic energy to rotor and provide torque. Special vortex mode of motion (laminar-vortex mode) of the liquid in the pipes will provide reduction of hydro-dynamical losses.

It is necessary to note: this mechanical machine is open physical system and it can operate in self-running mode only if we will provide transformation of environmental heat energy into kinetic energy of rotor. From this point of view, this machine is analogy with heat pump.

Development of the project requires team work. Designers and engineers can develop experimental device to provide new level of power engineering with wide range of industrial and commercial application. Innovation of this new technology will reduce cost of energy.

This research work is one of rare projects in the field of advanced power engineering.

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