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NPTEL
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On Industrial Automation and Control

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Topic Lecture – 16

Feedforward Control

Ratio Control (Contd.)

Now we look at another control which is like which has both a feedback and a and a feed-forward flavor, it is a very common control configuration which is used in especially in chemical processes.

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So it is a special feedback feed forward control loop configuration which is widely used for maintaining composition control, fuel air ratios in burners. For example, let us say if you have a any kind of burner let us say a boiler, so boiler the furnace. So you have to produce flame, for producing flame you need two things you need the fuel and you need the air, but they must be provided in such a ratio such that complete combustion takes place.

So if you do not have enough fuel then you are going to, you will probably not generate enough heat, on the other hand if you do not have enough air then the fuel will not be completely burnt and you will produce pollutant like carbon monoxide into the atmosphere. So for complete combustion it is very important to maintain fuel air ratios right.

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Similarly in distillation columns reflux ratio is a very important thing which decides product quality. So there are various situations where two materials must be must be brought together in some reactor or some chamber in precise volumetric flow ratios right. It is in this situation that you apply ratio control, there are two typical configurations in which ratio control is used.

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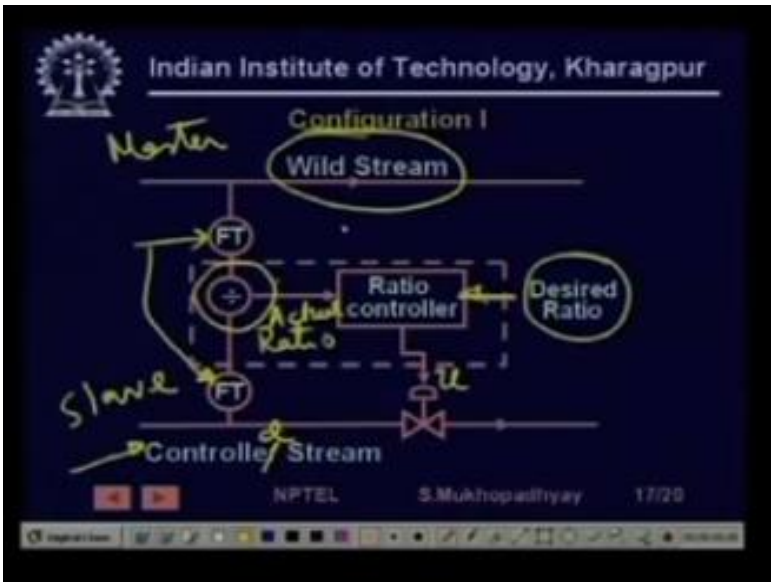

So the first one is configuration one let us see that, so you see in ratio control we have two streams, the first one we can recall the wild stream. So we do not directly control that stream, that stream is controlled by other considerations may be from production volume words. but so it is like a master stream which changes independently because of some operator change etc. And this is the slave stream or the controlled, this is not controller, this is controlled stream.

So basically I will tell you our idea is that if the wild stream changes we must change this stream in such a manner that the ratio of the volumetric flow rate in the wild stream and the volumetric flow rate in the controlled stream are maintained as constant right. this is our objective. So obviously to be able to reach that we have to measure these streams, so we are putting two flow transmitters, so they actually measure the volumetric flow rates.

So here we are dividing them to get the ratio, so this is the actual ratio, and this is the desired ratio. So and this is the ratio controller so this is another input, this is another input and this ratio controller gives this input on the valve, so that the control stream is change, increased or decreased such that this ratio will keep changing. So you see that in this way you can maintain the ratio. there is there is another way by which you can do, you could do it.

For example, in this configuration what you are doing is see you are this time you are actually providing the set point from the wild stream.

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So you are saying that you measure the flow rate in the wild stream, if you multiply by the derived ratio what we will get, you will get that at this flow rate of the wild stream how much of the control stream material should come. So in that sense it is a set point for controls for the flow rate of the control stream.

So using this you are providing a set point and then it is an usual feedback control. So this is, so you could do it in actually in either manner and get the ratio. So this brings us to the end of this lecture.

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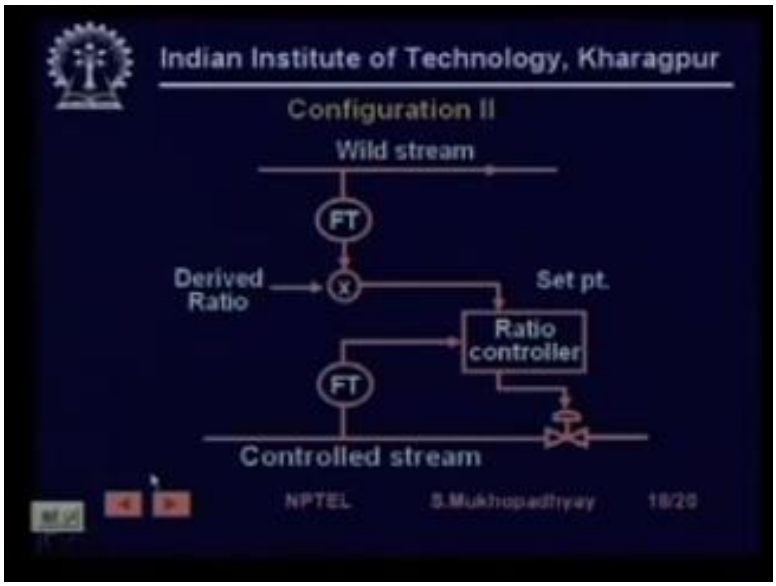

And we have to.

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Let us review this lesson so first of all look at a fundamental disadvantage of feedback control in the sense that it cannot respond immediately to changes in disturbance and is slow to that. So that happens because sometimes the disturbance takes long time to affect the output and a feedback controller by its essential control configuration can respond only to changes in output and has no way of knowing what disturbances are occurring, that causes errors to be, that is errors must be formed to be corrected.

In a feedback control errors must be formed to be corrected and if they form slowly then it takes then errors exist for long periods of time. So if we want to get good response our one way of doing that is to, there are many situations where we can measure the disturbances. So if we can measure the disturbances then, for example, we have seen that if the inlet temperature, if the temperature of the inlet flow rate is a disturbance, then it can be easily measured.

So in situations where we can measure the disturbance we should be able to change our control action immediately in response to disturbance changes, even before they have actually caused, so we should neutralize the disturbance before it can produce an effect at the output. So it is from

that desire that we have feedback feed forward control and this is the basic advantage of feed forward control.

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And but we have also seen that this, it has a big disadvantage that we need to have the models accurately and therefore, feed forward control cannot be used in isolation, it must be used along with a feedback trim. Then we have seen the design of feed-forward controllers both based on a steady state model as well as a dynamic model I mean a very simple dynamic model and we have seen that if we want to make design a feed forward controller based on dynamic models and we expect that it will match the, that is the process output will from point to point will match the set point.

Then so for certain kinds of set point changes we may get, I mean unreasonable output in inputs to the plant may be demanded which is not possible to be given. So therefore, from that point of view in such cases we have to apply what is known as a command pre-filter to the feed-forward before the set point can be applied to the feed forward controller.

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Then we have seen that basically for that reason that models in practice especially dynamic models cannot be obtained very accurately it is nearly always very difficult to get dynamic models accurately. Therefore, we must combine a feedback controller along with the feed forward controller, so that the control error due to the modeling inaccuracies will be connected, corrected in the feedback loop slowly but eventually they will be corrected.

So you will get lot of disturbance correcting action very fast and whatever errors will remain they will eventually will also be corrected. So this is what we saw.

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And then we saw a ratio control configuration which is a mixed feed forward feedback configuration, in the sense that the disturbance to the plant you can say that the wild stream we are sensing and at the same time we are creating a feedback. So that we can control the, so the control stream is being controlled in a feedback configuration whose set point is coming from the wild stream which can be, which may or may not be in our hand. So if it is not in our hand then it is like a disturbance.

So that is why it is a mixed feedback feed-forward structure. Finally we come to some points to ponder.

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That is which are the cases where feed forward control is desirable, so cases where the disturbance will take lot of time to affect the output disturbance can be measured those are the cases. And why feedback feed forward control is generally applied with feedback this also you will find an answer in this text, we have said it may in this lesson we have talked about it many times. And give a practical example of feed forward control, feed forward control is applied in again in many situations in motion control, in let us say in rolling mills in, obviously in temperature control problems as we have already seen.

So try to find out some example, some one example of your own and see how the feed forward control is applied there, and finally is ratio control a form of feed forward control or is it a form of feedback control or is it a mixture. So ponder over it could be called a feed forward control because it is sensing the disturbance, but at the same time there is also a feedback loop. So justify whether it is a pure feed-forward or for feedback or what sort of a structure it is. So that is all for today, thank you very much we will meet in the next lesson again.