Finding a needle in the solution

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Back in 1968 when I was just starting out as a very junior engineer, I worked for Chromatronix [1] designing sensors for and building High Pressure Liquid Chromatography [2] (HPLC) equipment. In those days, "High Pressure" was 500 psi going up to 1,000 psi with research on 3,000 psi equipment well underway.

I was recently doing some research on CBD analysis [3] and decided to look into the state of the art. At Chromatronix, I designed a UV sensor that fit around the quartz glass column. It was a single silicon diode with a deuterium lamp source. It was state-of-the-art at the time. Nowadays, you can get diode arrays [4] which, along with a diffraction grating, allow you to look at multiple wavelengths as the sample passes through the column. Other types of sensors in use these days include Refractive Index, Infrared, Fluorescent, and radiation detectors in cases where the sample has been tagged with a radioactive element or compound. There are other sensors [5]. If you are designing electronics for the sensors, you need to look at low-noise amplifiers, which can increase the detection limits of your HPLC setup. Those amplifiers will most likely be low-frequency JFET input amplifiers for high-output impedance detectors. For low-output impedance detectors, a low-noise bipolar input amplifier is better. If you can chop the light source mechanically or electrically, you need not be quite so concerned with DC stability.

There are other things you can do to increase the accuracy of your HPLC equipment. One of them is to maintain the column at a constant temperature [6]. The column volume and the tubing leading into and out of the column should be as much as possible be kept in an insulated chamber. To keep the costs down, especially if you are using thermoelectric (TEC) heating and cooling, [7] the chamber volume needs to be as small as possible taking into consideration any preheat or precool requirements. If you do heating and cooling, you will need a bipolar current source to drive the TEC. If you are just doing heating, a unipolar source is all that is required unless you decide to use an AC power source. However, you need to take into account any local EMI generated by your power source. This is true for whatever way you control the column temperature. Noise reduces the sensitivity of the HPLC equipment. Temperature control is tricky for another

reason — you have to choose a temperature sensor. Generally, thermistors are the most sensitive to variations in temperature, but they are nonlinear and are prone to long-term drift.

Diode sensors are less sensitive, but they are linear to a first-order approximation. Diodes are susceptible to long-term drift and, like the thermistors, have absolute accuracy problems. For best stability and accuracy platinum resistance, sensors are preferred. They are also relatively costly and are not as sensitive as diode or thermistor sensors. That means that for tighter control, you will need more gain. That puts you in the area of low-noise amplifiers. And that raises costs. All temperature sensors require a current source. You can handle that in a number of ways. One way is to measure the actual current without worrying about its absolute value. And then there is the self-heating problem, which will change the temperature measured if it can't be accurately accounted for.

Obviously, there is more. That includes constant pressure pumps, which will require pressure sensors and servo systems to control the pumps. And I haven't even considered how you keep such a system free of contamination. That will require collaboration with the chemical, mechanical, and software engineer(s) also working on the system design. Lots of trade-offs will need to be made to get a system that meets the requirements of the sales department. But that is the fun of engineering — looking for a sweet spot in a mass of conflicting requirements.

M. Simon's e-mail can be found on the sidebar at Space-Time Productions [8].

Engineering is the art of making what you want from what you can get at a profit.

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