Header How to Effect Orifice meter in Natural Gas Flow Measurement

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The header is typical disturb of natural gas transport station, Natural gas flow measurement is mostly by orifice meter in the nation. Mostly orifice standard don't act the header as "typical disturb", they only act it as "other disturb", so it needed pipeline length is more long than the standard prescriptive pipeline length. This paper introduce the orifice meter in different place which is installed after header in natural gas flow measurement and analyse ,so can get the first conclusion, so can help the man who measure by orifice meter in the gas station.

Subject: header, orifice, natural gas

1. Prelude

Now the standard orifice meter is one of the most mature flow meter. It is a kind of standard disturb with long-term development . And accumulated abundant technique data,the ISO 5167-1«»is these technique data's summarization document.It needn't natural gas flow measurement to make sure the flow meter's uncertainty once strictly abide the standard's request.

Because of the effect by machining, installing and the deposit powder, abrasion, smudginess in use etc, it couldn't completely satisfy the rule of standard, especially different installation condition will influence flow meter differentely.

The header is typical disturb of natural gas transport station.More than 90% of the Nature gas station use header. Mostly orifice standard don't act the header as "typical disturb", they only act it as "other disturb", so it needed pipeline length is more long than the standard prescriptive pipeline length. This paper introduce the orifice meter in different place which is installed after header in natural gas flow measurement and analyse ,so can get the first conclusion, so can help the man who measure by orifice meter in the gas station.

2 Testing Method

These testing was done by the Secondary Standard Facility of Chengdu Verification Branch for Natural Gas Flow Meter of National Crude Oil Large Flow Measurement Station (CVB).

2.1 Testing Instrument

Through tested the effect of orifice meter's veracity by the different installation's distance of upstream header, so can get the paper's conclusion.Testing instrument are standard flow meter, orifice meter and

The standard flow meter is a critical Venturi nozzle bank of CVB. The uncertainty is 0.25%, the flow range is 1～2555 m^3/h.

The orifice meter for research is senior orifice valve. Both the orifice's size and straight pipe upstream or downsream meet the iso5167 requirement. The experiment adopted DN100 senior orifice valve and three orifice with different β（0.25，0.5，0.7）.All the experiment use the flange pressure tap type. The concrete orifice parameter in experiment are listed in Table 1.

Table 1-- The concrete orifice parameter in experiment

Sequence number	Value of β	Orifice number	Pipe diameter (mm)	Orifice inside diameter (mm)	Material
1	0.7	20116	100.129	69.995	1Cr13, 2Cr13
2	0.5	20114	100.129	50.003	1Cr13, 2Cr13
3	0.25	20112	100.129	24.984	1Cr13, 2Cr13

The orifice meter's second instrument are temperature, pressure and different pressure measure instrument. Their measure uncertainty are better than 1/2 of orifice meter's veracity scale. Orifice pressure was measured by Rosemount pressure transducer, uncertainty is 0.075%. Orifice different pressure was measured by Rosemount

different pressure transducer, uncertainty is 0.075%. Temperature was measured by PT100 thermocouple and temperature transducer, uncertainty is 0.2□.

The header for experiment is DN300 stainless steel header. There are three apertures on the header's left, middle, right part. In the experiment orifice meter was installed on DN100 test pipeline.

2.2 Installation mode

A was installed after the header so the orifice's installation place that nearest the header is 13D downstream from the header. The testing choosed three different installation modes: 13D, 25D, 25D(with plate flow conditioner) downstream from the header. Through contrasted with the standard reference and compare condition ,we draw a conclusion. The installation mode listed in table 2.

Table 2—Installation mode

Sequene number	Installation condition		explanation
1	reference and compare condition		225D straight pipe upstream from the orifice (with out step, slick inside pipeline). Steady flow field (without disorder fiow, without burble flow)
2	Header effect	13D downstream from the header	The orifice was installed 13D downstream from the header.
		25D downstream from the header (without Flow conditione)	The orifice was installed 25D downstream from the header.
5	Flow conditioner	25D downstream from the header (with Flow conditione)	The flow conditioner was installed 25D downstream from the header. The orifice was installed 13D downstream from the flow conditioner

2.3 Test pressure and flowrate

In order to enlarge the measuring range of the orifice meter, two kinds of different pressure meter high and low were adopted so the different pressure measuring rang could arrive at 1:100. And the orifice meter's measuring range could arrive at 1:10.

Testing pressure are 0.4, 0.8, 1.0, 1.2, 1.6MPa. In the experiment, every installation mode only adopted 2 or 3 pressure point of testing pressure.

Flow points of each testing pressure:

1) Six flow points:4, 8, 12, 20, 30, 48KPa were adopted.
2) Each flow points must be tested 6 times at least.
3) Each testing at least 30 seconds.
4) Different pressure transducer : 10KPa, 60KPa.
5)

3. Results

3.1 Testing Date

The testing got 1008 valid testing points. Every 6 testing points is 1 date point, 168 valid date points were got from testing. Looking the orifice discharge coefficient got under the reference and compare condition as standard value. Contrasted this standard value with the same orifice discharge coefficient got from one installation condition with the same Renault, we could got Coefficient relative error. The test date under all the installation condition were listed in table 3.

3.2 Testing chart and Analyse

The meters were tested under three different pressure, three different orifice discharge coefficientβand four different installation modes. The paper only discuss influence of header's installation on orifice meter.

3.2.1 Test pressure : 1.6MPa

Theβare 0.7, 0.5, 0.25 When test pressure is 1.6MPa. Figure 1, Figure 2 and Figure 3 are 3 different installation mode's discharge coefficient error figure.

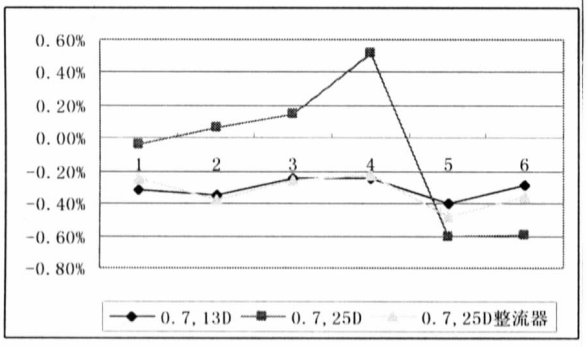

figure-1 1.6MPa, β0.7 Discharge coefficient error diagram

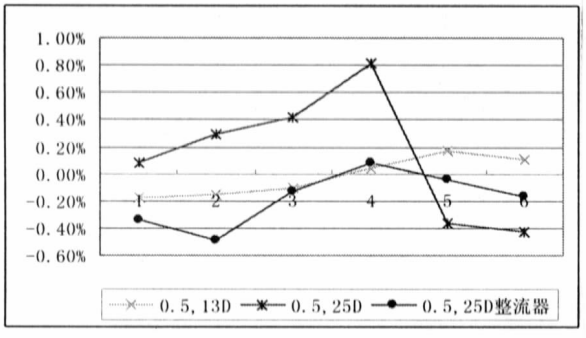

figure-2 1.6MPa, β0.5 Discharge coefficient error diagram

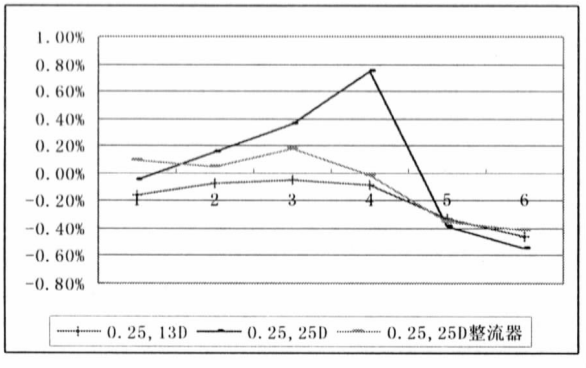

figure-2 1.6MPa, β0.25 Discharge coefficient error diagram

We can get the conclusion from above 3 figure.

A. Because of the lower veracity and instability, we could only get tendency conclusion by contrasted outflow coefficients. It only for reference. It need some more testing for assured conclusion.

Table 3 --test date

Installation condition	Pres-sure MPa	Diameter ratio β		
		0.7	0.5	0.25
		Max/Min/Avg error(%)		
13D downstream the header	1.6	-0.24/-0.40/-0.31	0.17/-0.18/-0.02	-0.06/-0.47/-0.20
	1.0	-0.13/-0.70/-0.39	0.10/-0.34/-0.09	0.29/-0.50/-0.23
	0.4	naught	naught	-0.59/-1.04/-0.77
25D downstream the header (without flow conditioner)	1.6	0.51/-0.61/-0.09	0.82/-0.42/0.14	0.75/-0.54/0.05
	1.0	0.57/-0.63/-0.02	0.93/-0.47/0.15	0.98/-0.63/0.03
	0.4	naught	naught	0.01/-0.42/-0.21
25D downstream the header (with flow conditioner)	1.6	-0.22/-0.48/-0.32	-0.08/-0.49/-0.18	0.17/-0.41/-0.08
	1.0	-0.11/-0.68/-0.31	0.25/-0.31/-0.06	0.31/-0.57/-0.13
	0.4	naught	naught	naught

B. In the test, when β is closer to 0.5,the flowmeter is affected less by the header ;When β is farther from 0.5,the effect is greater; When β is 0.5, the average error of orifice discharge coefficient 13D downstream the header is -0.02% ; When β is 0.25 and 0.70,the average error of orifice discharge coefficient 13D downstream the header is –0.23% and –0.31% each , it is greater than the orifice of 0.5 in evidence.

C. In the test, pressure is 1.6MPa, the orifice discharge coefficient will on the low side when orifice was installed 13D downstream the header. And it will make the value of flow lower, it max lower range probably reachs –0.40%.

D. In the test, pressure is 1.6MPa, the effect of flow meter is little when orifice was installed 25D downstream the header. It is hardly effected by it in the test.

E. In the test, pressure is 1.6MPa, the

effect of flow meter's performance is greater when flow conditioner was installed 13D downstream the header, orifice was installed 25D downstream the header. The effect is nearly the way of installing 13D, the value and direction are very closed too. the orifice discharge coefficient will on the low side . And it will make the value of flow lower, it max lower range probably reachs –0.49%. The plat flow conditioner was used in the test, the possible reason are: The processing of flow conditioner isn't good enough; the plate flow conditioner do a great effect on the orifice plate ; the flow conditioner wasn't operated to improving flow field, on the contrary turned into a disturb; The flow meter performance is instable.

3.2.2 Test pressure 1.0 MPa

Theβare 0.7, 0.5, 0.25. When test pressure is 1.0MPa.,Figure 4, Figure 5 and Figure 6 are 3 different installation mode's outflow coefficient error figure.

A. In the test, when β is closer to 0.5,the flow meter is affected less by the header ;When β is farther from 0.5,the effect is greater; When β is 0.5, the average error of orifice discharge coefficient 13D downstream the header is -0.09% ; When β is 0.25 and 0.70,the average error of orifice discharge coefficient 13D downstream the header is –0.23% and –0.39% each , it is greater than the orifice of 0.5 in evidence.

B. In the test, pressure is 1.0MPa, the orifice discharge coefficient will on the low side when orifice was installed 13D downstream the header. And it will make the value of flow lower, it max lower range probably reachs –0.70%.

C. In the test, pressure is 1.0MPa, the effect of flow meter is little when orifice was installed 25D downstream the header. It is hardly effected by it in the test.

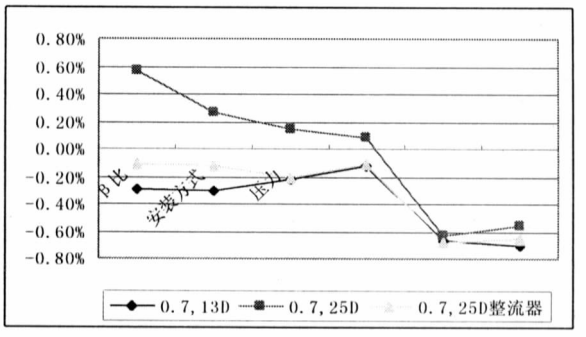

figure-4 1.0MPa, β0.7 Discharge coefficient error diagram

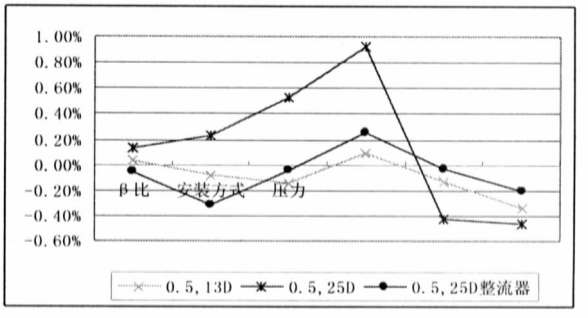

figure-5 1.0MPa, β0.7 Discharge coefficient error diagram

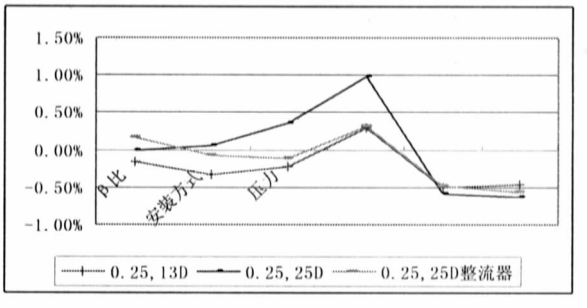

figure-6 1.0MPa, β0.7 Discharge coefficient error diagram

D. In the test, pressure is 1.0MPa, the effect of flow meter's performance is greater when flow conditioner was installed 13D downstream the header, orifice was installed 25D downstream the header. The effect is nearly the way of installing 13D, the value and direction are very closed too. the orifice discharge coefficient will on the low side . And it will make the value of flow lower, it max lower range probably reachs –0.68%.

3.2.3 Test pressure 0.4MPa

Under this pressure , we only do the experiment with β is 0.25 . The following figure7 is the discharge coefficient error diagram which belong to it's 3 kinds of different installing way.

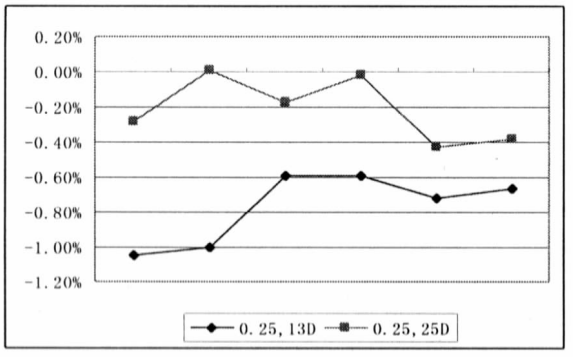

figure-7 0.4MPa, β0.25 Discharge coefficient error diagram

The first conclusion can be got by compared 3 kinds of different installing way under 4.0MPa :

A. In the test, pressure is 0.4MPa, the orifice discharge coefficient will on the low side when orifice was installed 13D downstream the header. And it will make the value of flow lower, it max lower range probably reachs –1.04%. It's effect range is far greater than other two pressure.

B. In the test, pressure is 0.4MPa, the orifice discharge coefficient will on the low side when orifice was installed 25D downstream the header. It max lower range probably reachs –0.42%, but effect is little compared with 13D in evidence.

C. There is no testing data with effected by flow conditioner under 0.4Mpa in the test.

4. Conclusions

Because of the lower veracity and instability, we could only get tendency conclusion by contrasted outflow coefficients. It only for reference. It need some more testing for assured conclusion.

According to the above analysis and combining with data comparison, the aspect of that the header upstream the orifice affects orifice can be got as follows:

A. In the test, the header upstream the orifice made the orifice discharge coefficient on the low side, and the negative error will be made in value of flow. The distance between the header and orifice plate flowmeter is much longer, the effect of orifice plate is less. The effect can be eliminated in mostly circumstance by 25D's distance of straight pipe, but to low pressure (0.4Mpa) and little value-β, The effect can't be eliminated by 25D's distance of straight pipe.

B. In the test, the plat flow conditioner was installed 13D downstream the header, orifice was installed 25D downstream the header, which couldn't eliminate the effect of header. The effect to performance of flow meter is greater by added a flow conditioner, it's affected nearly with installing a flow meter at 13D downstream the header, it's error numerical value and direction are close, it made the orifice discharge coefficient on the low side, And it will make the value of flow lower, it's most lower range probably reachs –0.49%. the possible reason are: The processing of flow conditioner isn't good enough; the plate flow conditioner do a great effect on the orifice plate ; the flow conditioner wasn't operated to improving flow field, on the contrary turned into a disturb; The flow meter performance is instable.

C. In the test, the effect isn't change with the pressure's changing when the pressure is hyper- a certain value. Especially from the test data under 1.0MPa and 1.6MPa, mostly error curve and error value are accordant.

D.In the test. For flow meter, the effect by header are out of all relation to Renault. When augmented Renault, some orifice 's discharge coefficient turned lower, some turned into zero. There are little data under 0.4MPa and without data above 2.0MPa, so we didn't adequately observe the effect of orifice with

high Renault, it needs some more test data.

E. In the test, when β is closer to 0.5, the flow meter is affected less by the header ;When β is farther from 0.5,the effect is greater.

Acknowledgement

Thanks colleagues' assist of CVB.

References

[1] ISO 5167

[2] AGA No.3

[3] SY/T 6143—1996 Measurement of natural gas flow by means of standard orifice meter