EFFECTS OF THE LATEST REVISION OF ANSI/API 2530/AGA 3 ON ORIFICE METER PRIMARY ELEMENTS

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INTRODUCTION

Based on the results of a comprehensive test program, in 1991 API released a revised edition of Chapter 14, Section 3 in 4 part format. The results allowed a new , improved equation to be issued which has reduced uncertainty. Along with the new equation, new , tighter tolerances are required of the mechanical equipment. These specific requirements are detailed in Part 2 of the Standard, w hich has become know n in the industry as API 14.3.

Use of equipment manufactured to the new standard along w ith the new equation essentially reduces the error on the coefficient of discharge to about one half of w hat it w as using the older version of the standard. The new equation assumes certain mechanical features w ithin the meter tube to have tighter control of tolerances than w as previously required. Any meter not made in accordance w ith the 14.3 document must have an in-situ calibration to determine the coefficient of discharge over the expected reynolds number range.

Existing, installed equipment falls under a grandfather clause and can be used, but with higher uncertainty probability. Smaller line sizes are more susceptible to greater uncertainty. Older equipment not meeting the latest standard should not be used in new installations. It is recommended that the new equation be used, even w ith older equipment that does not meet the new tolerances though the uncertainty w ill be higher.

MECHANICAL CHANGES

The most significant changes affecting fittings and meter tubes will be discussed in this paper.

1. Eccentricity of plate to fitting bores.
2. Seal gap/seal recesses and protrusions
3. Internal diameter tolerances and surface finish
4. Pressure tap and plate seal leak tests
5. Orifice plate bore dimensions

ECCENTRICITY

Eccentricity (fig.1) in this instance is the relationship of the installed orifice plate bore to the fitting bore. Zero” eccentricity would indicate that the two bores were located on the same centerlines, both vertical and horizontal. In practice this is impractical to achieve or maintain. Any offset in either or both directions is called eccentricity and is closely controlled by the new standard.

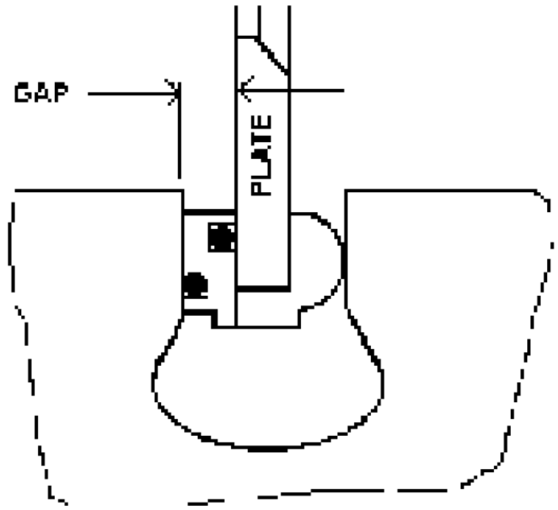


Figure 1: Eccentricity

Previous issues of the standard allow ed up to 3% eccentricity. The latest issue of 14.3, Part 2 has reduced this by a factor of ten. An example of the effect of this tolerance reduction is to look at the change in a typical 2” size. A 2” sch. 40 using a design of .75 beta was previously allow ed 0.062” eccentricity in the direction of the pressure taps. The same installation to the 14.3 requirements now limits this eccentricity to 0.006”. There is a stipulation that allows increasing this tolerance to 0.020 if a penalty of 0 to 0.5% additional uncertainty is acceptable.

The eccentricity in the plane 90 degrees (perpendicular) to the taps can be up to four times that allowed in the direction of the taps, but only if the eccentricity in the tap hole plane measures less than the calculated maximum times .707(cosine of 45 degrees).

For example, 2”, sch.40, 0.75 beta allows a tap hole plane eccentricity of .006”. If the measured value is .004(.707 times .006) or less, then the perpendicular measurements can be as much as .024”.

Eccentricity tolerances are beta ratio related, with the lower betas having increased tolerance. It is considered good practice, however, to use .75 beta for design purposes, since it is difficult to anticipate future requirements for any meter.

For older stations not meeting the new tolerance requirements or to minimize any eccentricity effects, the standard mentions connecting pairs of upstream and downstream taps to average pressures at each location. If this is done, the eccentricity tolerances can be doubled. There are certain details outlined for this procedure, if used, that should be followed.

These requirements apply to orifice flanges as well as orifice fittings. Previously, orifice plates were centered within orifice flanges by the flange bolting. Due to bolt hole/bolt clearance, this will not meet the new requirements. To properly center the plate, dowel pins or some other method is required. Since there is no industry standard for orifice plate outer diameters, plates for these flanges should be from the flange manufacturer. This also creates a conflict with ANSI B-16.36 on orifice flanges which is based on the older version of AGA.

Users of orifice meters to the new standard should incorporate procedures to insure that all flanges/fittings/plates meet the specifications when purchased and during the life of the equipment, particularly during maintenance and parts replacement.

SEAL GAP, RECESS/PROTRUSION

New emphasis has been placed on the area around the orifice plate sealing device in orifice fittings. Section 2.5.1.4 defines the "gap" (fig. 2) between the face of the orifice plate and the sealing surface of the fitting. In all situations, no seal protrusion(fig. 3) is allowed. This means that regardless of seal design or width of gap, no protrusion of the seal ring is allowed.

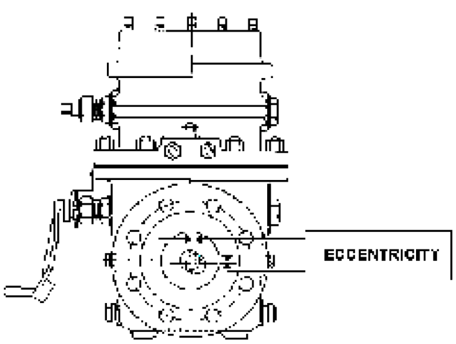


Figure 2: Seal gap

The other stipulations are more complex. If the gap exceeds .250", other factors come in to effect. Now, the seal inner diameter must be within .25% of the measured fitting bore and still cannot protrude into the bore. Care should be taken to insure that any eccentricity of the plate carrier assembly does not cause the seal to protrude into the line. If this tolerance cannot be maintained, an unspecified additional uncertainty must be added to the coefficient of discharge or the beta ratio must be restricted. Using this approach can cause manufacturing difficulties and require precise user documentation of fitting/seal bore combinations. Replacement parts, including seals, that can affect concentricity or protrusion must be inspected for conformance to the requirements.

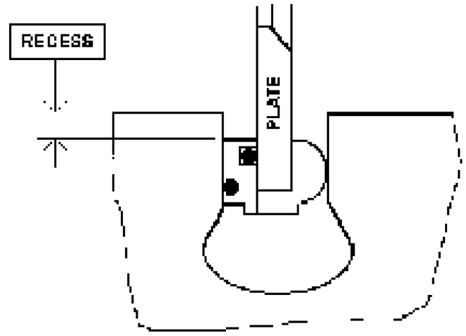
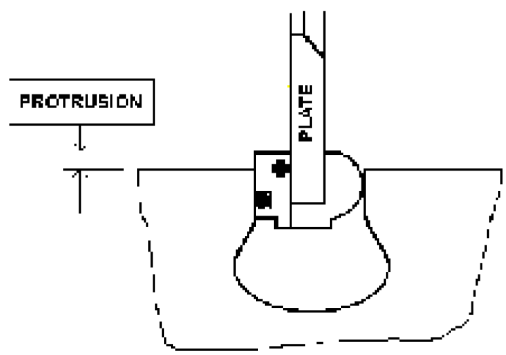


Figure 3: Seal Protrusion

However, if the seal gap measures .250" or less, then the sealing device can have an inner diameter any amount larger than the fitting bore which is noted as a recess(fig. 4) at this point. This also applies to orifice flanges with a compressed gasket thickness below .250". No beta restrictions or added uncertainty applies to this design. As long as there is no seal protrusion, the fitting is in compliance.

Figure 4: Seal Recess

PIPE ROUGHNESS AND INTERNAL



DIAMETER TOLERANCES

One new requirement was added to meter tube internal diameter requirements. Now , within 1 pipe diameter upstream of the orifice plate, all internal measurements must be within .25% of the arithmetic average of readings obtained in the 1" upstream (tap hole) plane. This is further defined as the "First Mean Diameter Upstream"(FMDU). This amounts to one half the previous tolerance allowed. In smaller line sizes, this is not such a problem since this plane falls in the machined bore of the fitting. In larger sizes, however, the "FMDU" falls in the upstream weld or pipe, creating more strict pipe and weld finishing requirements. The remainder of the meter tube tolerances are unchanged from the previous standard.

Pipe roughness requirements have been reduced from 300 to 250 micro inches for beta ratios above 0.60. This generally exceeds the surface found in commercially available pipe. To meet this requirement, as well as the previously mentioned inside diameter roundness tolerances, “cold drawn” seamless or honed pipe will normally be required.

PRESSURE TAP HOLE/PLATE SEAL LEAK TESTING

Since orifice fittings are generally made from castings, there has been concern about the integrity of the pressure tap holes being drilled through the cast metal. Castings sometimes have porosity or cracks which could allow communication of tap hole pressure to some other area in the casting, causing a false reading. To insure a sound tap hole, the new standard now requires that each tap hole be pressure/vacuum tested to prove soundness. This test must be performed after the meter tube has undergone hydrotest.

Using a blank orifice plate, a plate seal test is to be performed on each orifice fitting to show integrity of the seal and sealing surfaces of the fitting. This test is also required after the meter tube is hydrotested. Test pressure and hold time are not specified, but most users prefer a high pressure test held for two to five minutes.

ORIFICE PLATE BORES

The previous standard allowed some tolerance on the orifice bore, based on diameter. The new standard states that the exact measured bore, corrected to it’s value at 68ºf be used. Some manufacturers are complying by measuring the bore, correcting this value to it’s 68ºf diameter and further identifying it as d as noted in 2.3.1.2 r of the standard. The calculated or “target” value of the bore is mainly for reference purposes. The d value should be used in all beta calculations r and should be entered into the flow computer along with the thermal coefficient of expansion of the orifice plate material.

CONCLUSION

Certain tolerances and finish requirements have been tightened in the latest version of the orifice measurement standard. These result in better measurement with less uncertainty than in the previous edition. More sophisticated equipment is required to meet and maintain the exacting specifications and both manufacturers and users need to be aware of their responsibilities to comply.

By: Ray Kendrick

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Emerson Process Management
Daniel Measurement and Control, Inc.
www.daniel.com

North America / Latin America:
Headquarters
USA - Houston, Texas
T +1.713.467.6000
F +1.713.827.3880
USA Toll Free 1.888.FLOW.001

Europe: Stirling, Scotland, UK
T +44.1786.433400
F +44.1786.433401

Middle East, Africa: Dubai, UAE
T +971.4.811.8100
F +971.4.886.5465

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