

MARINE SCIENCE TOOLS – M-SEAS INSTRUMENT

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Hello, everyone. My name is Jim Patten. I work for the Center for Ocean Technology here at the University of South Florida's College of Marine Science. I'm going to tell you about a chemical sensor that we have created here at the Center for Ocean Technology called M-SEAS.

And M-SEAS stands for Multiple Parameter Spectrophotometric Elemental Analysis System. We use spectrophotometric procedures to measure concentrations of analytes in the ocean. Some of the analytes that we are going to measure with this instrument are dissolved inorganic nitrogen, nitrate and nitrite, phosphorus, phosphate, silicate.

We can measure the carbon system parameters, which are the amount of total carbon dissolved in the ocean, dissolved CO₂, and we can measure the pH. Myself, my specialty, is trace elemental analysis, specifically, iron. We can measure iron with this device.

Why is this device important? The main goal of oceanographers in understanding oceanic processes is to increase the resolution and the precision of the data, that is, the number one paradigm for doing this. And that's exactly what this instrument does. It increases 1,000 fold the resolution of the data and gives us precision to measure analytes that is not capable of any other bench top systems.

The component pieces of the M-SEAS are represented by this diagram where the instrument itself stands about 2, 2 and 1/2 feet tall. It has a pump array, a heating element, control electronics, and a battery pack. And so we have it broken out in the component pieces.

We have the pump array here, which is composed of six pumps, which are small pumps. They're oil filled. We can put them down full ocean depth. And these are full ocean depth rated. So they, the pumps, will mix sea water with the reagent chemicals, so that we can measure the analytes. This is the electronics control system with the heater system. And at this point, we have bench pumps hooked up to make it easier to do the testing.

So now we're going to show you how we measure some of the principles of spectrophotometry and how we measure in analytes. Basically, to sum it up, what we do is we shine light through a tube from a light source to one end and a photo detector on the other end. We measure the amount of light going through.

And that's represented here by this graph. This is an intensity graph of a spectrum, wavelengths from 400 to 750 nanometers. And what we do is we'll take, and we'll create what we call a reference at that level, which I'm going to take with this. And then what we'll see is the spectra here, represented as a flat line, because there's no absorbance going on.

So what we're going to do is we're going to mix a reagent with the seawater sample, and it will form a color forming reagent, a compound that absorbed at certain wavelengths. And in this case, for this

chemistry, it's 514 nanometers and 550 nanometers. So when we start the reagent pump, you will see a double peak absorbance, maximum absorbance form.

So we'll start the chemistry. And in a couple minutes, you'll see it form. And with the SEAS instrument, we can look at both the spectra of the absorbance, and we can measure the absorbance as it will be collected over time. You can see it here as a baseline of zero. So it's flat. There's no absorbance going on.

And then when the color comes in, when the reagent comes in, you'll see the signal of the absorbance start to rise. And you'll see the spectra correspondingly form a double peak maximum absorbance.

And here it comes. So you'll see it. It should form pretty nice colors. And so essentially that's what it is. We're pumping the reagent through. I'm just going to increase the scale here. So that doesn't get off scale. And you'll see the peak absorbance. Well, the more absorbance allows us more sensitivity to the signal. So the higher the peak gets, the greater the concentration. But it also allows us to measure at the most color.

So we look for chemistries where we have peak absorbance wavelengths. And we pick those wavelengths. You can see right here, we're looking at 514 nanometers and 550 nanometers. And so what do these numbers mean? Measuring light from 400 nanometers to 700 nanometers is light in the visible spectrum, light that human beings can see with their eyes.

400 nanometers represents the lower end, the red end of the spectrum. 750 is the blue-green end of the spectrum. The 514 and 515 maximum wavelengths absorbance peaks that we see here are in the red end of the spectrum. They're more of a pinkish crimson color is what I'm looking at, when the reagent comes out after the colors form. And you will see exactly that. You'll see a crimson bag full of sample.