Vortex Induced Vibration Aquatic Clean Energy

Review paper by:

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ABSTRACT

VIVACE stands for Vortex Induced Vibration Aquatic Clean Energy. It is a unique hydrokinetic system that relies on 'Vortex Induced Vibration' and on conventional energy forms like waves, tides, turbines or dams. The equipment used to harness this energy is called 'VIVACE'. It works in flows moving slower than 2 knots (about 2 miles per hour). Most of the Earth's current are slower than 3 knots. Turbines and water mills need an average of 5 or 6 knots to operate efficiently. VIVACE uses physical phenomenon of vortex induced vibration in which water current flows around cylinders including transverse motion. The energy contained in the movement of the cylinder is then converted to electrical energy using suitable rack and pinion mechanism.

Keywords *– Vortex flow, Energy Generation, Flow over cylinder, Vortex induced vibration, High Reynolds's number*

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1. INTRODUCTION

Vortex Induced Vibrations (VIV) results from vortices forming and shedding on the downstream side of the bluff body in a current. Vortex shedding alternates from one side to other, thereby creating a vibration or oscillation. The VIV phenomenon is non linear, which means it can produce useful energy at high efficiency over a wide range of current speeds. It introduces optimal damping for energy conversion while maintaining VIV over a broad range of vortex shedding synchronization. VIV occurs over very broad ranges of Reynolds number. Only three transitions regions suppress VIV.

VIVACE is the name of machine which is used to harness the energy available with under water currents of ocean and river. The overall objective of this project is to design and build a Power Take Off system for a VIVACE converter. This system will be comprised of four sub functions. First it must convert oscillatory motion of the VIVACE into motion that is usable for energy conversion. Second it must convert kinetic energy into electrical energy. Third it must be able to transmit electrical energy so that it can be used. Finally it must seal electrical equipment in dry environment.

2. LITERATURE REVIEW

2.1 VIVACE : A new concept in generation of clean and renewable energy from fluid flow.

An energy converter vivace has been design and tested. Three gradually improving models – I,II and III have been built and tested in the low turbulence free surface water channel of the university of Michigan. It is simple with all mechanical and electrical components sealed from the water environment; it is based on readily available offshore technology implying robustness and at least a 20 yr life.

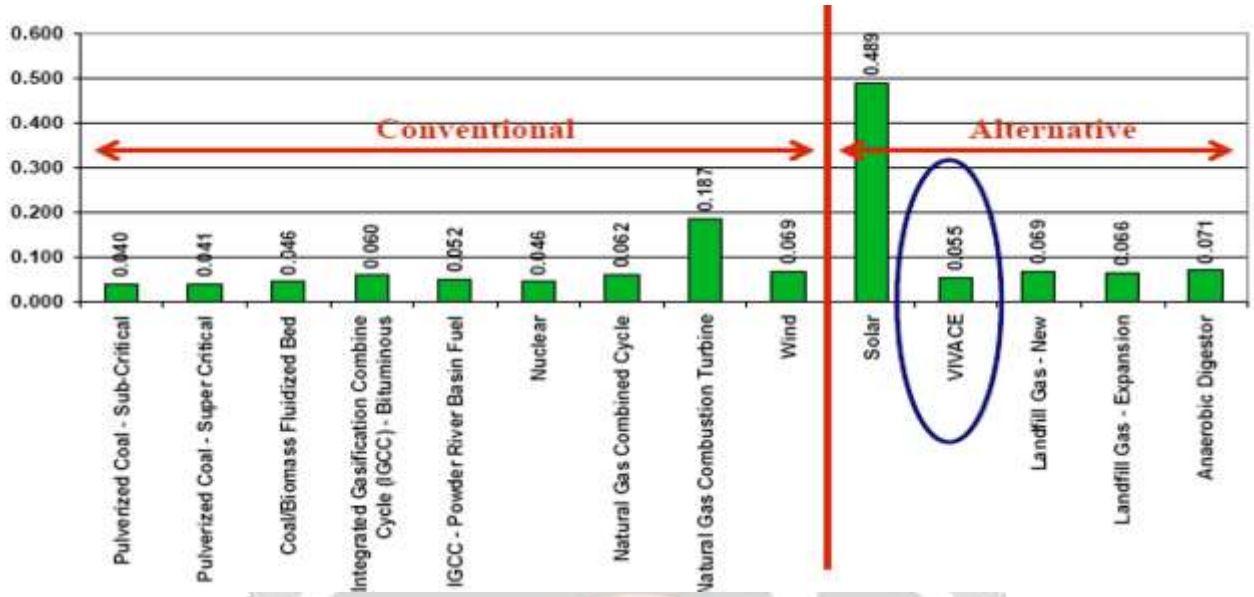

Chart . 1 Cost comparison between conventional and alternative sources of energy and the VIVACE converter

2.2 Control of flow over a cylinder using rotational oscillation

In this paper they focused on two dimensional, incompressible viscous channel flow over an infinitely long cylinder and examine the effect of controlled rotational cylinder oscillation in reducing the drag exerted on the cylinder.

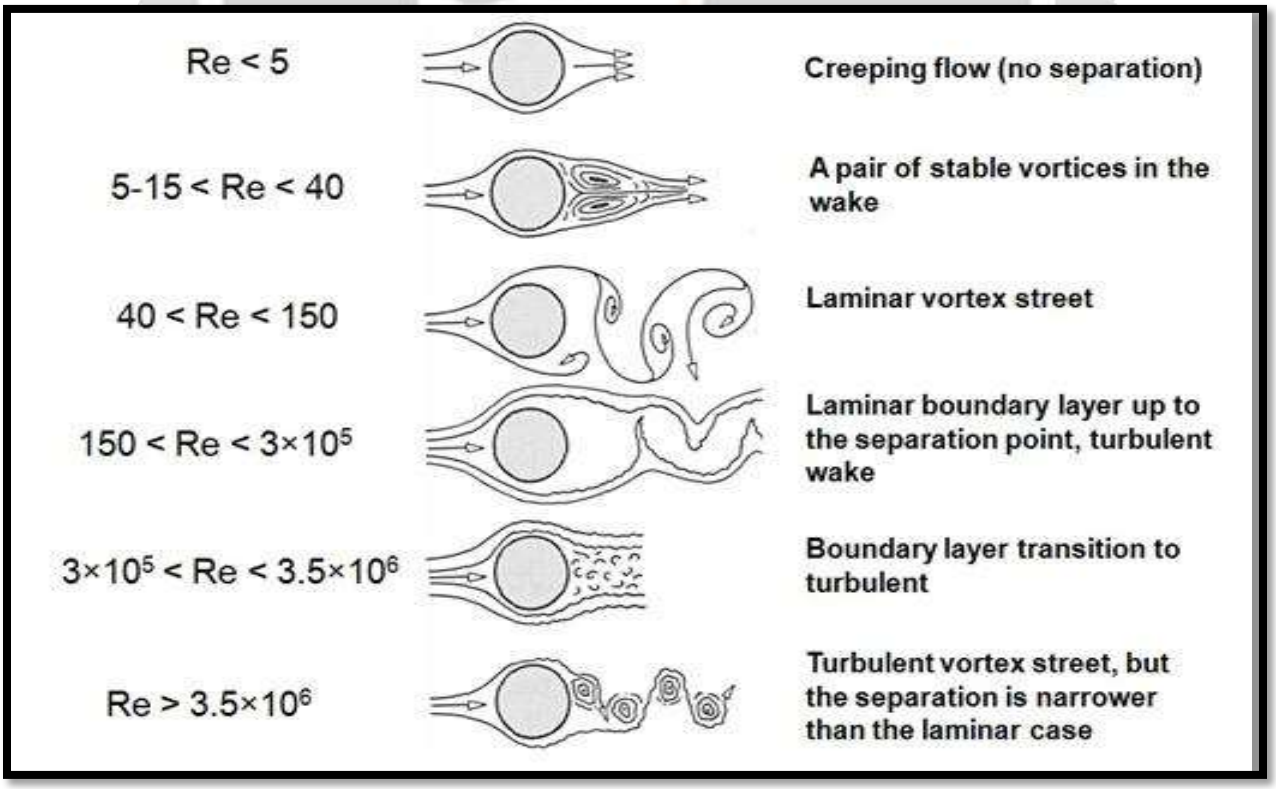

Fig. 1 Flow over a cylinder at different Reynolds number

2.3 Design of a vortex induced vibration based marine hydro-kinetic energy system

The main objective of the current study is to drive design guidelines for a VIV generator to optimizing he VIV process. This model was validated for a number of Re using both, experiments as well as simulations. To begin with, a flow over a stationary cylinder was first validate in the range of 50<Re<200 when the flow in the wake is still laminar and two dimensional.

2.4 Experimental investigation of Reynolds number effect on vortex induced vibration of rigid circular cylinder on elastic support

This is of particular interest in the design of the VIVACE converter, which extracts hydrokinetic energy from ocean/river currents. The range of synchronization of the upper branch of VIV increases with increase in Reynolds number. The amplitude ratio increases with Reynolds number within the upper branch.

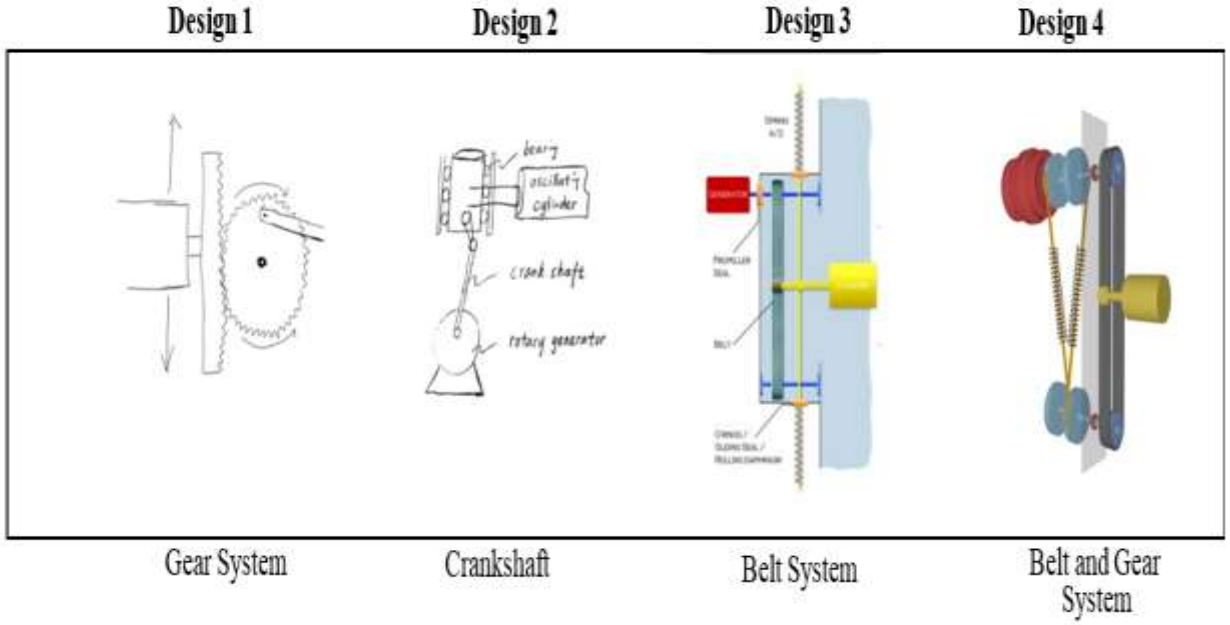

Fig. 2 Mechanical to electrical power conversion option available

2.5 Vortex induced vibration (VIV) of a circular cylinder in combined steady and oscillatory flow

VIV of a circular cylinder in combined steady and oscillatory flows is investigated by a numerical method. Among all the flow ratios, the highest cross-flow amplitude occurs at a=0.8, which is about 1.5 times cylinder diameters.

2.6 Virtual damper – spring system for VIV experiments and hydrokinetic energy conversion

A VIVACE converter with programmable spring and damping values was designed, built and verified. It consists of a cylinder, rack and pinion transmission, a generator and a controller. The controller provides a damping force and a spring force through feedback based on additional artificial force-displacement phase lag, which would bias energy conversion.

2.7 Waves and currents in tide dominated location off Dahej, Gulf of Khambhat

A tide at 14m was larger than that at 24m water depth with an increase of 0.19m in the mean tidal range. The maximum current speed was 3m/s with average value of 1m/s at 24m water depth and 3.3m/s with average value of 0.8m/s at 14m water depth.

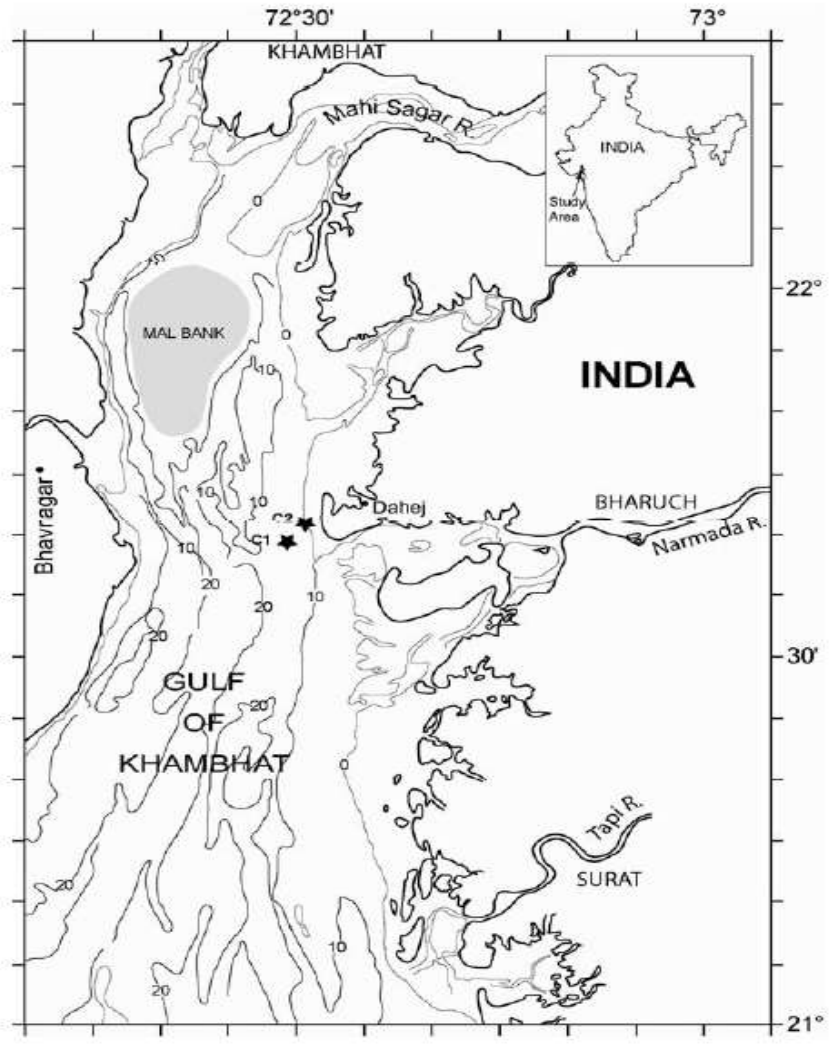

Fig.3 Dahej, Gulf of Khambhat

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