SENSAPHONE®

APPLICATION NOTE

Application:
Pump Station Volumetric Flow Calculation

Functions:
C Programming, Pump Control, Data Logging

Sensaphone Model:
SCADA 3000

Who needs to perform Volumetric Flow Calculations?

Anyone who needs to know how much liquid flows through a process, such as:

- Municipal Water and Sewer Departments
- Managers of Environmental Remediation sites
- Agriculture & Aquaculture facilities

Who specifies flow monitoring equipment?

Designers of municipal and industrial water pumping and collection systems, civil engineering firms, instrumentation designers, and control systems integrators.

Why is SCADA 3000 a good choice for performing flow calculations?

It provides a cost-effective alternative to using expensive flow measuring instruments. The SCADA 3000's ability to perform both mathematical and data storage functions allows it to calculate flow and log totals. In addition, the flow information can be accessed and retrieved remotely using SCADA 3000's optional internal modem.

It is essential for water and sewer system administrators to know how much volume is being pumped by each of their pump stations. One way to accomplish this is to install a flowmeter and controller combination that provides an output pulse when a programmed number of gallons have passed through the flowmeter. This is an expensive solution because totalizing flowmeters can cost thousands of dollars.

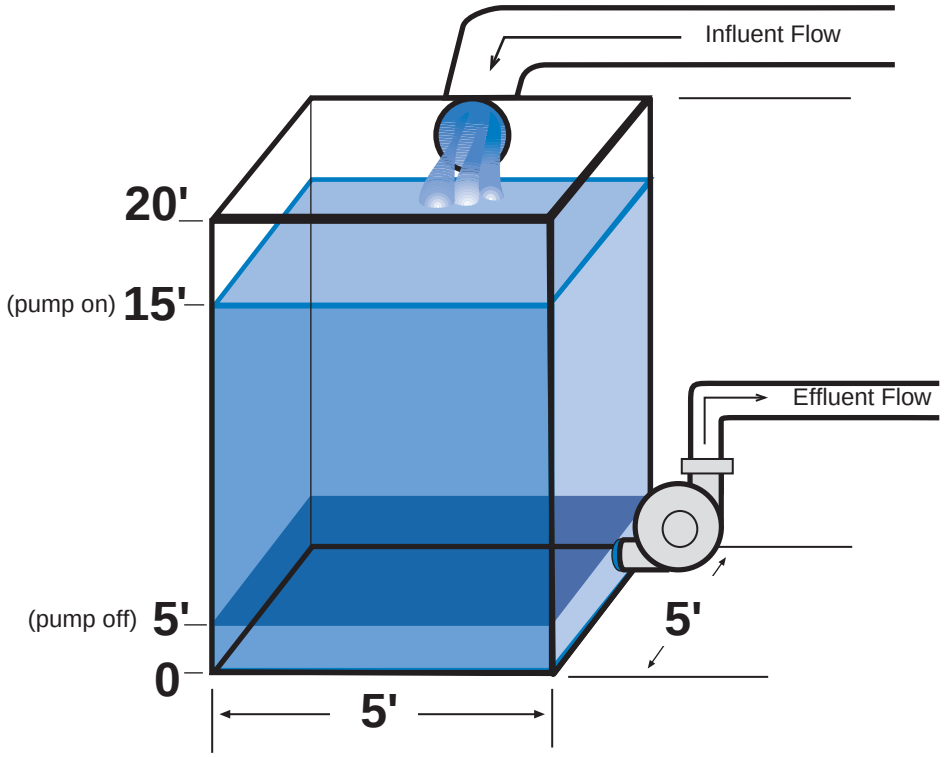
The Sensaphone SCADA 3000 can approximate volumetric flow without the need for an expensive flowmeter.

If the well level is monitored and controlled with float switches, the volume calculation is very simple. Volume = well area x (upper float level - lower float level)

Example 1:

Example 1 volume calculation:

20 foot deep well with 5 foot x 5 foot square cross section
Lower pump control float switch elevation = 5 feet
Upper pump control float switch elevation = 15 feet



Well volume = (5 x 5) x (15 - 5) = 250 cubic feet
1 cubic foot = 7.48052 gallons
Well volume = 250 cubic feet x 7.48052 gallons/cubic foot = 1870 gallons

Remember that while the well is being pumped out, the influent flow doesn't stop. The total gallons flowing into the well during the pumping-out process must be added to obtain the correct flow total.

Without a flowmeter on the influent line, the volume of influent flow must be approximated. The SCADA 3000 must first calculate the time required for the well to rise from 5 feet to 15 feet. The influent flow rate is the well volume divided by this time.

Example 1 Influent flow rate calculation:

Using the above example: Well volume = 1870 gallons

Time required for the well to rise from 5 feet to 15 feet = 30 minutes

Influent flow rate = 1870 gallons / 30 minutes = 62.33 gallons/minute

Now that we know the rate the well is filling up, we can calculate the gallons flowing into the well during the pump-out cycle. This is the number of minutes required to pump the well level from 15 feet down to 5 feet, multiplied by the influent flow rate.

Example 1 Influent volume calculation:

Using the above example: Well influent flow rate = 62.33 gallons/minute

Time required to pump the well down from 15 feet to 5 feet = 6 minutes

Influent volume during pump-out time = 6 minutes x 62.33 gallons/minute = 374 gallons

The total volume pumped out of the well during the pump-out cycle can now be calculated.

Total volume pumped = Well volume + Influent volume during pump-out time

Total volume pumped = 1870 gallons + 374 gallons = 2244 gallons

This method of calculating flow totals assumes several things:

1. The well's cross-section area is constant.
2. The influent flow rate remains constant during the duration of the current pump-out cycle.

If the well level is measured with an analog level sensing device, the flow totals can be calculated more accurately.

The analog level sensing device can be used to obtain a better approximation of the influent flow rate. Using analog level measurement, track the time required to fill only the last small volume of the well before the lead pump starts. The influent flow rate would then be equal to the small known volume divided by the time elapsed to fill that volume. Since it uses the most up-to-date influent flow rate, this method provides a better approximation of the influent flow total.

Example 2:

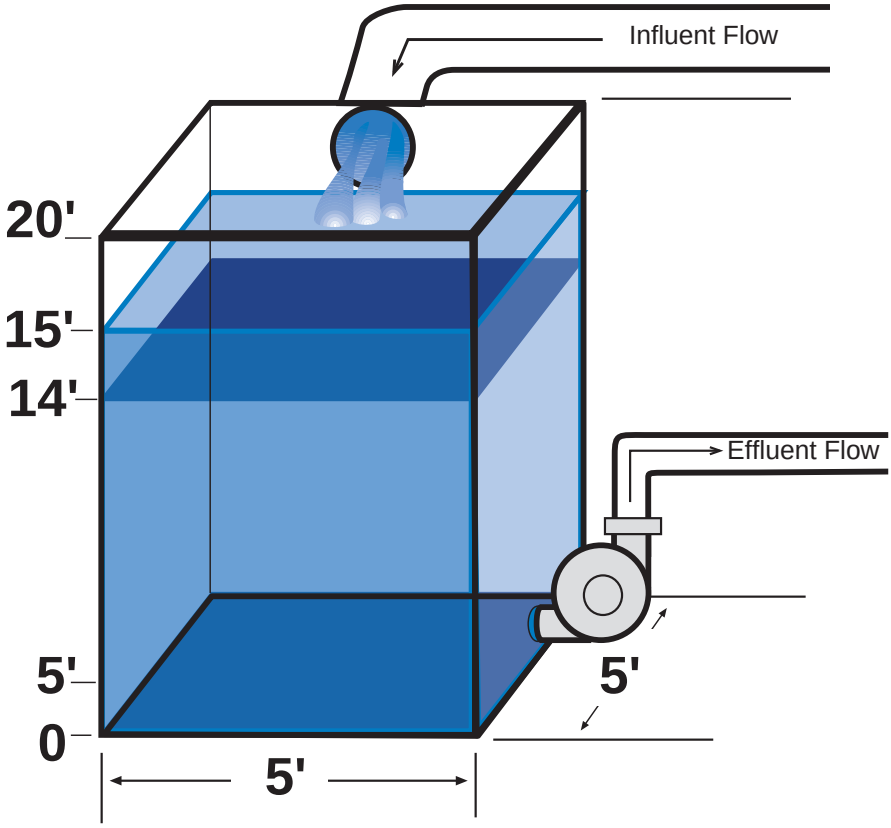
Assume same well dimensions as the 1st example:

20 foot deep well with 5 foot x 5 foot square cross section

Pump OFF well depth = 5 feet

Pump ON well depth = 15 feet

Well volume = (5 x 5) x (15 - 5) = 250 cubic feet or 1870 gallons



Example 2 Influent flow rate calculation:

Calculate the volume of the top 1 foot of well before pump ON point:

Volume of top 1 foot of well = (5 x 5) x (1) = 25 cubic feet

1 cubic foot = 7.48052 gallons

Volume of top 1 foot of well = 25 cubic feet x 7.48052 gallons/cubic foot = 187 gallons

Time required for the well level to rise from 14 feet to 15 feet = 2.5 minutes

Influent flow rate = 187 gallons / 2.5 minutes = 74.8 gallons/minute

Now that we know the rate the well is filling up, we can calculate the gallons flowing into the well during the pump-out cycle. This is the number of minutes required to pump the well level from 15 feet down to 5 feet, multiplied by the influent flow rate.

Example 2 Influent volume calculation:

Example 2 influent flow rate = 74.8 gallons/minute

Time required to pump the well down from 15 feet to 5 feet = 6 minutes

Influent volume during pump-out time = 6 minutes x 74.8 gallons/minute = 449 gallons

The total volume pumped out of the well during the pump-out cycle can now be calculated.

Total volume pumped = Well volume + Influent volume during pump-out time

Total volume pumped = 1870 gallons + 449 gallons = 2319 gallons

This method also assumes that both the well cross section and influent flow rate remain constant for the duration of the pump-out cycle.

The methods described in this application note allow the SCADA 3000 user to calculate and store total station flow without the use of an expensive flowmeter. The SCADA 3000 can perform the flow calculations easiest using a C program. Ladder logic can be used, but there are lots of math functions involved, so it would require a large number of program rungs and ladder instructions.

Once the station's flow total has been calculated, SCADA 3000 can store the value in its built-in datalogger, send the total as part of a daily faxed report, or use the flow total to trigger alarms for high and low station flow.

Sensaphone® SCADA 3000

HARDWARE CONFIGURATION

16 Universal Inputs:
- Contact closures
- Thermistors
- 4-20mA Analog
- 0-5 Volt Analog
- Run time accumulation

8 Outputs:
- Latching 2 amp relays
- LED status indication

2 RS232 ports:
- Local programming
- Data radio communications
- RJ11 Phone interface for optional voice and data communications

LCD:
- 4 by 20 character scrolling display
- User customized content for local viewing

FEATURES:

Data Logging:
Fully user programmable built-in data storage for logging I/O points or calculated variables

Event Logging:
Internal tracking of all significant alarms and events

Ladder Logic Programming:
Standard ladder programming included for true PLC-type control.
Visual ladder editor is part of free software package.

C-Programming:
Built-in C-compiler, allowing complex calculations.
C-program is capable of running on a schedule, independent of ladder program.

PID:
Eight PID loops are built-into internal programming
Any I/O points are selectable to function in PID calculations.

AGA Gas Flow Calculation

Options:

Input/Output Options (expandable to 144 points):
- •Universal inputs (same as 16 already built-in)
- •High Speed pulse count inputs, up to 10kHz
- •Thermocouple inputs: Types J,K,R,S,T and E
- •Relay Outputs
- •Analog Outputs (4-20mA)
- •Annunciator Panel

Communication Options:
- Phone modem – allows modem, fax, and pager communications
- Voice module – allows custom voice messages over standard phone lines

Power Supply Options:
- Hard-wired power supply for 110 or 220 VAC operation
- Plug-in power supply for 110 or 220 VAC operation
- Standard battery backup
- Extended battery backup

Software:

Included in the purchase price, it provides the capability to program units, develop ladder programs, develop C-programs, retrieve and analyze the data and event loggers plus print all necessary reports.
- • Automatically polls for data using phone lines or radio modems.
- • Performs all standard SCADA functions with customized on-screen graphics
- • True 32-bit code for Windows™ 95 or Windows™ NT