수치해석을 이용한 5kW급 튜뷸러 터빈 성능에 관한 평가

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An Evaluation of 5kW Tubular Turbine Performance Using Numerical Method

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Key Words : Tubular Turbine, Numerical Method, Hydropower, Efficiency

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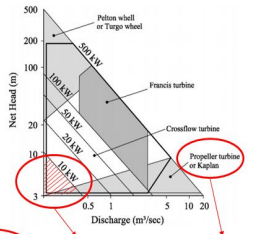
I. Potential Hydropower Capacity in Korea and Study's Objective:

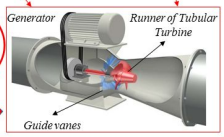
Division	Number of sites	Developable capacity (kW)
River	120	147,000
Sewage treatment plant	55	5,300
Water cleaning center	58	2,500
Agricultural reservoir	163	48,000
Agricultural dam	100	5,000
Irrigation ditch of multi-purpose dam	6	6,744
Total amount	502	227,544

Developable small hydropower capacity
KEMCO [2007]



Power Output Range	Hydropower schemes
1,000 kW – 10,000 kW	Small scale
100 kW – 1,000 kW	Mini scale
Less than 100 kW	Micro scale
Less than 5 kW	**Pico scale**

This is a main target of the present research



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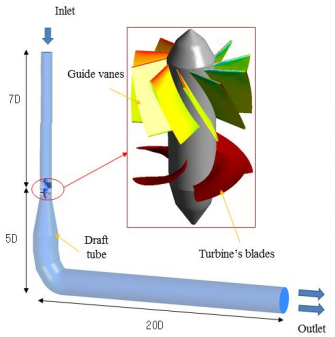
II. Numerical Method and Boundary Conditions:




Tetra-mesh for the guide vanes


Hexa-mesh for the runner

Analysis method	Steady state
Turbulence model	k-ω SST
Rotor-stator interface	Frozen rotor
Inlet	Total pressure (Head = 2 m)
Outlet	Mass flow rate Q = 290 - 470 kg/s
Wall	No slip

Runner's diameter (D_r): *450 mm*
Hub's diameter: *200 mm*
Number of rotor blades: *4*
Number of guide vanes: *10*
Designed head: *2 m*
Designed flow rate: *0.36 m³/s*
Designed rotational speed: *410 rpm*
Designed power output: *5 kW*

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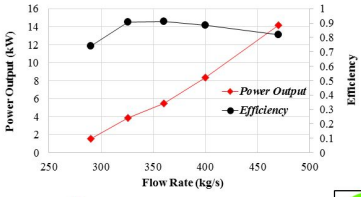
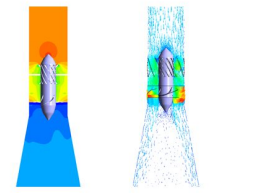
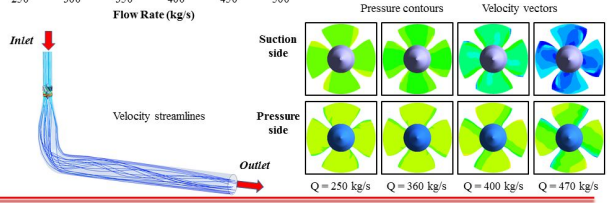
III. Results and Discussion:







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IV. Conclusions:

From this study, several conclusions are given as follows:

1. The designed turbine can obtain 5kW power output at a flow rate Q = 0.36 m^3/s, corresponding to 91.22 % of efficiency.

2. At flow rates higher than the designed flow rate of 0.36 m^3/s, especially at Q = 0.47 m^3/s, the cavitation occurs intensively at pressure side of the blade surface (exit pipe).

3. The pressure in the turbine passage are absorbed by the runner effectively at the best efficiency point. Nevertheless, there still exist some secondary flows at the draft tube..

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