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Filter Feeding Mechanism Simulated Machine Paradigms – A Theoretical Approach

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ABSTRACT
Bionics is the emerging branch of bio engineering where in the structures and functions of organism are utilized to construct a gadget that resembles the structure and performs similar function. The functional principles are also used to construct special gadgets to perform functions in the form of simulated robots. Animal models have also been used in creation of many structures/machines, for example the organization and flight mechanism of birds, echolocation in bats, and internal ear of mammals have been taken as blue prints to design aero planes, radars and telegraphic systems respectively.
Here we are using ciliary feeding mechanisms in animals to create a machine that can be used for a particular purpose. Cilia are minute finger like protoplasmic extensions serve different functions like movement, creation of water current propelling and filter feeding in animals. In many invertebrates and lower chordates rotor movements of cilia create whirl pool of water current to obtain food material. Animals those use cilia for feeding are referred to ciliary feeders or filter feeders. The filter feeders are highly diverse in their habit but share common requirements. The filter feeders may be sessile or free swimming forms but the principles of feeding remains the same. In lower chordates the pharngometry of pharynx plays a decisive role in filter feeding. The filter feeding mechanism is highly evolved in animals through well designed evolutionary paradigms.
Key words — Bionics, Rotary motion, Turbines, whirl pool force

I. INTRODUCTION

The process of drawing inspirations from nature for manmade design has been interchangeably defined as Bionics, Bionics is emerging as a science that studies nature as a model, then imitates or takes inspiration from these designs and processes to solve human problems. After billions of years of evolution, nature has learned what works, what is appropriate and what would last. It also learned how to use minimum resources to achieve maximal performance and came up with numerous lasting solutions. Advancement in machining processes, measurement techniques, micro, nano technology has made Bionics to spread over in several fields such as robotics, surface engineering, automobiles and materials sciences etc

Bionics is an interdisciplinary field on the way to establish itself a science. To look for inspiration in nature or to study nature intensively in order to learn from it is not new to artists and engineers. The works of Leonardo da Vinci (1452-1519) are some of histories best documented examples. In the quest of perfection, man is trying his best to develop biological systems with engineering precision, and somewhere in the near future we could have a truly bionic (artificial) man. The good thing is that it could help the disabled and ailing in a great way.

Water under pressure contains energy. Turbines convert the energy in water into rotating mechanical energy. A turbine is a rotary mechanical device that extracts energy from a fluid flow and converts it into useful work. A turbine is a turbo machine with at least one moving part called a rotor assembly, which is a shaft or drum with blades attached. Moving fluid acts on the blades so that they move and impart rotational energy to the rotor. Early turbine examples are wind mills and water wheels. Impulse turbines convert the kinetic energy of a jet of water to mechanical energy. Reaction turbines convert potential energy in pressurized water to mechanical energy. Gas, Steam and Water turbines usually have a casing around the blades that contains and controls the working fluid.

In practice, modern turbine designs use both reaction and impulse concepts to varying degrees whenever possible. Turbines use an air foil to generate a reaction lift from the moving fluid and impart it to the rotor. Cross flow turbines are designed as an impulse machine, with a nozzle, but in low head applications maintain some efficiency through reaction, like a traditional water wheel. Turbines with multiple stages may utilize either

reaction or impulse blading at high pressure. At low pressure the operating fluid medium expands in volume for small reductions in pressure. Under these conditions, blading becomes strictly a reaction type design with the base of the blade solely impulse. The reason is due to the effect of the rotation speed for each blade. As the volume increases, the blade height increases, and the base of the blade spins at a slower speed relative to the tip. This change in speed forces a designer to change from impulse at the base, to a high reaction style tip.

A bearing is a machine element that constrains relative motion and reduces friction between moving parts to only the desired motion. The design of the bearing provides for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Many bearings also facilitate the desired motion as much as possible, such as by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts. Adopting friction less bearings in turbines will improve the efficiency of the power generation. Since this is a theoretical approach, the manufacturing viability may have a wide opportunity to improve the efficiency.

II. PRINCIPLE

i. Rotary movement of cilia creates whirl pool of water in filter feeders. This whirl pool force creates a force to draw water.
ii. Lateral unidirectional beating of cilia sets a constant flow of water by propelling.
The movement of cilia in (both these cases) biological systems obtain energy from ATP.

2.1 PRINCIPLE – i BASED DESIGN

The plan: Refer Fig 1. The rotor with fan wings fitted on a bearing run by interaction of three gears creates a suction force. The water/air drawn in moves through the central hallow pipe. This beam of water/air current creates the series of turbines attached to generator set to generate electricity.
This set up is designed to function in stagnant water or in air media.

Description: A central hollow pipe of a desired diameter is fitted with a bearing of even size of the bearing is adjusted on to the bearing. Above this a fan is fitted tight to the larger spur wheel.

The rotation of this spur gear rotates the fan. The larger spur gear is rotated with the help of small spur gear rotated through the worm gear that is attached to electric motor through a shaft. The energy required for operation of electric motor is supplemented by solar energy. The movement of fan creates a whirl pool force that to draw the water or air. The gushing in water or air through the central pipe instigates the turbine wheels to rotate, the turbine wheels are connected to gen set to produce energy. The same gadget if reverted upright can draw in the floating material in water by suction. The materials so drawn can be collected below in a huge wet bag tied to a central hallow column. This can also be used to clear the scum by churning movement. The force involved in this principle is explained through a mathematical derivation as a mathematical model.

2.2 PRINCIPLE – ii BASED PARADIGMS

The Plan: Fan wings are fitted on to an articulating gear system. The gear wheels are turned using the power generated by electric motor run by solar energy. The rotating wings propel the water the turbines in a series are rotated by the running water. The turbines are attached to gen set to generate electricity. This setup is designed to function in a narrow lane of stagnant water.

Description: The blue print for the proposed gadget involves interacting gears. The worm gear attached to shaft of electric motor rotates with the movement of motor kept above the water level. The worm is connected to smaller spur gear which in turn interacts with the larger spur gear connected to a vertical right angled shaft adjusted to bearing attached to fan wheel. The interaction of the gear wheels generates faster powerful movement of the fan to push the water with a force that propagates in water. Along the length of running water, a series of turbines installed are rotated by forcing water. The turbines that are attached to generator set generate electricity by the rotary movement. The energy required for electric motor is obtained by solar energy. The requirement of water for this purpose is very limited and can be used even in the utmost draught places to generate electricity.

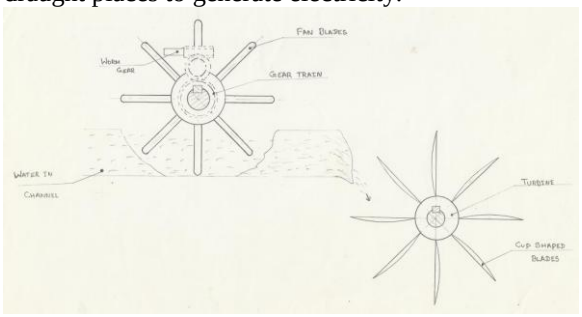

Fig: 1

III. CALCULATIONS

Assumptions:

Height of the rotor	h = 25 mm
Density of water	δ = 1 gm/cc

Calculations:

Mass (m) = δ V ---------- (1)

Volume (V) = $\pi r^2 h$ ---------- (2)

Velocity (v) = (π r) / t ---------- (3)

Centripetal force(F):

$$F = \frac{mv^2}{r}$$ ---------- (4)

Centripetal acceleration(ac):

$$ac = \frac{v^2}{r}$$ ---------- (5)

Angular acceleration (a):

$$a = \frac{ac}{r}$$ ---------- (6)

Angular velocity(w):

$$w = \frac{v}{2\pi r}$$ ---------- (7)

Kinetic Energy (K.E):

$$KE = \frac{mv^2}{2}$$ ---------- (8)

Moment of inertia (I):

$$I = \frac{2KE}{w^2}$$ ---------- (9)

Torque (T):

$$T = I \times a$$ ---------- (10)

Power (P):

$$P = T \times w$$ ---------- (11)

Three iterations are carried out with change in radius of rotor fan within a range of 10-20mm to calculate various terms. Results are as shown in table1:

Table 1.

	Iteration 1 (r= 15mm)	Iteration 2 (r= 20mm)	Iteration 3 (r= 10mm)
F(N)	34.87	74.79	9.05
ac(m/sec^2)	3.333	0.190	0.096
a(rad/sec^2)	222.2	9.92	9.62
W(rad/sec)	0.5	0.5	0.49
KE(N-m)	0.265	0.738	0.0452
I(Nm-s)	2.12	5.94	0.1848
T(N-m)	471.06	58.92	0.0177
P(KW)	253.53	29.46	0.8

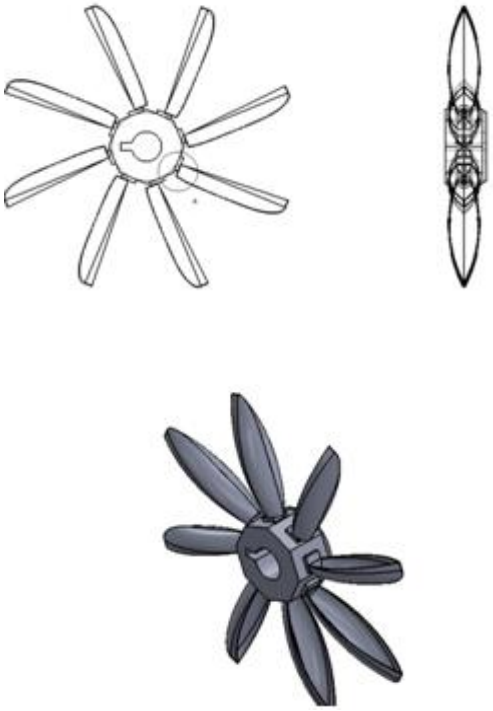

Fig 2

IV. CONCLUSION

The calculations of force involved are represented in mathematical calculations and the representation of the diagram in Fig.1and Fig 2. The same force of water flow through and the series can be maintained by setting another fan at the rear end. The functions of animals have evolved through a series of evolutionary tests. Evolutionary paradigms are long lasting, sustainable for animals and time tested. The proposed paradigms designed on this basis also sustainable. The proposed models are non-conventional methods of producing energy using inexhaustible natural resources, which is essence of sustainable development. The proposed paradigm, as we feel work out very well in medium and small scale production of energy. The short comings and benefits have to be peered through experimentation. What we propose here are purely theoretical approaches and simple blue prints.

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