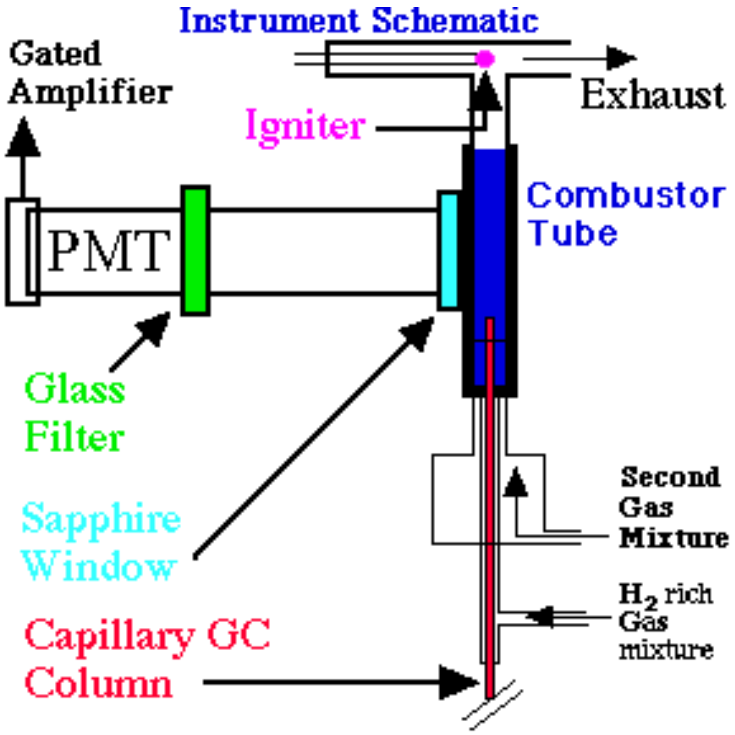
The Pulsed Flame Photometric Detector

A QuickTime move (with sound narration) of the pulse flame photometric detector is available online (size 3.7 MB). For those with less available bandwidth and/or less patience a GIF animation is here too (size 212k). Like all GIF animations it is silent.

Introduction

The pulsed flame photometric detector (PFPD) is a relatively new weapon in the arsenal of the analytical chemist. Though it uses a flame like its namesake, the flame photometric detector or FPD invented over 30 years ago, the PFPD is a significant improvement because it can provide better sensitivity and selectivity for sulfur and phosphorus. The old FPD was generally only used for sulfur and phosphorus selective detection; however, the PFPD allows for selective detection of S and P primarily but also detects N, As, Sn, Se, Ge, Te, Sb, Br, Ga, In and Cu among others.



Schematic of the pulsed flame photometric detector

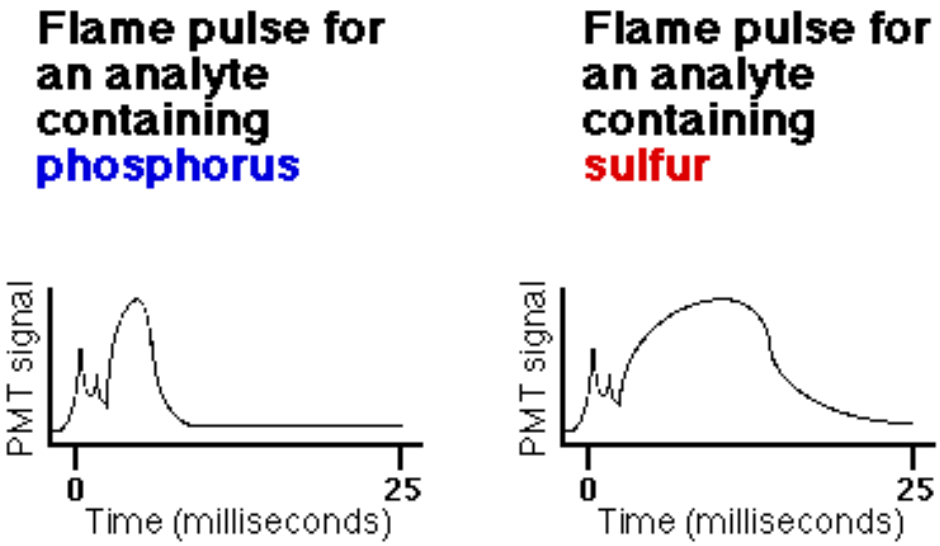
As this instrument's schematic diagram above shows, the **PFDP** has a combustion chamber (or combustor tube) like the old FPD and a photomultiplier tube?or PMT?again like the FPD. However in this new detector, two different combustible gas flows enter the bottom of the combustion chamber through narrow gas lines. The normal FPD has only one fuel line?for hydrogen. (It also has air plumbed in.) The second incoming gas flow's job in the PFPD is to help fill up the outer volume of the combustion chamber (and outside the combustion zone

which is in the center of the combustion tube) while the analyte and the primary combustion gas flow into that chamber. This second flow also helps to optimize the analyte emission brightness in the combustion process. The capillary gas chromatographic column from the GC oven enters at the bottom of the combustor (also like the FPD).

At the top of the PFPD is an ignition wire which stays continuously red hot. When the gases flowing into the combustor?including the analytes exiting the GC column?reach a flammable mixture they are ignited by the ignition wire and the flame propagates back down the combustor. And here is another big difference between the pulsed flame photometric detector and the old FPD: The flame front terminates, that is, uses up all of the quickest burning flammable material in the combustor in less than 10 milliseconds **and the flame goes out**. And it is AFTER this short flame pulse that the slower burning analytes are excited and emit the light that is characteristic of their elements. And therefore also during this period that the PMT, in a manner similar to the old FPD, records the arrival of the analyte's light from the combustion chamber. After about 300 milliseconds, the flame pulses again as new flammable material fills the combustion chamber from the inlet tubes and GC column and that combination once again constitutes a flammable mixture. In this way about 3 flame pulses are recorded per second.

The shape of the flame pulse profile-over time-depends on the elements in the analytes that are present in the flame. As the two plots of PMT signal versus time show below, the maximum light emission is different for different element containing analytes.

Flame pulse plots for analytes containing sulfur (right) or phosphorus (left)

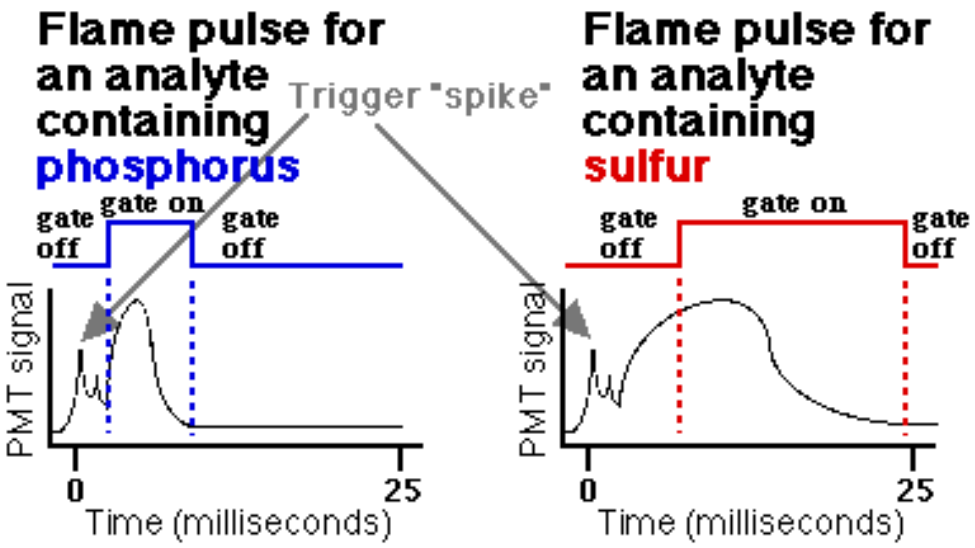


The right flame pulse plot is for a chromatographed analyte containing sulfur and the left plot is for an analyte containing phosphorus. Each of these represents just one PMT recorded flame

pulse (for different analytes) and these emissions would be repeated again approximately 300 milliseconds later during the next flame pulse as long as that analyte is exiting the column. And since the average high resolution peak in capillary GC is, say 6 seconds wide, approximately 18 pulses would be recorded during the time an analyte is detected.

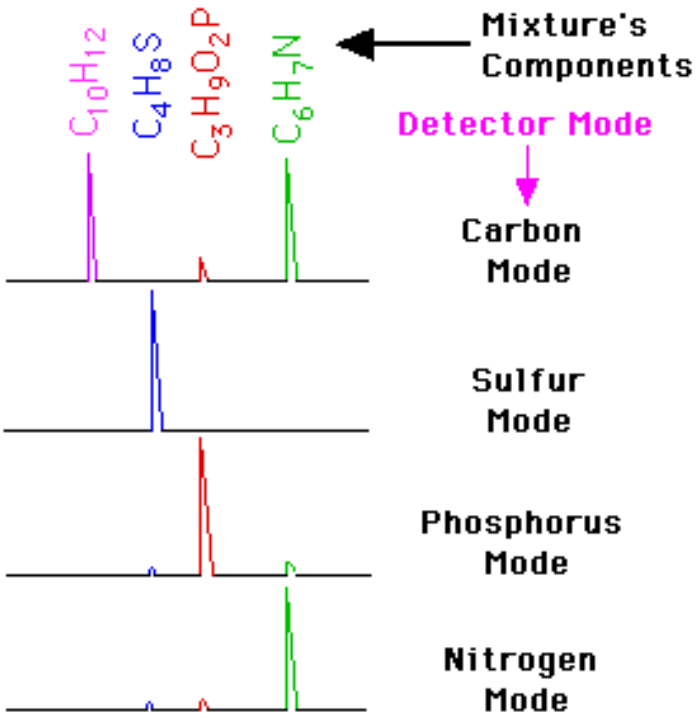
By using a gated amplifier, controlled by a computer, the analytical chemist chooses which part of each pulse to amplify and to record. The example plots below suggest gating schemes that might be used. The computer uses the initial sharp pulse (reproducible from pulse to pulse and independent of what analytes are present) as a trigger so it can detect the beginning of each pulse and then know when to "open the gate." The time and length of the chosen gates are determined in advance using standards.

Amplifier gating schemes for elementally selective detection of S or P



This analytical discrimination gives the pulse flame photometric detector the ability to selectively, and sensitively detect some analytes co-eluting in the presence of others and, as the image below shows, the ability to produce element specific chromatograms. The following image contains four chromatograms of the same chemical mixture; however, only those peaks containing specific elements are detected depending on the configuration of the detector for that run. Remember that each chromatographic injection contains the same four analytes.

Four different element specific chromatograms for the same mixture



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These notes were written by Dr. Thomas G. Chasteen at Sam Houston State University, Huntsville, Texas.

Send suggestions for additions to this page, corrections or comments to:

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