North Sea FLOW Measurement Workshop

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Impulse-Line Blockage Diagnostics of Differential Pressure Flowmeters

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1 INTRODUCTION

Differential pressure (DP) flowmeters are widely used throughout industry. Although DP transmitters and orifices are very reliable, impulse-lines are vulnerable to blockages caused by fluid condensation, freezing, or corrosion. Blockage diagnostics technique has been developed by detecting fluctuations of static, differential pressures.

2 DIAGNOSTICS BY SENSING PRESSURE FLUCTUATIONS

In general, fluids in closed conduits flow in turbulent region, which cause fluctuations in static and differential pressures. When blocking in impulse lines occurs, the amplitude of fluctuations decreases. Silicon-based resonant sensors are capable to detect rapidly the fluctuation amplitude for both static, differential pressures. Diagnostics algorithm is based on statistical calculation of these fluctuations and provides prognostic information of impulse-line blocking status in order to reduce maintenance workload.

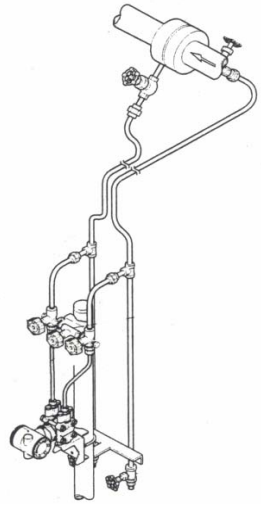


Fig.1 Impulse-line connection for liquids

3 FLUCTUATIONS OF STATIC AND DIFFERENTIAL PRESSURES

Fluctuating components of static, differential pressures generally decrease when an impulse line is blocked. Fluctuating components are calculated as the square summation of the difference of static and, differential pressures that are sampled at very short time intervals.

Table 1. Fluctuating component values in impulse lines

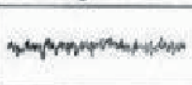
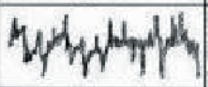
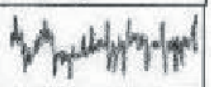
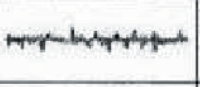
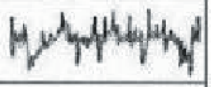
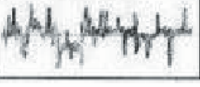
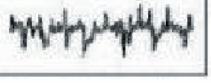
	H/L side both blockage	H side blockage	L side blockage	No blockage
PH (Static Pressure H side)				
PL (Static Pressure L side)				
DP (Differential Pressure)				

Table1 shows the value of the fluctuating components when blocking occurs on the Hi-side, Lo-side, and both sides. The values for when no blocking occurs are also shown. When both sides of

impulse lines are blocked, all fluctuating components decrease. When one side of an impulse line is blocked, the corresponding fluctuating component decreases. In this case the fluctuating component of differential pressure is larger than when no blockage occurs.

4 DIAGNOSTICS ALGORITHM

Differential pressure DP is the difference between Hi-static pressure PH and Lo-static pressure PL; DP=PH – PL, then fluctuating components are described as $F_{dp}(i)=F_{PH}(i) – F_{PL}(i)$, where i stands for sequential timing of sampling. For definite interval of total sampling N, the extent of fluctuation is represented by following definition:

$$R.M.S_{dp}=SQRT(Sum(F_{dp}(i)^2)/N)\ ) \quad (1)$$

$$R.M.S_{PL}=SQRT(Sum(F_{PL}(i)^2)/N) \quad (2)$$

$$R.M.S_{PH}=SQRT(Sum(F_{PH}(i)^2)/N) \quad (3)$$

Taking into account that when Hi-side impulse line is blocked, correlation between $F_{PL}(i)$ and $F_{dp}(i)$ becomes dominant, we derive the blocking factor F using correlation functions CorL, CorH as follows:

$$CorL=Sum(F_{dp}(i)\cdot F_{PL}(i))/N/(R.M.S_{dp}\cdot R.M.S_{PL}) \quad (4)$$

$$CorH=Sum(F_{dp}(i)\cdot F_{PH}(i))/N/(R.M.S_{dp}\cdot R.M.S_{PH}) \quad (5)$$

Error! Objects cannot be created from editing field codes. (6)

Blocking factor F approaches to +1 for Hi-side blocking and -1 for Lo-side blocking. Generally in most applications, impulse-line blocking would not progress at same rate. Whichever impulse-line is blocked, we can diagnose blocking status of the impulse-lines by means of the blocking factor F.

5 BLOCKING DIAGNOSTICS FOR WATER FLOW

Fig.2 shows blocking diagnostics for water flow using flow test facilities. Needle valves are installed in the middle of the impulse-lines, simulating impulse-line blocking. The figure shows the blocking status of Hi-side and Lo-side in which F approaches +1 and -1 respectively.

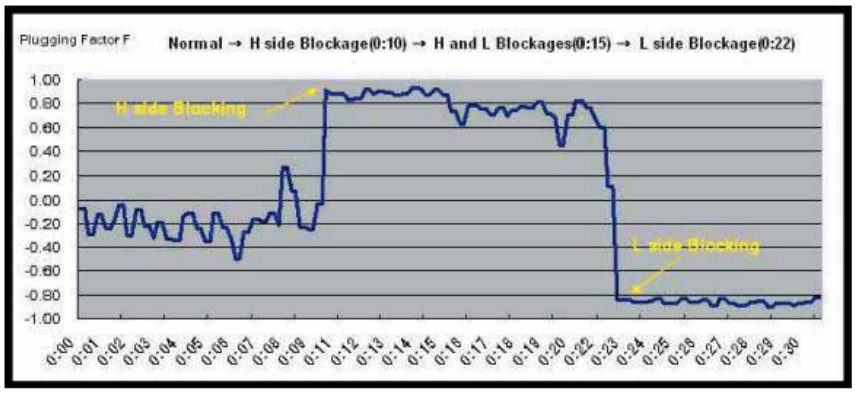


Fig.2 Blocking diagnostics for water flow

The blocking factor can be effectively used for predictive diagnostics of impulse-line blockage.

References

[1] Paper presented at the North Sea Flow Measurement Workshop, a workshop arranged by NFOGM & TUV-NEL

Note that this reference was not part of the original paper, but has been added subsequently to make the paper searchable in Google Scholar.