Paper 16

Long Term Operational Experience of Turbine Meters

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Long term operational experience of turbine meters

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1. ABSTRACT

The gas turbine meters are widely used for custody transfer measurement of large gas - flows. The meters are usually calibrated with atmospheric air and with natural gas at - operating pressure. The accuracy of the meter proved by calibration may be as high - as 0.3 % in the limited range. -
Will the meter maintain this accuracy during the operation? -

This paper describes the operational experience gained with turbine meters on the - border metering station in Hungary and makes an attempt to answer this question. -
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The strange behaviour of the meters during the first year of operation will be shown. - Results of the regular serial tests indicate some “break in” period for the turbine - meters. -

After the “break in” period the balance of the pipeline indicates excellent agreement - between the metering results of two stations and consequently the good stability and - accuracy of the turbine meters. -

2. BACKGROUND

The Hungarian high pressure natural gas transportation system is connected to the West European pipeline system via HAG (Hungarian Austrian Gas) pipeline. It connects the Austrian gas hub Baumgarten with the Hungarian border station Mosonmagyaróvár.

The length of the pipeline is 62 km, nominal diameter is 700 mm. The nominal transportation capacity of the pipeline is 4.2billion m3/year. There are two in-take metering station at the Austrian end of the pipeline and one off-take metering station at the Hungarian end of the pipeline. There is no off-take point along the pipeline. The in-take and off-take metering stations are practically identical in terms of piping layout and instrumentation.

The metering stations consist of 2 or 3 operating meter runs and one master meter run. The station piping layout is constructed in such a way that the master meter run can be connected in series with any of the operating meter runs (fig. 1).

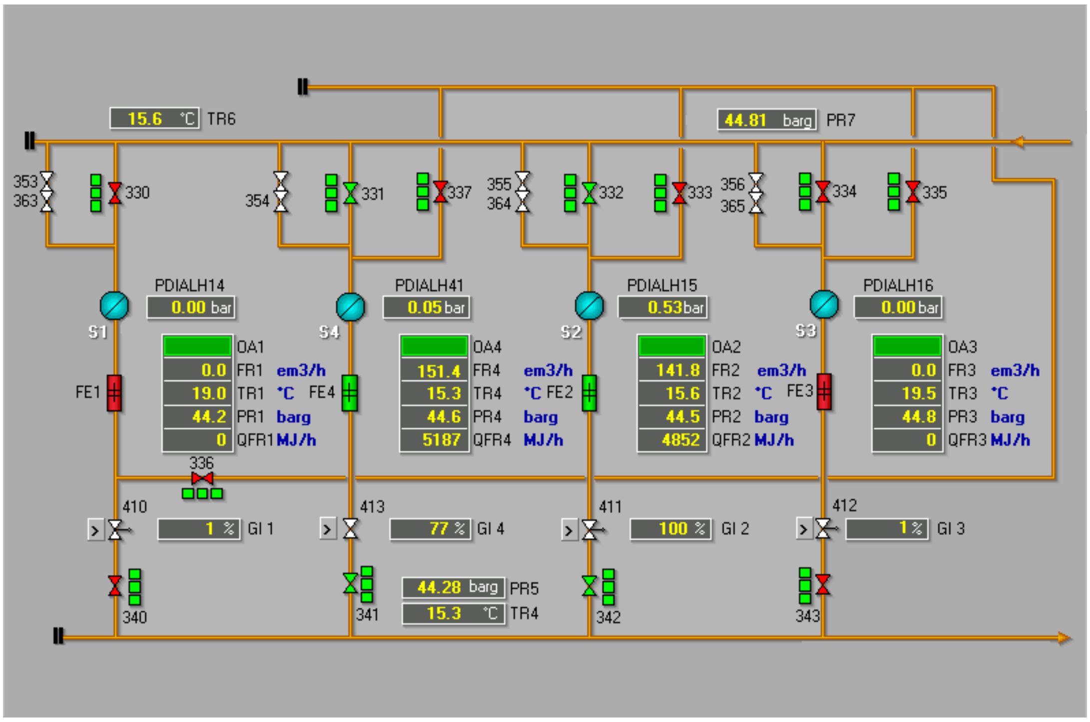

Fig. 1. Mosonmagyaróvár metering station

The pipeline was put into operation on 1 October 1996. At the start-up only one in-take station on the Austrian side was put into operation. The second in-take station was put into operation one year later.

3. THE TURBINE METERS

The gas flow is measured by means of turbine meters. The turbine meters are DN300, - ANSI600 and G2500 size. -
The meters at the Hungarian side after manufacturing were calibrated at the Pigsar - facility at 50 bars while the meters at the Austrian side were calibrated at the - Westerbork facility at 62 bars. -
The accuracy requirements to the turbine meters were 0.3 % maximum error in the - range of 13 to 100 % of Qmax and 0.8 % maximum error in the range of 5 to 13 % of - Qmax. -

The flow computer is connected to the high frequency pulse output of the turbine - meter with continuous pulse integrity checking. The pressure and temperature are - measured in each meter run. The gas composition for the compression factor - calculation and the heating value for the energy calculation are provided by the on-line process gas chromatograph. -

Serial test of the turbine meters is scheduled once a month on each meter run. Both - volume at line conditions (corrected to the pressure and temperature of the master - meter) and volume at base conditions are compared during the test. The standard - duration of the test is 20 minutes. -

4. GAS BALANCE OF THE PIPELINE

The volume and the heat balance of the pipeline are calculated on the daily basis. The change in the line pack is taken into account.

The hourly flow rate of the gas through the stations and the unaccounted for gas from the start-up to the end of 1997 are shown on the fig. 2.

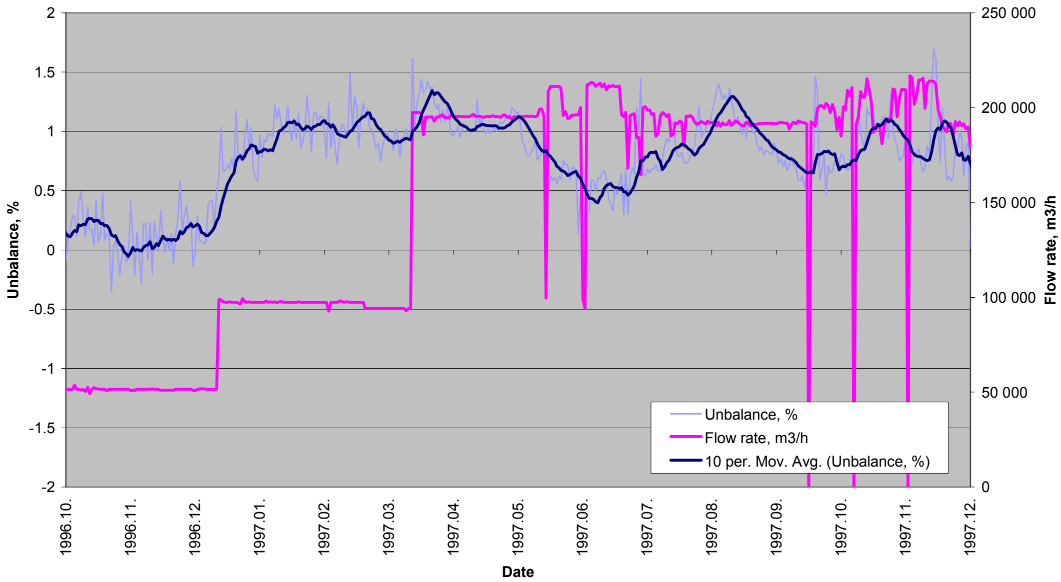

Fig. 2. Unaccounted for gas and hourly flow rate

During the first two month of operation the gas balance remained within +/-0.3 %. One meter run was in operation. The turbine meter worked at 25 – 30 % of Qmax. On the 1 January 1997 the flow rate doubled and unaccounted for gas dramatically increased up to 1 % or more. Still one turbine meter was in operation, working at 50 – 55 % of Qmax.

On 1 April the flow rate doubled again. From this moment two meter runs were put into operation both working at 50 – 55 % of Qmax. The unaccounted for gas remained on the level of 1 %. The Hungarian station at the off-take point measured less, then the station at the in-take point. Such a high unbalance of the pipeline was unacceptable of course. Operators at the both ends of the pipeline started investigate the possible reasons for the unbalance.

5. TEST OF THE TURBINE METERS

The simplest way for turbine meter test was the serial test with the master meter. The regular monthly and some extraordinary serial tests have been done. As can be seen on fig. 3. the turbine meter No. 60420 showed remarkable negative drift during the first 6 month of operation. The reading of the meter comparing to the master meter decreased by 1.2 % by the end of the period. Another turbine meter appeared to be more stable although had some +/-0.2 % variation from one serial test to other. The serial test results on the Austrian in take station indicate good stability of that meters in both meter runs.

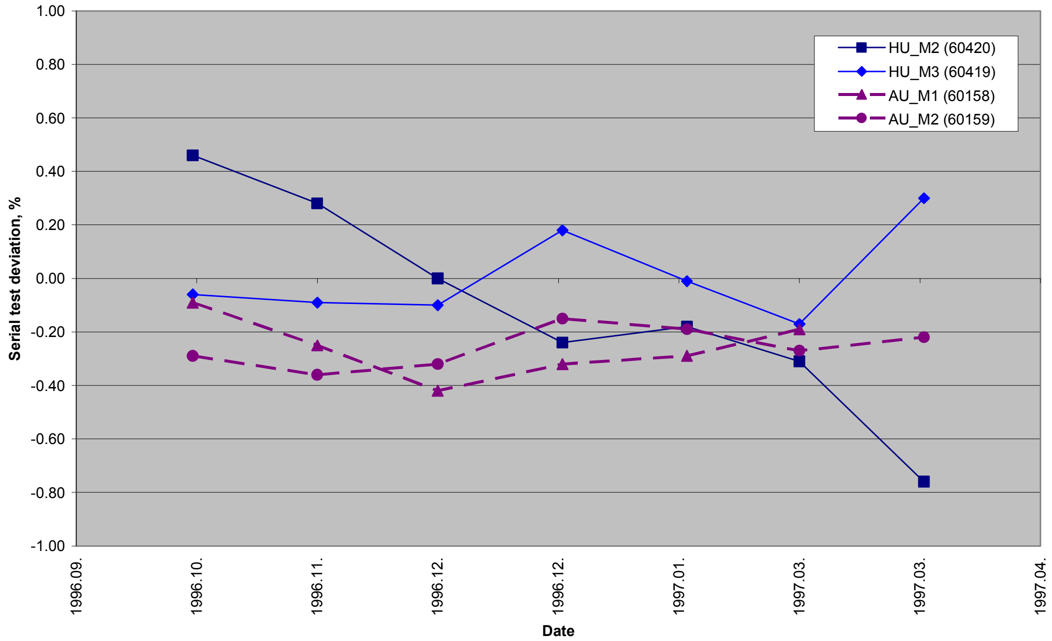

Fig. 3. Serial tests 1996 - 1997

Another way of checking the meters was to recalibrate them. Having no high pressure calibration facility in Hungary recalibration with atmospheric air has been done. Fig. 4 and 5 show the error curves of the meters No. 60420 and 60421 respectively.

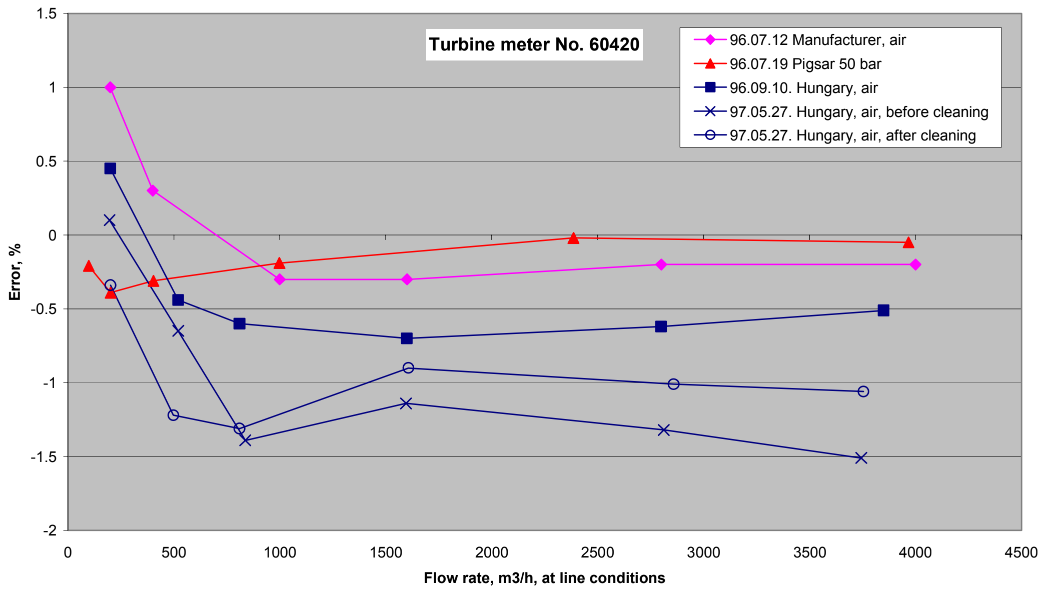

Fig. 4. Meter No. 60420 error curves at the Hungarian station

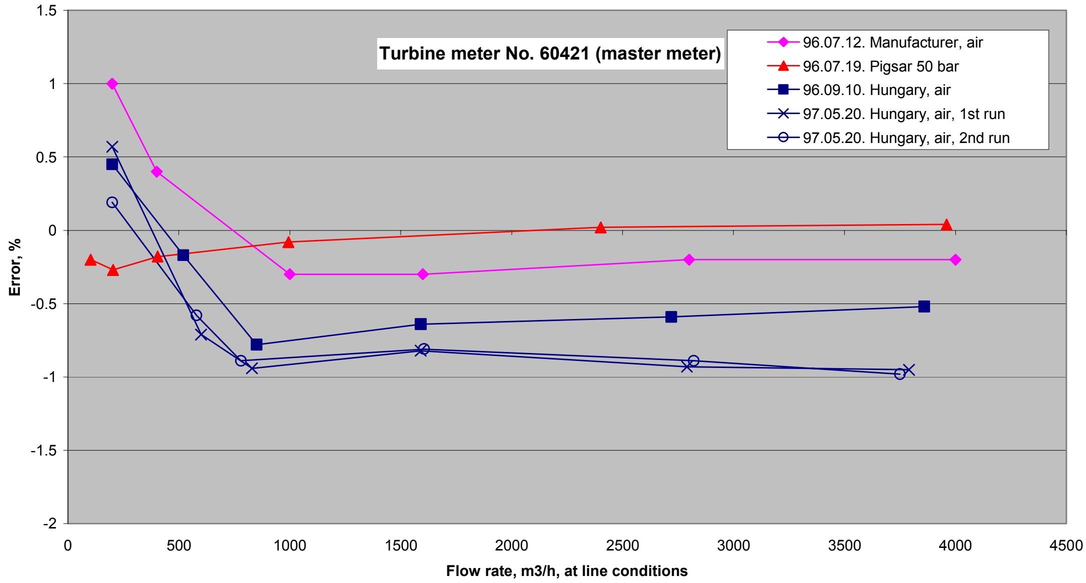

Fig. 5. Meter No. 60421 e rror curves at the Hungarian station

Before the start up of the meters they were calibrated at the manufacturer site with air, then at the Pigsar facility with natural gas and also at the Hungarian calibration facility with air. Comparing the error curves from the Hungarian air calibration made before start up and after 6 month of operation it is clear that the meter No. 60421 drifted from its original curve by 0.2 – 0.4 % and meter No. 60420 drifted by 0.6–1.2 % to negative direction. The first recalibration was done on the meters as they were removed from the meter run, without any cleaning. Then the meters were washed internally and the recalibration repeated. Some improvement can be seen on the error curve but most of the negative drift remained.

The meter No. 60421 was the master meter. The different magnitude of the negative drift of the meters No. 60420 and 60421 explains the negative drift of the meter No. 60420 during the serial tests.

The third way for checking of the meters was to compare the meters installed at the in-take and off-take metering stations. The master meter from the Hungarian station was taken to the Austrian station and serial test has been done on the two meters. The test results indicated that the Hungarian master meter was slower than the Austrian master meter at about 0.6 – 0.7 % This, together with the negative drift of the working turbine meter on the Hungarian station comparing to the master meter explains the unbalance of the HAG system.

On the basis of the test results meter No. 60620 was returned to the manufacturer for repair and recalibration. According to the manufacturer information the meter in fact did not require any repair. The meter was recalibrated with air and natural gas and the error curve was shifted to get it inside the allowed limit by changing the pair of gears. No explanation had been given why the drift occurred in the meter.

6. INSTALLATION EFFECTS

During the long lasting investigation the installation effect to the turbine meters was also examined. The meters were installed with about 20 D straight pipe section upstream. Tube bundle flow straightener was installed in the straight pipe section at the distance of 5 D upstream the meter. There is a Y-form strainer upstream of the 20 D section.

Serial test had been carried out with flow straightener installed and removed and also with strainer basket installed and removed. In fact no significant installation effect was discovered.

7. SUBSEQUENT TURBINE METER TESTS

By the end of the year the recalibrated meter No. 60420 was installed into the working meter run again.
At the same time the turbine meters installed at the first Austrian in-take station and originally calibrated at Westerbork facility had been recalibrated at the Pigsar facility at 50 bar. One of the turbine meter has been replaced by a new one also calibrated at Pigsar.

Fig. 6. shows the influence of the remedial action taken to the unbalance of the pipeline. The firs positive step into the direction of decreasing of the unaccounted for gas was the installation of a new, calibrated at 50 bars, turbine meter at the Austrian station. The second important step was the removal of one of the working meter at the Hungarian station from the operation. It was the meter No. 60419 which showed negative drift, less then the meter No. 60420 but still not negligible. It has been replaced by the meter used earlier as the master meter (No. 60421).

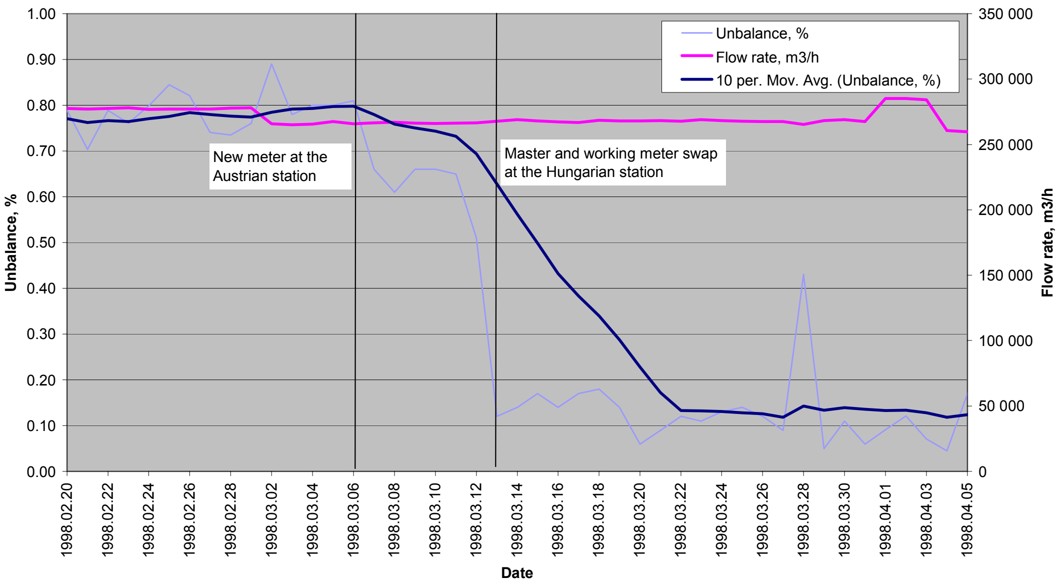

Fig. 6. Unaccounted for gas during March 1998

Thanks to the above mentioned actions the unbalance of the pipeline reduced to the acceptable level. It remained within +/-0.3 % during the whole period of subsequent operation.

Fig. 7. indicates the serial test results of the turbine meters from the very beginning of the operation up to the recent days on the Mosonmagyaróvár station.

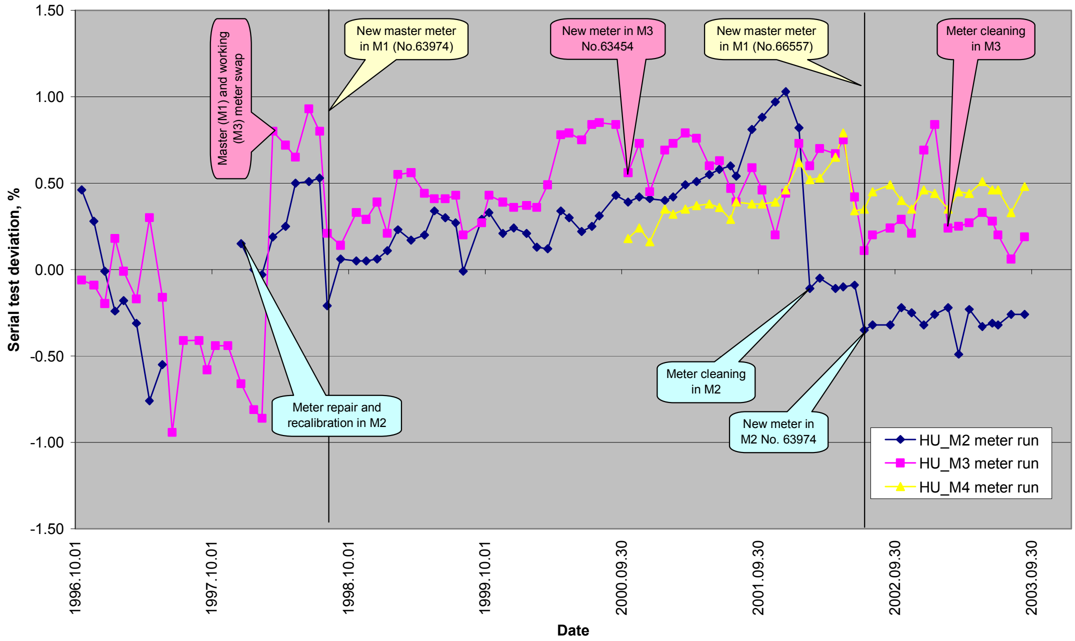

Fig. 7. Serial tests at the Hungarian station

As can be seen some drift of the turbine meter occurred during the subsequent years as well. E.g. from June 2001 to the end of that year the drift of the meter in meter run No. 2 increased to the limit of the acceptable level. After removing the meter from the meter run it appeared that some kind of liquid formed a thin layer on the internal wall of the turbine meter. After thorough washing the internal of the meter the subsequent test showed that the turbine meter returned to its original condition The same thing happened from November 2002 to January 2003 on the meter run No. 3. The washing helped again to recover the turbine meter.

Fig. 8 shows the process of disappearing of the accumulated unaccounted for gas.

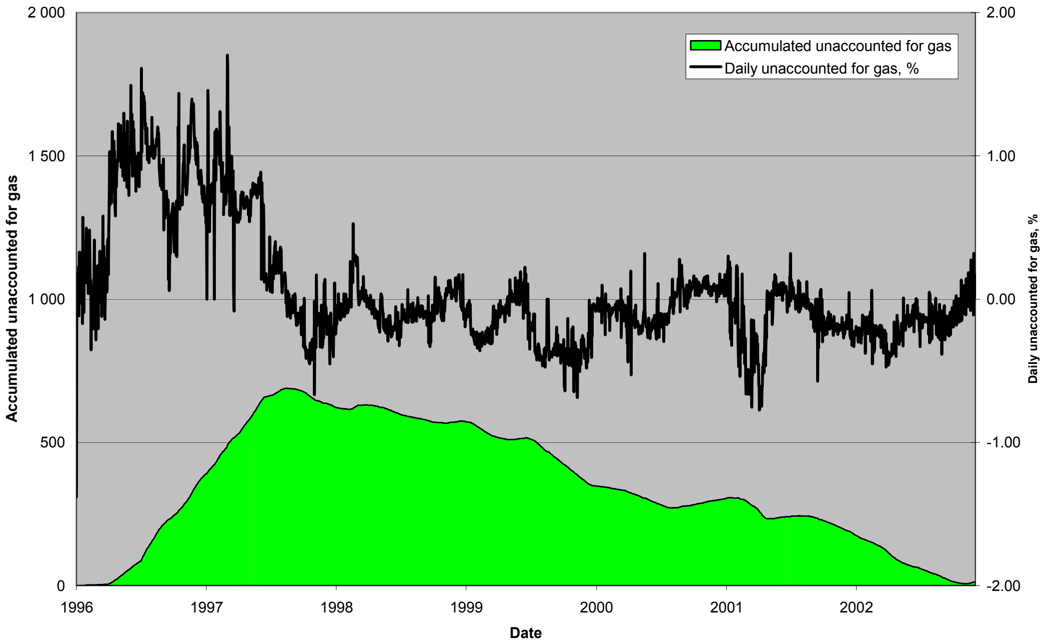

Fig. 8. Accumulated unaccounted for gas

8. CONCLUSIONS

During the first 1 – 1.5 years of operation the turbine meters at the Hungarian metering station indicated remarkable drift in the error curve. The reason for this drift could be some “break in” period for the turbine meter or, and this is more likely to be the case, the liquid and/or solid pollution coming out from the pipeline after the construction works. Although the pollution usually speed up the meter (as it could be seen during the subsequent years of operation) in this particular case it slowed the meter.

Operating turbine meters, one should never forget that the manufacturers usually state that the turbine meter is intended to use for measuring dry and clean gas. As far as no ideally clean natural gas exists in practical life maintaiing the required accuracy requires permanent attention tothe meters. The thorough analysis of the balance of the pipeline system and the regular serial tests help you to identify any inconsistency in your metering results.

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.