HOLLOW CONE ROTATING UNDER WATER TRANSLATES

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ABSTRACT
A hollow rigid cone, with constant rotation about its long axis and submerged in a quiet fluid, is predicted to translate parallel to that axis blunt end leading and apex trailing. Due to Bernoulli's law applied to closed streamlines, the pressure distribution over the cone's surfaces, both inside and outside, is highest at the apex and lowest at the base. Consequently, the tendency to translate is stronger, essentially double, that for a solid cone of similar size, shape and weight in water. Friction in the flow is theoretically zero inside and outside of the cone because of the radial functions of the orbital velocity in the streamlines and according to the Navier-Stokes equations. If small vanes are attached pointed outward around the rim of cone's base, and all slanted the same way, translation will maintain or possibly augment the given rotation rate.

Keywords: Hollow Rigid Cone, Rotation Causes Translation

1. Introduction
Recently put forward [1] is the idea that if a solid cone, submerged in water, is made to spin at constant angular velocity about its long axis, it will translate about that axis with the base leading and the apex trailing. Laminar flow is assumed to prevail. No experimental verification of the proposal is available at this time.

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Behind the concept is physics that is elementary, such as Bernoulli's law. At the cone's surface fluid sticks due to friction and rotates with the cone forming closed streamlines. Along each closed streamline Bernoulli's law can be applied, and then they can be termed Bernoulli loops [2]. Where the speed is greatest the pressure is least. Since the orbital speed increases from the apex to the base, the pressure decreases from the apex to the base. Such a pressure distribution on the cone's surface is expected to drive the rotating cone horizontally with the base leading.

A feature of the surrounding flow is that the speed at the cone's surface decays radially outward with the magnitude proportional to $1/r$ perpendicular to the long axis, where r is the radius. This outcome is generalized from what had been found theoretically for a submerged rotating cylinder [3], and it can be shown from the Navier-Stokes fluid dynamics equations in plane polar coordinates that friction in the flow is zero. That is an amazing result.

In order to make laboratory studies in the future easier to accomplish, modifications of the basic arrangement are suggested below. To start a cone rotating under water may not be so easy to do.

2. Modified Model

If a rotating cone under water can be established, and then it starts to translate, the first modification that would aid the translation is to change the front face to a more "streamlined" shape, a lens, something between a flat surface and half a sphere, with a smooth transition between the lens and the cone to avoid turbulence. Call it a ball-cone for short. Adding two slanting vanes attached vertically to the surface of the lens would cause the given translation to enhance the rotation. Therefore translation produces rotation and rotation causes translation. What are the likely possibilities? No lab trials have occurred yet.

There is some friction in the problem, located mainly near the lens, which would have the effect of slowing down the translation (not the rotation). But countering that effect is a net reaction force pointing in the direction of translation. Action equals reaction, Newton's third law, arises as the fluid near to the solid body accelerates and decelerates [4]. For a solid body that is asymmetric front to back there is a net reaction force, and in the present situation it points forward. Not known is whether or not the net reaction force can equal or overcome the friction force. If it could, the possibility of a perpetual motion machine, the ball-cone, could take place.

An alternative approach has a chance of achieving a "better" result: open the base of the rigid cone to the fluid, hollow it out completely and keep the apex closed. After sufficient rotations from start-up, when the fluid motions outside and inside have reached equilibrium, the fluid inside will exhibit solid body rotation. Since the velocity function in that case decreases linearly from the cone to the center, friction is zero inside the cone as well as outside. Consequently there is a doubling up of the tendency for translation with the blunt end in the lead. Pressures from the Bernoulli loops on the inside and the outside surfaces of the cone decrease from the apex to the base.

In order for translation to produce rotation, vanes can be attached outward from the base's edge and all slanted the same way. Whether or not the rotating cone can continue to translate on its own is not determined at this time. Some friction exists but the amount is not known. Trials are needed. A squat cone shape would be best, more like a funnel than a wind sock, because the pressure gradient on the surfaces would be stronger.

3. Discussion

Further variations of the rotating and translating cone configuration in water can be attempted, but there are already enough variables to give an experimentalist a headache. If the goal is to come as close as possible to constructing a perpetual motion machine, there is no a priori method of going about it. Looking to nature for a solution, which most scientist don't see the potential benefit of attempting, is hindered by the knowledge that there is no example of a living creature using rotation in a fluid to get from point A to point B.

Steven Jay Gould published a chapter in one of his many popular books entitled: There Are No Wheels in Nature. After that it was pointed out to him that in a TV nature show a video showed a certain species of spider in a desert in Africa pull in its legs and roll down a sand dune. Readers can decide if this is an exception to the main train of thought here.

Universal belief is that perpetual motion involving a machine is impossible, although no law would be broken if an example turned up. Reducing the amount of friction on a body getting through a fluid is a direction to go with practical consequences. A rotating cone does that, and there could be more to be gained by a further study of the phenomenon.

4. Conclusions

For the main conclusion, a prediction is stated. Given that a solid cone rotating in water should translate, which has been put in print but not yet verified experimentally, a hollow cone is expected to travel significantly faster for the same mass and rotation rate. Then if a few small vanes are attached to the base, pointing radially outward and slanted, the rotation rate might be either maintained or augmented for an initial translation speed.

References

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