

**UNIVERSITI TEKNOLOGI MARA**

**EFFECT OF PROCES PARAMETERS ON THE  
PROPERTIES OF INCO 718 THERMAL SPRAYED  
COATING**

**S.ROAIDI BIN ROKIK**

Thesis submitted in fulfillment  
of the requirements for the degree of  
**Master of Science**

**Faculty of Mechanical Engineering**

**August 2014**

## AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic institution or non- academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

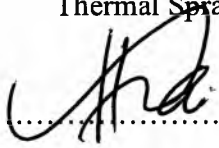
Name of Student : S.Roaidi Bin Rokik

Student I.D No : 2006137715

Programme : Master of Science in Mechanical Engineering ( EM 780 )

Faculty : Mechanical Engineering

Thesis Title : Effect Of Process Parameters on The Properties of Inco 718  
Thermal Sprayed Coating

Signature of Student : .....

Date : August 2014

## ABSTRACT

Inconel 718 materials have been used widely as a source for coating materials produced by thermal spray techniques. The materials can be applied by using the plasma spray, High Velocity Oxy Fuel ( HVOF ) , Wire arc and normal combustion technique. In this study, the coating on test samples have been produced by plasma spray technique and HVOF, spray distance 2, 4, 6 and 8 inch with 20,40 and 60 gram/minute were studied for the coating produced by Plasma Technique. On the other hand, spray distance 6,10,14 and 16 inch with 20,40 and 60 gram/minute powder feed rate were the selected value of the studied parameter for coating produced by HVOF technique. The influence of spray distance and powder feed rate on the coating microstructure, hardness and residual stress of the coating were studied in this thesis. Additionally, the influence of the coating microstructure against the hardness and residual stress were also been discussed. Results showed that the increased in both spray distance and powder feed rate had significantly influenced the amount of porosities and oxides in the coating structure produced thermal spray process. The formation of oxides in the HVOF coating were mostly due to the coating heating of the substrate or previously deposited material and the dwell time of the metal particles during the spraying process. The data also confirmed that coatings produced by HVOF exhibited denser coating structure relative to plasma coating. It has been observed in this study that microhardness has been effected with powder feed rate for coatings produced by HVOF and Plasma. A strong correlation between spray distances against microhardness of the coating was seen for coatings produced by Plasma technique. The further analysis reveals that oxides in the coating influence the value of the microhardness in the plasma sprayed coating.

The effect of spray distance and feed rate were studied and it has been observed that the data for the coating produced by plasma has shown an increase of compression stress with powder feed rate for short stand of distance .The data for plasma coating indicates that as the spray distance increases, the residual stress also change from compression to tension. The same effect of spray distance with residual stress has been reported in this study for HVOF coating test data.

## TABLE OF CONTENTS

	<b>Page</b>
<b>AUTHOR'S DECLARATION</b>	ii
<b>ABSTRACT</b>	iii
<b>ACKNOWLEDGEMENTS</b>	iv
<b>TABLE OF CONTENTS</b>	v
<b>LIST OF TABLES</b>	viii
<b>LIST OF FIGURES</b>	ix
<b>LIST OF ABBREVIATIONS</b>	xii
<b>CHAPTER ONE: INTRODUCTION</b>	1
1.1 Background	1
1.2 Statement of the Problem	2
1.3 Objectives	3
1.4 Aim and Motivation of the Present Work	3
1.4 Scope of the Work	4
1.5 Structure of the Thesis	4
<b>CHAPTER TWO : THEORY AND LITERATURE REVIEW</b>	6
2.1 Thermal Spray	6
2.2 Thermal Spray Techniques (Plasma and HVOF)	8
2.2.1 Plasma Spray Technique	8
2.2.2 High Velocity Oxy-Fuel Technique (HVOF)	9
2.3 Process Parameters of the HVOF and Plasma Spray Technique	11
2.4 Coating Properties	13
2.4.1 Morphology of Coating	14
2.4.2 Hardness of Coating	14

2.4.3	Residual Stress of Coating	15
2.4.4	Adhesion Strength of Coating	17
2.4.5	Properties of Coating	17
2.5	Summary	18
<b>CHAPTER THREE : MATERIALS AND RESEARCH APPROACH</b>		<b>19</b>
3.1	Materials	19
3.1.1	Inco 718 Metal Powder	19
3.2	Research Approach	20
3.2.1	Thermal Spraying of the Test Samples	20
3.2.1.1	Samples Labeling and Cleaning	22
3.2.1.2	Grit Blasting	22
3.2.1.3	Thermal Spraying	23
3.2.1.4	Visual Inspection	25
3.2.2	Experimental Work	26
3.2.2.1	Metallographic Preparation	27
3.2.2.2	Microhardness Test	31
3.2.2.3	Residual Stress Analysis	32
<b>CHAPTER FOUR: RESULTS AND DISCUSSIONS</b>		<b>33</b>
4.1	Inco 718 Thermal Spray Powder Particle Characteristic and Size Distribution	33
4.2	Powder Feed Rate and Spray Distance Against Coating Microstructure	34
4.2.1	The Effect of Powder Feed Rate to The Amount of Porosity and Oxides in The Coating Produced by Plasma Technique.	38
4.2.2	The Effect of Spray Distance to The Amount of Porosity and Oxides in The Coating Produced by Plasma Technique.	41
4.2.3	The Effect of Powder Feed Rate to The Amount of Porosity and Oxides in The Coating Produced by HVOF Technique.	43
4.2.4	The Effect of Spray Distance to The Amount of Porosity and	