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The 1st International Conference On Science

"Science Enhancement For Developing Countries"

FACULTY OF MATHEMATICS AND NATURAL SCIENCES
HASANUDDIN UNIVERSITY

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PREFACE

Makassar city, the capital of South Sulawesi province known as one of the biggest cities in Indonesia and also having Hasanuddin University, the biggest university in eastern part of Indonesia, has plenty of natural resources and human resources. Having a strategic position at the center point of Indonesia, Makassar has been developing very rapidly, and has been contributing to the regional, national and even international economic development. Given this, science can play important roles and therefore is needed to support rapid development in various sectors.

With regard to this, cooperates with Ministry of Environment Indonesia, Atmospheric and Ocean Research Institute (AORI) Japan, University of Kebangsaan Malaysia (UKM), Alfred Wagener Institute (AWI) Germany, Queensland University of Technology (QUT) and Flinders University Australia, Faculty of Mathematics and Natural Sciences Hasanuddin University carried out “The First International Conference on Science (ICOS-1)” on November 19-20, 2014, in Hotel Clarion Makassar. The theme of ICOS-1 is “Science Enhancement for Developing Countries”. The conference attended by two hundred participants and came from Asia (Japan, Malaysia, Indonesia), Australia, and Europe.

There are approximately 97 research articles for oral presentations and 16 poster presentations, ranging from Biology, Statistics, Mathematics, Chemistry, Physics, Geophysics, Computer Science and Environmental Science. Of the 113 papers, there are approximately 79 papers were selected to be published in the proceedings of the ICOS-1 through the peer review process.

With regard to the delivery of the ICOS-1 in 2014 and the completion of the proceedings ICOS-1, 2014, allow us to thanks to: the authors for providing the content of the program, the conference participants who came from several public and private universities, the program committee and the senior program committee, who worked very hard in reviewing papers and providing feedback for authors to be included in the Proceedings of ICOS-1, 2014, the hosting organisation Hasanuddin University, our keynote and invited talk presentations including Ir. Muh Ilham Malik M.Sc, from Ministry of Environment Indonesia, Prof Koji Inoue from AORI Japan, Prof Mohammad B Kassim from UKM Malaysia, Dr.rer.nat Dominik Kneer from AWI Germany, Prof Dadang A. Suriamihardja and Prof Alfian Noor from Hasanuddin University, Prof Kerrie Mengersen from QUT and Dr. Darfiana Nur from Flinders University, Australia.

Hopefully is of benefit to all readers.

Yours faithfuly,
Prof Dr. Hanapi Usman M.S
Dean of Faculty Mathematics and Natural Sciences
Hasanuddin University

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THE INFLUENCE OF REYNOLDS NUMBER ON THE DRAG COEFFICIENT OF A CIRCULAR CYLINDER

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Abstract

Tandem configuration of two circular and type-I cylinder will be simulated numerically in two dimensions. Dis the diameter of the circular cylinder and dis the diameter of the type-I cylinder. Type-I cylindersis used as apassive controller is placed in front of the circular cylinder with the aim of reducing drag coefficient received by the circular cylinder. Tosolvethisproblemusedthe Navier-Stokes equation and solved with finite difference. The distance between the cylinder Type-I with a2D circular cylinder and the Reynolds number is varied. The purpose of this paper is the last to get a mathematical model of the drag coefficientis affected by the Reynolds number

KeyWords:*Drag Coefficient, Pasive Control, Reynolds Number*

1. INTRODUCTION

We often find in many places, such as off shore construction, bridge structures, and other engineered products are often designed in groups. Object build in gor bridge or other structure that interacts with the fluid flow. These objects will receive the load from the top and the area around the object. Besides the influence of the load and the surrounding area, geometric shapes of the objects are the main factors to be considered in designing an object, because the flow of fluid through objects with different geometric shapes will produce different characteristics, as well as stand-alone objects or groups.

Particles that move around an object will move slowly or may not move due to the viscous force, this occurs in a laminar flow and turbulent flow through the surface of an object. While others stream will flow faster than the flow closer to the object. This phenomenon can increase the shear stress. She are stress affects the speedin each layers, it is called the boundary layer.

The rapid growth occurs in the study of fluid flow on the surface of an object. The concept of the boundary layer has managed to reveal some of the answers to the effects of shear stress, that the shear stress has avery important role in the characteristic drag around objects[1]. Research has been done that the flow of fluid through a circular cylinder[2], circular cylinder type-Dortype-I[3,4], as well as fluid flow through more than a cylinder with size different from the tandem configuration[5]. Circular cylinder by flowing fluid will produce adverse drag. The amount of dragis influenced by several parameters, one of whichis the drag coefficient C_D.

The fluids flowing through a circular cylinder will produce adverse drag. The amount of drag that is received by the cylinder is affected by several parameters, one of which is the drag coefficient. One way to reduce the dragon acircular cylinderis to add a small cylinder in front of the circular cylinder is called passive control. Many research have been done that way, which can reduce the drag coefficient of 48% compared without passive control[6]. It has also been done with the variation of the Reynolds number as a result of the minimum pressure coefficientis low [7].

2. NUMERICAL METHOD

Equations of Navier-Stokes for unsteady incompressible fluid, is

$$\frac{\partial \boldsymbol{u}}{\partial t} + \nabla \cdot \boldsymbol{u}\,\boldsymbol{u} = -\nabla P + \frac{1}{Re}\nabla^2 \boldsymbol{u}$$

$$\nabla \cdot \boldsymbol{u} = 0$$

where $\boldsymbol{u}$ is the velocity, P is the pressure, and R_e is the Reynolds number.

Completion of the above equation can be used numerically, and which need to be considered in dealing with this is the following steps

$$\frac{\partial \boldsymbol{u}}{\partial t} = -\nabla \cdot \boldsymbol{u}\,\boldsymbol{u} + \frac{1}{Re}\nabla^2 \boldsymbol{u}$$

This equation further is solved and it is obtained u, then

$$\frac{\partial \boldsymbol{u}}{\partial t} = \frac{u^{**} - u^{*}}{\Delta t} = -\nabla P$$

We now put divergence on both sides, the result

$$\frac{\nabla u^{**} - \nabla u^{*}}{\Delta t} = -\nabla^2 P$$

and since $\nabla u^{**} = 0$, then the equation turns into

$$\frac{\nabla u^{*}}{\Delta t} = \nabla^2 P$$

This equation is called the Poisson equation and we will obtain the P. The last step is a correction velocity, ie.:

$$\frac{\partial \boldsymbol{u}}{\partial t} = -\nabla P$$

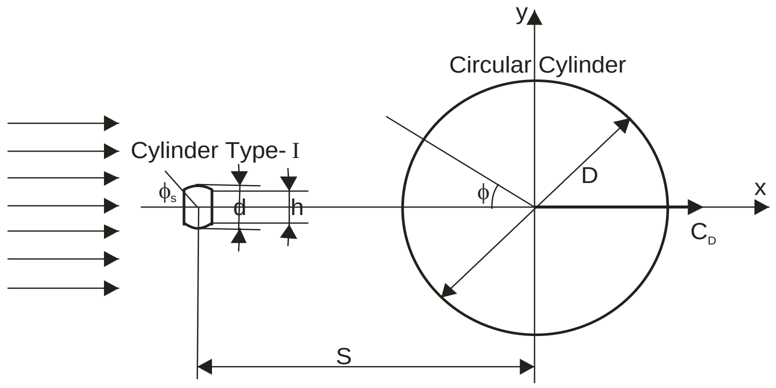

Figure 1.Schema of Circular Cylinder and Cylinder Type-I

3. RESULT AND DISCUSSION

After the Navier-Stokes equations solved numerically, then created a program to simulate it. The system is built size $10D \times 20D$, where D is the diameterof thecircular cylinderand$d$ is thediameter of thecircular cylindertype Iwith$d/D = 0.125$. Center of the cylindertype-Iput inthe coordinates($5D, 5D$) from the front of the system and the distance between the circular cylinder with acylindertype-Iis$S$with$S/D = 2.0$as in Figure1.

The correctness of the simulation program, performed drag coefficient value comparison of experimental results or numerical simulations of other researchers. Comparison of the drag coefficient with some previous studies with$R_E = 100$ as shown inTable1.

Tabel 1. Comparison of drag coefficien to facylinderforRe=100

Researcher	Imron[11]	Zulhidayat[8]	Sintu[9]	Lima[10]
CD	1.358	1.4	1.431	1.39

The results of the simulation program with $S/D = 2.0$ and R_e=100,1000,7000,10000,53000andS/D=2.0,can be seen in Table2, and the graph can be seen in Figure2.

Tabel 2. Valueof thedrag coefficient$C_D$with differentReynoldsNumbersR_e

R_e	100	1000	7000	10000	53000
Log(R_e)	2	3	3.8451	4	4.7243
C_D	0.993665	0.893473	1.345664	1.373385	1.883849

Five drag coefficient data from Table 1. and by using the value of the approach, in which the drag coefficient is a function of R_e, we obtain the equation, namely

$$C_D = -0.801\, x^3 + 1.0222\, x^2 - 3.6839\, x + 4{,}9125$$

where $x = \log(R_e)$.

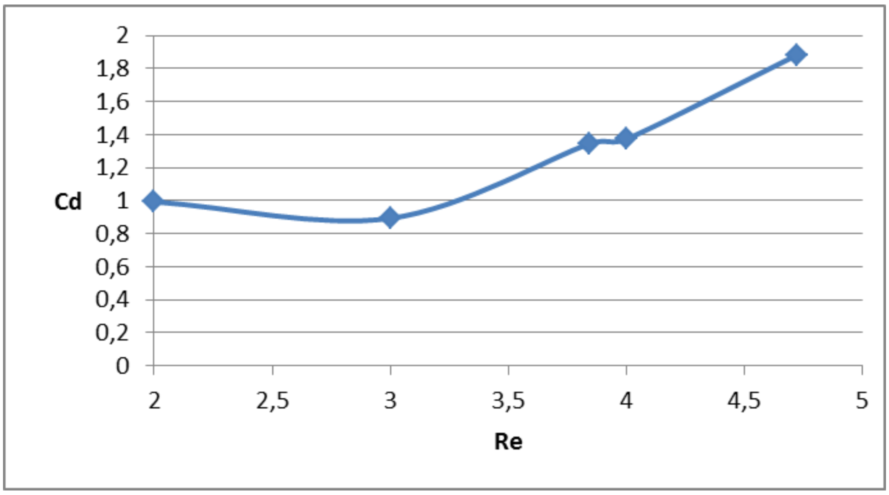

Figure 2.Schema of Circular Cylinder and Cylinder Type-I

4. CONCLUSION

The amount of the drag coefficient received by circular cylinder with passive control cylinder type-I, which is placed in front of the circular cylinder with domains $R_e = 100$ until $R_e = 53000$ and $S/D = 2.0$. We have mathematical models of the drag coefficient of a bluff body with the passive control type-I, is

$$C_D = -0.801\, x^3 + 1.0222\, x^2 - 3.6839\, x + 4{,}9125$$

where $x = \log(R_e)$.From this equation, it can be found that the smallest drag coefficient obtained when $\log R_e = 1.2453$ or $R_E = 697.5$with $C_D = 1.755451$.

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