# OIL PARTICLE ANALYSIS USING FOURIER TRANSFORM INFRARED SPECTROSCOPY

**NURUL ASYIKIN BINTI ADENAN**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**


**UNIVERSTI TEKNIKAL MALAYSIA MELAKA (UTeM)**

# Oil Particle Analysis Using Fourier Transform Infrared Spectroscopy

Report submitted in accordance with the partial requirements of the Universti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering (Material Engineering)

By

NURUL ASYIKIN BINTI ADENAN

Faculty of Manufacturing Engineering
April 2008

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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JUDUL: OIL PARTICLE ANALYSIS USING FOURIER TRANSFORM INFRARED SPECTROSCOPY.

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MOHD. ASYADI 'AZAM BIN MOHD. ABID
*Pensyarah*
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Ayer Keroh
75450 Melaka

Alamat Tetap: 295, PENGKALAN LEBAI MAN,
08000, SUNGAI PETANI,
KEDAH

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Tel : 06-233 2421, Faks : 06 233 2414
Email : fkp@kutkm.edu.my

**FAKULTI KEJURUTERAAN PEMBUATAN**

Rujukan Kami (Our Ref) :
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Pustakawan
Perpustakawan Universiti Teknikal Malaysia Melaka
UTeM, No 1, Jalan TU 43,
Taman Tasik Utama, Hang Tuah Jaya,
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Sekian dimaklumkan. Terima kasih.

"BERKHIDMAT UNTUK NEGARA KERANA ALLAH"

Yang benar,

.....
MOHD. ASYADI' AZAM BIN MOHD. ABID
*Pensyarah,*
*Fakulti Kejuruteraan Pembuatan*

# APPROVAL

This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Materials Engineering). The members of the supervisory committee are as follow:

(Main Supervisor: Mohd. Asyadi 'Azam bin Mohd. Abid)

(Official Stamp & Date)
MOHD. ASYADI 'AZAM BIN MOHD. ABID
*Pensyarah*
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Ayer Keroh
75450 Melaka

.....

Co-Supervisor

(Official Stamp & Date)

# ABSTRACT

The purpose of doing this project is to study the oil being used in stamping machine at Miyazu is the main cause of dings and dent of the stamped automotive parts. The FT-iR spectrum of clean and used oil is analyzed using the difference spectroscopy method to pinpoint the impurities, oxidation and water content level which is identified as the main cause of cleaning degradation. This achieved through a series of systematic experiments through following studies. The studies of oil used in production line tools is covered the properties of clean oil. The results are beneficial in order to understand the original characteristics of materials used in this investigation. In order to determine the sources of the contaminant, several aspects of the mechanism of oil flow, oil recycle and cleaning actions and is studied in details. The results are the important input for oil particle analysis. The oil quality is investigated by using FTIR Spectroscopy equipments. The samples of clean oil and used oil in four stage process at upper die and lower die stamping machine area is analyzed of water content in oil, soot loading (resulting in increased wear and viscosity), oxidation, nitration, antiwear components, sulfating (sulfate by-products), and ethylene glycol contamination. The result is important to identify the main cause of cleaning degradation and part rejection.

# ABSTRAK

Projek ini adalah bertujuan untuk mengkaji minyak yang digunakan dalam mesin penghentakan di kilang Miyazu(M) Sdn.Bhd. yang berkemungkinan menjadi punca utama menyebabkan hasil pengeluaran automotif tersebut mempunyai kesan lekuk. Spektrum FT-iR untuk minyak yang belum digunakan dan minyak yang telah digunakan dianalisa menggunakan beberapa kaedah untuk mengkaji bendasing, pengoksidaan, dan kandungan air yang menyebabkan kurangnya keberkesanan dalam proses pembersihan. Ini dapat dicapai melalui beberapa siri sistematik eksperimen dalam kajian. Kajian terhadap minyak yang digunakan di bahagian pengeluaran ini adalah meliputi kajian terhadap kandungan yang terdapat dalam minyak tersebut. Hasil dari kajian tersebut adalah penting untuk memahami dan mengetahui kandungan asal dan sifat dalam minyak yang sedang dianalisis. Dalam usaha untuk menentukan punca sebenar yang menyebabkan pencemaran terhadap minyak tersebut, beberapa aspek telah diambilkira untuk dianalisa. Aspek-aspek tersebut adalah seperti mekanisma kadaran minyak, kadar pertukaran minyak dan pembersihan di kawasan pengeluaran tersebut. Kualiti minyak pula dikenalpasti dengan menggunakan peralatan *FTIR Spectroscopy.* Contoh minyak sebelum digunakan dan selepas digunakan di empat kawasan atas acuan dan bawah acuan proses mesin hentakan ini dianalisa kandungan air, jelaga (yang mempengaruhi kelikatan), pengoksidaan, penitratan, bahan pengelak kehausan, pengsulfuran dari produk dan pencemaran bahan *ethylene glycol*. Keputusan dari ujikaji ini adalah penting untuk menentukan punca utama ke atas kurangnya keberkesanan proses pembersihan dalam mesin dan berlakunya kerosakan pada barangan yang dihasilkan.

# DEDICATION

*For My beloved father and mother.*

*Thank you very much for your continuous support and effort towards the publication of this thesis.*

# ACKNOWLEDMENTS

*Bismillahirrahmanirrahim...*

Firstly, I would like to convey my gratitude towards the Al-Mighty for giving me the strength and willingness to complete Final Year Project. I am indebted to many people in this dissertation effort. First and foremost, I would like to express my sincere gratitude and appreciation to Mr. Mohd. Asyadi' Azam Bin Mohd.Abid, my supervisor, Mr. Fairuzdimin, my co-supervisor 1, and Mr. Mohd Hazley Bin Abu Bakar, my co-supervisor 2 for their advice, support and tireless effort, who guided me to this end in this area that I like most: oil particle analysis using Fourier transform infrared spectroscopy. I deeply appreciate for the countless hours spent by them all on this dissertation since it was first started as a pilot study. Them refinement of this dissertation is invaluable.

An extended note of appreciation is in order for Madam Intan Shahrida and MR.Haidir for his constructive comments and suggestions as my panel presentation.

Special thanks and appreciation are due to my parent, Mr. Adenan Bin Ahmad and Madam Siti Meriam Binti Md.Isa for their sacrifice, encouragement, understanding and assistance in the dissertation effort. Acknowledgement of appreciation also goes to my friends for their patience and support. Without all of you, I cannot achieve what I have today. Thank you again.

*Wassalam...*

*Nurul Asyikin Binti Adenan*

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# LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCALTURE

| | | |
|---|---|---|
| FTIR | - | Fourier Transform Infrared Spectroscopy |
| IR | - | Infrared |
| (M) Sdn.Bhd. | - | Malaysia Sendirian Berhad |
| (CAD/CAM) | - | Computer-aided design and manufacturing |
| Utem | - | Universiti Teknikal Malaysia Melaka |
| EDM | - | Electrical Discharge Machining |
| TAN | - | Total Acid Number |
| EDX | - | Energy Dispersive X-ray Spectroscopy |
| Sc | - | Source |
| Det | - | Detector |
| ATR | - | Attenuated Total Reflectance |
| SNR | - | Signal-to-noise |
| GI UD | - | First stage at upper die |
| G2UD | - | Second stage at upper die |
| G3 UD | - | Third stage at upper die |
| G4 UD | - | Fourth stage at upper die |
| G1 LD | - | First stage at lower die |
| G2 LD | - | Second stage at lower die |
| G3 LD | - | Third stage at lower die |
| G4 LD | - | Fourth stage at lower die |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Project

In this project, several samples of oil taken from the industry will be studied in details using FTIR facilities provided by the university. Several lecturers and students will be involved in analyzing and presenting the data from the analysis. The results could be beneficial to the industry in understanding the quality of the materials used in the production line. The university can employ these opportunities to enhance the knowledge and skills of the students by experiencing real industry based projects.

For this research, I need to study about the metal stamping process, the oil particle analysis and also the contamination that involve in the oil that they used in order to help the industry to prevent the defect from occurring again.

In order to start progress with the oil particle analysis, I need to study about the product cleaning system in stamping process that involve in the industry to gain knowledge about the metal stamping process and the defect that occur in the metal stamping process. By doing this study, I can define how the defect occur and what make the defect occur in the process.

When the contamination and the sources of how the contamination occurs had been identified, its can make improvement to prevent it from occur again. By doing this research, hopefully it can help the industry in order to reduce the defect of the product and can improve their productivity in their production line.

### 1.1.1 Background of Metal Stamping Machines

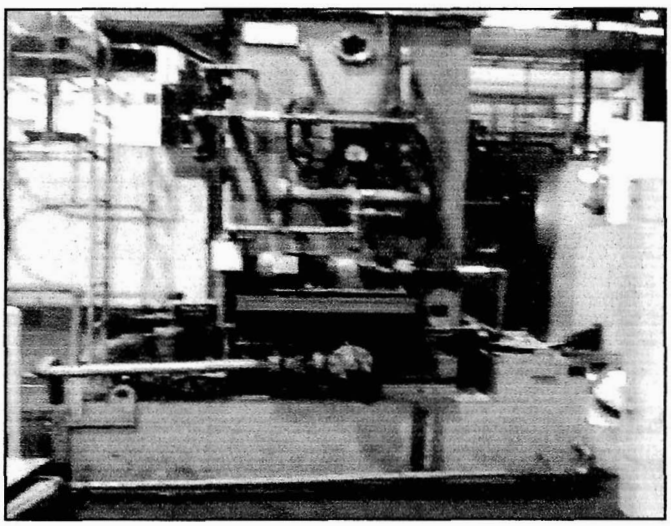

Figure 1.1: Metal Stamping Machine

Metal stamping is a process where the sheet of metal is stamp for manufacturing metal part according to the design that had be done. A metal alloy sheet is used as the stock and the stock is either stamped on a press using dies and punches or drawn into shapes on hydraulic deep drawing machines. Common product produce are automobile parts, electronic parts, aerosol spray can and also household ware product such as pots and pans. In metal stamping process, dies and punches are used to cut the metal into the required shape which is called male components for the punches and the female component for the dies. Press machine tools are used in the stamping process. This metal stamping is use oil as lubricant for product cleaning system in dies and punches for clearing all impurities before next cutting.

### 1.1.2 Background of Oil Particle Analysis

Oil particle analysis is an analysis to measurement of all particles that have accumulated and contaminant within oil, including those metallic and non-metallic, fibers, dirt, water, bacteria and any other kind of debris. It is most useful in determining fluid and system cleanliness with a fluid viscosity.

Contamination can be defined as any unwanted substance or energy that enters or contacts the oil. Contaminants can come in a great many forms; some are highly destructive to the oil, its additives, and machine surfaces. It is often overlooked as a source of failure because its impact is usually slow and imperceptible yet, given time; the damage is analogous to eating the machine up from the inside out. While it is not practical to attempt to totally eradicate contamination from in-service lubricants, control of contaminant levels within acceptable limits is accomplishable and vitally important.

Particles, moisture, soot, heat, air, glycol, fuel, detergents, and process fluids are all contaminants commonly found in industrial lubricants and hydraulic fluids. However, it's particle contamination that is widely recognized as the most destructive to the oil and machine. This explains why the particle counter is the most widely used instrument in oil analysis today. And, the central strategy to its success in reducing maintenance costs and increasing machine reliability is proactive maintenance.

### 1.1.3 Background of FTIR

FTIR (Fourier Transform Infrared) Spectroscopy is an analysis technique that provides information about the chemical bonding or molecular structure of materials. It is used in failure analysis to identify unknown materials present in a specimen, good to bad sample comparison and comparison of materials from different lots or vendors. Fourier transform spectroscopy is a measurement technique whereby spectra are collected based on measurements of the temporal coherence of a radiative source, using time-domain measurements of the electromagnetic radiation or other type of radiation. It can be applied to a variety of types of spectroscopy including optical spectroscopy, infrared spectroscopy(IR), nuclear magnetic resonance, and electron spin resonance spectroscopy.

### 1.1.4 Background of Miyazu (M) SDN. BHD.

Miyazu (Malaysia) Sdn. Bhd., an anchor Class A large dies and moulds producer in Malaysia, is a collaboration between Proton (51%), Miyazu Seisakusho (Japan) (34%) and Sojitz Corporation (15%). From a tooling shop in PROTON Shah Alam then designing and engineering the stamping dies for various PROTON models, the company expanded its operations by localizing the production of dies for PROTON Wira, Perdana and GEN2 models between 1994 and 2003.

In 2004 Miyazu went on to engineer and localize all the body parts for the PROTON Savvy, with a total of 712 dies. It subsequently produced dies for PROTON Persona and began exporting dies to Takao Thailand and Mazda in 2005 and 2006 respectively.

In April 2006, Miyazu expanded its portfolio to include stamping parts production and thus commenced the implementation of TPS in collaboration with TABM to enhance its production capability in order to qualify to meet TABM supply

standards. In April of this year, Miyazu launched an A-Class Tooling Plant in PROTON City, Tanjung Malim, further transforming the company into a key automotive tools manufacturer in the ASEAN region.

Miyazu's new tooling plant marks Malaysia's entry into the highly specialized and technology intensive industry of designing, engineering and manufacturing of automotive tools. Miyazu Malaysia's position as an anchor Class A large dies and moulds producer is expected to pave the way for the formation of Tool Maker clusters. This in turn will result in the creation of an even bigger supporting industry such as casting, hard chroming, machining, production of dies components, logistics and calibration, to name a few.

The company has a paid up capital of RM17.5 million with strength of 250 personnel based at its Class A automotive tooling plant at the PROTON Tanjung Malim Vendor Park in Tanjung Malim. The 3,600-square metre plant, located on a 10.5-acre site, houses state-of-the-art design, engineering, machining and finishing facilities which include computer-aided design and manufacturing (CAD/CAM) applications, and double-column, coordinate-measuring and pressing machines.

These are critical tools required to design, engineer and produce the dies and moulds for the production of automobile components such as roof, bonnet, fender, dashboard, and door, side and other body panels. At full operational capacity, Miyazu Malaysia, together with its technology suppliers and business partners, is able to manufacture and localize over 400 dies annually, thus reducing dependency on foreign expertise in terms of the design, engineering and manufacturing of dies.

## 1.2 Problem Statement

Several studies in production line show that the dusty environment of the industry causes a lot of problems to the quality of the product. The deposited dust causes defects on the surface of the stamped parts. In order to remove the deposited dust, several cleaning actions have been employed to clean the product using specialized oil. The oil have been used repetitively and recycled to clean numbers of parts. Up to several time of usage, the oil has to be changed to maintain the cleaning quality. At the moment, the limited studies to detect the level of contaminant for each cycle of oil. This research emphasizes the analysis of contaminant level of oil based on the cycles or times of usage using FTIR. The study involves the comparison between 'good' and 'contaminated' oil and impurities detection of the oil compositions. This research will enhance the information of the level of oil contaminants in each cycle. The results of the study also can be used to predict the suitable time to replace the oil.

## 1.3 Objective of Project

It is compulsory for an UTeM student to pass the "Project Sarjana Muda" before being awarded the degree. The overall objective of this project is to determine if the oil being used by the stamping line at Miyazu is the main cause of dings and dent of the stamped automotive parts. The FT-iR spectrum of clean and used oil will be analyzed using the difference spectroscopy method to pinpoint the impurities, oxidation and water content level which has been identified as the main cause of cleaning degradation. This will be achieved through a series of systematic experiments through following studies:

### 1.3.1 To understand the characteristics of oil used in production line:

The studies of oil used in production line tools will cover the properties of clean oil. The results would be beneficial in order to understand the original characteristics of materials used in this investigation.

### 1.3.2 To understand the mechanisms of cleaning actions in production line:

In order to determine the sources of the contaminant, several aspects of the mechanism of oil flow, oil recycle and cleaning actions and will be studied in details. The results would be the important input for oil particle analysis.

### 1.3.3 To analysis the oil quality using FTIR spectroscopy:

The oil quality will be investigated by using FTIR Spectroscopy equipments. The samples of clean oil and used oil in four stage process at upper die and lower die stamping machine area is analysis of water content in oil, soot loading (resulting in increased wear and viscosity), oxidation, nitration, antiwear components, sulfating (sulfate by-products), and ethylene glycol contamination. The result would be important to identify the main cause of cleaning degradation and part rejection.