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Application guidance for Optimass flowmeters to be used on abrasive fluids

For almost 20 years KROHNE Coriolis mass flowmeters have been successfully used on abrasive fluids such as slurries (mineral and metal mining) and sand & water mixtures.

In these applications a single straight measuring tube will always offer clear advantages over other designs with tube geometries that suffer erosion and premature failure of flow dividers and bends in the abrasive fluid stream. Notwithstanding this, even a meter with a single straight tube will suffer some erosion unless simple precautions are taken.

Other specific problems with abrasive fluids are typified by their tendency to separate out with the heavier particles falling to the bottom of the pipeline and the carrier fluid flowing above in a stratified flow.

The purpose of this application guidance is to highlight potential issues so that they can be mitigated against during the planning and installation of the meter.

1. Use “transition pieces” to protect the flange raised faces

Since the meter measuring tube will typically have a different internal diameter than the process pipework, a “step change” will occur where the flanges are connected. This edge presents a very obvious erosion point and after a period the weld between the flanges raised face and measuring tube could fail causing a leak path.

Transition pieces (fig.1) are stainless steel (although Hastelloy can be used) discs that are sandwiched between the two flanges, secured by through bolts and centered by rubber sleeves around the bolts.

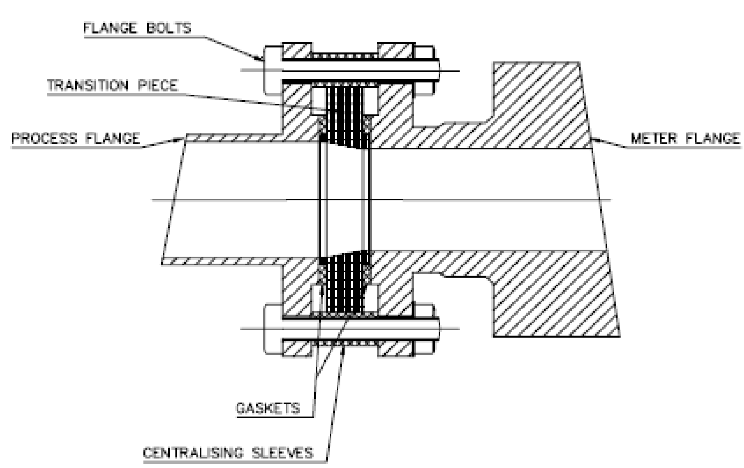

Figure 1 Transition Pieces to protect leading edge of meter and to match to the process pipe ID

The taper on the internal diameter of the disc is manufactured to correct the difference between the meter and process pipe, thus providing a gradual transition for the abrasive fluid into the meter.

They must be considered as “sacrificial wear parts”, and should be removed periodically for inspection of the internal taper dimension and replacement if necessary.

Prices for these parts are available from KROHNE.

2. Manage the fluid velocity

There are two considerations here based on the fluid flow rate and density:

Maximum velocity: To prevent excessive erosion this should be never be more that 4 m/sec (12 ft/sec).

Minimum velocity: So the particles and carrier are homogeneous mixed this should be at least 1 m/s (3 ft/sec).

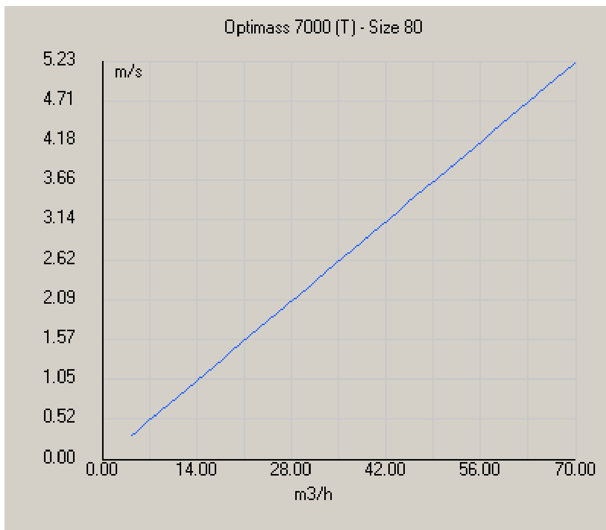

Figure 2 Example of relation between flowing velocity and mass flow rate in a three inch mass meter

The Optimass sizing software will assist you in calculating these limits. For abrasive slurries always size according to these velocity limits, and not lowest measuring error which tends towards a smaller meter size and hence a higher velocity.

3. Always use titanium as the measuring tube material

This is related to the fact that size-for-size, a titanium measuring tube has a greater wall thickness than either stainless steel or Hastelloy. So simply put, this tube has more material to erode before failure, so extending the working lifetime of the meter.

Table 1 KROHNE OPTIMASS straight tube meter details

Meter size	Material	Outside dia.	Wall thickness	Internal dia.
40	T	38.10 ±0.13	0.91 ±0.09	36.28
	H	38.10 ±0.1	0.71 ±0.07	36.68
	S	38.10 ±0.13	0.71 ±0.07	36.68
50	T	50.80 ±0.15	1.24 ±0.01	48.32
	H	50.80 ±0.15	1.00 ±0.01	48.80
	S	48.26 ±0.13	1.00 ±0.01	46.26
80	T	73.00 ±0.254	2.10 ±0.02	68.80
	H	73.03 ±0.254	1.04 ±0.01	70.95
	S	73.00 ±0.13	1.40 ±0.01	70.20
		All dims. mm		

The only exception to this is when stainless steel or Hastelloy are required for fluid compatibility (corrosion resistance).

4. Conditioning of the fluid flow profile as it enters the meter

Firstly remember that a Coriolis mass flow meter directly measures mass flow and density of the fluid. It does not measure velocity, so from a measuring principle standpoint there is no need for flow profile conditioning.

However with an abrasive fluid, there is the requirement to condition the flow so that the abrasive particles enter the meter parallel to the tube wall. This minimizes the probability that any given abrasive particle will strike the tube wall and remove (erode) the tube material.

If the flow is “tumbling” or “swirling” as it enters the meter, then there is a risk that erosion will occur at the specific point where the particles preferentially impact onto the tube wall, so causing premature failure. These problems are always associated with using a pipework bend or elbow very close to the meter inlet.

Therefore we recommend a straight length of inlet process pipe equal to at least 10, or preferably 20 x pipe internal diameters.

5. Installation of the flow meter

In order to keep the heavy abrasive particles evenly dispersed in the carrier fluid as a homogenous mixture that is required for correct meter operation, we would recommend a vertical meter installation. Otherwise there is the tendency, especially at lower flow velocities, for the fluid to separate out and become stratified.

Further, a flow direction vertically upwards is normally preferred to ensure that meter is always full of liquid, and does not “siphon” empty.

6. Inclusion of air or gas in the fluid

High density fluids such as mineral slurries typically require high drive energy due to their tendency towards being in homogeneously mixed.

Entrained air or gas will cause a further increase in the required energy to drive (vibrate) the tube system. If the inclusion is too great then a meter will not operate correctly. This problem is particularly pronounced on older style larger sized meters (T 50 & T 80), which typically are used for abrasive fluid applications in order to reduce the fluid velocity to acceptable levels. KROHNE's new EGM available in the new MFC400 converter and newest sensors all but eliminates this concern.

So we would recommend that all efforts be made to prevent the inclusion of air or gas in the fluid as part of the process design, since from our experience once entrained in the fluid it is virtually impossible to remove prior to the metering point

7. Consider installing the meter in a by-pass

If the application is for density measurement only, then often a more cost-effective solution is to install a smaller sized meter (although size 25 is smallest recommended) in a by-pass line off the main pipeline.

Conclusions

We are confident that if the seven steps above are followed correctly, then the probability of application related problems are greatly reduced, and the operating lifetime of the meter greatly increased.

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