instrumentationtools.com

What is Ratio Control ? - Example of Ratio Control System

Editorial Staff

5–7분

Most people reading this article have likely had the experience of adjusting water temperature using two hand valves as they took a shower: one valve controlling the flow of hot water and the other valve controlling the flow of cold water.

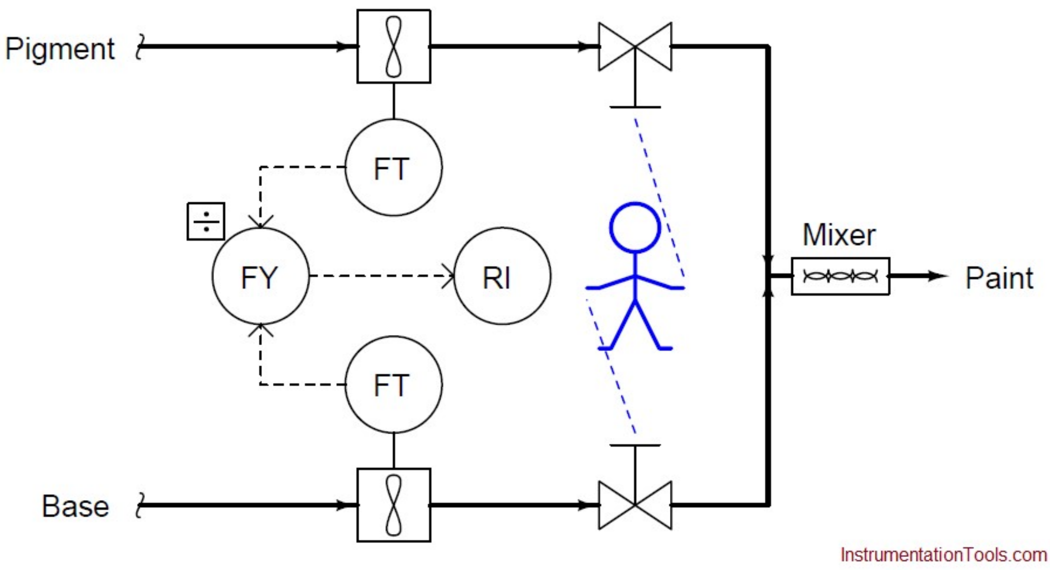
In order to adjust water temperature, the proportion of one valve opening to the other must be changed. Increasing or decreasing total water flow rate without upsetting the outlet temperature is a matter of adjusting both valves in the same direction, maintaining that same proportion of hot to cold water flow.

Although you may not have given it much thought while taking your shower, you were engaged in a control strategy known as ratio control, where the ratio of one flow rate to another is controlled for some desired outcome.

Many industrial processes also require the precise mixing of two or more ingredients to produce a desired product. Not only do these ingredients need to be mixed in proper proportion, but it is usually desirable to have precise control over the total flow rate as well.

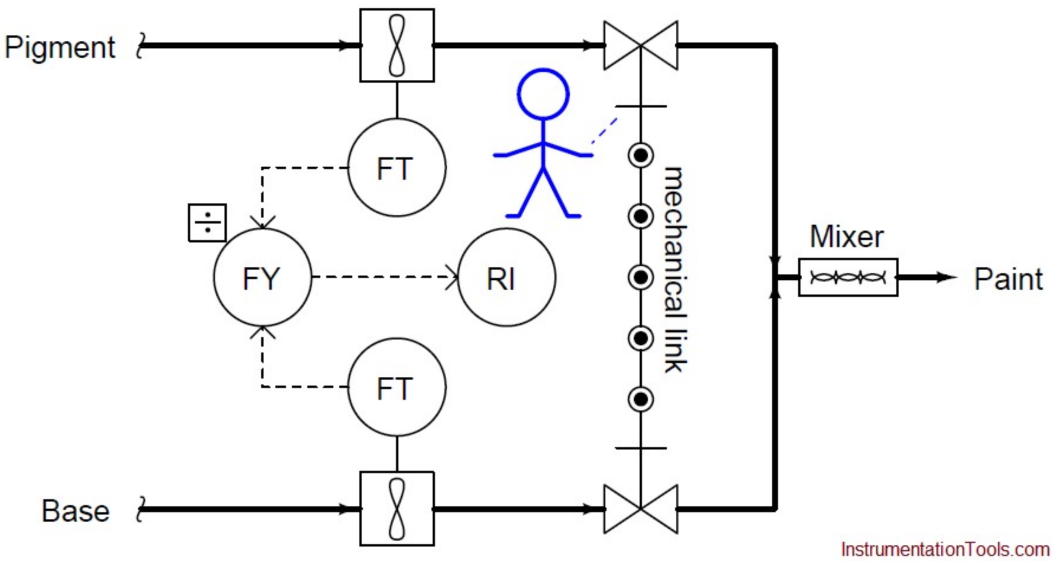
A simple **example of ratio control** is in the production of paint, where a base liquid must be mixed with one or more pigments to achieve a desired consistency and color.

A manually controlled paint mixing process, similar to the hot and cold water valve “process” in some home showers, is shown here. Two flow meters, a ratio calculating relay, and a display provide the human operator with a live measurement of pigment-to-base ratio:



One alteration we could make to this mixing system is to link the two manual control valve handles together in such a way that the ratio of base to pigment was mechanically established.

All the human operator needs to do now is move the one link to increase or decrease mixed paint production:

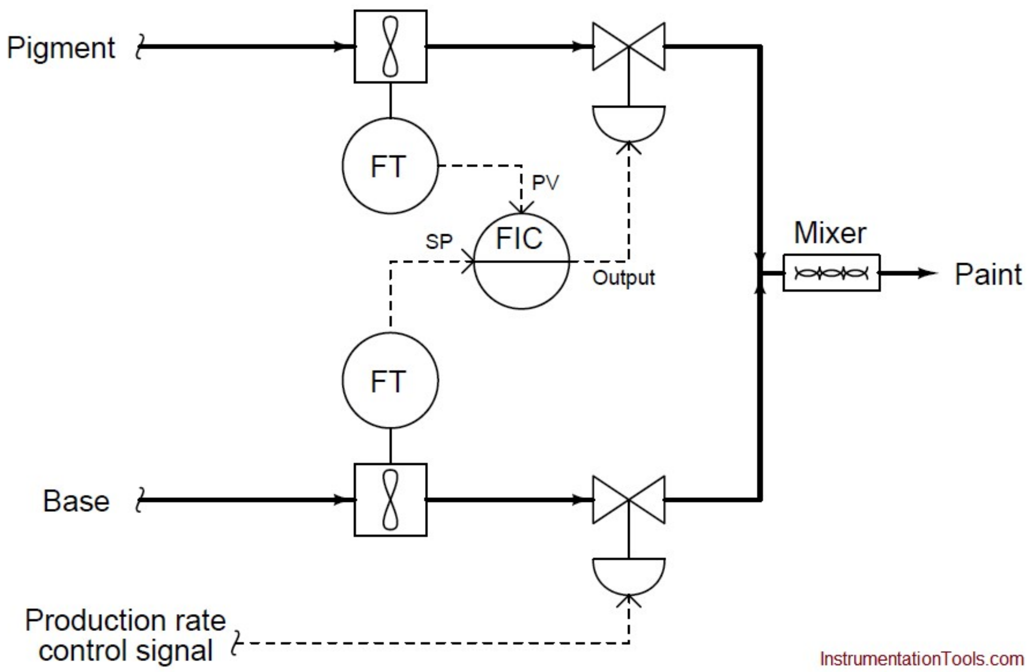


Adjusting the pigment-to-base ratio is now a matter of adjusting the linkage ratio, a task most likely performed by a mechanic or someone else skilled in the alignment of mechanical linkages. The convenience of total flow adjustment gained by the link comes at the price of inconvenient ratio adjustment.

Mechanical link ratio-control systems are commonly used to manage simple burners, proportioning the flow rates of fuel and air for clean, efficient combustion. A photograph of such a system appears here, showing how the fuel gas valve and air damper motions are coordinated by a single rotary actuator:

As you can see in this photo, the fuel gas valve is actuated by means of a cam, allowing precise “tuning” of the valve characteristics for consistent fuel/air ratio across a wide range of firing rates. Making ratio adjustments in such a linkage system is obviously a task for a skilled mechanic or technician.

A more automated approach to the general problem of ratio control involves the installation of a flow control loop on one of the lines and a flow-sensing transmitter on the other line. The signal coming from the uncontrolled flow transmitter becomes the setpoint for the flow control loop:



Here, the flow transmitter on the uncontrolled line measures the flow rate of base, sending a flow rate signal to the pigment flow controller which acts to match flow rates. If the calibrations of each flow transmitter are precisely equal to one another, the ratio of pigment to base will be 1:1 (equal).

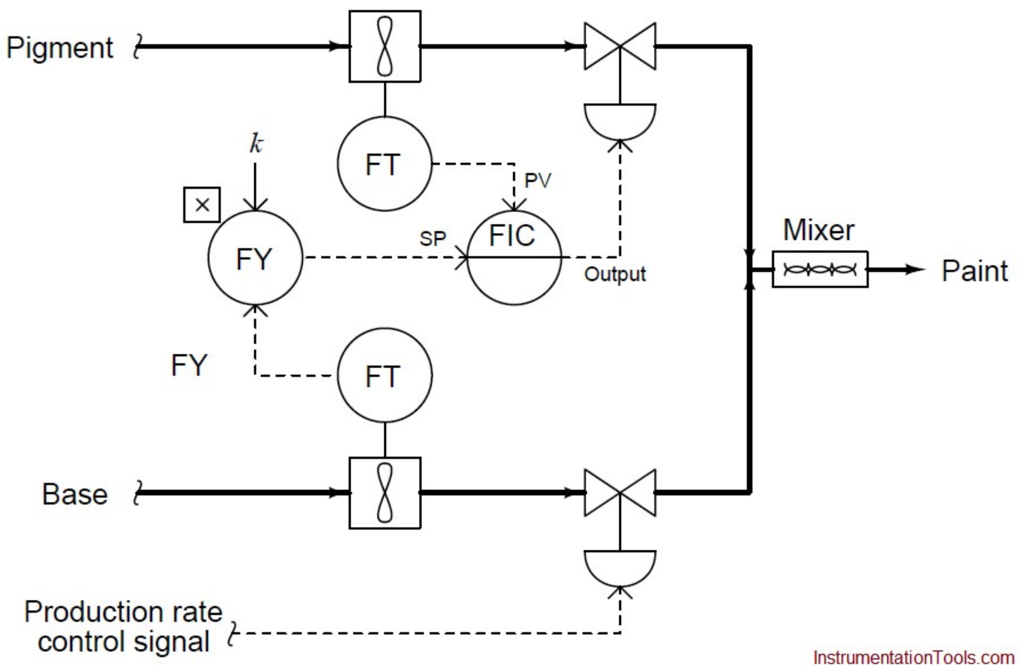
The flow of base liquid into the mixing system is called a wild flow or wild variable, since this flow rate is not controlled by the ratio control system. The only purpose served by the ratio control system is to match the pigment flow rate to the wild (base) flow rate, so the same ratio of pigment to base will always be maintained regardless of total flow rate.

Thus, the flow rate of pigment will be held captive to match the “wild” base flow rate, which is why the controlled variable in a ratio system is sometimes called the captive variable (in this case, a captive flow).

As with the mechanically-linked manual ratio mixing system, this ratio control system provides convenient total flow control at the expense of convenient ratio adjustment. In order to alter the ratio of pigment to base, someone must re-range one or more flow transmitters.

To achieve a 2:1 ratio of base to pigment, for example, the base flow transmitter's range would have to be double that of the pigment flow transmitter. This way, an equal percentage of flow registered by both flow transmitters (as the ratio controller strives to maintain equal percentage values of flow between pigment and base) would actually result in twice the amount of base flow than pigment flow.

We may incorporate convenient ratio adjustment into this system by adding another component (or function block) to the control scheme: a device called a signal multiplying relay (or alternatively, a ratio station). This device (or computer function) takes the flow signal from the base (wild) flow transmitter and multiplies it by some constant value (k) before sending the signal to the pigment (captive) flow controller as a setpoint:



With identical flow range calibrations in both flow transmitters, this multiplying constant k directly determines the pigment-to-base ratio (i.e. the ratio will be 1:1 when k = 1; the ratio will be 2:1 when k = 2, etc.).

If the k value is easily adjusted by a human operator, mixing ratio becomes a very simple parameter to change at will, just as the total production rate is easy to adjust by moving the base flow control valve.

Articles You May Like :

What is Cascade Control ?

PID Tuning Methods

What is PV Tracking ?

Temperature Control Loop

Feedback Control System