

การพาความร้อนแบบลามินาร์ในท่อสามเหลี่ยม

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002093

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาคณะหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต

แผนกวิชาวิศวกรรมเครื่องกล

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พ.ศ. ๒๕๑๘

I16714982

LAMINAR FORCED CONVECTION IN  
TRIANGULAR DUCTS

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A Thesis Submitted in Partial Fulfillment of the Requirements  
for the Degree of Master of Engineering  
Department of Mechanical Engineering  
Graduate School  
Chulalongkorn University  
1976



หัวข้อวิทยานิพนธ์      การพาความร้อนแบบลามินาร์ในท่อสามเหลี่ยม  
 ผู้                              นายพีรพงศ์    ตั้งศิริมงคล  
 แผนกวิชา                  วิศวกรรมเครื่องกล  
 ปีการศึกษา                ๒๕๑๘

บทคัดย่อ

ในงานนี้ ได้ออกแบบและสร้างอุปกรณ์เพื่อหาข้อมูลการพาความร้อนในท่อสามเหลี่ยมคานเท่า และสามเหลี่ยมหน้าจั่วที่มีมุมยอดเป็นมุมฉาก ที่มีการไหลแบบลามินาร์ ซึ่งกำหนดสภาวะการณเป็นดังนี้ คืออุณหภูมิของผนังท่อเท่ากันตลอด ความเร็วและอุณหภูมิกำลังเปลี่ยนรูปพร้อม ๆ กัน ผลการทดลองได้นำมาเปรียบเทียบกับผลทางทฤษฎีที่มีอยู่แล้ว ปรากฏว่าค่านี้สเซลต์นัมเบอร์ เกิดการเบี่ยงเบนออกจากกัน โดยเฉพาะที่ค่าเกร็ดส์นัมเบอร์สูง ๆ การทดลองยังได้ขยายขอบเขตออกไปจนถึงการไหลแบบทรานซิชัน ทั้งนี้ก็เพื่อว่าช่วงของค่าเรโนลด์ส์นัมเบอร์จะได้กว้างขึ้น ผลจากการทดลองได้นำมาสร้างเป็นสูตร เอมไพริคัลเพื่อใช้ในการออกแบบอุปกรณ์แลกเปลี่ยนความร้อนต่อไป



Thesis Title   Laminar Forced Convection in Triangular Ducts  
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Department     Mechanical Engineering  
Academic Year  1975



#### ABSTRACT

Test equipment was designed and constructed for the investigation of laminar forced convection in the equilateral triangular and right-angled isosceles triangular ducts with simultaneously developing velocity and temperature profiles, for the thermal boundary condition of constant wall temperature. Experimental results were obtained and compared with the existing theoretical solutions. Comparisons show deviations of Nusselt number especially at high Graetz number. To cover a wide range of Reynolds numbers, the test programme was extended into the transition flow regime. An empirical formula, covering both laminar and transition regions, is suggested to be used for designing heat exchangers.

## ACKNOWLEDGEMENTS

The author wishes to express his sincere gratitude to:

Dr. Prida Wibulswas, Head of Mechanical Engineering Department, King Mongkut Institute of Technology, for his valuable advice, encouragement and attention throughout his supervision of this experimental work.

Asst. Prof. Dr. Kulthorn Silapabanleng, Head of Mechanical Engineering Department, Chulalongkorn University, for his guidance and valuable advice.

Mr. Chanchai Limpiyakorn, instructor of Mechanical Engineering Department, Chulalongkorn University, for his recommendation and providing excellent lecture in heat transfer course.

Mr. Charat Sawangwan, the manager of Cooling & Controls Engineering Co.Ltd., for furnishing temperature control instruments and providing valuable guide lines for this work.

The technical staff of Mechanical Engineering Department especially to Mr. Thongchai, for their helps in building up test apparatus.



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B-2 Orifice meter calibration curve for  
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60



## NOMENCLATURE

|           |   |
|-----------|---|
| A         | Area  |
| $A_c$     | Cross sectional area  |
| $C_p$     | Specific heat at constant pressure of fluid                   |
| $d_h$     | Hydraulic or equivalent diameter of a duct, $4A_c/P$          |
| h         | Surface heat transfer coefficient                             |
| k         | Thermal conductivity of fluid                                 |
| L         | Length of a duct  |
| P         | Perimeter of a cross section                                  |
| p         | Pressure of fluid   |
| $\dot{q}$ | Rate of heat transfer   |
| t         | Temperature of fluid  |
| u, v, w   | Velocities of fluid in the x, y and z directions respectively |
| V         | Volumetric flow rate of fluid                                 |
| x, y, z   | Cartesian co-ordinate axes                                    |
| z         | Distance along a duct   |
| $\alpha$  | Thermal diffusivity of fluid, $k/\rho C_p$                    |
| $\mu$     | Dynamic viscosity of fluid                                    |
| $\rho$    | Density of fluid  |
| $\phi$    | Half apex angle of triangular ducts                           |



### Dimensionless Groups

|    |  |
|----|--|
| Gz | Graetz number, $Re \cdot Pr / (z/d_h)$ |
| Nu | Nusselt number, $h_l d_h / k_b$        |
| Pr | Prandtl number, $C_p \mu / o$          |
| Re | Reynolds number, $\rho w_b d_h / \mu$  |

### Subscripts

|    |  |
|----|--|
| b  | Bulk, average value  |
| c  | Centre   |
| f  | Final value  |
| l  | Logarithmic value  |
| m  | Mean value   |
| o  | Initial value  |
| w  | Wall   |
| H1 | Boundary condition referring to constant axial wall heat flux with uniform peripheral wall temperature |
| T  | Boundary condition referring to constant and uniform wall temperature, both axially and peripherially  |