國立中興大學機械工程研究所

碩士論文

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單缸二行程引擎白煙不透光率分析量測

The Analysis and Measurement of the White Smoke Opacity at Single Cylinder 2-Stroke Engine

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摘要

車輛所排放的廢氣是都會地區空氣污染的主要來源，二行程機車由於結構簡單保養容易、體積小輕便因此深受民眾青睞。但二行程機車所排放的白煙是污染中最明顯的一部分，由於可用肉眼明顯的分辨出來，因此為民眾所厭惡，降低機車白煙也成為民眾一致的訴求。目前機車白煙的測試程序相當繁複，執行不易，使得白煙排放改善較不明顯。本文分析二行程機車的白煙排放現況，發現機車不透光率的分布呈現γ分布，主要集中在低不透光率區域。本文並針對無負載急加速測試的結果，以峰值最大值、峰值平均值、積分最大值與積分平均值分別來計算，發現以峰值平均值或積分最大值來判定機車白煙的不合格率較為合理。

本文以濾紙秤重法對機車冷熱車時的白煙進行比較，發現冷車時機車排氣中含大量碳粒，為冷車不透光率較高的原因，顯示冷車與熱車產生PM的原因不一樣，白煙的成分也不相同。本文以連續氣室模式來模擬oil/fuel ratio提高時白煙產生的機制，發現不透光率與模式中的出口濃度的變化皆為剛開始與快結束時變化較慢，中間過程變化較快。本文同時在動力計上對機車排煙進行量測與分析，發現冷熱車狀況對排煙有很大的影響，機車在熱車狀態下不透光率都很低，但若使用舊排氣管在高轉速時會使不透光率增加，顯示排氣管新舊對不透光率有很明顯的影響。

本文以高速攝影機觀察到機車排氣管所冒出的煙柱並不是連續的，而是呈現脈波現象，尤其在減速時排煙的脈波現象十分明顯，可以用肉眼觀察到。本文以熱釋放率與不透光率的變化說明脈波現象與引擎燃燒的關係，發現引擎燃燒時的熱釋放率有高有低，不完全的燃

燒造成白煙的產生，沒有燃燒或熱釋放率低的循環反而不會產生白煙，影響脈波現象主要的因素為熱釋放率與引擎轉速。

最後本文提出使用全合成機油來取代傳統礦物機油來降低機車的排煙，實驗發現全合成機油對降低白煙有不錯的效果，此外在汽油中加入汽油添加劑對降低白煙也有不錯的效果。

ABSTRACT

White smoke is the most obvious part of the exhaust emitted from Two-Stroke engines. The method for smoke testing currently used in Taiwan is the rapid acceleration test under no load. The current situation of white smoke emission was studied in this paper. It was found that the white smoke is gamma distributed. Four ways to treat the original smoke data were carried out and the results showed that the averaged peak values and the maximum integral values are the most suitable ways to define the white smoke level of motorcycles.

The components of white smoke are different at hot test and cold test. At cold test the white smoke is mainly composed of carbon and unburned oil however, while at hot test only the unburned oil is the major component. Lubrication oil is the source of white smoke. Increasing the oil/fuel ratio would cause the smoke opacity to arise slowly due to the absorption effect of muffler. In order to explain this phenomenon successive chambers model was established. Experiment results have good correspondence with the model. At the start and the end smoke opacity arise slowly but rapidly in the middle. On the bench test we find that the engine temperature has significant affect on the smoke opacity. At hot test with an used muffler, the opacity is always low except at high engine speed and exhaust temperature.

The white smoke photography using high speed video camera shows that the smoke emitted from the engine is not continuous. Smoke is emitted like a pulse wave and the pulse wave become more obvious at decelerating. It was found that the engine heat release rate is well correlated with the opacity variations. The opacity at high heat release ratio cycle is higher than that at low heat release ratio cycle. This reveals that at low heat release ratio cycle the engine doesn’t combust so the unburned oil will accumulate in the muffler. Engine speed and heat release ratio are the main factors that affect the smoke opacity.

Finally we compare the smoke opacity by using fully synthetic oil and mineral oil. The fully synthetic oil has better effect on reducing the opacity. Another method to reduce the opacity is to add petrol injection cleaner in the fuel. After driving about 84 km the opacity is reducing 15% .

目　錄