Simple TDS sensor system technical guide

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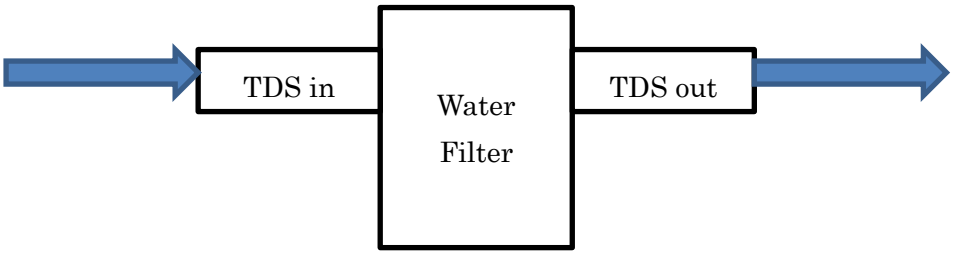
1, Abstract

This chapter describes overview of Aplix Simple TDS sensor system.

There are traditional TDS meters which enable users to measure TDS/Conductivity of water. However it's difficult for users to check TDS of the water coming into the filter since there's no access path to put TDS meter.

Traditional TDS meter

Aplix developed Simple TDS sensor system that enable users to see "exclusion rate" of the filter from TDS_in and TDS_out value on the Internet screen.
Customers can put 2 TDS sensor probes before and after Water Filter. The system will calculate Conductivity and TDS by measuring the electric resistance of water.
This system calculates "exclusion rate" of the filter from TDS value and upload the results into the cloud system for users to monitor.



Aplix Simple TDS sensor system diagram

As mentioned above, exclusion rate can be calculated with the formula.

$$Z = 1 - \frac{tds_{out}}{tds_{in}}$$

2, Exclusion rate calculation

Formula (1) shows exclusion rate calculation.

$$Z = 1 - \frac{tds_{out}}{tds_{in}} \quad (1)$$

TDS value is proportional to the conductivity of the water.

The conductivity is proportional to charging time when the capacitor is charged via water resistance. Therefore when charging time is T_{in} and T_{out}, TDS is calculated with formula (2) and (3). A is constant value.

$$tds_{in} = \frac{A}{T_{in}} \quad (2)$$

$$tds_{out} = \frac{A}{T_{out}} \quad (3)$$

Then Exclusion Rate, Z is described with formula (4) and (5)

$$Z = 1 - \frac{tds_{out}}{tds_{in}} = 1 - \frac{\left(\frac{A}{T_{out}}\right)}{\left(\frac{A}{T_{in}}\right)} \quad (4)$$

$$= 1 - \frac{T_{in}}{T_{out}} \quad (5)$$

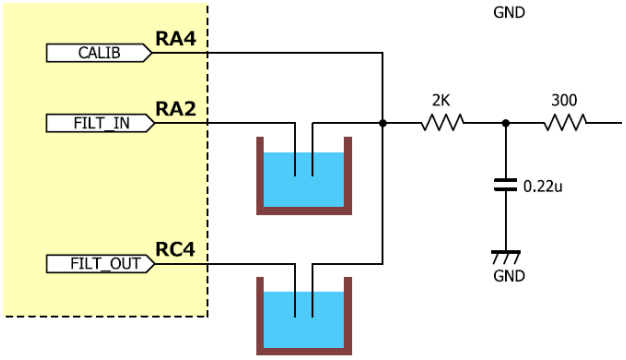
Exclusion Rate, Z is calculated from T_{in} and T_{out}.

3, TDS measurement electrical circuit

Water resistance can be measured using TDS probe which has 2 needles. User needs to put 2 needles in to the Water and add voltage on a needle.
When the water includes more impurities, electrical resistance becomes lower because water includes more ions to carry electric charge.

TDS probe with 2 needles

Electrical circuit is shown below.
Voltage will go from the left needle to the right needle with the water in between to charge capacitor. By measuring the time for capacitor voltage reaching the threshold level, water resistance can be calculated.



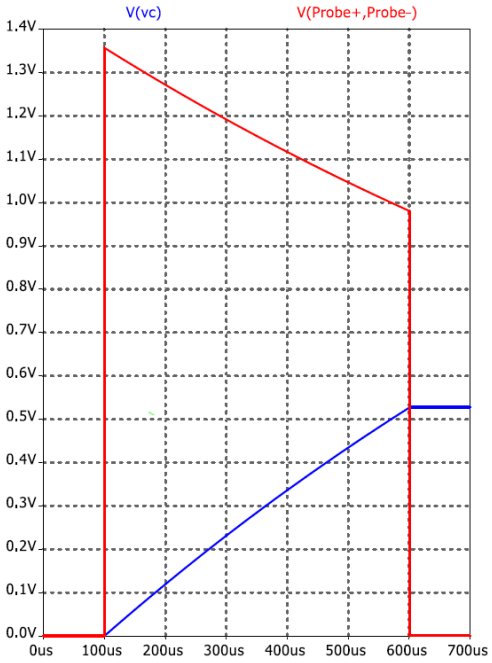
Measurement circuit

For example when charge 0.22uF capacitor via resistance R, voltage Vc is formula (7)

$$V_C = 1.9 \times \left(1 - e^{-\frac{t}{0.22 \times 10^{-6} \times R}} \right) \qquad (7)$$

Time t can be calculated with formula (8)

$$t = 7.15929 \times 10^{-8} \times R \qquad (8)$$



Conductivity is calculated from the time that capacitor charge to the threshold level.

4, Example: tap water and filtered water in Tokyo Shinjuku Building

Normal condition

TDSin 100ppm

TDSout 10ppm

Exclusion Rate＝1-10ppm/100ppm　＝0.9＝90%　->OK

Filter damaged

TDSin 100ppm

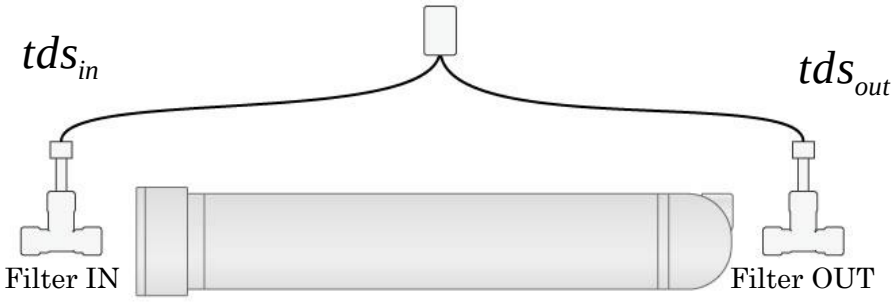
TDSout 30ppm

Exclusion rate＝1-30ppm/100ppm　＝0.7＝70%　->NG

To detect the damaged filter IoTIZR threshold should be set at 0.8=80%

About Simple TDS sensor calculation value

Aplix Simple TDS sensor calculates Exclusion Rate, Z which represents the ratio of TDSin and TDSout.



$$Z = 1 - \frac{tds_{out}}{tds_{in}}$$

In case of TDSin as 100ppm and TDSout as 10ppm, Exclusion Rate＝90%.
While Exclusion Rate is high enough, the filer is working well.