Gas Sulfonation Dechlorination Systems

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Introduction

The dechlorination process removes all or part of the total available chlorine residual remaining after chlorination. Of the common sulfur-bearing chemicals used in dechlorination processes, this bulletin will explain dechlorination using sulfur dioxide in the gaseous state in conjunction with Capital Controls' gas sulfonators and controls.

Design Parameters

In order for any control system to operate efficiently, accurately, and reliably, the equipment must be carefully sized to satisfy the constraints of the control process. In this case, the dechlorination system must be sized for the actual water flow and demand of the water or wastewater being treated. The formula utilized to calculate the requirements for a sulfonation system is:

English Units:
PPD = gpm X 0.012 X ppm

Metric Units:
g/h = m^3/h X mg/l

The sulfur dioxide demand (dosage) depends upon the chlorine residual. The sulfur dioxide requirement is determined by the following equation:

$SO_2 + Cl_2 \rightarrow 2Cl^- + SO_4^=$

The stoichometry establishes 0.9 parts of sulfur dioxide for each part chlorine. In the majority of installations, the systems are designed to provide a sulfur dioxide to chlorine ratio of 1:1. If the chlorine residual is 1 ppm, then 1 ppm of sulfur dioxide is required. To calculate the gas feed rate at a flow rate of 50 gpm (11.4 m^3/h):

PPD = 0.012 X 50 gpm X 1 ppm
PPD = 0.6
or
g/h = 11.4 m^3/h X 1 mg/l
g/h = 11.4

Types of Systems

Both manual and automatic systems are available for dechlorination. Automatic control systems are the most common due to requirements for accurate and reliable control of the chlorine residual. Automatic control systems most frequently used are flow proportioning, residual, compound loop, and feed forward.

Regardless of the type of system used, basic components of the sulfonation system, excluding the controller, are identical to a chlorination system, and consist of the following items as shown in Figure 1:

1. Gas supply (directly from container, manifold, or vaporizer system)
2. Vacuum regulator
3. Gas flow control cabinet including gas flowmeter and automatic valve, controller
4. Ejector or chemical induction system

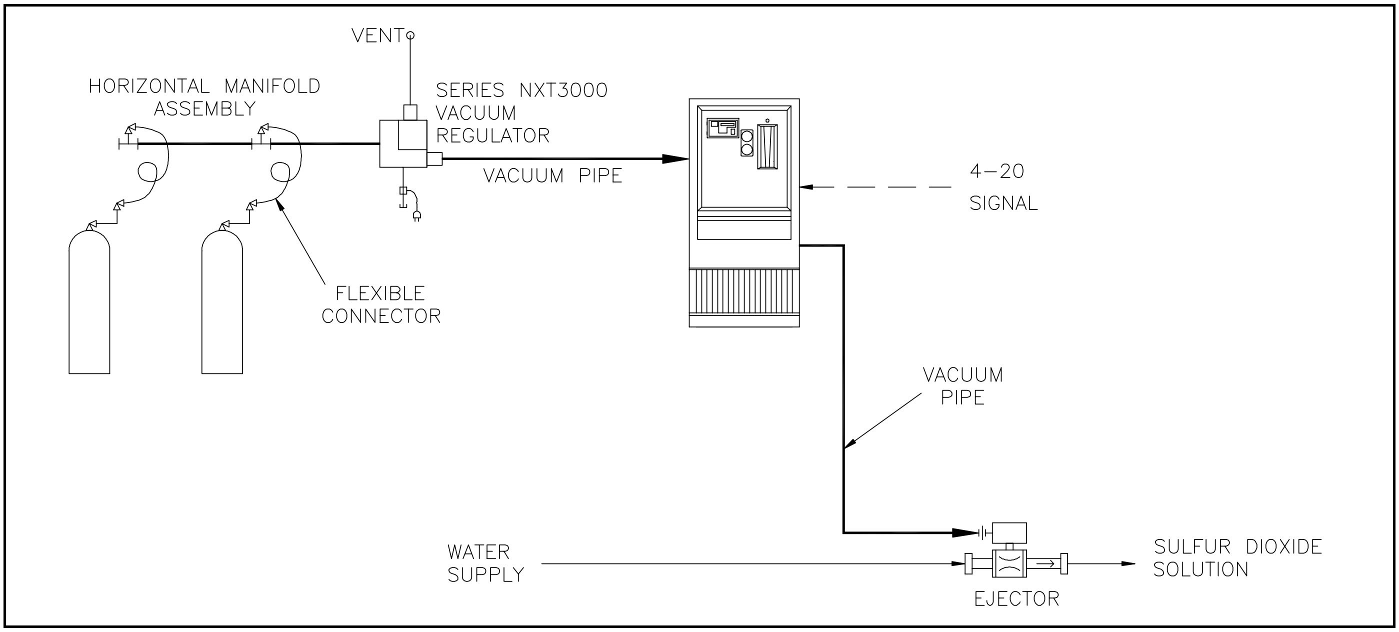

Figure 1 - Typical Dechlorination System

No matter what control system is used to dispense and control the flow of gas, good mixing of sulfur dioxide solution with the process water is essential for accurate control. This can be best accomplished through the use of a CHLOR-A-VAC chemical induction system (see bulletin 130.4005).

Automatic Control Design

Parameters

Flow Proportioning

Flow proportioning (open loop) is the simplest automatic system that can be used in water and wastewater dechlorination. This system should be used only when the demand of the process water (residual chlorine) is relatively constant with a variable flow. A typical flow proportioning control system is shown in Figure 2. Since the controller responds to a flow signal, the accuracy of this unit is dependent mainly upon the signal from the meter. Any flow proportioning flow meter must provide a signal that is representative of the actual flow conditions experienced at any time.

Residual Control

Direct residual control (closed loop) may also be applied to dechlorination systems. Its use should be limited to those systems which have a constant water flow rate but varying demand. A direct residual control system should not be used whenever a zero residual must be maintained. If the chlorine residual may be controlled to a level greater than or equal to 0.1 mg/l, a dechlorination residual control system will work effectively.

For treatment systems requiring chlorine residuals below 0.1 mg/l, use a sulfite analyzer in lieu of the chlorine residual analyzer to control to a positive sulfite level.

The major components of a residual control system are shown in Figure 3 and consist of an automatic valve, a residual controller, and a chlorine residual analyzer.

Not only will rapid flow changes affect residual control systems, but excessive lag times (loop time) also have a detrimental effect on the system response. The lag time for the system must be minimized. To avoid excessive lag time, the ejector and automatic valve should be located close to the point of application, the sample point should be strategically located close to the point of injection of sulfur dioxide provided adequate mixing is obtainable, and the analyzer should be located as close as possible to the point of sampling.

Compound Loop

The compound loop control system combines a flow proportioning and residual control so that sulfur dioxide is dispensed to the point of application in proportion to a flow signal and a residual signal.

The basic components of this system are shown in Figure 4. The controller responds mainly to the water flow signal to control the feed rate of sulfur dioxide gas while the residual portion of the controller automatically adjusts the dosage to maintain the desired residual in the effluent. Cycling caused by flow rate variations and chlorine levels are minimized. Since the residual control action trims the feed rate of gas, a larger lag time can be accommodated with the system (3 to 5 minutes). Finally, as in the residual system, the analyzer choice will depend upon the chlorine residual required.

Feed Forward

A feed forward control system uses a flow meter and a residual signal, measured upstream of the point of injection of sulfur dioxide, which is directed to a controller. The controller combines these two signals to proportion the feed rate of sulfur dioxide gas to the amount of residual chlorine in the water. This can be accomplished in two different ways.

The simplest method is to multiply the flow signal with the residual signal from the upstream analyzer to determine the pounds per day of chlorine in the water that must be treated with sulfur dioxide as shown in Figure 5. The sulfonator controller receives and processes the two signals directly.

The second method compensates for changes in the process by adjusting the dosage potentiometer in the flow proportioning unit. However, this system may be inefficient if the dosage adjustment is not correctly balanced for the flow conditions. That is, if the dosage adjustment is set too high, over-sulfonation can result which not only wastes gas, but also tends to drop the pH of the process water and adversely affect the dissolved oxygen content.

As in a compound loop system, a feed forward control system must rely upon an accurate flow and analyzer signal to control efficiently. However, in the case of a feed forward system, the analyzer samples effluent with a high chlorine residual which prevents fouling and other problems caused by sampling water after dechlorination.

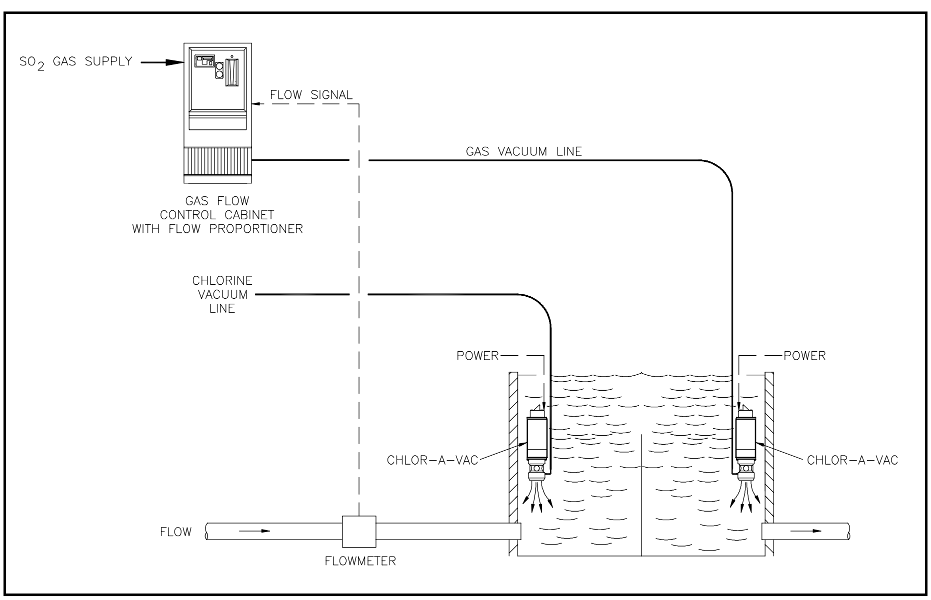

Figure 2 - Flow Proportioning System

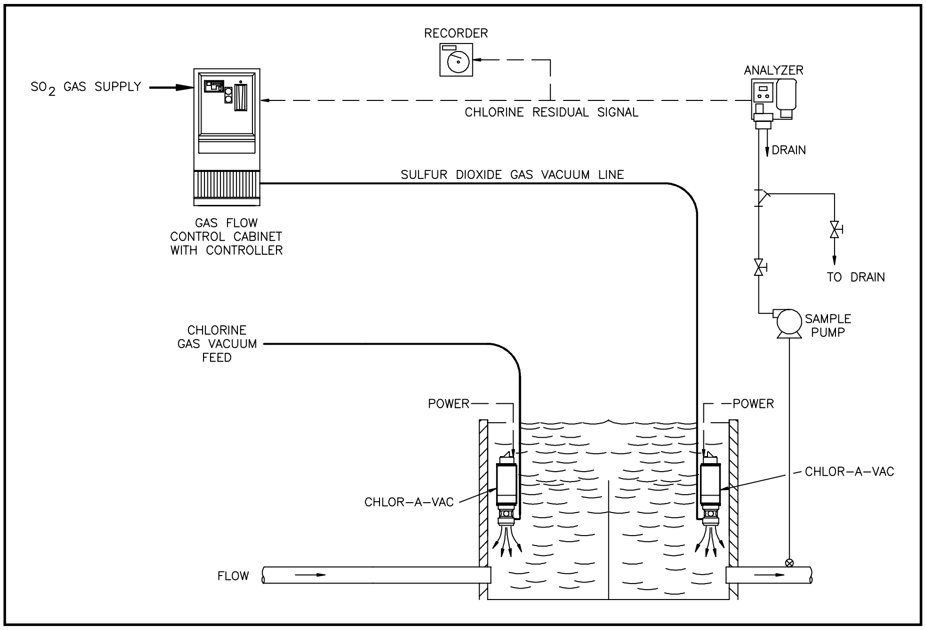

Figure 3 - Residual Control System

If it is required to demonstrate that the residual in the dechlorinated flow is at the desired set point, a second analyzer may be used.

Summary

Many control methods are available for dechlorination systems to provide an optimum system for each application, the following items should be carefully considered:

1. A feed back control system is the most efficient type of system for dechlorination of water that requires low chlorine residuals.
2. The characteristics of the receiving stream should be reviewed to determine how accurate a control system must be used.
3. The characteristics of the treat-ment plant system should be reviewed to determine what type and capacity of control system is appropriate.
4. Methods should be provided to ensure rapid and adequate mixing of the sulfur dioxide solution with the process water.

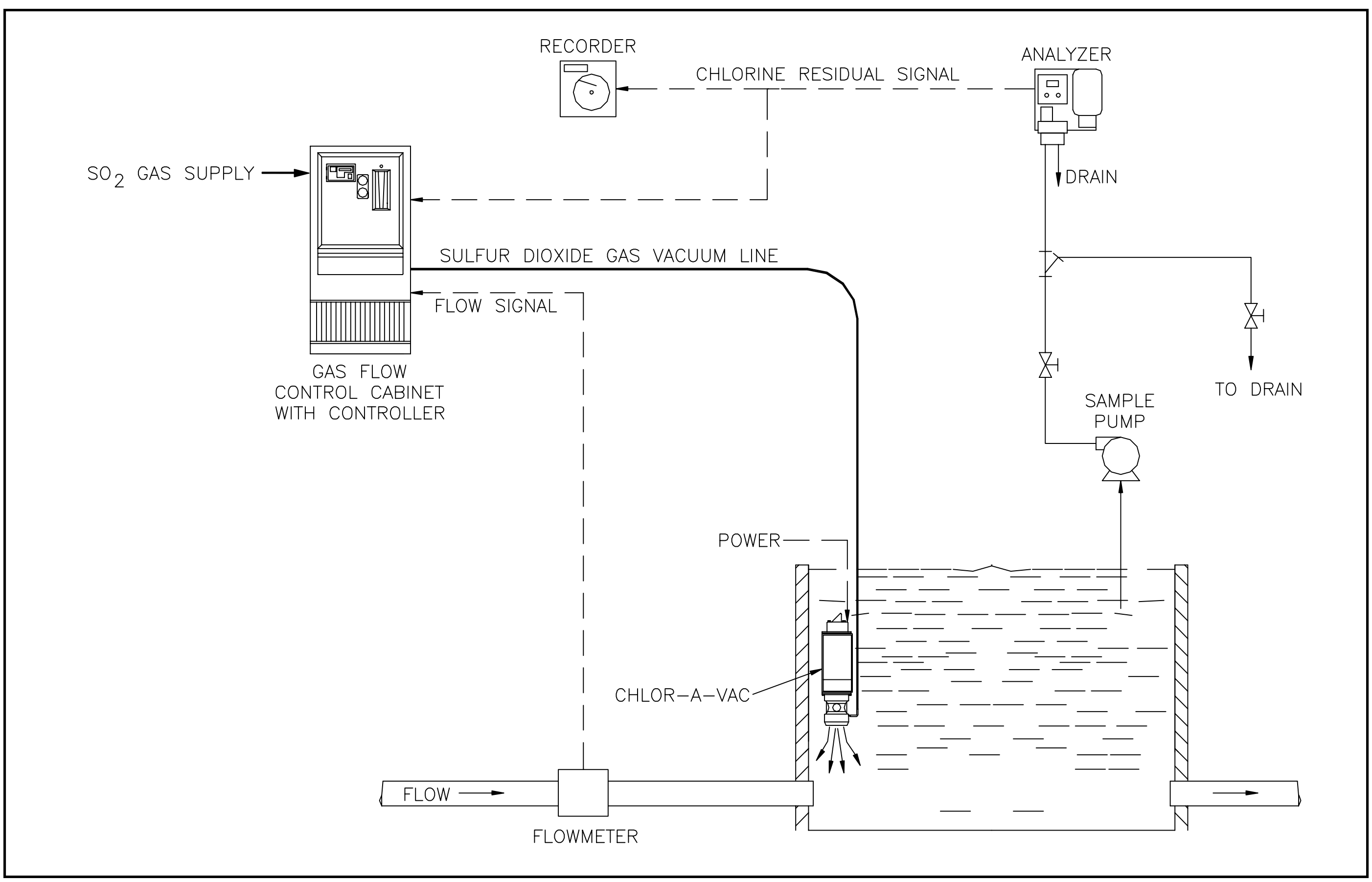

Figure 4 - Compound Loop System

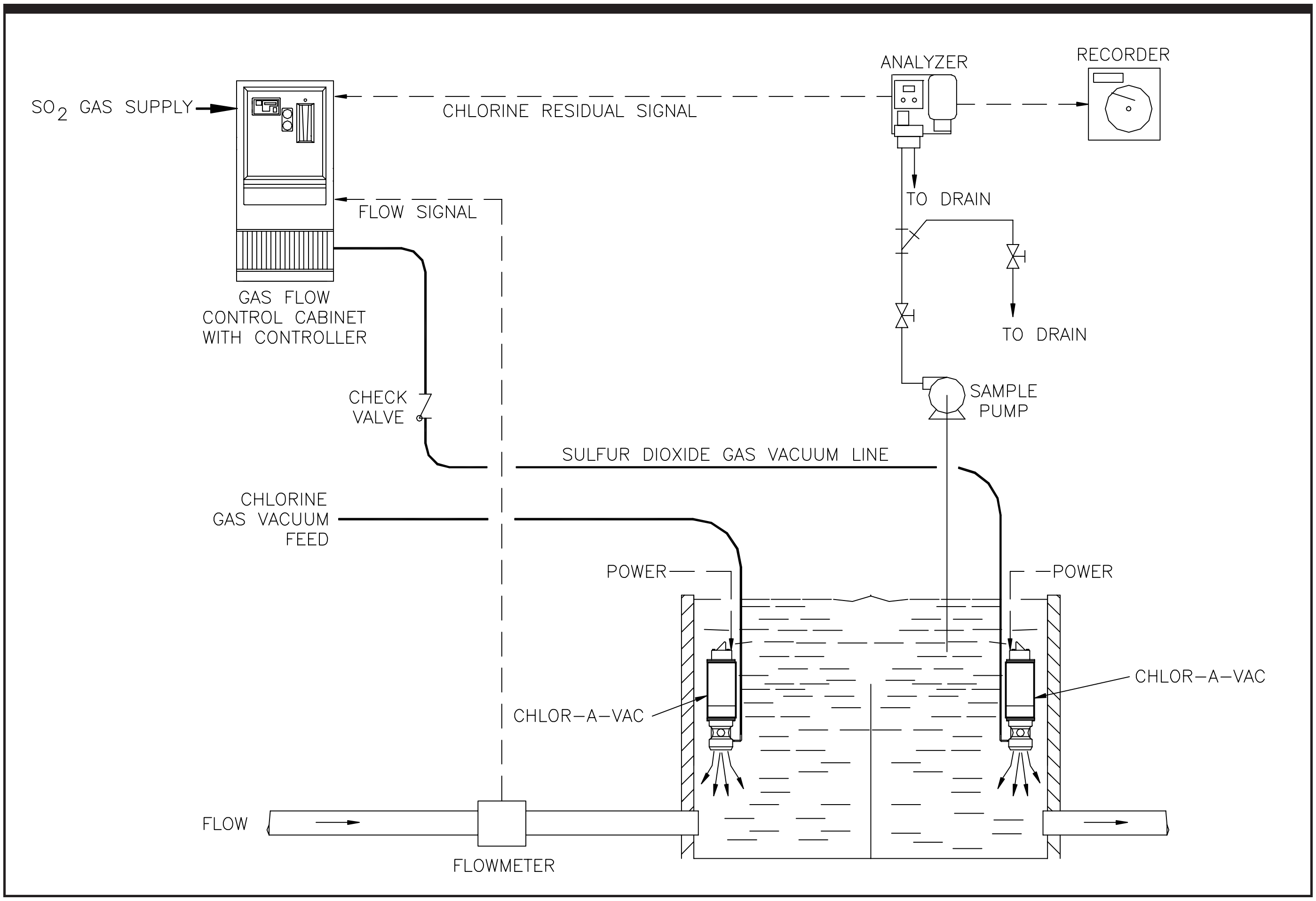

Figure 5 - Feed Forward System

Design improvements may be made without notice.

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