Research of The Mobile Ultrasonic Gas Flowmeter as Work Standard

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Abstract:

Now, most gas flowmeters are taken to the special verification station to test (verify or calibrate) by manufacture in the world. It's obvious that shortcoming and wasting.The ChenDu Verification Branch(In brief CVB) imported a set of mobile gas ultrasonic measurement system for nature gas, which is much advancer of the world from the Instromet company in Holland. After the gas ultrasonic meters have been tested in CVB, the system's performance is proved that it work very well and also can meet the requirement the nation build the mobile work standard for flowmeters in the field. It inaugurate the new epoch which use the mobile gas flow verification system to test((verify or calibrate) those gas flowmeters in the field.

Key words: Mobile gas ultrasonic flow verification system Critical venturi nozzle

Preface:

Natural gas, significant chemistry industry raw and processed materials, is laid store by various governments. As a sanitary fuel which substitute coal and gasoline will be used in serving heat and public traffic to improve the quality of atmosphere.

With the development of economy and embedment of reform opening, customer and dosage of natural gas have been in creasing continuously people pay more and more attention to verification of natural gas. At present, most calibration facility of gas flow verification is fixed, so customer have to send their flowmeter to the special calibration station to be verified. For certain flow meters, to body the actual calibration accuracy, users will be asked to send the front and back straight piping to the station, the method is not only inconvenient, but also not forehanded. May be it will bring forth another problem whether we can assure its accuracy or not by installing again. so the CVB imported a set of mobile ultrasonic gas flow verification system as work standard. The CVB review work capacity of the imported ultrasonic gas flow verification system to confirm whether it will meet the requirements of the these work standard criterion and regulations according to JJF1033 - 2001 measurement standard check criterion ,meanwhile we will do corresponding work to found the mobile work standing the work of the CVB consist of :

1)Study the influence to system uncertainty. repeatedly and stability caused by the condition of complex piping installment;.

2)Study the influence to orifice , turbine ,ultrasonic gas flowmeter when the mobile equipment has been certificate;

3)Study the influence to the system caused by field.

1 . The configuration of mobile gas ultrasonic flow verification system:

The system consists of the following components:

1) Cargo

It consists of a Nissan cargo made in Japan and a Tm - ZR303 cargo derrick.

2) Verify system

a)DN300 flowmeter measurement module and fittings, consist of Q.sonic-5s gas ultrasonic flow meter and its corresponding straight tube and flange.

b)DN100 flowmeter measurement module and fittings, consist of Q.sonic - 3s gas ultrasonic flow meter and its corresponding straight piping and flange.

c)Chromatogram apparatus and fitting, consist of the ENCAL2000.

3)Electric connecting ark.

4)Translator

There are 2 field measurement translator fittings,

one is used in ultrasonic flowmeter, another is in the calibrated flowmeter, they consists of the following facilities:

a)Two sets of Rosemount pressure translator with 3051CA type;

b)Two sets of Rosemount different pressure translator with 3051CD type;

c)Two sets of Rosemount temperature translator with 3144 type;

2.The test of performance toward the mobile gas ultrasonic flow verification system

The method and condition of test: It will be divided into six flowrates between the minimum flow and the maximum flow when it test the ultrasonic flowmeter using venturi nozzle tube as standard. Each flowrates will have been tested for six times repeatedly at least. Each testing time will be not less than two hundred seconds.

When mobile ultrasonic gas flowmeter as flow verification system tests orifice plate, turbine , UFM etc, we should install mobile ultrasonic gas flowmeter. In the upstream, and their comparing distance exceeds 50D.

Uncertainty of Venturi sonic nozzle tube standard facility is 0.25%.

Test pressure fluctuation ≤ 0.2%.

Test temperature fluctuation ≤ 0.20℃.

Test gas composition fluctuation ≤ 0.08%,(the demanding ≤ 0.1%)

Natural gas relative density 0.5≤ Gr≤ 0.80.

Flow fluctuation while acquiring date≤ 0.25% (the requirement ≤ 0.5%)

a) We can compare the test data between the mobile ultrasonic gas flow measurement system and the secondary venutri sonic nozzle tube to check out whether the system's relative error or repeatedly will meet the requirement as the work standard.

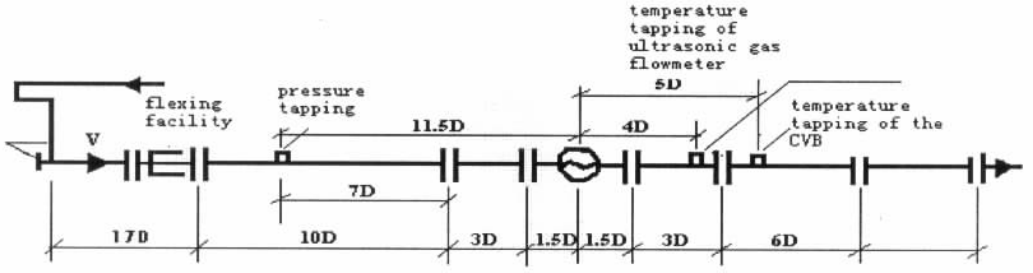
b) We will do serial tests and then get data comparison between the orifice flowmeter(DN100) , the turbine flowmeter(DN100) ,the ultrasonic gas flowmter(in brief UFM,DN250) which verified by the CVB and the mobile ultrasonic gas flow verification system .It will check out whether the apparatus can calibrate the spot flowmeter successfully as the work standard, and effort the field flowmeter's accuracy.

3. Q.sonic

1) Q.sonic - 5s (DN300)

UFM comparing to the venturi critical Nozzle.

(Installation condition of the complex piping)

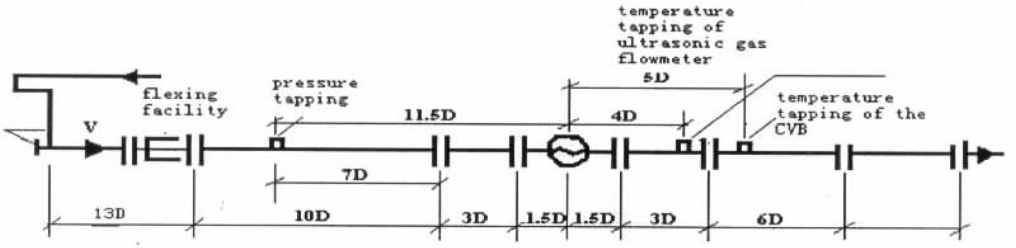


NO	Test pressure (KPa)	Test temperature (℃)	Venturi Nozzle actual flowrate (m3/h)	Measured actual flowrate (m3/h)	Relative error %
1	1613.090	25.793	100.273	100.519	0.245
2	1629.723	24.474	495.198	495.342	0.029
3	1625.387	23.067	1979.232	1971.243	-0.404
4	800.763	19.357	4725.286	4699.140	-0.553
5	1211.269	21.925	3284.973	3258.511	-0.806
6	1625.278	23.783	1232.464	1232.481	0.001

After tested, Q.sonic - 5s DN300 UFM's relative error is with 0.9%. Each index (performance)

meet GB/T 18604 requirement. But we have to correct some flowrates if UFM apply field metrology and it's relative error is in the 0.5%.

2)Q.sonic - 3s(DN100) UFM comparing to the venturi critical Nozzle (Installation condition of the complex piping)

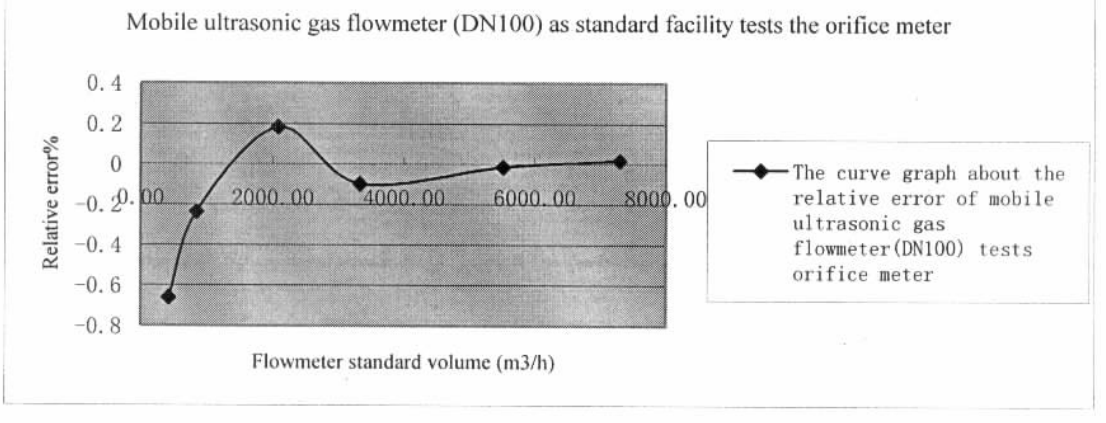


NO	Test pressure (MPa)	Test temperature(℃)	Venturi Nozzle standard flowrate (m^3/h)	Ultrasonic standard flowrate (m^3/h)	Relative error %
1	1.078	25.615	424.203	421.4	-0.661
2	1.077	25.540	845.770	843.8	-0.233
3	1.080	25.572	2079.363	2083.2	0.1845
4	1.057	25.644	3340.684	3328.1	-0.377
5	1.077	25.820	5545.456	5516.7	-0.519
6	1.058	25.787	7336.739	7295.0	-0.569

After testing Q.sonic - 3s (DN100) .UFM relative error is in the 0.6%. Each index meet GB/T 18604 requirement, working stabilization, it don't need correcting and also can meet the requirement of relative error in the 0.75% if it applies in the field metrology.

4.Mobile ultrasonic system as standard facility tests a series of meter.

1)Q.sonic - 3s (DN100).UFM tests orifice plate meter.



From the upper graph we can draw:

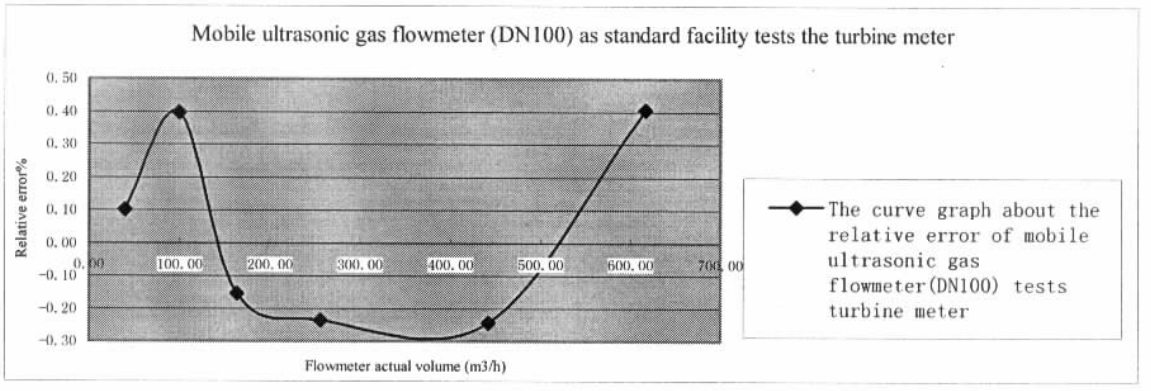
a)The orifice plate meter has been verified and authorized eligibility by Venturi Critical Nozzle standard facility, the maximum relative error not exceeds 1.0%,As the standard facility mobile ultrasonic system testing the orifice plate maximum relative error doesn't exceed 0.68%,In other words, using mobile ultrasonic system Tested the orifice plate meter comparing to Venturi Critical Nozzle standard facility testing conclusion is the same.

b)The UFM install in the orifice plate meter's

upstream (>50D) in the same piping and no influence to orifice plate meter metrology.

c)For the little flowrate especially under of the transition gas flowrate of UFM, caution of using it.

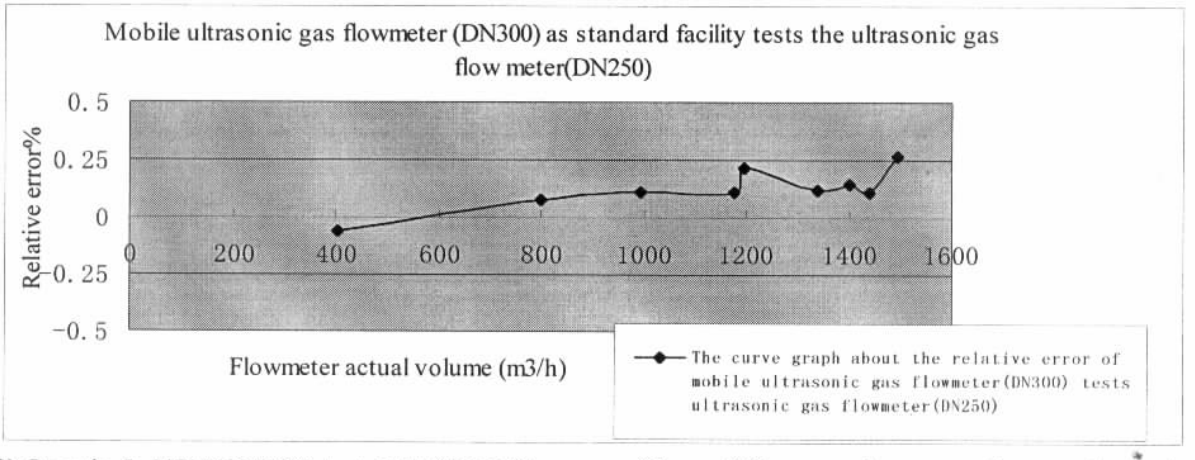
2)Q.sonic-3s (DN100) UFM tests turbine flow meter(DN100)



From the upper graph we can draw:

a)The turbine flow meter has been test and authorized eligibility ,the maximum relative error did not exceed 0.5%, As the standard facility mobile ultrasonic system testing the turbine flow meter maximum relative error didn't exceed 0.42%,In other words, using mobile ultrasonic system Tested the orifice plate meter comparing to Venturi Critical Nozzle standard facility testing conclusion is the same.

b)The UFM install in the Turbine flow meter upstream(>50D) in the same piping and no influence to Turbine flow meter metrology.



3) Q.sonic-5s UFM(DN300) tests UFM(DN250).

From the upper graph we can draw:

a) The UFM(DN250) has been test and authorized eligibility , the maximum relative error does not exceed 0.5%. As the standard facility mobile ultrasonic system testing the UFM maximum relative error doesn't exceed 0.24%,In other words, using mobile ultrasonic system Tested the UFM comparing to Venturi Critical Nozzle standard facility testing conclusion is the same.

b)The UFM(DN300) install in the UFM(DN250) upstream(about 50D) in the same piping and no influence to the UFM metrology.

c)Two difference diameter of gas ultrasonic meters establish with a changing adapters ,If the direct pipe of each meter meet the GB/T 18604 requirement. It will no influence on the accuracy of each gas ultrasonic meter.

4)Conclusions:The mobile ultrasonic Verification system can test various gas meters well as wok standard. The advantages are high accuracy, wide rangeability, no influence on the accuracy of the tested meters , shorter straight piping between the standard meter and tested meter , no making influence on the fluid profile.

5.Conclusion and suggestion .

1)There are certain reasons to chose multiply-paths ultrasonic flowmeter as work standard because it is very good instrument of itself .
The advantages are high accuracy, good repeatability, wide rangeability, strong disturbance-resistance ability , little maintenance , no pressure loss etc .

2.)Because of UFM no block appliance interior and no broking gas flow profile. The best way is install the UFM in the upstream when test the UFM and the other flow meter ,So it will not influence metrology precision in each other.

3)The system should be test and compare to the many types of the flow meter before ensured it as field metrology working standard. After get many experimental data, ensuring it's performance whether meet the requirement of build standard.

4)It also is considered field environment and remote transportation may be make measured error to field metrology work standard. It is CVB next step job of researching.

6.Applying prospection .

1)Greatly convenience to customer in testing meters.
Firstly, mobile UFM verification system change people a idea which customer must send their meters to our station, now we can provide service for customer in the field. Secondly, Greatly alleviating customer's job-day , avoiding no necessary procedure ,saving the time and money.

2)Developing to flow metrology.
Now There is a good many Flow Verifying station using meters as standard facility in the world , but up to now ,There is no using UFM as work standard , the CVB is first to attempt using UFM .UFM is a kind of new instrument of itself. It's advanced technology, high precision and integrated vehicle as mobile metrology standard will arise highly attention of flow metrology academe.

3)Making prospect studying to the relative complex meter weather or as field metrology standard.
Following testing mobile ultrasonic gas flow verification system one by one ,we may understand some advanced technology and structure relative complex flow meter as mobile gas metrology standard. Remote transportation , badly working conditions in field and environment in the field whether or making influent to metrology performance etc , All these factors is next needing to take considering problems.

Reference

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2.JJG198-94 Velocity verifying Regulations
3.Draft AGA Report No.9 Measurement of gas by ultrasonic meters 1997.