TELEDYNE
INSTRUMENTS
Advanced Pollution Instrumentation
A Teledyne Technologies Company

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Service Note

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CALIBRATION OF M201A ANALYZER

I. PURPOSE:

To help guide you through the calibration of the M201A ammonia analyzer.

II. TOOLS:

NO calibration gas
NH3 calibration gas
Calibrator to perform a GPT (Optional or when trouble shooting)

III. PARTS:

023260100 - SS tube for NH3 converter (potentially needed)
KIT000138 - Quartz tube for NH3 converter (potentially needed)
KIT000139 - Ceramic bushings for NH3 converter (potentially needed)

IV. PROCEDURE:

1. The calibration of the M201A ammonia analyzer is a two-part span procedure. Part one is the calibration of the instrument on NO gas, part two is the calibration on NH3.
2. The calculation of NH3 concentration relies on the calibration of the analyzer to both NO and NH3. If you don't calibrate the analyzer on both NO and NH3 the analyzer is not going to be able to measure sample gas accurately.
3. As a matter of course the very high temperature that the converter runs at will cause the SS tube to eventually become so fatigued that it will develop a hole in it & eventually break completely in half. This typically happens right at the input fitting, and you are going to find that the converter efficiency is going to drop down to almost nothing, probably over night. A quick inspection of the quartz tube will show that the SS tube is laying in the bottom of it. When this happens we would suggest that you replace both the SS tube and the quartz tube.
4. Even though the quartz tube is not broken it has been thermal cycled enough times that it will probably break when you remove the SS tube and it might break when you put the converter back together (even when new, so be careful).
5. If you have the analyzer down for maintenance you ought to leak check the analyzer. The tube in the NH3 converter is Quartz and can break. If the converter is leaking you can not get a good calibration nor are you going to collect accurate data from the analyzer.
6. Once you have the leak check done and the analyzer is not leaking then you will be able to perform the actual dynamic calibration on gas.
7. Input zero air into the instrument & allow it to run until it is stable, this might take 20 minutes or as long as 45 minutes.
8. Push “CAL-ZERO-ENTER” & the instrument is now calibrated at zero.
9. Push “CAL-CONC-CONV-SET” and set the converter efficiency value to 1.000 push “ENTER-EXIT” back to the sample menu.
10. Input your NO gas to the analyzer at say 400 PPB (the value of gas that you use is up to you. We are going to use the 400 PPB value for this example).

IMPORTANT NOTE:
Ammonia is a special gas and as such we offer a special option to the M201A instrument. This option is an M702SS precision calibrator. This calibrator is specially plumbed with Stainless Steel components. This ensures the accuracy of the calibration gas and allows the end user to use the NH3 in only their special NH3 calibrator. There are a number of reasons for this. One reason is that NH3 is a slow moving gas that is "sticky" this means that if you use Teflon tubing it tends to take some time for the gas to move from one place to another and to become stable. For calibrations this is especially important as you don't want to spend hours waiting for the gas to travel through the Teflon lines and the instrument to stabilize. Fortunately this is for the most part only a calibration issue. The ammonia values in the air that are being monitored are Not changing very rapidly so this slow moving gas is not an issue in the sample. Also, we use SS where we can in the instrument to alleviate any problems that this might create, within the instrument itself.

That being said, the references below are going to be specific to the M201A that has the M702SS connected to it. We suggest that the M702SS be located directly above the M201A so that a solid SS line can be plumbed from the output of the M702SS directly into the M201. this again makes the response times of the instrument better when trying to calibrate.

Another advantage to the M702SS is that you can plumb up two bottles to the back of the M701SS and do "one touch" calibrations. This means that if you are using 50 PPM bottles you can push the DILUENT button and get zero air. Push the DILUENT button and the CYL 1 button and get NO at some value, push the DILUENT button and the CYL 2 button and get NH3 at the same value as the NO gas. This simple calibrator uses the same flow controller for CYL 1 as CYL 2 so that you get the same dilution ratio and the same gas for both types of gas (this does assume that both the concentrations of gas in the bottle are the same value, but that is not typically an issue).

If you are taking your NO and NH3 from a calibrator that has Teflon tubing in it and has more than 1 foot of tubing connected between the calibrator and instrument expect the response time (to 100% not to 90%, to take much longer than a normal NOx analyzer that is being calibrated on NO).

11. Push the CAL button and enter the value of your NOx gas into the menu under the TN and TNx buttons.
12. When the analyzer becomes stabile and the stability number on the front panel of the analyzer is down to <1 PPB push the SPAN and ENTER button.
13. If you find that your slopes are close to each other (within 2% or so), but that they are either very high (>1.75) or very low (<.25), a more complete look at the instrument is necessary. This might involve leak checking the instrument. Doing converter efficiency testing on the Moly converter in the M201A,
14. Input 400 PPB of NH3 into the analyzer. You are likely to see something like this:
    TN = 40 PPB
    TNx = 380 PPB

    This is normal. You are seeing that the Moly converter is converting about 40 PPB of NH3 to NO and that the NH3 converter is only converting about 380 PPB of the 400 PPB of NH3 to NO.
15. Take the TNx channel output and subtract the TN channel output and divide by the concentration of gas that you are putting into the analyzer (400 PPB). You are going to now have the conversion efficiency of the NH3 "SYSTEM". This is the efficiency of the entire system which includes the Moly converter the NH3 converter and the losses and gains of the entire system.

    TNx – TN = NH3
    380 – 40 = 340

16. Devide the NH3 value that you are measuring by the value that you are putting into the analyzer.

    340 / 400 = 85% efficient system.

17. Push “CAL-CONC-CONV-SET” and enter in the efficiency of the NH3 system (0.85) and hit ENTER.
18. You are done with the calibration of the analyzer now. The analyzer should now read the proper concentration of NH3 when you input it into the analyzer.
19. If you find that when you are inputting the NH3 that the conversion efficiency is down to 50% or below you might take the converter apart and look at the quartz tube. You might find that the SS tube in the quartz tube has been heated to past its usefulness and that it has fallen into the quartz tube. If that is the case you are going to get terrible conversion efficiency but the analyzer and converter are going to pass the conventional leak check.
20. When you take the converter apart you might find that the SS tube in the converter looks oxidized or rusty. This is normal and the converter actually works better after it runs in for a while and gets some of this oxidation on this tube. If you have to change the tube we would recommend that you allow the converter run at temp for a minimum of 24 hours (48 hours will provide more consistent results) before you put it back on line and calibrate it.
21. We would suggest that you have a quartz tube and an SS tube in your spare parts so that if you have a problem with the converter that you can install these parts. These parts are considered consumable parts as filters and diaphragms are.
22. Another test that ought to be performed once a year or so is a GPT test. This test will tell you how efficient the Moly converter & the M501NH is @ converting NO2 to NO. it will also tell you if the converters are plumbed in properly. if this is the first calibration since the instrument has been taken down for service (either preventative or corrective), leak check the instrument first, flow check the instrument second, & then perform this GPT test. Once you have made sure that the converters are working properly & that they are plumbed up properly then goto step one of this procedure.
23. Generate 450 ppb of NO (with a calibrator that has the ability to do GPT’s) & input that into the instrument. Allow the instrument to stabilize for about 15 minutes & to write down the TN & TNx values. We are going to call this TN(NO) & TNx(NO).
24. Start your GPT with 450 ppb NO & 350 ppb O3, this will produce 100 ppb NO & 350 ppb NO2. allow the instrument to stabilize for about 15 minuets & write down the TN & TNx values. We are going to call this TN(GPT) & TNx(GPT).
25. What you should find is that you get rather good converter efficiency values for both the TN & TNx channels. Use the equation below to calculate the converter efficiency.

$$\frac{TN(NO) - TN(GPT)}{450 \text{ ppb NO}} \times 100\% = \text{Converter Efficiency}$$

26. Now do the use the same equation to calculate the TNx efficiency.

$$\frac{TNx(NO) - TNx(GPT)}{450 \text{ ppb NO}} \times 100\% = \text{Converter Efficiency}$$

27. You should find that your TN converter efficiency should be >96% & your TNx converter efficiency should be >94%.
28. If you find that your TN or TNx value is reading 100 ppb, then the instrument is plumbed up incorrectly. Use the service note “M201A SINGLE Moly CONFIGURAITON”, to check the plumbing on the instrument & configure it back to the proper configuration. Even if the NO & NH3 calibration appeared to calibrate correctly & that the instrument appears to work, if this step is not right & your converter efficiencies are not right, the instrument will NOT read NH3 properly. if you do not have this service note, please contact your API representative or distributor.

M201A ammonia analyzer calibration form:

Serial number:_____

STEP		TARGET	ACT
Input ZERO @ Zero			
	TN	0	_____
	TNx	0	_____
	NH3	0	_____
Input NO @ 400 ppb NO			
	TN	400 (+/- 10%)	_____
	TNx	400 (+/- 10%)	_____
	NH3	0	_____
Input NH3 @ 400 ppb NH3			
	TN	40 (+/- 10%)	_____
	TNx	400 (+/- 10%)	_____
	NH3	360	_____
Perform GPT @ 450 ppb NO, 350 ppb O3			
	TN	450 (+/- 4%)	_____
	TNx	450 (+/- 6%)	_____
	NH3	0	_____