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# DRY DEPOSITION MONITORING IN VIETNAM AND REMOVAL OF AIR POLLUTANTS BY USING BIODIESEL FUEL

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**Abstract:** Filter pack method (FPM) was used for dry deposition monitoring in HoChiMinh City. Gaseous species like sulphur dioxide, ammonia, hydrogen chloride, nitric, formic, acetic acids and soluble species in particles were monitored during the period from July 2001 to April 2002. Seasonal variations in concentrations of gases, ions in particles as well as in component proportions of particles were observed. This phenomenon is clearly related to regional meteorological characteristics. Precipitation and wind played an important role in reduction of dry deposition concentrations. Except ammonia, concentrations of other species in the second half of rainy season and dry season were higher than in the first half of rainy season. Total dry depositions of some acidic species were estimated. Biodiesel fuel(BDF) from waste food oil was produced by using sonolysis and emission of pollutants from diesel engine of BDF were determined

**Keywords:** acidic substance; tropical monsoon climate; dry deposition. Pollutants from diesel engine, biodiesel fuel, waste food oil

## 1. INTRODUCTION

Air pollution in Vietnam especially in HoChiMinh City is increasing due to rapid industrialization and boom of private transport means. As a result, the potential risk related to excess deposition of acidic substances is great. An air monitoring program was set up by Ministry of Science, Technology and Environment. The common method for monitoring of gaseous species is flow injection method. There are only very few monitoring stations equipped with automatic real-time analyzers in HoChiMinh and Hanoi – the biggest cities in Vietnam. However the concerned chemicals are mandatory parameters according to Vietnamese Standard for Ambient Air Quality like sulphur dioxide, nitrogen oxides, carbon monoxide, lead and mass of particulate matter. The total acid deposition is not in consideration. In our research the filter packs were used parallel with automatic continuous analyses for dry deposition monitoring. Fitter packs are applied widely in Europe (UNECE ICP on Integrated Monitoring), America (CASTNET), East Asia (EANET). . . owing to ability to monitor many parameters at relatively low cost.

Biodiesel (fatty acid alkyl esters) is a cleaner burning diesel replacement fuel made from natural, renewable sources such as new and used vegetable oils and animal fats. Just like petroleum diesel, biodiesel operates in combustion-ignition engines. Production of BDF from waste food oil has the advantage for the reduction of global warming gas.

Dry deposition flux  $F$  was estimated from dry deposition velocity  $V_d$  and concentration of species  $C$  as follows:

$$F = V_d \times C$$

Typical dry deposition velocities are given in table 1.

**Table 1:** Dry deposition velocities of some species.

Species	SO <sub>2</sub>	SO <sub>4</sub> <sup>2-</sup>	NO <sub>x</sub>	HNO <sub>3</sub>	NO <sub>3</sub> <sup>-</sup>	HCOOH	CH <sub>3</sub> COOH
$V_d$							
Land	0.3–0.4	0.1	0.09	2.0	0.1	2.0	1.1
[cm/s]			0.08	1.0		1.0	1.02
Ocean							

## 2. EXPERIMENT

### 2.1 Filter pack method.

Filter pack consists of some stages depending on collected substances

1). Each stage contains a filter impregnated with appropriate absorbing reagent. Details of filter packs used in our laboratory for dry monitoring are given in table 2.

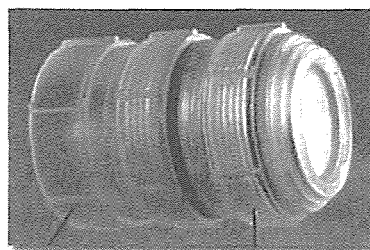


Figure 1: Two-stage filter pack

Table 2: Filters, impregnating reagents and collected substances used in filter packs.

	Stage	Filter type	Impregnating reagents	Collected substances
Four-stage filter pack	F0	PTFE, 0.45 $\mu\text{m}$ pore size		Particles
	F1	Polyamide, 0.45 $\mu\text{m}$ pore size		$\text{SO}_2$ , $\text{HCl}$ , $\text{HNO}_3$ , $\text{NH}_3$
	F2	No. 51A cellulose filter	6% $\text{K}_2\text{CO}_3$ , 2% glycerin aqueous solution.	$\text{SO}_2$ , $\text{HCl}$ which have gone through F1
	F3	No. 51A cellulose filter	5% $\text{H}_3\text{PO}_4$ , 2% glycerin aqueous solution.	$\text{NH}_3$
Two-stage filter pack	F0	PTFE, 0.45 $\mu\text{m}$ pore size		Particles
	F1	No. 51A cellulose filter	10% TEA, 5% glycerin aqueous solution.	Low aliphatic carboxylic acids, $\text{HCl}$

### 2.2 Prepare for sampling

PTFE and polyamide filters without impregnating were used. Cellulose filters were washed with Millipore water in ultrasonic bath, and then soaked in impregnating solutions. The redundant solution was drained off. The filters were kept in polypropylene vessels in sealed aluminum envelopes and stored in refrigerator.

Filters were mounted into filter holder just before sampling. The sampling was carried out in open air once a week with flow rate of 1 l/min from July 2001 to May 2002.

After sampling the filters were taken out and preserved in clean, sealed polypropylene tube and sent to laboratory for analysis.

### 2.3 Analyzing procedure

Filters were extracted with appropriate solutions in ultrasonic bath at  $50^\circ\text{C}$ ; then the extractions were analyzed by ion chromatography as given in table 3.

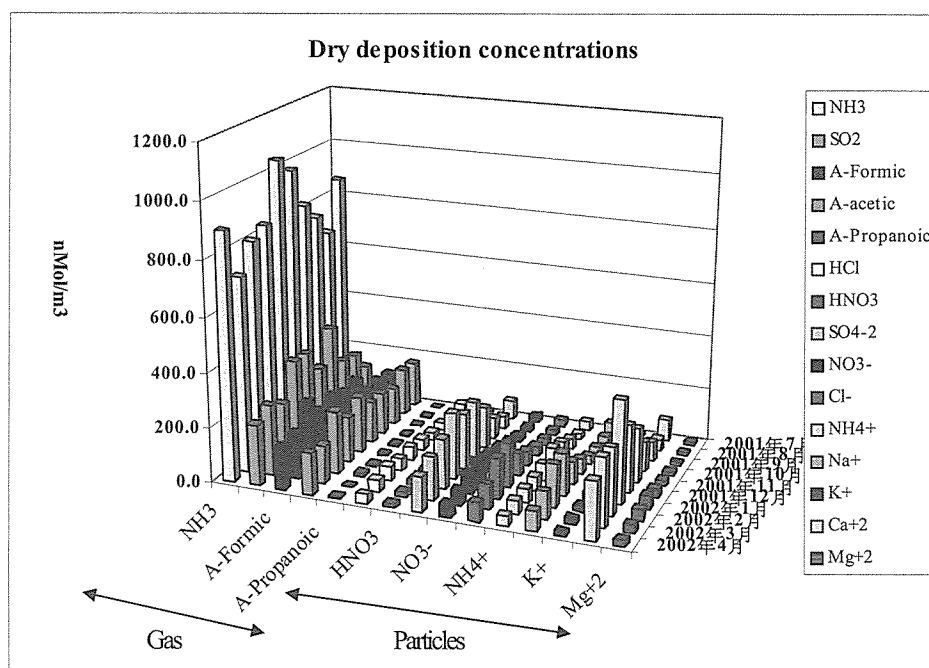
Table 3: Extraction solutions and ions to be analyzed.

Stage	Extraction solution	Ions
F0/4	Water	$\text{Na}^+$ , $\text{K}^+$ , $\text{Ca}^{+2}$ , $\text{Mg}^{+2}$ , $\text{NH}_4^+$ , $\text{Cl}^-$ , $\text{NO}_3^-$ , $\text{SO}_4^{-2}$ , $\text{PO}_4^{-3}$
F1/4	Water	$\text{Cl}^-$ , $\text{NO}_3^-$ , $\text{SO}_4^{-2}$ , $\text{NH}_4^+$
F2/4	0.3% $\text{H}_2\text{O}_2$ in water	$\text{Cl}^-$ , $\text{SO}_4^{-2}$
F3/4	Water	$\text{NH}_4^+$
F0/2	Water	$\text{Na}^+$ , $\text{K}^+$ , $\text{Ca}^{+2}$ , $\text{Mg}^{+2}$ , $\text{NH}_4^+$ , $\text{Cl}^-$ , $\text{NO}_3^-$ , $\text{SO}_4^{-2}$ , $\text{PO}_4^{-3}$
F1/2	Water	$\text{CH}_3\text{COO}^-$ , $\text{HCOO}^-$ , $\text{C}_2\text{H}_3\text{COO}^-$ , $\text{Cl}^-$

### III. RESULTS AND DISCUSSION

Monthly concentrations of dry deposition from July 2001 to April 2002 are shown in figure 2. Concentrations of gaseous  $\text{SO}_2$  and  $\text{NH}_3$  were much higher than concentrations of particulate  $\text{SO}_4^{2-}$  and  $\text{NH}_4^+$ .

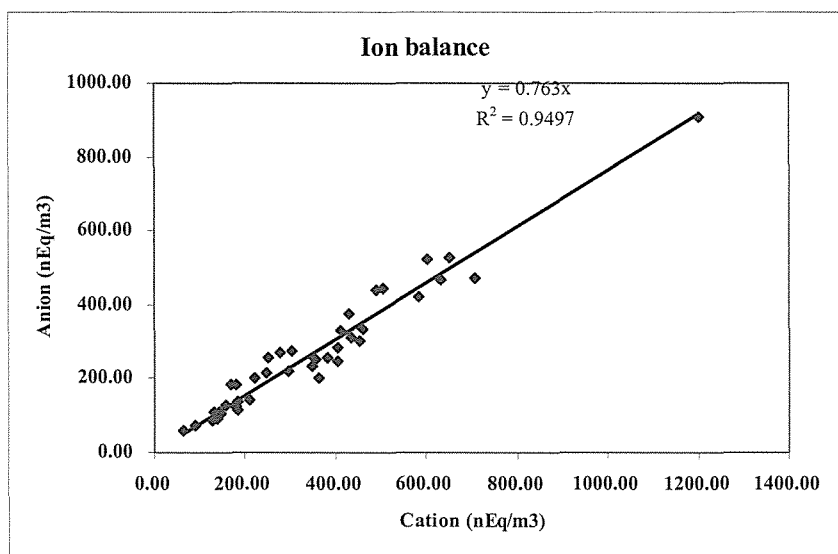
In gas phase, concentrations of  $\text{C}_2\text{H}_5\text{COOH}$ ,  $\text{HCl}$  and  $\text{HNO}_3$  were very low. Content of gaseous species was as followed:  $\text{NH}_3$  about 50-60%,  $\text{SO}_2$  about 15–20%,  $\text{HCOOH}$  and  $\text{CH}_3\text{COOH}$  about 10% of each.



**Figure 2:** Dry deposition concentrations during the period from July 2001 to April 2002.

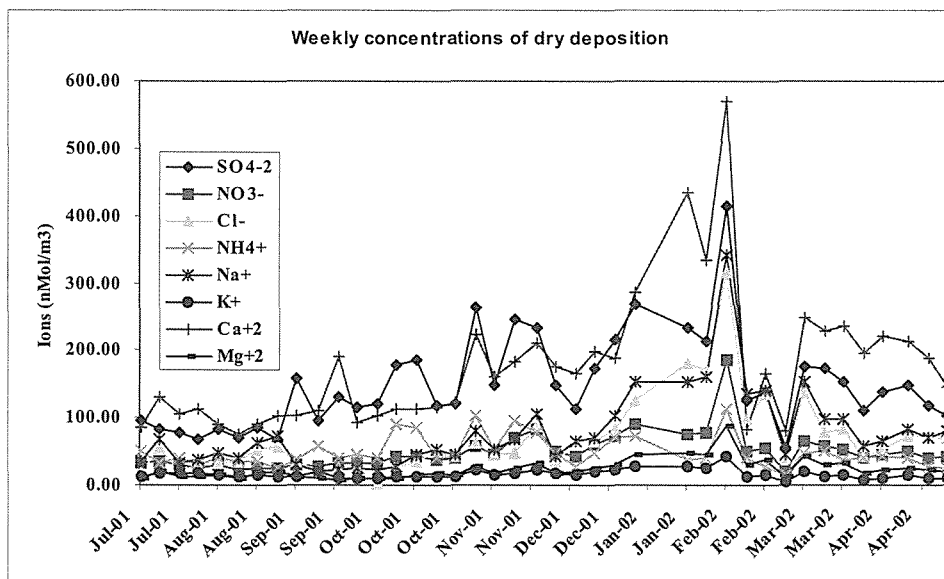
Concentrations of soluble particles in the end of rainy season and in the middle of dry season are comparable. This points out that precipitation is not the only factor influencing dry deposition concentrations. The variations in dry deposition concentrations in dry season are attributed to regional wind systems. The maximum concentrations coincide with minimum local wind speed recorded; therefore the source of particles must be local. Horizontal air circulation in strong wind period disperses air pollution layer to distance area, as a result air quality is improved.

The dominant anions and cations in particles are  $\text{SO}_4^{2-}$  and  $\text{Ca}^{+2}$ . The fact that  $\text{Ca}^{+2}$  ions were about half of the total amount of cations and the reverse relation between wind speed and dry deposition concentrations indicates that major part of particles was originated from soil risen up by vehicles. Figure 3 showed ion balance of soluble species in particles. The sum of anions was almost three fourths of cations. The missing anions are named A. Missing anions are likely carbonates. Since carbonate/bicarbonate eluent was used for analyzing anions so it was impossible to measure them.



*Figure 3:* Ion balance of soluble species in particles.

Figure 4 shows weekly concentrations of dry deposition. The abnormal high concentration from 4 to 11 February and low concentration during next three weeks were observed. This phenomenon related to enhanced transportation activity a week before Vietnamese Traditional New Year “TET” which was on 12<sup>th</sup> February 2002. New Year lasts some weeks and at this time most industrial activity and heavy traffic were stopped. The same phenomenon was seen for gaseous species.



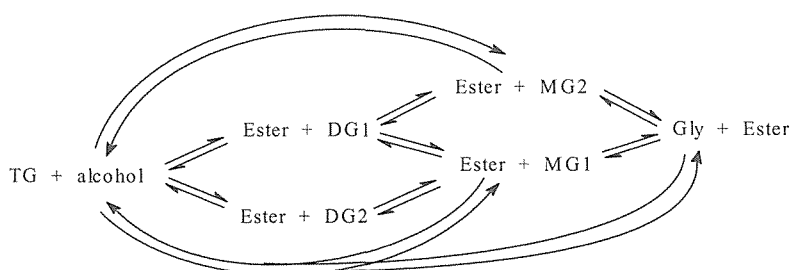
*Figure 4:* Weekly concentrations of ions in particles from July 2001 to April 2002.

A set of experiments was carried out to see the effect of alcohol type to triglycerides.

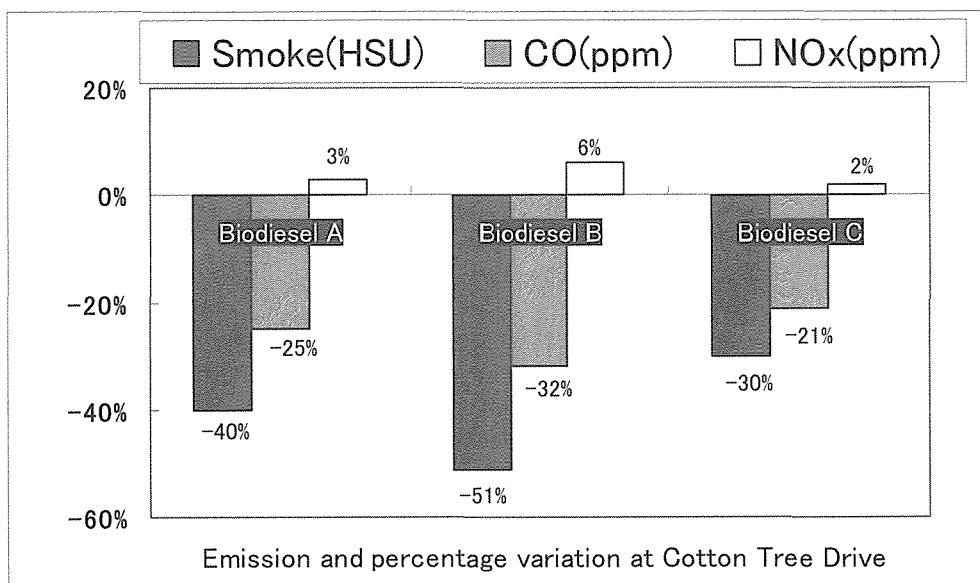
**Table 4.** The influence of alcohol on the transesterification time

No.	Alcohol	Time to complete conversion [min]	
		Stirring	Ultrasonic irradiation
1.	Methanol	60	20
2.	Ethanol	20	20
3.	<i>n</i> -Propanol	10	10
4.	<i>iso</i> -Propanol	No conversion*	Some conversion*
5.	<i>n</i> -Butanol	Some conversion*	Some conversion*
6.	<i>iso</i> -Butanol	No conversion*	No conversion*
7.	<i>tert</i> -Butanol	No conversion*	No conversion*

After 60 minutes reaction time



**Scheme 1.** The mechanism of transesterification.



**Figure 6** Reduction of Pollutants by using BDF

When the catalyst was added in a ratio of 0.5% and 1.0% to the vegetable oil (wt/wt) the yield of isolated product was 90-95% and there were no notable differences in the time to complete the reaction. Low frequency ultrasounds can be a valuable tool for the transesterification of fatty acids, aiming to prepare the bio-diesel fuel. As shown in Fig.6

pollutants such as smoke and CO emitted from bio diesel engine combustion were reduced.

#### ACKNOWLEDGMENT

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