

**THE EFFECT OF SURFACE SCALLOPING ON FLOW  
HYDRODYNAMICS AND PRESSURE DROP**

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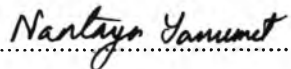
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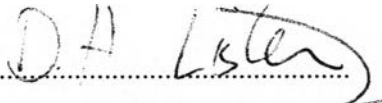
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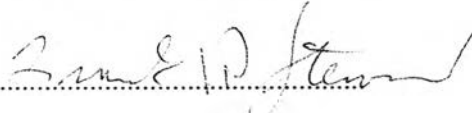
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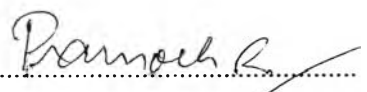
  
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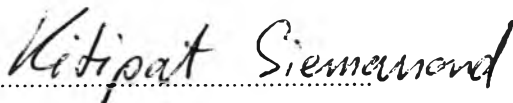
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**ABSTRACT**

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Chaiwat Lertsurasakda: The Effect of Surface Scalping on  
Flow Hydrodynamics and Pressure Drop  
Thesis Advisors: Assoc. Prof. Thirasak Rirksomboon, Prof. Derek H.  
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Scalping, a texturing of a corroding surface that imparts the appearance of orange peel, is commonly observed in the area exposed to the flow assisted-corrosion. The effects of surface scalping on flow hydrodynamics and pressure drop remain unclear. The scalloped surface characteristics are believed to be mainly a function of flow hydrodynamics. On the other hand, the special surface characteristics of the scallop are also believed to change the hydrodynamics which affects the pressure drop. In this thesis, two dimensional (2D) scalloped surface was studied. The experiments were conducted in an atmospheric-pressure, recirculating loop. The internal surface of the acrylic test section was machined into scalloped surfaces. Static pressure was measured along the test section with various Reynolds numbers of flow. Flow separation causing flow recirculation was observed in congruence with a previous study. Flow hydrodynamics simulated by CFD code - Fluent 6.3.26 was validated with the experimental results and SST  $k-\omega$  is the most appropriate viscous model. It was found that the pressure drop of 2D scalloped surface was proportional to its surface area but was not a function of scalloped distribution. The von Karman equation for fully roughness in turbulence flow cannot be used to predict the friction factor for the scalloped surface accurately and the values of friction factor obtained from backward and forward flows on the scalloped surface were unidentical even though the roughness was the same.

## บทคัดย่อ

ชัยวัฒน์ เลิศสุรศักดิ์ : ผลกระทบของพื้นผิวชนิดสเกลอปต่อคุณสมบัติการไหลของน้ำและความดันตกของระบบ (The Effect of Surface Scalloping on Flow Hydrodynamics and Pressure Drop) อ.ที่ปรึกษา : รศ.ดร.ธีรศักดิ์ ฤกษ์สมบูรณ์, ศ.ดร.ดีเรก เอช ลิสเตอร์ และ ศ.ดร.แฟรงค์ อาร์ สจ๊วต 58 หน้า

พื้นผิวชนิดสเกลอปเป็นพื้นผิวซึ่งมีลักษณะคล้ายเปลือกส้มที่เกิดจากการกัดเซาะโดยของไหลมีส่วนสำคัญในการทำให้เกิดการกัดเซาะอย่างรุนแรง ปัจจุบันผลกระทบของพื้นผิวชนิดสเกลอปต่อคุณสมบัติการไหลของของไหลและความดันตกของระบบยังไม่เป็นที่เข้าใจแน่ชัด เชื่อกันว่าคุณสมบัติการไหลของของไหลเป็นตัวการสำคัญในการกำหนดคุณลักษณะของพื้นผิวชนิดสเกลอป ในทางกลับกัน เชื่อว่าพื้นผิวชนิดพิเศษนี้สามารถเปลี่ยนคุณสมบัติการไหลของของไหลซึ่งส่งผลกระทบต่อความดันตกของระบบได้/ งานวิจัยนี้ศึกษาพื้นผิวชนิดสเกลอปแบบสองมิติในระบบที่มีการหมุนวนของของไหลที่ความดันคงที่ โดยกลึงพื้นผิวภายในท่อออร์ลิคให้เป็นพื้นผิวแบบสเกลอป ทำการวัดความดันตกหลายตำแหน่งต่างๆตามความยาวท่อทดลองที่ค่าเรย์โนต่างๆของของไหล จากการทดลองพบว่าเกิดการแยกไหลของของไหล ส่งผลให้เกิดบริเวณที่ของไหลเกิดการหมุนวน ได้จำลองคุณสมบัติการไหลของของไหลโดยโปรแกรมฟลูเอน (FLUENT) พบว่ามีความถูกต้องตรงกลับผลการทดลองโดยที่โมเดลความหนืดชนิด เอสเอสที เคโอเมกา ให้ความถูกต้องแม่นยำที่สุดในการทำนายคุณสมบัติการไหลของของไหล จากการทดลองพบว่าความดันตกของพื้นผิวชนิดสเกลอปแบบสองมิตินั้นแปรผันตามพื้นที่ของพื้นผิวชนิดสเกลอปโดยที่การกระจายตัวของพื้นผิวแบบสเกลอปนั้นแทบจะไม่มีผลต่อความดันตกของระบบ สมการวอน คาแมน (von Karman) ที่ใช้สำหรับพื้นผิวที่ขรุขระมากในการไหลแบบปั่นป่วนไม่สามารถใช้ทำนายการไหลได้ นอกจากนี้ค่าสัมประสิทธิ์ความฝืดที่คำนวณได้จากการทดลองที่ใช้ของไหลวิ่งไปข้างหน้า และ ของไหลวิ่งย้อนกลับมีค่าไม่เท่ากันทั้งที่ค่าความขรุขระมีค่าเท่ากัน

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## TABLE OF CONTENTS

	<b>PAGE</b>
Title Page	i
Abstract (in English)	iii
Abstract (in Thai)	iv
Acknowledgements	v
Table of Contents	vi
List of Tables	vii
List of Figures	ix
Abbreviations	xii
List of Symbols	xii
<b>CHAPTER</b>	
<b>I INTRODUCTION</b>	1
<b>II LITERATURE REVIEW</b>	4
2.1 Flow-Assisted Corrosion in Nuclear Power Plant	4
2.2 Scalloping Phenomena	6
2.3 Roughness and Pressure Drop	10
2.4 FLUENT CFD and Viscous Model	11
<b>III EXPERIMENTAL</b>	14
3.1 Materials	14
3.2 Equipment	14
3.3 Methodology	14
3.3.1 Test Section Design	17
3.3.2 Validation of FLUENT CFD model	28
3.3.3 Effect of Scallop's Surface Area on Pressure Drop	31
3.3.4 Effect of Scallop's Distribution on Pressure Drop	32

<b>CHAPTER</b>	<b>PAGE</b>
<b>IV RESULTS AND DISCUSSION</b>	<b>33</b>
4.1 Validation of FLUENT CFD model	33
4.1.1 Flow Visualization	33
4.1.2 Pressure Measurement	34
4.1.3 CFD Simulation and Viscous Model Selection with FLUENT	39
4.2 Effect of Scallop's Surface Area on Pressure Drop	46
4.1.1 Effect of Scallop's Surface Area with Forward Flow Direction	46
4.1.1 Effect of Scallop's Surface Area with Backward Flow Direction	48
4.2.3 Comparison of Friction Factor	49
4.3 Effect of Scallop's distribution on Pressure Drop	50
<b>V CONCLUSIONS AND RECOMMENDATIONS</b>	<b>52</b>
<b>REFERENCES</b>	<b>54</b>
<b>APPENDIX</b>	<b>55</b>
<b>CURRICULUM VITAE</b>	<b>58</b>

**LIST OF TABLES**

<b>TABLE</b>		<b>PAGE</b>
3.1	Scallop profile coordinate	19
3.2	Scallop's surface area test matrix for both forward and backward flow	31
3.3	Scallop's distribution test matrix	32



## LIST OF FIGURES

FIGURE	PAGE
1.1 Scallop found on outlet feeder pipe k16	1
2.1 Schematic of primary coolant in CANDU reactor	4
2.2 Scalloping on the inner surface of a carbon steel feeder pipe	5
2.3 Flute hydrodynamics	7
2.4 Stages in the delopment of experimental Flutes and grooves	8
2.5 Schematic flow fields (skin-friction lines and streamlines associated with mature flutes and mature grooves)	9
2.6 The pressure drop vs. time	10
3.1 Scalloping test loop	15
3.2 Scallop test section	15
3.3 Plaster scallop contour	16
3.4 Scallop profile before regression	18
3.6 Smooth scallop contour	19
3.7 2D drawing of scallop piece	20
3.8 3D layout of scallop piece	20
3.9 Connector between the first part and the second part	21
3.10 Connector between the second part and the third part	22
3.11 Configuration of the test section	22
3.12 Male connector	23
3.13 Female connector	23
3.14 Flat surface connector	23
3.15 Fabrication of flat surface section	23
3.16 The pressure tap used to measure the static pressure	24
3.17 Prepared acrylic pieces	25
3.18 Cutting tool	25
3.19 CNC lathe	26
3.20 The acrylic pieces while machined	26

<b>FIGURE</b>	<b>PAGE</b>
3.21 Finished acrylic pieces	27
3.22 Downstream Section	27
3.23 Finished test section	28
3.24 Scalloping loop	28
3.25 Polished scallop pieces	29
3.26 Test section with one scallop	29
3.27 Test section with two scallops	30
3.28 Pressure taps around the scallop area	30
3.29 Position and distribution of the pressure taps	31
3.30 The arrangements of scallops	32
4.1 Picture from high speed camera	33
4.2 Stream line visualized by low shutter speed technique	34
4.3 Pressure transducer and its meter	35
4.4 The wall static pressure along the pipe at 6 GPM, 1 scallop	36
4.5 The wall static pressure along the pipe at 9 GPM, 1 scallop	36
4.6 The wall static pressure along the pipe at 12 GPM, 1 scallop	37
4.7 The wall static pressure along the pipe at 15 GPM, 1 scallop	37
4.8 The wall static pressure along the pipe at 18 GPM, 1 scallop	38
4.9 The wall static pressure along the pipe at 12 GPM 2 scallops	38
4.10 Mesh's resolution on the cross section area of the pipe	39
4.11 Mesh independent study	40
4.12 Comparison of the results from first order and second order calculation	41
4.13 Comparison of viscous models at 6 GPM	42
4.14 Comparison of viscous models at 9 GPM	42
4.15 Comparison of viscous models at 12 GPM	43
4.16 Comparison of viscous models at 15 GPM	43
4.17 Comparison of viscous models at 18 GPM	44
4.18 Prediction of SST K- $\omega$ at 12 GPM, 2 scallops	45

<b>FIGURE</b>	<b>PAGE</b>
4.19 Velocity and pressure contour at 9 GPM, SST k- $\epsilon$ model	45
4.20 Flow path line near scalloped surface	46
4.21 Forward flow direction	46
4.22 The pressure drop increase constantly with the scallop's surface area for forward flow direction.	47
4.23 The pressure drop is proportional to Reynolds number square for forward flow direction.	47
4.24 Backward flow direction	48
4.25 The pressure drop increase constantly with the scallop's surface area for backward flow direction.	48
4.26 The pressure drop is proportional to Reynolds number square for backward flow direction.	49
4.27 The friction factors from the experiment are compared with the one calculated from Von Kaman equation.	49
4.28 At the same numbers of scallops, the pressure drop is the almost the same regardless the scallop's distribution.	51
A1 Velocity contour for backward flow direction	55
A2 Pressure contour for backward flow direction	55
A3 Velocity contour of backward flow direction with five scallop	56
A4 Velocity contour of forward flow direction with five scallop	56
A5 Velocity contour of backward flow direction with five scallop	57
A6 Velocity contour of forward flow direction with five scallop	57

## ABBREVIATION

2D	Two dimension
3D	Three dimension
CFD	Computational fluid dynamic
DES	Detached eddy simulation
FAC	Flow-assisted corrosion
LES	Large eddy simulation
Re	Reynolds number
SST	Shear-stress transport
R	Realizable
RNG	Renormalization-group
RSM	Reynolds Stress Model

## LIST OF SYMBOL

$\varepsilon$	Turbulence dissipation rate (epsilon)
$\omega$	Specific dissipation rate (omega)
$e$	Roughness height
$\rho$	Density
$\Delta p$	Pressure drop
$\mu$	Viscosity
$d$	Diameter
$f$	Friction factor
$g$	Specific gravity
$h_f$	Surface energy lost
$k$	Turbulence kinematics viscosity
$L$	Characteristic length
$V$	Velocity