




APFAN PT-2 Workshop

Food Analysis Workshop: Proficiency Testing and Reference Materials Development



Flow Injection Analysis (FIA) for continuous monitoring of food product quality

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INTRODUCTION

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The development of food industrial must be followed by development of monitoring of industrial process and product quality

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The monitoring of samples properties is usually performed by taking separate samples and sent the samples to a laboratory for analysis.

One technique usually and easily used for determination food quality is spectrophotometry / colorimetry

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This technique is widely used for determination of food quality

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Physical properties that can be determined spectrophotometrically are : color and turbidity,
Chemical properties including metals, nonmetals (boron, chloride, fluoride, cyanide, nitrate, nitrite, sulphite etc.), and organic constituents

Although determination of these properties spectrometrically is relatively easy and quickly done, the sample preparation is still time consuming & includes time used for mixing of reagents and sample complex formation


On the other hand, in monitoring food quality routinely, not one or two but tens or hundreds of samples must be analyzed

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Those difficulties can be overcome by FIA – spectrophotometric / colorimetric detection. Using FIA, reagents & samples do not need to be mixed manually; reagents are delivered by peristaltic pump to the manifold and, after mixing, go into a flow cell coupled to a detector in the spectrophotometer/colorimeter.

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**FLOW INJECTION ANALYSIS
(FIA)**

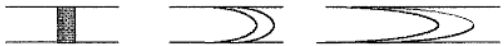
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Flow injection analysis is a relatively new method in analytical chemistry, first developed in 1975 by Ruzicka and Hansen.

Flow injection analysis is based on the injection of a liquid sample into a moving, nonsegmented continuous carrier stream of suitable liquid

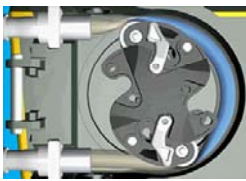
The injected sample forms a zone, which is then transported to-ward a detector that continuously records the absorbance, electrode potential, or other physical parameters as it continuously changes as a result of the passage of the samples through the flow cell

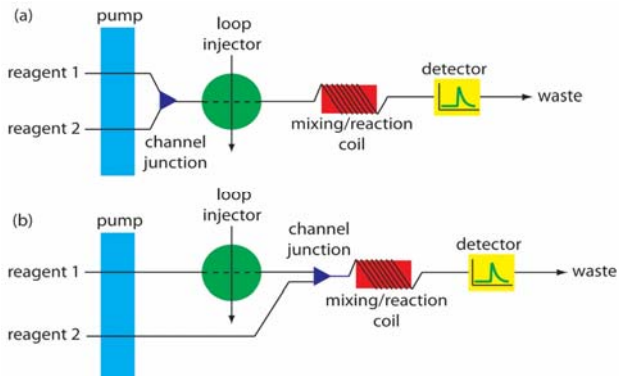


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The simple flow injection analyzer consists of :

- (a) a **peristaltic pump** used to propel carrier stream through a tube
- (b) an **injection port** through which a well-defined volume of sample solution is injected into the carrier stream in a very reproducible manner;
- (c) a **reaction coil or manifold**, in which the sample zone disperses & reacts with component from carrier stream to form a species;
- (d) a **flow-through detector cell (FC)** that allows continuous measurement [3]






(a) Channel junction configuration: A pump feeds reagent 1 and reagent 2 into a channel junction. The carrier stream then passes through a loop injector, a mixing/reaction coil, and a detector before going to waste.

(b) Loop injector configuration: A pump feeds reagent 1 and reagent 2 into a loop injector. The carrier stream then passes through a channel junction, a mixing/reaction coil, and a detector before going to waste.


<https://youtu.be/Asa6miVcUKA>



The major advantages of an FIA system when compared to other systems :

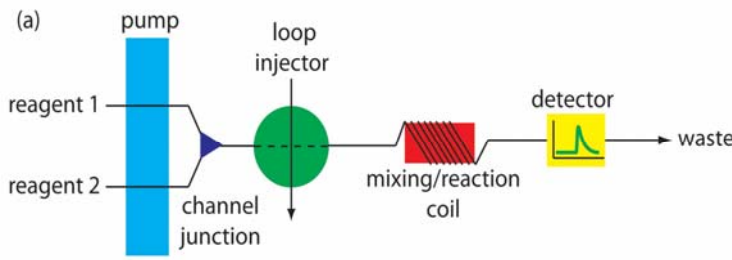
- (a) high sampling rate;
- (b) fast response;
- (c) smaller sample and reagent volume requirements;
- (d) accurate results; and (e) good precision

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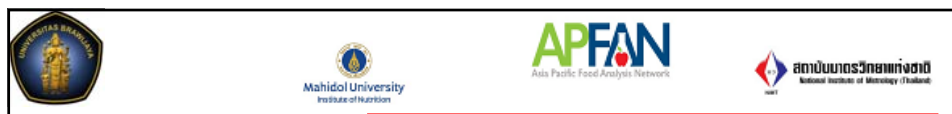


The samples are presented to an automatic injection valve where they are loaded. The valve is then switched, and the analytical stream is directed through the valve to sweep the sample. The sample and the reagents move into the reaction manifold where the analytical processing occurs. The reaction product is fed to the flow-through cell of an appropriate detector to generate an analog signal

(a)




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<p>In the FIA, the tubing used is usually of small diameter (0.5 mm), & laminar flow within the tube is achieved</p>	<p>So a sample zone injection into a flowing carrier/reagent stream will rapidly adopt a parabolic concentration profile, where the sample nearest the walls of tubing will have zero velocity while that at the center will be twice</p>
<p>The major dispersive influence at this stage is axial or longitudinal convection. If this situation were to prevail, the sample zone would become progressively more elongated</p>	<p>However, samples at the walls radially diffuse into the following carrier stream, and the sample concentration profile changes successively downstream from the injection point until radial diffusion dominates and the sample approaches a Gaussian concentration profile</p>

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<p>Applications of FIA have been reported in many fields of chemistry, including environmental studies, chemical analysis, agriculture, biotechnology, and food analysis</p>	<p>Besides using a colorimeter, FIA can also be detected using atomic absorption spectrometry and can be combined with voltametry, amperometry, and potentiometry</p>
<p>By using a computer, the FIA system will give the absorbance and develop a calibration curve for assays</p>	<p>A single-line manifold allows the determination to be performed at the rate of up to 240 samples per hour</p>

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**FLOW INJECTION ANALYSIS
FOR DETERMINATION OF
FOOD QUALITY**

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Determination of Nitrite and Nitrate

Nitrites and nitrates are used in processed meat due to their effect on organoleptic characteristics (colour stabilization, flavour development), oxidative stability of lipids and inhibition of pathogenous microorganisms, such as *Clostridium botulinum* and *Listeria monocytogenes*

In liquid, the forms of nitrogen are nitrate, nitrite, ammonia, and organic nitrogen. Nitrate generally occurs in trace quantities in surface liquid, but high levels may occur in some low level. Nitrite is an intermediate oxidation state of nitrogen, that is, in the oxidation of ammonia to nitrate and in the reduction of nitrate

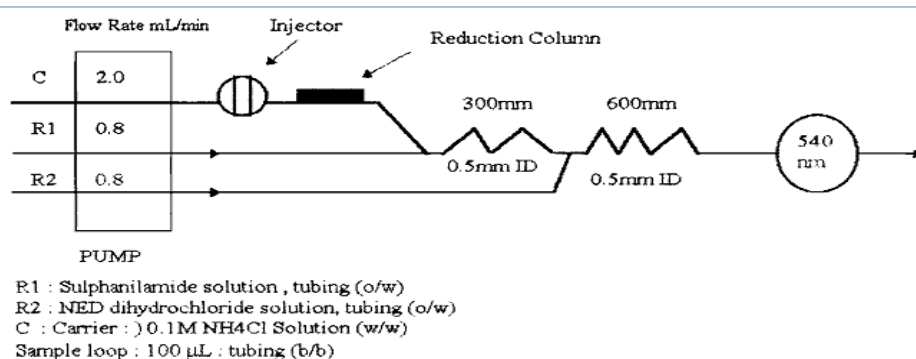
Nitrate and nitrite can be analyzed using FIA spectrophotometry. Nitrate is reduced almost quantitatively to nitrite in the presence of cadmium

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One of the methods for determination of nitrate and nitrite using FIA/spectrophotometry is the method involving the reduction of nitrate to nitrite using an in-line copperized cadmium column followed by diazotization with sulphanilamide.

The diazo compound is coupled with N-(1-naphthyl) ethylenediamine dihydrochloride and the azo dye is formed (represents total nitrate and nitrite); it is then detected spectrophotometrically at 540 nm. The reaction between nitrite and sulphanilamide and the coupled reaction with N-naphthylamine hydrochloride

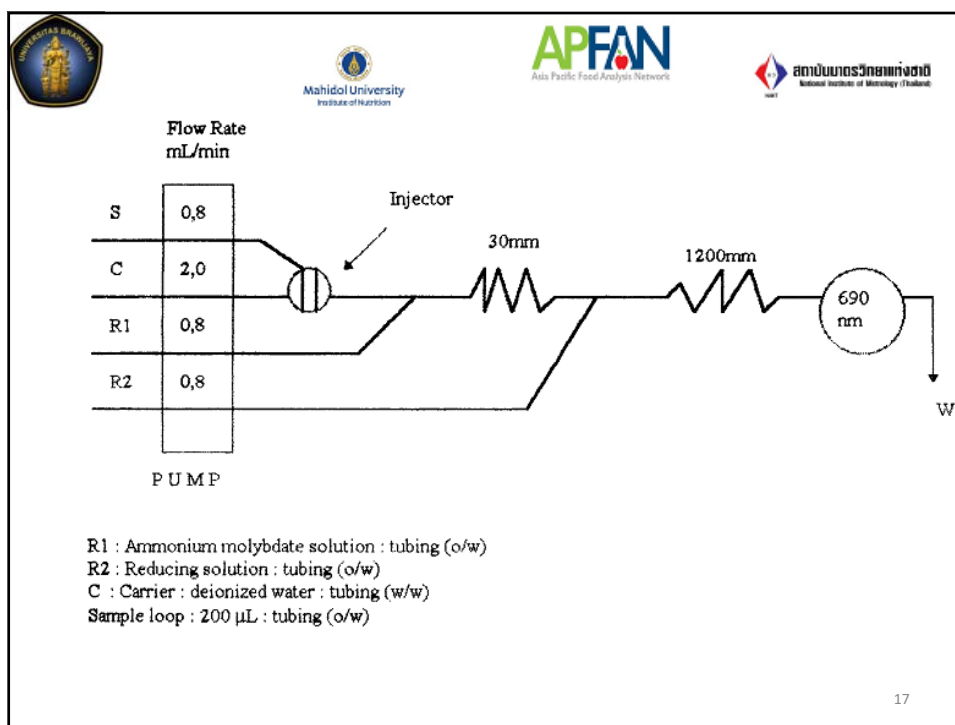


Determination of Phosphorus

Phosphorus is an essential and sometimes growth-limiting nutrient for human. Phosphorus occurs as phosphate, orthophosphate, condensed phosphate, and organically bound phosphate

Phosphate in liquid samples that respond to colorimetric tests without preliminary oxidative digestion are termed reactive phosphorus. Phosphates that respond to colorimetric tests with preliminary oxidative digestion are termed total phosphorus. Dissolved reactive phosphorus (DRP) is defined as that portion of the dissolved phosphorus that will react with ammonium molybdate to produce phosphomolybdenum blue

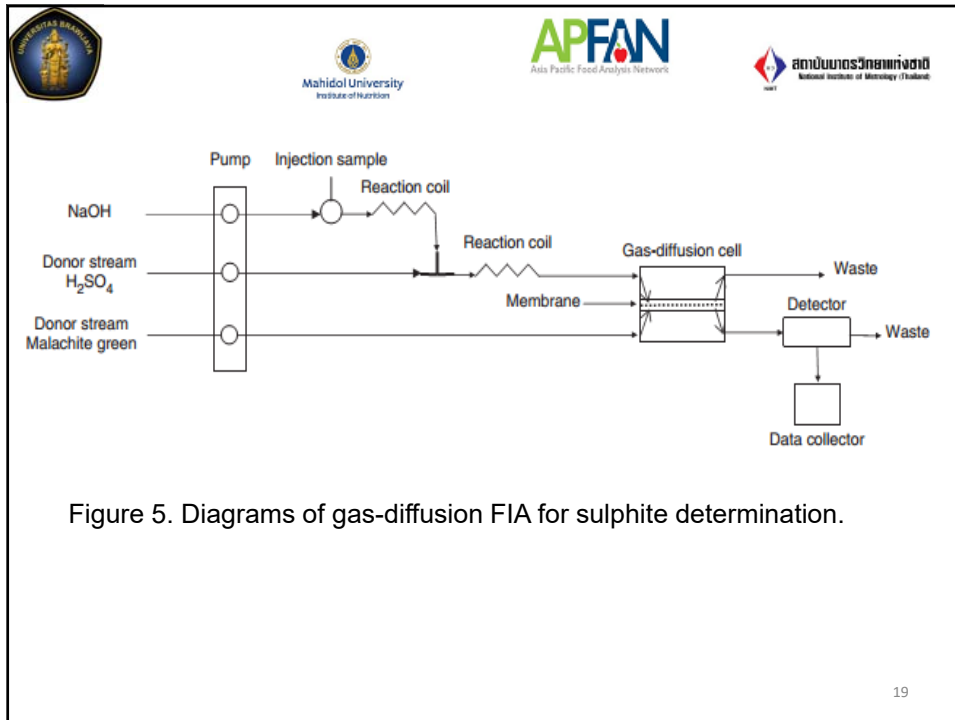
Using an FIA system, the phosphomolybdenum formed is reduced by the addition of stannous chloride and hydrazine sulphate to form molybdenum blue. Tartaric acid is added to minimize the interference from silica .



Determination of Sulphites

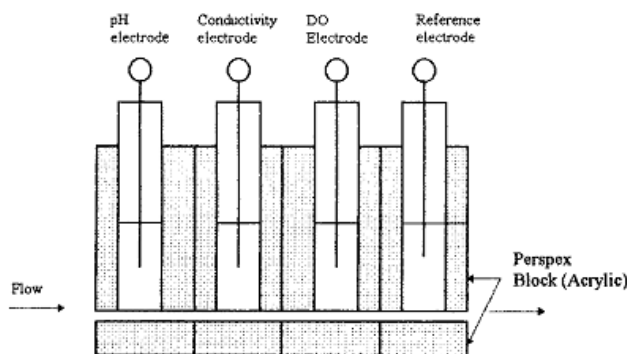
Sulfites are used as preservatives in food and beverages to prevent oxidation and bacterial growth. In meat, sulfites also help to give a bright colour as appearance (colour) is one of the prime factors motivating consumer choice. In the EU, the maximum permitted amount of added sulfite agents in different meat products is 450 mg/kg, expressed as SO₂

FIA procedures have been extensively researched for determining sulfites in beverages and foods in an attempt to overcome these limitations and reduce the time and effort required. Most FIA procedures have been developed for liquid foods, with far fewer for solid foods and, especially, for muscle tissue. It has been reported that the FIA procedure is a more rapid, accurate and precise method for the determination of total sulfite in food



Measuring of pH, Conductivity, and Dissolved Oxygen

Each electrode is connected to potentiometer, conductometer, DO meter



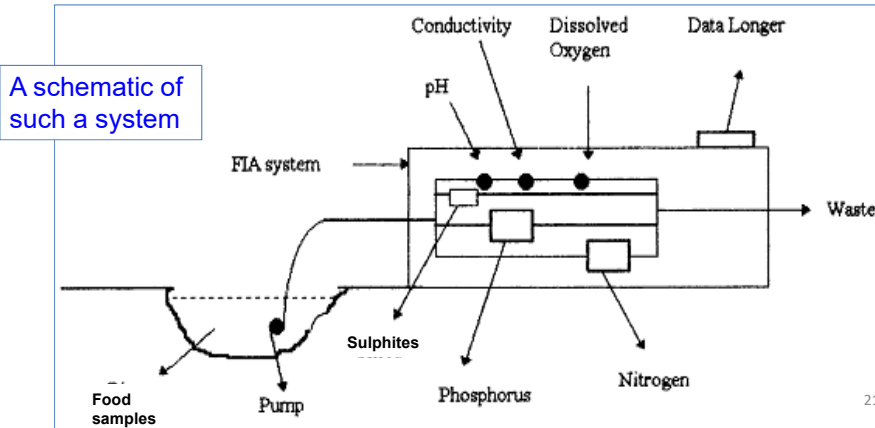
Measuring of pH, conductivity, dissolved oxygen (DO), cations and anions use electrodes which are put by series in the block of acrylic. The food samples are presented via a capillary using a peristaltic pump

Figure 8. Schematic diagram of electrodes in the block of acrylic that are connected to recorder.

Continuous monitoring of food quality

The instrument for continuous monitoring will contain the capacity to continuously monitor of temperature, pH, and conductivity and will be coupled with nutrient analyzer, dissolved oxygen, turbidity, etc.

The information produced by the system will be stored in a data logger.



Campus of Brawijaya University in the late of afternoon

The Office of MALANG City Major