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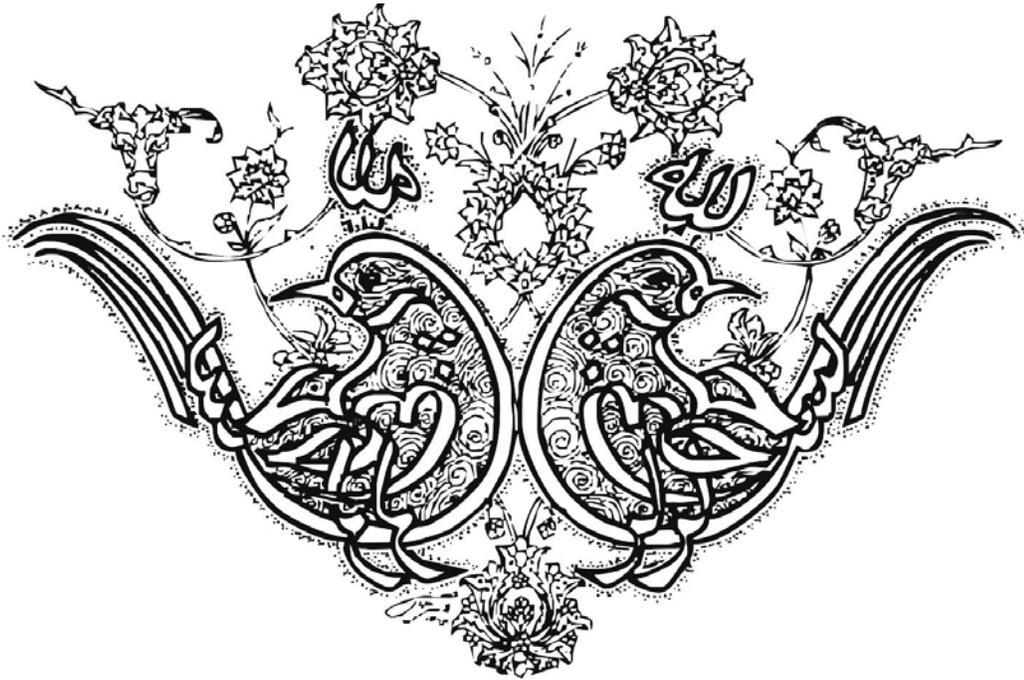
**Ph.D. Thesis**  
**In Mechanical Engineering**

**ANALYSIS OF FROST FORMATION OVER A  
HORIZONTAL CYLINDER BY NATURAL  
CONVECTION**

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**October 2009**



*In the name of*  
*God*  
*the compassionate*  
*the merciful*

**IN THE NAME OF GOD**

**ANALYSIS OF FROST FORMATION OVER A HORIZONTAL  
CYLINDER BY NATURAL CONVECTION**

**BY**

**ALI REZA TAHAVVOR**

**THESIS**

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**Dedicated to my parents, *Mohammad Reza* and *Roya*,  
the legends of patience and sacrifice**

**Dedicated to my brother, *Amid*,  
my great supporter in life**

**without their support, this document would not exist**

**and**

**Dedicated to my wife, *Negar*,  
who has brought a new level of love into my life**

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## **ABSTRACT**

### **ANALYSIS OF FROST FORMATION OVER A HORIZONTAL CYLINDER BY NATURAL CONVECTION**

**BY**

**ALI REZA TAHAVVOR**

Horizontal cylinders are commonly encountered in heat exchangers and evaporators of heat pumps and refrigerators. The frost over such horizontal tubes and pipes influences the system operation and reduces heat transfer between the refrigerant and ambient environment. Design and operation of such systems require a detail understanding of the process of frost formation. From the review of the literatures, it is observed that very few reports about frost formation on horizontal cylinders under natural convection are available. Therefore, in this study attempt will be made to presents a numerical model to simulate frost formation over a horizontal cylinder under natural convection. To carry this task, following steps are considered.

For the first time, soft programming code of Artificial Neural Networks are used to simulate natural convection flow and temperature field around a cold horizontal circular cylinder and a column of horizontal cylinders for different Rayleigh numbers. Very good agreement is found between ANN and CFD schemes and results show that ANN methods can easily be used with remarkable less computational time and cost as compared to CFD methods. Based on a developed computational code, the novel study of transient analysis of the early-stage of frost growth over a horizontal cylinder during natural convection with the assumption of supersaturation effect for the frost formation process is investigated. New experiments are carried out for natural frost formation over a horizontal cylinder and transient model of the fully developed stage of frost growth are developed. Results of numerical simulation are compared with experimental measurements. The agreement between numerical simulation and experimental measurements are excellent. Also, soft programming code of ANN as a new scheme is compared with experimental results for study frost formation around a cold horizontal circular cylinder under natural convection for various cases. This scheme captured the effect of all parameters for frost growth process as much as possible. Finally, based on experimental measurements and numerical results new correlations are proposed for practical applications of cooling and frost growth over cold horizontal cylinder(s).

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