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Article / Book Information

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種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Mechano-Micro Engineering	専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	(Engineering)
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Temperature is one of the most obvious factors that can have an effect on the viscosity behavior of a material. Some materials are quite sensitive to temperature and a relatively small variation will result in a significant change in viscosity. Consideration of the effect of temperature on viscosity is essential in the evaluation of materials that will be subjected to temperature variations in use or processing, such as motor oils, greases and hot-melt adhesives.

Experimental viscosity-temperature measurement data are often used as the basis for determining the quality of the selected fluids. Unfortunately not all data are equally qualified enough. Uncertainty analysis is the procedure used to quantify data validity and accuracy. Accuracy is the key point in enhancing viscometers and improving fluid quality. Therefore, measuring temperature values in high precision is vitally important for viscosity measurement.

A high precision temperature measurement can be achieved with capillary viscometers. However, this viscometer can only provide one-point viscosity measurement. In one-point viscosity measurement, the results are more accurate but it takes days to obtain equivalent data of continuous viscosity measurement.

This research arises from the need of a swift, accurate and an economic viscometer which can carry out effective continuous viscosity measurement. Vibrational viscometers were selected to achieve this purpose because these viscometers are easy to use, their prices are economic and they have very high capability for continuous viscosity measurement. Unfortunately vibrational viscometers (and also rotational viscometers) are not as accurate as capillary viscometers. The main reason of this problem is the non-uniform temperature distribution problem. This problem significantly degrades the accuracy of rotational and vibrational viscometers seriously.

Due to this reason, this work is focused on the temperature measurement problem inside a fluid and its effect on viscosity measurement.

Based on the observations, non-uniform temperature field in vibrational viscometers and rotational viscometers is primarily caused by three factors;

1) Heat generation of oscillators
2) Thermal conduction
3) Thermal convection

The purpose of this research is to reduce the viscosity measurement errors caused by non-uniform temperature field via these factors and provide viscosity measurement results with higher precision.

In industry and academia, the viscosity values that are determined by capillary viscometers are accepted as standard viscosity values. Only in that case, these measured viscosity values are universally accepted as faultless. However as it was mentioned, this process requires days and too much labor force.

By the help of this research, it is claimed that; in case a vibrational viscometer can obtain viscosity measurement results as accurate as a capillary viscometer, a methodology for continuous viscosity measurement which is qualified enough to provide standard viscosity values may be proposed.

By following the guidance of the results of this research, a vibrational viscometer with minimum non-uniform temperature

distribution problem may be designed. This viscometer should be swift and very accurate in continuous viscosity measurement. Also, it should be easy to use and economic in price. A vibrational viscometer with minimum non-uniform temperature distribution problem is proposed in Chapter 6 Conclusion and Future works. Similar to vibrational viscometers, a rotational viscometer with minimum non-uniform temperature distribution problem may be designed based onto this research.

As a conclusion, the objectives of this research can be listed as following;

1) Measure the effects of heat generation of oscillators, thermal conduction and thermal convection to the viscosity measurement.
2) Propose solutions to the problems of heat generation of oscillators, thermal conduction and thermal convection
3) Propose a methodology for vibrational viscometers which can provide standard viscosity values as exact as a capillary viscometer can provide.
4) Propose a new design of vibrational viscometers that do not have non-uniform temperature distribution problem.

Chapter 1 "Introduction"
As a first step, commercially available viscometers are investigated and their merits and demerits are investigated. In this process capillary type viscometers, rotational type viscometers and vibrational type viscometers are investigated in depth.

Chapter 2 "Heat generation problem of oscillators"
This research was focused on the heat generation effect of boundary layers of oscillators and non-uniform temperature distribution problem of vibrational viscometers.

Chapter 3 "Thermal conduction"
This study focused on the problem of non-uniform temperature field via thermal conduction in vibrational viscometers.

Chapter 4 "Thermal convection"
This study was focused on the topic of non-uniform temperature field via thermal convection in vibrational viscometers.

Chapter 5 " Proposal of a non-dimensional parameter for heating speed"
This chapter focused on the solution for the problem of non-uniform temperature distribution in vibrational viscometers. A new concept that is called acceptable heating speed is proposed in order to solve this problem. By the help of this concept, it is claimed that vibrational viscometers can also provide as faultless viscosity measurement results as capillary viscometers can do.

Chapter 6 "Conclusions and future work"
This chapter summarizes the results of this study and proposes a new design for a vibrational viscometer with minimum non-uniform temperature distribution problem as future work.

During this research, the non-uniform temperature distribution problem of viscosity measurement and solution proposals are investigated in Chapter 2, Chapter 3 and Chapter 4. In Chapter 5, a non-dimensional parameter is proposed for vibrational viscometers. This parameter may provide us to obtain as accurate viscosity measurement results as a capillary viscometer can do. Finally, in Chapter 6.2 Future works, a new design of a vibrational viscometer with minimum temperature distribution problem is proposed based onto the results of Chapter 2, Chapter 3, Chapter 4 and Chapter 5.

Therefore, the objectives are accomplished by these chapters.