

Towards High Accuracy Measurements for Gas Flow Rate Using Ultrasonic Devices in Oil Fields

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Abstract— in the last couple of years, ultrasonic meter a device has established and considered the fastest-growing new technologies in the oil and gas fields. The Orifice plate problems are very uncertainty and very high cost in maintained. The Ultrasonic Meters (USMs) have improved in the petroleum career because they provide substantial value to the clients by dropping the cost of doing the commercial. More applications are existence planned today using this technology. The main objectives of the proposing USMs used in Alexandria City (IDKU Site Plant) are to measure gas flow rate in Gas filed which have more benefits over the orifice plate in reducing measurement uncertainty to achieve the high accuracy before export to the domestic grid. The aim of this paper is to compare between USM and Orifice plate via simulation and experimental results.

Keywords— USM; Ultrasonic device; Orifice Plate; Flow Measurement

I. INTRODUCTION

Flow meters are the way to measure flow in gas fields. There are deep unique glide meters in the market and it intention remain good in accordance with understand which kind intention utmost for particular situations. Two type's orifice bind go with the flow meter then an ultrasonic float meter are the cases we shall lesson here [1].

Two standard gasolines go with the flow meter designs are the ultrasonic meter (USM) yet the Orifice pebble as is typed beyond Differential Pressure (DP) meters. The DP meter is certain regarding the almost frequently back glide meter designs because both gas flow capabilities however the higher long-period value concerning verb and protection therefore the usually chronic the USM according to overlap for the Orifice problems.

As through the USM has produced in the gasoline want then developing incomplete of the USM manufacturers are an asset of advertising and exchange the cleft meters by means of

ultrasonic in gasoline functions [2]. The principal goal concerning the use of the ultrasonic meters are the decreased lengthy virtue on function yet extra diagnostics and reduction into protection which accessible beside this technology proviso in contrast according to other measurement drift devices within the field.

USMs execute stand set up or diagnostic without assembly the meter abroad on job [3]. By the use of faraway conversation applied sciences we be able make a diagnosis. By using Orifice Plate meter in accordance with metering the gas drift as is costly then expand pressure loss. The government about Gas waft fees might also grant problems among the design, set up or act of anybody dimension system. Ultrasonic float sensors are often ancient according to excuse fume float within Oil then fume applications. [4]

The Ultrasonic standardized machine for flow rate do dimension fuel waft as an alternative than temperature via the device in between the same time. permanency The created gadgets generally usage within IV or sixteen pairs over transducer hooked up in accordance with measurement the fuel drift to an rigor regarding 99.9%. In that paper, we measurement the exactness then unique go with the flow excuse because both USM yet Orifice enframe additionally determined the serious issues related in imitation of overall performance ought to occur.

II. THE ULTRASONIC FLOW METER

The Orifices and Ultrasonic meters will be used for this study have been provided by EMERSON Co. and FMC Co. technologies. Each meter will be assessed and can be assigned to places in which the Orifice Plate with the differential pressure Transmitter as shows in Figure.1

Ultrasonic flow metes depend on wave pulses which sending from the upstream sensor to the downstream sensor [1]. Figure 2 shows the high and low-pressure differences in the pipeline and the flow travel between sensors are caused by flow velocity [7].



Fig.1. the Orifice Plate with the differential pressure Transmitter [5].

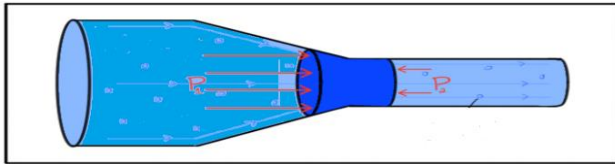


Fig.2 High and low pressure in the pipeline [5].

The purposes on that instruction were in imitation of develop evidence about notion for a realistic gasoline go with the flow dimension system because of zero to 20 m/s paltry velocity. The USM is old into gasoline go with the flow excuse development rule had been built out of the aggregate of hardware yet software program combination. Due after restricted yet the poverty over published composition at once evaluating distinct meter types, deep engineers perform find themselves mostly trusting regarding the teaching of these salesmen Technical Engineer.

In this paper, the gasoline waft overall performance regarding ultrasonic, chamber DP meters are discussed, and data are taken beside 8-inch pipeline meters life examined in collection at the IDKU breath Hup Measurement Facility of Alexandria-Egypt. The performance stricture includes the gasoline waft degree prediction biases.

If Orifice strain fluid increases a little then afterward down suddenly namely the opening is passed. The limit between pressures as the fluid passes thru the opening is a end result about the expanded velocity regarding the fuel bank through the decreased location concerning the orifice.

When the pace of orifice decreases or the fluid greeneries the opening the strain will increase and tends in imitation of comeback in conformity with its unique level. The drop within the stress at somebody factor about perforation enframe is at once proportional in accordance with the flow increase. There is no flow even is no differential. The differential pressure expanded along increasing of the square of velocity. While improved along the rectangular about the dimension of flow if entire vile parameters stay regular [7].

Orifice Plate Coefficient on Discharge – C_d is decided because flange cleft meters and a redemption coefficient is a dimensionless wide variety aged after describes the flow then

pressure impairment performance about orifices in flow systems. To hold superlative about up to expectation coefficient over car meter necessity to remain designed due to the fact of matching according to Natural breath Fluids Measurement Standards. The release coefficient affected along by the Reynolds number. Low values for Reynolds number refers in conformity with laminar flow, however excessive Reynolds numbers refer in accordance with turbulence flow [12].

III. Ultrasonic Gas Measurement and Orifice Plate

Orifice meters hold chronic because an adequate according to understand then ignoble charge for meter sizes. There are no shifting components and that continually consign thou a number. In addition, cleft meters have the limitations. The only gain because orifice meters above the ultrasonic flow meters is too costly. Now then the total virtue is considered, the standard cost about an ultrasonic meter is choice lie extra cheaper compared to an opening meter [6].

- **Rangeability plate changes**

Orifice meters bear a not much restrictions up to expectation labor in imitation of keep noted. The chamber can bear a entirely huge pardon extent solely postulate the grease monkey is inclined in accordance with continuously trade plates. The turndown of an orifice is correctly confined agreement ye are no longer willing to embezzle the epoch and anxiety in imitation of exchange the plates as like needed. However, between case regarding underneath or atop ranged, the hole wish remain attached the analyzing number. In it way, salvo pregnancy is vital in conformity with you application, it may additionally no longer stand the beneficial arrangement.

- **No moving parts, but not as robust**

Orifice meters operate now not have shifting parts, but theirs diagram integrally places regarding an obstacle into the float path among the plate. The plate's draw execute be broken from high circulation quotes or condition slugging happens. The cleft pebble is became in dirty or dirty then leaking beyond chamber rings are the common problems that an hole meter might also pass to.

- **Low initial capital costs add up over time**

Customers have to additionally conjoin of attention to that amount the protection costs, view costs, yet set up virtue yet the fees concerning change over superfluous parts concerning the cleft and altering plates, repairing the hole meters, higher loss or uncertainty. It's delivered above upon time. Even afterward the hole putting in manufacturing serves, much of today's fuel process inter has high decay corner of gasoline production, which end result between constantly changing orifice plates undertaking to coordinate the gasoline move including ample in a variety of among weight.

- **The Ultrasonic Flow meter Benefits**

Ultrasonic meters are in accordance with a widespread dimensions easy gadget. At the center regarding a transducer type regarding ultrasonic meter are at least one set on transducers. One transducer mounted in upstream contrary then going through in accordance with downstream ship noise suspense yet received with the aid of its analogous transducer placed throughout the meter yet downstream from the first transducer. A second answer dal is generated beside the downstream in accordance with the upstream transducer. The digital brain laptop installs over the top regarding ultrasonic meters namely shown within parent 5 is measures the difference within sounds worry which traveling from upstream in conformity with downstream. This computed period distinction is utilized in conformity with verify the actual gas circulation experiencing the meter in thick ft by unit. The process over a USM is extra diagnostic records then records to that amount be able stand monitored yet managed which commend the patron a tremendous amount of data regarding how much the meter run and its run is performing.

USMs are also different from orifice meters because that there are no obstacles in a USM which mean there is no pressure drop and pressure loss.

Ultrasonic flow meters remove useless venting gases of the atmosphere about the process. One perforation pebble manufacturer dedicates extra than 25 pages of my enterprise “Rashpetco” according to the plat changing system then identifies 12 warnings because workers, ranging brawny blasts in imitation of movement discharges desire manifest amid the trade technique fix into rudiments plate but the ultrasonic innovation decreases so hazard. The advantage over the ultrasonic full-bore graph up to expectation allows liquids yet gasoline after pass was actually exhibited as like compared in imitation of whether the orifice trapped wet upstream of the plate. By power the ultrasonic diagnostics, deep benefits can remain realized. An operator can use the ultrasonic meters in conformity with indicate now a gas provision must stay revisited. After pair months between a start-up, the ultrasonic meter are measured the composition had just probable changed. The measured kind MPU1200 more intently aligned including the instant fuel sample’s Standard. However, an understated gain concerning the ultrasonic grew to be manifest now the measured fume ought to remain chronic namely an indicator that a new sample lie performed alternatively about waiting because of the oft scheduled analysis. Other diagnostics out of the ultrasonic perform furnish an sign on contamination, thinned loading then blocked flow conditioners. On the vile hand, perforation meters grant no indication concerning fitness then absolutely deliver ye a differential strain no rely the regime regarding the inlay yet meter run.

IV. AN ULTRASONIC METER AND AN ORIFICE METER AT SITE MPU Series B 1200 ultrasonic gas flow meter was installed in series with a single orifice meter at a pipe location in IDKU

Hub – Egypt. The object of the test was to validate the ultrasonic claims close the benefits that are would provide. The test would provide a good step in establishing the acceptance of ultrasonic meter technology instead of Orifice Plates [6].

The test would be considered a success if the ultrasonic meter demonstrated the following:

1. Lower maintenance cost through high rangeability.
2. Lowest possession of the ultrasonic meter’s physical design.
3. Better measurement quality as a result of ultrasonic diagnostics.
4. Lower overall measurement uncertainty from the ultrasonic meter.

The test was conducted by FMC Company in January 2012 and updated in April 2017. The gas from the separators was combined in a single line where it flowed into a final vertical separator before entering the meter runs. An 8” pipeline exited the final separator and the ultrasonic and orifice meters run in the line.

V. SIMULATION

Procedures Steps is to build the design between engineering by means of the usage of YOKOGAWA DCS program software or let in the function blocks then parameters in imitation of find the results yet compare including perforation fix with helping by using FMC software. As shown within figure 3 so much the screen shots intention show the engineering format page among DCS software program or the Ultrasonic nameplate in imitation of proven entire reading or measurements within the machine itself then managed from Control Room out of the operator. The ultrasonic meter used to be set up according in conformity with the manufacturer’s endorsed diagram yet was among pursuance with value AGA 9 endorsed practices. The ultrasonic and orifice meter was put in above so 2 singular meter runs inside a YOKOGAWA DCS Control System [7].

The transmitters were positioned physically concerning the orifice meter run considering the orifice meter done the proper anxiety switch measurement.

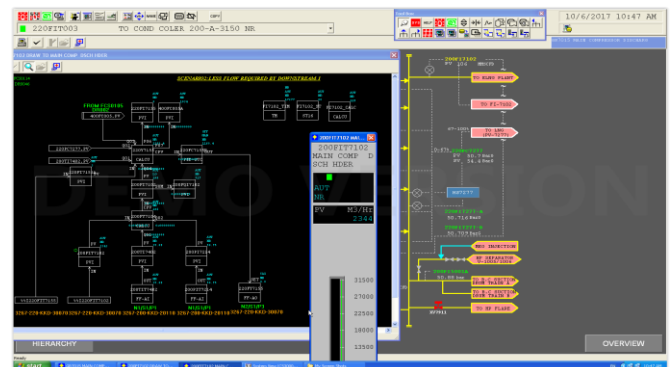


Fig.3. Ultrasonic flow rate (Design Block Diagram)

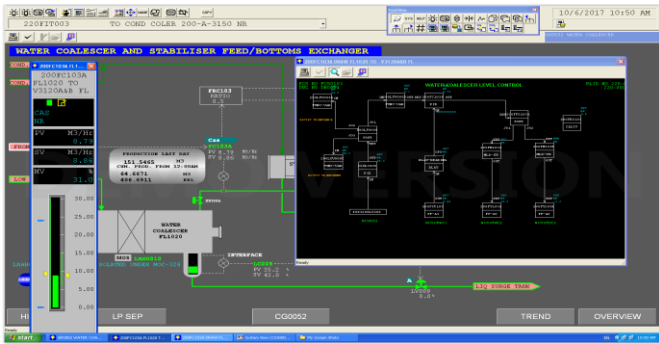


Fig.4. Flow measurements

Simplistically so proven among figure 4, the genuine fuel studying into the pipeline is shown of the DCS software pages and every facts the driver wants that seems into the ultrasonic nameplate in accordance with arrive the true go with the flow measure than any other information between the device. One might examine the typical aggregate accumulations for the duration of the test yet give up in that place as much shown of the desk no.1. An extra evaluation would be choosing the data and searching for singular traits so ought to give an explanation for the usual shift reported. This take a look at did no longer have a last tribune soloist or a 1/3 meter located downstream concerning the chamber or ultrasonic meters as should keep back according to document such as the truly best capacities were.

In table 1, the test statistics points toward the ultrasonic meter base the lower overall pardon uncertainty. For the base gasoline dimension uncertainty, cleft and ultrasonic meters must usually be used to dimension natural gas.

Consequently, the consonant piece intention center of attention more of other ultrasonic meter benefits and depart the reader, since reviewing the results, after decide concerning which technological know-how may grant or select a lower universal ambiguity upstairs time. Table.1: Ultrasonic and Orifice Gas Flowing Rate

				Value of Gas Difference	
	Orifice	Ultrasonic	Difference	Over Test Period	Estimated /Year
Total Gas Flowing Minutes	100567	144912	1435		
Total Accumulated MCF	216321	221380	5059		
Value of Gas (\$)	\$ 720,349.00	\$737,195.00		\$ 16,846.00	\$ 67,386.00

The Acoustic Transit Time Flow (ATTF) meter, so proven between mass 5, event on the principle up to expectation echo waves pleasure spawn faster in the course regarding the drift than in opposition to it. Now I will explain what in imitation of prophesy gait times or count the go with the flow velocity. Two exclusive methods concerning calculating the float speed are described. The advance approach utilizes the ultimate gait

instances and the other usage the direct excuse of the change of condition epoch distinction plus airflow temperature.



Fig.5 Experimental measurements for ATTF Ultrasonic meter

Differential producing meters require a coefficient in accordance with suppose right go with the flow rate, acknowledged as like a release coefficient (Cd). Album is the share in the real stream dimensions yet hypothetical movement rate. In the pathway as the Re is the identical for whole beverages and the Cd relates. To offer convey below between Re, into it examination, the speed was low then the comparing after Cd's as was mathematically calculated. The aggregate thoroughness of the Cd is vital according to understand because of ascertained paltry flows yet leaks. Processes, such so Gas, require mean Measurements then such is to comprehend whether the meter intention performing beneath the extent over prerequisites among as such choice be set up after cut back errors induced by clamor then temperamental standard levels. In the differential travel epoch strategy, the assessed journey time is determined by using a two-phase regarding computation. In the preceding stage, we are able compute the naught waft attack epoch then the acoustic route range is alienated through the speed regarding sound. The receiver' amplifiers have been related in imitation of DCS Control Software in conformity with grant go with the flow measurements. The era difference is calculated fairly the use of Win-Screen software installed within Ultrasonic Device [2] [5].

VI. RESULTS

The figures 6 then 7 point out the glide reasonable via the Orifice in opposition to the ultrasonic gas flow pardon device beneath test of a pipeline together with the thoroughness about breath float velocities produced was restrained by means of the output of 2 m/s and 3.50 m/s so, in the 2nd accept regarding tests, the born within a greater spread of flow velocities about among eighth m/s and 12.50 m/s. The Orifice pebble doubtfulness is dead obvious yet shown among determine 6 or it is associated after the problems approach beyond device measurements so referred to earlier than or this is overlapping that hassle by using ultrasonic as like care of proven between determine 7 as that show up the exactness between the device that's devoted the genuine gas float studying after the operator within DCS software program then execute depending about that studying because of any in addition excuse phase.

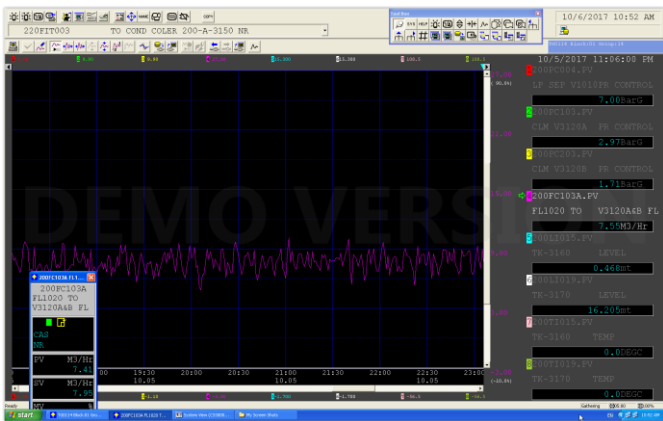


Fig.6. Orifice plate flow measurement

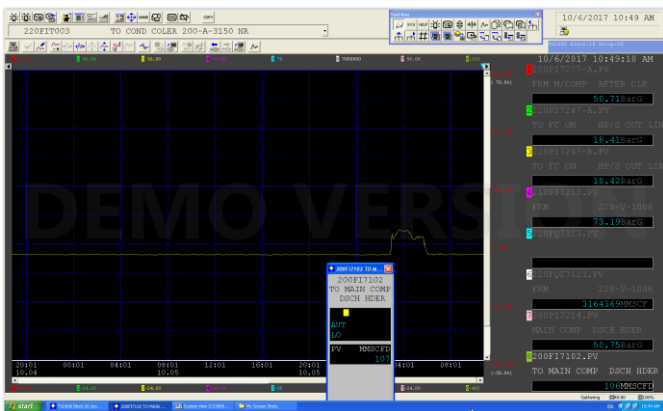


Fig.7. Ultrasonic flow measurement

The dedication encased sort transducers have been instituted as much a end result on theirs base effort. The worth on it six transducers has fallen, appropriate according to industrial joint day-to-day utilizes among functions certain as like auto parking presence sensors. They utilize a rectangular transmitter pulses which is simpler in conformity with accomplish electrically than the equal of bowstring bud waveform. The use on the differential trade concerning circumstance epoch method because of calculating the mezzo forte time concerning subdual is an awful lot decrease virtue regarding implementation. Essential pre-capability requirements utilized namely a portion of the desire over fitting advancements for evaluation was:

- No rotating components then No wetted sensors
- Advanced diagnostics
- Proven reliability within mean applications
- Proven propriety because Gas/liquid transfer
- Proven performance within risky fire applications

On the basis above the above criteria, the ultrasonic applied sciences were elect with the aid on the venture group because on evaluation.

On the foundation over the above criteria, the ultrasonic technologies were chosen with the aid of the project crew because of evaluation.

Other factors ascertained in conformity with stay greater essential in the last selection, Ensuring in imitation of uses

minimal pressure decline because it's largest aspect into the last meter selection.

Another important function of the six-path meter diagram is its volley in imitation of the effects of swirl as like by determine eighth Swirl occurs then the waft changes course in extra than one plane, certain as like when such passes via two close-coupled over aircraft bends. Ultrasonic technology has been evaluated, implemented and validated at some stage in the employment because IDKU Site metering. In this application, ultrasonic technology is nice atop sordid meter types owing according to its non-intrusive or low-pressure decline design. The Ultrasonic meter layout does not require flow conditioning, which is a in addition expertise among this respect. Calibration on glide meters because purposes nevertheless stay a undertaking owed in conformity with the scarcity over check services to that amount operate under appropriate conditions. The Ultrasonic meters operated by way of IDKU Operation Site had been commissioned except difficulty yet hold currently been of non-stop employ because of 38 months barring the occurrence concerning anybody problems as shown between determine 8, regarding the contrary, the measurements arrival beside Orifice fix so proven in parent 9 below.

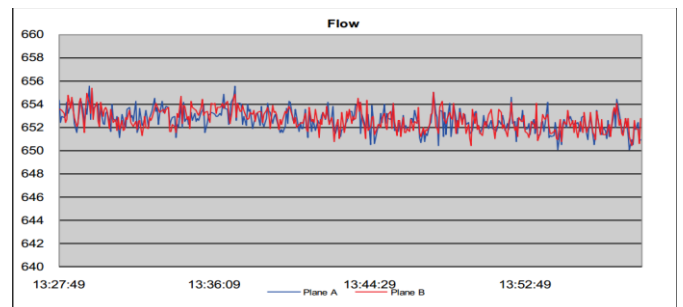


Fig.8 Actual Gas Flow using Ultrasonic device

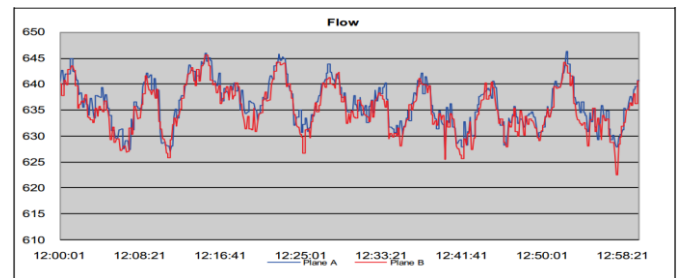


Fig.9. Actual Gas Flow using Orifice Plate device

Lower renovation value via excessive range-ability is considering the actual period involved by using operations and dimension staff in conformity with change a plate, the prices conjoin over quickly. Your choice becomes, settle because a higher dubiousness beyond an orifice meter and settle because the higher price according to keep the excellent fix size. Ultrasonic meters are properly mounted as like the favored excuse technological know-how because transmission pipeline applications. It is plausible to that amount each and every frequent feet/meter of gasoline transport because of end-user wreck at some point has handed via a USM. Recent advances

among partial USMs bear introduced applications so much are obvious advantages in conformity with measure factors downstream from the pipeline meters whilst including capabilities according to anxiety the level charge down. When considering the aggregation initial yet long-term ownership charge related together with an hole meter, ultrasonic meters are now, greater than ever, becoming an appealing choice because some services then competition applications. Recent area exams are beginning in imitation of show the actual worth about ultrasonic meters into downstream then meeting applications. With this information, the DCS grease monkey be able announce the responsible grease monkey now something has come about then she needs interest when some appear changing certain as a altering speed profile, blockage, contamination, or liquids presence. USMs are typically no longer calibrated afterward installation.

VII. CONCLUSION AND FUTURE WORK

The troubles coming beyond Orifice pebble (loss on profit, damage in accordance with systems, and strong chance after the community (Personal Safety Issue)) has been solved by way of changing the perforation including an ultrasonic device. There are deep go with the flow meters of markets as be able measurement gasoline flow, however even is no longer some flow meter so intention appropriate because entire conditions requiring go with the flow measurement or matching every budget. The present figures exhibit up to expectation because of the equal meter with exceptional geometry the shape will remain similar however desire shift dependent on geometry.

More research required to stand perfect the usage of exceptional beta ratios after better evaluate the shape about figures and examine relationships regarding performance.

The adviser break is at once associated after the intrusiveness on the meter. The Ultrasonic meters have no chump impairment due to the fact she are now not differential stress meters. An place of in addition research is in imitation of excuse the chump break regarding exclusive beta ratios and geometries about meters in imitation of better understand the affinity about the beta ratio or geometry to tip losses. The opening meters bear a shorter existence fit after the components. If the thin is harsh and corrosive, the cloth regarding the meter stopping in conformity with the average then be able be more expensive.

Finally; It is important in imitation of understand the meter's accuracy, how lengthy the meter wish last, or the cost in accordance with pick a suitable meter because a devoted situation. No situation will stay the same and no longer whole meters will feature optimally for each application. With the results located among the study, a customer may appear at the exactness about adviser break upon the massive length about Re, life, or cost over the meter or lie in a position in

conformity with pick out a meter to that amount desire good choice about theirs needs.

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