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AUTOMATIC CONTROLS IN THE SULPHURIC ACID INDUSTRY.

by

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The search for plant operating conditions which will remain correct in any circumstances, in spite of variations, voluntary or otherwise, in the quality and quantity of production has led us to undertake the mechanization of the main regulating acid circuits. This mechanization becomes more necessary as the number of control points increases and the volume of working-stock of acid is larger. Thus we thought that automatic control of the operation of a battery of lead chambers ought to prove advantageous both from the point of view of a reduction in manpower and of an improvement in the regularity of the flow. In the same way, automatic control of the various discharge points and acids for regulating the strength in a contact installation allows us to maintain the strength of the acids at a constant level, whatever the production coefficient of the plant and the various qualities of acid extracted.

A. CHAMBER ACID PROCESS

The vital point in regulating the rate of oxidation in the lead chambers is the flow of nitrous acid into the Glover tower. This flow needs to be continually adjusted to suit the variations of the outside temperature or of furnace combustion in order to maintain in the gases a ratio of NO : NO_2 which will ensure that we obtain good recovery in the Gay Lussac tower.

Automatic control has been made possible by a device which will show the degree of oxidation of the gases at a given point in the chamber. This has been in use for five years. By simply reading a dial situated at a central point, this device can be used to indicate conditions in the chamber at all times. Thus, warning that all is not well is given even before it would be possible to detect this by an analysis of the SO_2 as it leaves the chamber, because the device is placed at a point in the body of the chamber near the point of entry.

The principle is this: the measurement of the difference of potential existing between a platinum electrode which is simultaneously in contact with the ordinary water in the circuit and with the gases to be checked, and a standard calomel electrode dipped in to the same water. The potential increases the more

[illegible] oxidized. The [illegible]
chamber.

This device is used to give automatic control by means of a timer. A certain range of potentials is fixed and the needle of the indicator should remain within this range to ensure correct operation. If the potential leaves this range in one or the other direction the timer is set in motion, but it does not begin to act until the end of a period (which can be regulated at will - say, five minutes) and only if the needle is still outside the correct range at the end of this time. (There may in fact be very brief disturbances of no importance, due to the admission of air to a furnace or to a temporary lack of pyrites, mere incidentals which last only a few minutes, and for which there is no need to modify the controls). When the timer begins to operate at the end of this time its effect is to increase or decrease by a certain amount the flow of nitrous acid into the Glover tower.

At the same time it stops all other controls from operating for a certain time (say a quarter of an hour) in order to give the adjustment time to take effect. At the end of this period of adjustment, the needle of the potentiometer may have returned to its normal position, or it may still be outside its correct range.

If it has returned to its normal position, the control ceases to function and the timer returns to its starting point as before, so as to be ready to be set off by the next irregularity.

If, on the contrary, the needle is still outside the correct range, the control again operates an increased or decreased flow of nitrous acid into the Glover and again stops all the other controls for the same length of time (say a quarter of an hour).

And so on, until the correct potential is obtained.

Experience has shown that it is possible to run a chamber on an entirely automatic basis by this method, and supervision is thus reduced to a minimum.

B. CONTACT PROCESS

The automatic control is introduced at two points:

1. maintenance of a constant level in the tanks
2. maintenance of a constant strength of acid at a selected point.

1) Constant levels

This is all the more necessary when the volume of the tanks or reservoirs is small in proportion to the current output. Thus a tank with a volume of 15 cubic metres may be used for a circuit producing 100 cubic metres per hour, or even more, which amounts to saying that the tank would be emptied in 10 minutes if it were not filled again. In fact, the recirculation is usually very much superior to the flow of acid entering or leaving the tank, so that the duration on one cycle is actually much more extended; but we must bear in mind that (a) the total volume of the tank is not normally used, and (b) a certain minimum quantity of acid should in any case remain in the tank, equal to about half the total volume of the tank.

Therefore, the acid level in each tank must be controlled in such a way that it always contains a free volume which is more than adequate to receive the drainage from the apparatus which

feeds it. Below this upper level limit, a lower level limit is also fixed, corresponding to the required minimum volume, and the job of the automatic control is to maintain the actual level somewhere between these two level limits by increasing inflow or outflow of acid as required.

2) Regulation of the strength of the acid

When the concentration of the acid in the circuit shows a tendency to rise or fall, the desired quantity of weak acid (or water) or strong acid is introduced.

In all cases the flow of acid to correct the strength which needs to be admitted depends on (1) - the differential between the actual and required strength and (2) - the discharge of the acid being manufactured.

Thus it can be seen that the introduction of the fluid which corrects the strength does not depend entirely on the concentration of the acid which is being controlled, but also on the amount produced, so that the connection between the control device which dips into the acid and the control for regulating the inflow of the fluid which corrects the strength cannot be a fixed one, but must be flexible, consisting of a sliding scale which produces a continual variation in the desired direction in the inflow of the fluid which corrects the strength, until the correct strength is obtained. The inflow is then fixed in the final position until a fresh irregularity occurs to start the control system working again.

3) Instrumentation

There are three distinct phases: a. impulse
b. connection
c. operation

a. Impulse

For the control of the levels, we chose the bubble system: the dipper tube is fixed with its end level with the lower level limit. A drop in the acid level thus creates a fall in the pressure, which becomes nil when the lower level limit is reached.

For the control of the strength, there are two possible methods:

1) measurement of the strength may be linked with the density

In this case a special hydrometer is used, with automatic temperature correction, having at the top a reservoir containing a non-volatile material (such as oil) into which dips a tube containing air which escapes a bubble at a time. Thus, according to the depth at which the hydrometer floats, the pressure in the tube varies and the calibration of the instrument records the degree of concentration in terms of air pressure.

2) measurement of the strength may be linked with the resistivity of the acid

The instrument which provides the impulse in this case consists of an electrode dipping into the acid and comprising two platinum cylinders; another similar electrode, known as the standard electrode, is permanently in contact with an acid of known strength, maintained at the same temperature as the acid which is being controlled.

b. Connection

Since the maintenance of the levels does not require to be very exact, it is the actual air pressure between one bubble and another which acts on the control instrument. This is therefore a direct connection. On the other hand, control of the concentration must be very exact, and the admissible range of concentration, up or down, is very narrow, so that a flexible connection or sliding scale is used.

1) If the strength is measured by means of a hydrometer, the recorded pressure is made to operate on one chamber of a ring balance. A fixed pressure is maintained on the other chamber, set at the calue which corresponds to the desired concentration. As soon as the concentration moves away from the set value, the pressure impulse varies and the ring balance is set in motion, causing the vessel containing the fluid which corrects the strength to open (or close), which continues until the correct concentration is re-established. When this occurs, the ring balance ceases to move. The ring balance is connected to a system which makes it possible to vary the air pressure in a secondary circuit which acts directly on the control device.

2) If the strength is measured electrically, the indicator when it leaves the set range sends an impulse in one direction or the other to a sliding scale which is in phase and acts in the same way as the ring balance in the previous method.

c. Operation

The control of a flow of liquid may be effected in a number of ways, but usually by means of valves. These can be set in motion either electrically or by compressed air. We selected the least cumbersome appliances that are easy to handle and require, at any rate for controlling levels and concentrations by means of hydrometers, a negligible discharge of air under a pressure not exceeding 100 g. per ccm. These appliances consist in their essentials of a vertical glass tube equipped with slots, which are partially or totally masked by a similarly slotted glass sleeve around the tube.

Thus, the inflow of the acid depends on the raising of the sleeve, which is fixed to a bell cap with a mercury seal, which receives the air pressure which moves it from the top or the bottom, according to the direction in which the control is moving.

The same system is used for controlling the concentration by conductivity. For this, the sleeve is fixed to a cable which is rolled round a drum activated by the rheostat.

EFFICIENCY OF CONTROLS

We have been using this type of system for several years in a plant which produces 125 tons per day of H_2SO_4, and we have had no incidents of acids overflowing from the storage tanks, and the concentrations have been maintained at a very nearly exactly constant level, in spite of the varying working conditions in a plant whose output includes: 20% oleum, 98.5% acid, 92% acid and 60 AB (Bé?) acid.