Status and trends in Technology and Applications

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Introduction.

Well, the best trend is possibly seen from the programme of this years workshop:

Out of 5 papers in the 'Multiphase Metering' section of the workshop, three papers are reporting on experiences from implementation or operation of multiphase meters, two are presenting methods for improving the performance or better understand the data from multiphase meters, but no papers are presenting completely new technology.

Further, one could read a trend from the fact that while the multiphase metering papers cover as much as 20% of the conference papers, an exact equal focus is on wetgas metering, being the high end GVF of multiphase metering.

Now I should really stop, and leave it up to you to work out the trends from these facts. However:

Suppliers: From a few to several, and back again?

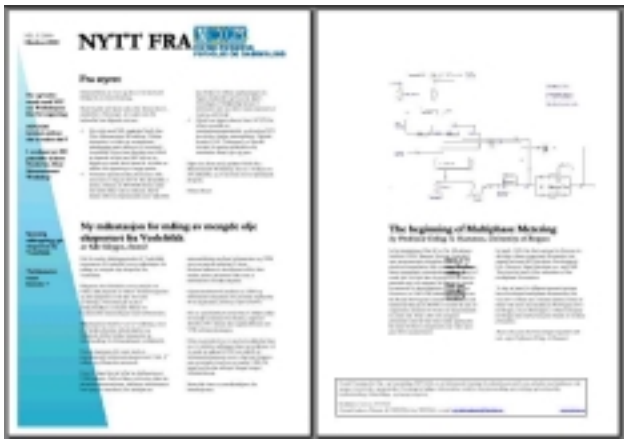
The first one to come on the market with a multiphase meter was Euromatic, which was commercially available already before 1990. Since then several concepts have been developed into commercial product and gradually entering the market. Even over the last few years we have seen newcomers, like Haimo from China, and latest Flowsys from Norway.

But from this it would not be correct to conclude that the number of suppliers is increasing. Several of the concepts have never reached a mature stage, some concepts have become products, but have later been withdrawn from the market, Euromatic being one of them. Both technical problems, company resources and market size have forced this development. Over the last few years, the market has been dominated by a few, being MFI (Roxar), Fluenta, Framo and Agar.

Over the past few years we have also seen some restructuring among multiphase metering suppliers. In 1997 Kvaerner Oilfield Products signed an exclusive licence agreement with CSIRO (Commonwealth Scientific Industrial Research Organisation) for the Gamma-Ray Multiphase Meter. The CSIRO multiphase meter is later known by the product name Kvaerner DUET MFM. At that time, Kvaerner had already developed a multiphase meter based on partial separation using a cyclone separator, and a Phase Dynamics water cut meter. This meter is now jointly marketed by Kvaerner as the Compact Cyclone Multiphase Flow Meter (CCM).

Also in 1998, another restructuring of the mfm suppliers was seen, when Schlumberger and Framo Engineering announced the merger of their technologies and manufacturing expertise,

and initiated the 3-Phase Measurements AS as a common resource centre for the two companies.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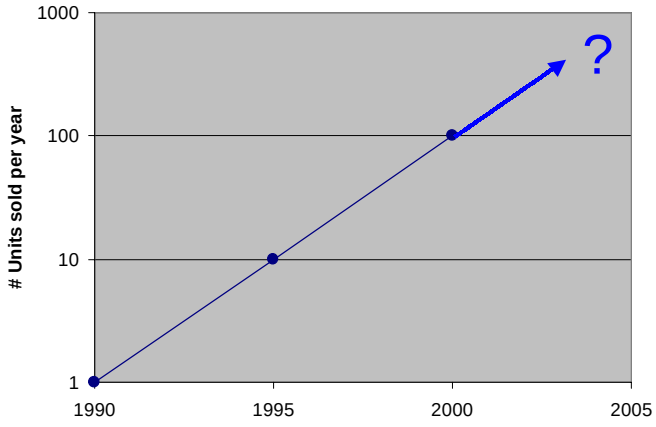
In the always well informed quarterly magazine "Nytt fra NFOGM", the always foresighted Prof. Erling Hammer said: " Those who join their knowledge together will win" (October 2000). Taking Prof. Hammer's advice very seriously, Roxar and Fluenta in February 2001 made the following announcement "Fluenta and Roxar join forces".

Roxar was established only two years before, in 1999, as the merger between Smedvig Technology and MultiFluid ASA. The Roxar acquiring of Fluenta, therefore in reality resulted in the merger of MultiFluid and Fluenta, two of the major competitors within multiphase metering. The merger gave birth to a new company named Roxar Flow Measurement AS, wholly owned by Roxar ASA.

So we conclude to see a trend of consolidation among metering suppliers. The reason for such consolidation is the high development costs, high market introduction costs, and a conservative market that has not been growing fast enough to sustain growth of all these suppliers. At the same time, the expected growth in this market demands suppliers with financial strength to build the required support and market network.

Market: From 0 - 100 in 10 years



Going back to 1990, the development of multiphase meters was still in its early days. Hardly any commercial supplies had been concluded. Five years later, the total world market had grown to some 10 meters per year, increasing to around 100 another 5 year later, in 2000. In current year we will most likely see close to 200 meters sold worldwide.

So which trend to we see in the market growth? Is it really exponentially? Could we expect it increasing to 1000 in 2005?

Status of technology: From pilot installations to state of the art

The large increase in number of meters sold over the last year is a clear indication of the technology being recognised as proven technology. Increasingly we see batch orders of 10 or more meters. After concluding years of r&d projects, laboratory testing and pilot installation, more and more operators now announce multiphase metering as proven technology. By this, the decision to use multiphase meter on a new project, or indeed on an existing field, is moved from the "new technologies" departments to the actual projects and operators. This does of course not mean that any multiphase meter is a approved, and new meters entering the market must still expect to be subject to extensive testing and pilot installations before being approved.

So there is a clear trend going from single unit purchase for evaluation purposes, to batch orders to engineering or system supply contractors, according to a list of approved vendors. The days of pilot installations for evaluation of the technology are (nearly) passed.

Operator experience: From Toy to Tool

As already discussed, several of the early multiphase meters were installed in series with a test separator for evaluation purposes. In these cases, the data from the multiphase meter is usually collected and analysed by "the technology department", and are offline compared against test separator readings. Discrepancies spark off a lot of questions, which are not always easily answered. In addition potentially problems with the multiphase meter itself, commonly the problem is found in the operation of the test separator (level control, carry-over, insufficient stabilisation time etc.), or in the conversion between different process conditions of the mfm and the test separator.

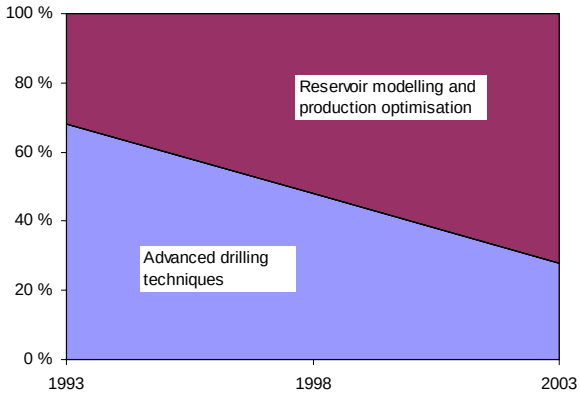
All the same, the test separator is the one accepted as the 'true value', and is the one that has to be used by the operator in his day to day operations. For many operators, the pilot installations of a multiphase meter has therefore been more of a hassle than help in their operations. The pilot meter has been regarded as the new toy of the "new technologies department".

Installations where the step of omitting the test separator and test line has been fully taken, are often the most successful ones. Someone might say this is because it is then not possible to validate the multiphase meter performance. I would rather claim that this is because the meter has then become a vital tool for the day to day operations, and that the operator will then take ownership to the new technology.

Having access to the new technology, many operators have learnt the value of real time data, and how it can be used to optimise well production, and as a tool for rapid identification or 'debugging ' of problem wells.

Production optimisation: From advanced drilling to reservoir monitoring

”Why install a multiphase meter, when we already have a well established and proven technology at hand? Why take the risk?” In the concept studies of new field developments, these were common questions just a few years back. Today this is turned upside down, and



the similar question would rather be: ”Why not use a multiphase meter, omitting the test line, test separator and associated equipment?”. In fact, several of the marginal, often remote, reservoirs would not be economically feasible without the multiphase metering technology.

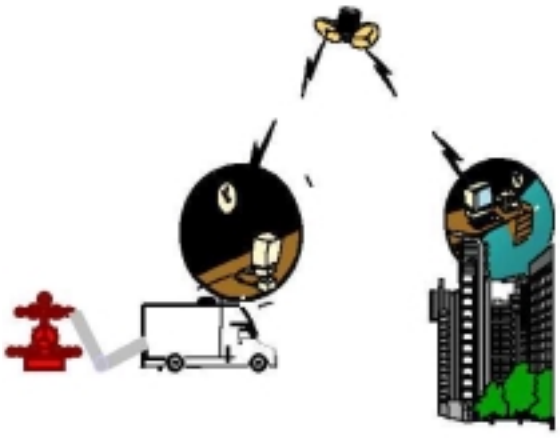
In addition to the obvious capex and opex savings, the frequent availability and overall quality of well test data leads to improved well and reservoir management, increasing the expected recovery from the field. Horizontal drilling, multilateral wells and other advanced drilling methods have for some time been dominating in the strategy for reservoir recovery optimisation. It is however expected that production optimisation strategies, based on reservoir modelling and online monitoring, will increase the recovery factor even further.

Well testing: From fixed installations to mobile well test service


Courtesy P. Mehdizadeh

We have already mentioned Schlumberger and Framo merging their technologies, and on basis of this they developed the VenturiX, which was brought to the market in 1999. The VenturiX is the heart of the PhaseTester, offered as a mobile well testing service by Schlumberger (see picture). With this service, the multiphase meter replaces the traditional setup using mobile test separators, allowing metered fluids to o be returned to the pipeline without pumping of liquids or flaring of the produced gas.

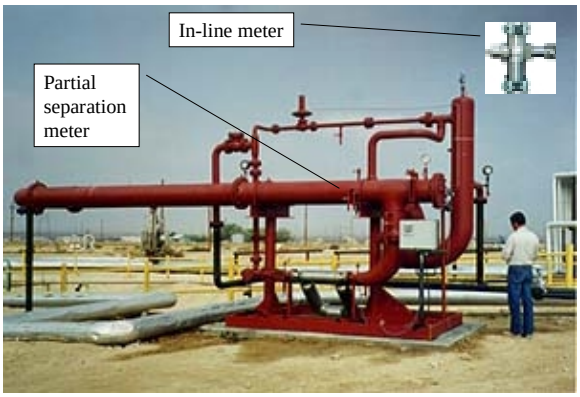
The mobile well test service dramatically reduces manpower requirements, rigging time and required test time for each well. Compared to the traditional well test service, the well testing by use of multiphase metes also give extra information from the instantaneous feature of the measurement, e.g. by monitoring of water or gas slugs for optimising operation of the well or pipeline.



At the 1999 NSFMW Pemex reported of their positive experiences using FMC as service provider with Fluenta meters. Several other well test service providers, like Halliburton, GeoServices and Expro North Sea, are also entering this market, not only for production well testing, but increasingly also for exploration well testing.

Technology: From a dinosaur to a highly intelligent mouse

Going back a decade, the first multiphase meters were designed more or less as compact versions of the test separator. Partly separation, mixing, by-pass flow lines and modified single phase flow meters are key-words for early meter designs. The trend since then has been towards mechanical compactness and simplicity, avoiding mixers, by-pass lines and mechanical type single phase meters.



It seem however that the partly separation type meters are surviving, and may find their niche in the market. In particular this is for the very high GVF, i.e. above 90% GVF, where the performance specifications of in-line meters tail off. Another advantage of the partly separation type meters are that they will significantly extend the range of a standard in-line multiphase meter.

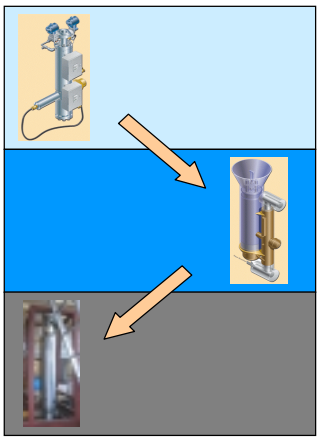
Some of the first meters on the market, being more or less compact test-separators as described above, were huge compared to today state-of-the art. The prototype 1990 model Texaco subsea meter was some 10x10x2,5 meters in size, and weighed around 45 tonnes. Also the meters of WellComp and Accuflow (large picture) are large compared to the in-line meters we see today (small insert picture). In-line meters will typically replace a section of a pipe, in the order of one meter long, depending on brand and pipe diameter.

While the early meters, with by-pass, mixing etc., did not require sophisticated computing in order to derive the oil, gas and water flow rates, the newer generation meters are consistently adding more advanced computing and signal processing. At last year NSFMW we even learned about multiphase metering by pattern recognition and neural network technology. Advanced signal processing is required for in-line meters without mixing to compensate for the otherwise significant effect of complex, chaotic and unpredictable flow regimes.

Intelligence is also built into the meters in order to improve reliability by self-diagnostics, and for improved performance by automatic compensation for changes in influence parameters, e.g. by implementing a PVT package. The user interface is becoming increasingly user-friendly, guiding the user through the set-up meny, and providing expert advice if something is wrong. Meters will typically also allow remote access through internet or a dial-up connection, allowing remote service and automatic generation of test reports or self-diagnostic data automatically transmitted by e-mail.

Technology: From topside to downhole

Even before the mfm technology was fully mature and qualified for topside applications, the first subsea installations were a reality. For some of these early installations, lessons have been learnt the hard way. However, this offensive approach, driven by the huge cost savings potential and operational benefits, has helped mature the technology much faster than it would otherwise, and today an increasing number of subsea meters are in continuous operation world-wide.

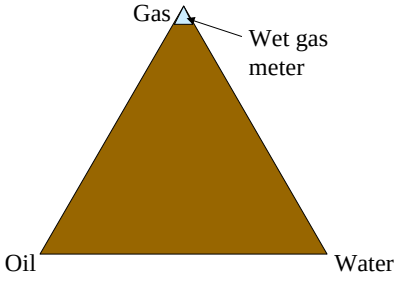


Permanent downhole monitoring can give several advantages in field development, such as increased flexibility in the development of multilateral and horizontal wells, optimisation of artificial lift systems and monitoring of multi-layered wells. Consequently there is a drive to move multiphase metering technology downhole.

As part of a long term strategy to develop such downhole multiphase flow rate meter, Expro North Sea and RFM have developed a downhole watercut meter. The first one was deployed in May 2000 at the Texaco Captain field, and is still providing quality data.

From multiphase to wet gas

Several of the applications for multiphase meters are at very high GVF, operating from 95% GVF up to and above 99%. Due to high repeatability, multiphase meters can often provide sufficient quality data for some applications, e.g. well control, even at this GVF.



Passing 95% GVF, one enter what is termed ‘wet gas’. Although wet gas in principle is just a special application, targeting just a corner of the three-phase metering triangle, a whole range of new metering concepts is entering this ‘niche’. As new gas fields are developed with minimum or no facilities, and with transport of the unprocessed gas over long distances, there is an increasing demand for accurate wet gas flow meters.

Concluding remarks

The driving force behind the development of multiphase metering technology over the last 15-20 years, has been the potential of cost efficient field development by omitting costly test lines, test separators, etc. This technology is now at hand, and multiphase metering is increasingly gaining acceptance as an alternative to the test separator. Operational experience is increasing by the day, as is the experience in implementing this technology in various applications.

Still, one should not overlook the potential problems and risks involved in implementing new technology. There have certainly been technical problems experienced with the different products, and there have been problems with interpretation of the results from the multiphase meters, and how to compare them with the ‘traditional’ readings. All of these are problems further described in papers later today. In many cases it is only the persistence of some entrepreneurs that have made the application successful. But these entrepreneurs have paved the way for those to follow, so listen carefully, and learn from their experiences.