[MUSIC PLAYING]

JESSICA HARROP: Hi, I'm Jessica. And today I'm going to be talking about a chemical demonstration I like to call the steaming gun. So you've probably seen this before at the drugstore or in your house. It's called hydrogen peroxide and it's the stuff you put on cuts.

But it has many other uses as well, from bleaching things to powering rockets, depending on its concentration. The solution that you get at the drugstore is usually 3%.

So it's called hydrogen peroxide and it's chemical formula is H2O2. So the atoms are arranged like this. It sort of looks like water, but the extra oxygen makes the molecule more reactive. Now if you leave it alone, it decomposes into water and oxygen. The equation looks like this. I'm going to balance it.

Now, normally, you can't see this reaction happening because at room temperature, it's very slow. But there are many ways to speed it up like increasing the temperature or adding a catalyst. In this demonstration MIT's Dr. Dolhun uses a catalyst to make the reaction go thousands of times faster than normal. Let's watch.

JOHN DOLHUN: So we're going to do this experiment here. And basically what we've got is we've got four bottles. We're each going to do the experiment in a bottle. We've got 15 mLs of hydrogen peroxide here. And we're going to be using a man-made catalyst. We're going to be using manganese dioxide.

And we're each going to take a scoop of this. And we're going to put it in. You can set it down on the tray. And just-- it's starting to work. You won't have to stand up to see this. You can start to see some condensed water vapor forming inside the flasks. Oxygen bundles are coming out. Now we're just going to lightly hold that. Whew!

JESSICA HARROP: OK, so what happened? Dr. Dolhun had hydrogen peroxide in the plastic bottle. Then he added a catalyst, some manganese dioxide or MNO2, and got a plume of water vapor.

So let's talk about how a catalyst works. I'm going to draw a potential energy diagram for this reaction.

[MUSIC PLAYING]

So here's my potential energy diagram. So I've got potential energy on the y-axis and the reaction coordinate, or time, on the x-axis. The reactants are starting at this amount of energy and the products have this amount.

Here, EA, that's the activation energy. It's the amount of energy you need to add to the reactants to make the reaction go. And delta H, that's the amount of energy that's released when the reaction happens. Now let's see what happens when I add a catalyst.

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With a catalyst, my activation energy is a lot lower. And even a small reduction in activation energy can make the reaction go thousands of times faster than it normally would. But notice that regardless of whether or not you have a catalyst, the delta H, the amount of energy released in the reaction, doesn't change. So the catalyst only speeds up the reaction. It doesn't change the amount of energy released. Now, take a look at this.

JOHN DOLHUN: Notice the size of the bottles. These are very exothermic reactions. The bundles have basically shrunk down to a very, very tiny size compared to the control bundles.

JESSICA HARROP: So as you can see, the catalyzed reaction releases so much heat that it actually melts the bottles and makes them smaller. Also, the catalyst itself remains unchanged by the reaction. And designing catalysts is actually a key subfield of chemistry. MIT's Richard Schrock won the Nobel Prize working in this field.

And remember how we used H2O2 on our cuts? Well, we have an enzyme in our bodies called catalase that does the same thing as the manganese dioxide that Dr. Dolhun used. That's why when you put hydrogen peroxide on a cut you see fizzing and bundles. The catalase in your blood is breaking down the hydrogen peroxide.

And according to recent studies, low levels of catalase may play a role in the graying process of human hair. If catalase levels are low, it can't break down all of the hydrogen peroxide in the blood. And that extra H2O2 starts to bleach your hair from the inside out.

So to wrap up, catalysts don't change the products of the reaction or how much heat is released or absorbed. They only change the time it takes for the reaction to finish.

[MUSIC PLAYING]

All right, that's it for me today. I'll see you next time.