

## DEVELOPMENT OF <MAGPIA PCB Measurement System>, A BIOASSAY OF HIGHLY SENSITIVE MAGNETIC IMMUNOCHROMATOGRAPHY FOR DETERMINATION OF POLYCHLORINATED BIPHENYLS (PCBs) IN TRANSFORMER OIL

Kobayashi K., Oka T., Kawabe K., Ishikawa F.

Sekisui Chemical Co., Ltd., 2-1, Hyakuyama, Shimamoto-cho, Mishima-gun, Osaka, 618-8589, Japan, TEL 075-962-3995, FAX 075-961-7571

### Abstract

A newly simplified bioassay named MAGPIA PCB Measurement System ( MAGPIA System ) based on the principle of magnetic sensing has been developed in order to determine PCB concentration in transformer oil. It is capable to quantitatively determine the concentration of PCBs in transformer oil in the range between 0.2 mg/kg and 3 mg/kg with good reproducibility. It was found that there was good correlation ( $R=0.930$ ) between MAGPIA System and GC-LRMS Method using 103 samples of transformer oil.

### Introduction

Recently bioassays has been focused as a useful method to sense environmental chemicals. Especially economical and simplified bioassays are demanded for PCB screening in transformer oil. Here we report the development of <MAGPIA PCB Measurement System> based on the principle of immunochromatography which has been successfully used in clinical assays, in combination with magnetic fine particles and high magnetic sensing.

### MAGPIA PCB Measurement System

PCB Rapid Test (10 Tests)



Immunochromatographic Device (10 pieces)  
Antibody coupled Magnetic Particle (10 pieces)  
Solvent (1 piece)

PCB Reader



Magnetic measuring instrument

### Materials and Methods

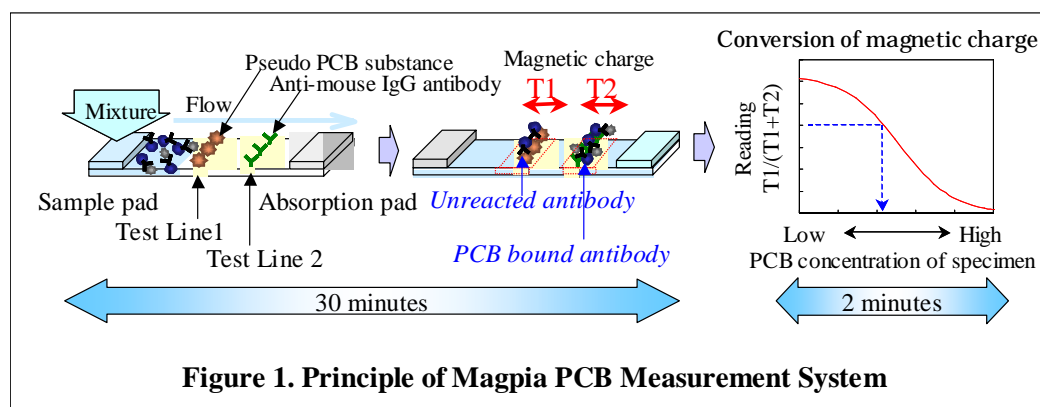
#### (1) Pretreatment of transformer oil

2.5 g sample of transformer oil is pre-treated in 4 processes, i.e. oil/DMSO partition, hexane extraction, silver nitrate/silica treatment and DMSO extraction. Finally, PCB extraction was adjusted to 1 g with DMSO.

## (2) PCB analysis by MAGPIA System

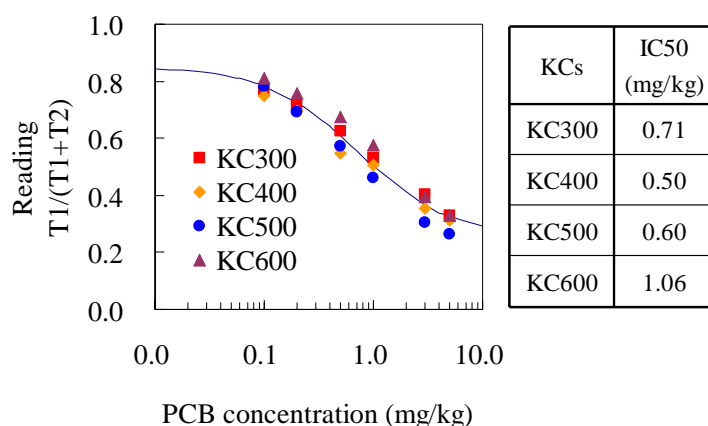
PCB determination is conducted using MAGPIA System (a product of Sekisui Chemical See photo below). This system is based on the principle of immunochromatography using anti-PCB monoclonal antibody coupled magnetic particles. The system is fast and the whole process including the pretreatment takes about 2 hours to get result. (See the diagram of Fig. 1)

The principle and the procedure of test is described here in details. Firstly add 150 $\mu$ L of solvent and 15 $\mu$ L of pretreated transformer oil specimen to the anti-PCB monoclonal antibody coupled magnetic particles, and mix well. 110 $\mu$ L of this mixture was dropped to the immunochromatographic device and flowed in 30 minutes at room temperature. In the development field of immunochromatography, there provided are Test Line 1 made of pseudo PCB substance and Test Line 2 made of anti-mouse IgG antibody. Unreacted antibody coupled magnetic particles will be captured by Test Line 1 and antibody coupled magnetic particles which have caught PCB in the specimen will pass Test Line 1 but be captured by Test Line 2. These Test Line 1 and 2 are detected for the strength of magnetic charge by a PCB Reader and the resulting values are automatically converted to PCB concentration, using the calibration parameter of 2-dimensional barcode label on the immunochromatographic device, and shown on the monitor of PCB Reader.

**Results and Discussion**

## (1) Study of reaction to various Kanechlors (KCs)

Cross reaction to various KCs of MAGPIA System was studied. (See Fig. 2) IC<sub>50</sub>s in competitive reaction with KC300, KC400, KC500 and KC600 were 0.71 mg/kg, 0.50 mg/kg, 0.60 mg/kg and 1.06 mg/kg respectively, which result indicated ability of MAGPIA System to detect each KC.



**Fig. 2** Standard reading curve for various KCs

## (2) Study of measurable range

A given quantity of KC300, KC400, KC500 and KC600 was each added to pure oil and an equal volume of each solution was pooled together to make a mix oil which was further diluted to prepare specimens of various

concentration from 0 to 5 mg/kg. Each specimen was measured 5 times (including pretreatment) to obtain coefficient of variance (CV). As a result we specify the measurable range to be 0.2 mg/kg to 3 mg/kg where CV is below 20%. (See Fig. 3)

### (3) Study of recovery and reproducibility

Specimens of 0.2 mg/kg, 1.0 mg/kg and 3.0 mg/kg concentration in oil of each KC300, KC400, KC500, KC600 and equal blend of all KCs were prepared, pretreated and tested for PCB quantitative determination. The recovery rates at each concentration were 106.2 %, 95.9 % and 95.4 % respectively and the reproducibility at each concentration was 14.0%, 8.7%, 15.7% respectively, which indicated good recovery performance and reproducibility. (See Table 1)

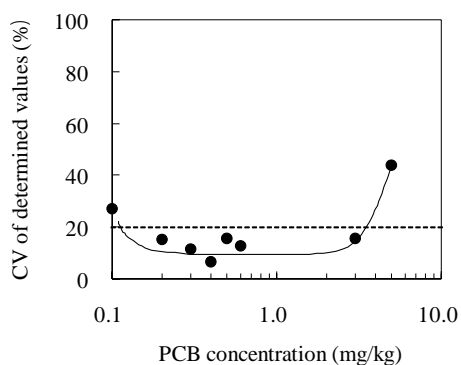


Fig. 3 Survey of measurable range

Table 1. Study of recovery

PCB concentration (mg/kg)	Average (mg/kg)	Standard deviation	Reproducibility (CV in %)	Recovery rate (%)
0.2	0.21	0.03	14.0	106.2
1.0	0.96	0.08	8.7	95.9
3.0	2.86	0.45	15.7	95.4

### (4) Study of screening accuracy

Specimens of 0.1 mg/kg, 0.2 mg/kg, 0.3 mg/kg, 0.4 mg/kg, 0.5 mg/kg, and 0.6 mg/kg concentration in oil of each KC300, KC400, KC500, KC600 and equal blend of all KCs were prepared, pretreated and tested for PCB quantitative determination. (See Fig. 4) The result indicated that if the contaminated oil was defined to have 0.5 mg/kg or more of PCB concentration, 0.3 mg/kg would be the cut-off concentration for this system.

### (5) Correlation between MAGPIA System and GC-LRMS Method

We evaluated the correlation between MAGPIA System and GC-LRMS Method using 103 samples of transformer oil. It was found that there was good correlation ( $R=0.930$ ) between the two methods. (See Fig. 5)

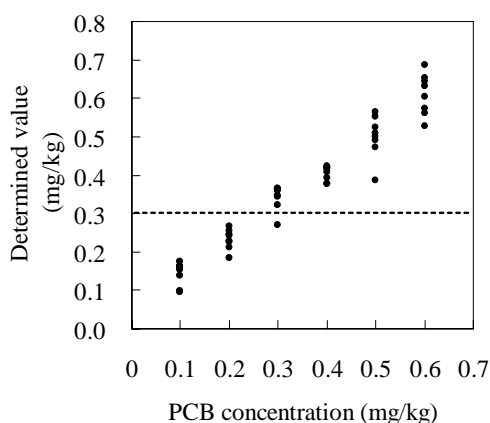


Fig. 4 Study on screening accuracy

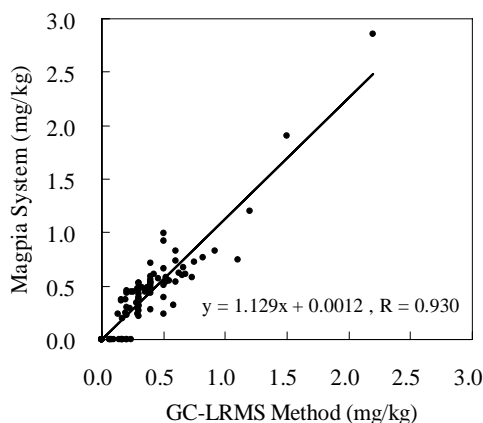


Fig. 5 Correlation between LRMS and Magpia

## Conclusion

MAGPIA System is capable to quantitatively determine the concentration of PCBs in transformer oil in the range between 0.2 mg/kg and 3 mg/kg with good reproducibility. MAGPIA System can be adopted as a simplified screening method having the cut-off concentration of 0.3 mg/kg.