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Development of a Customized Net Oil Compensation Module–Based DCS Control System for Enhanced Metering Efficiency

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Abstract—Accurate hydrocarbon metering is critical to production monitoring, custody transfer, and regulatory compliance in the oil and gas industry. However, conventional metering systems are often challenged by multiphase flow conditions, fluid property variability, and inherent measurement uncertainties, leading to inaccuracies in reported production volumes. This paper presents the development of a customized Net Oil Compensation (NOC) module implemented within a Distributed Control System (DCS) framework to enhance metering efficiency and accuracy. The proposed methodology integrates real-time fluid characterization, advanced signal processing techniques, and adaptive compensation algorithms to dynamically correct raw flow measurements. Simulation and validation results demonstrate that the developed Net Oil compensation approach reduces measurement errors by up to 15% compared to uncompensated metering methods, while also improving operational reliability and reducing maintenance requirements. The findings confirm the effectiveness of DCS-based Net Oil compensation as a robust solution for modern oil and gas metering applications.

I. INTRODUCTION

Metering efficiency is a fundamental requirement for operational excellence, fiscal accountability, and regulatory compliance in the oil and gas industry. Accurate flow measurement directly influences production allocation, custody transfer transactions, and revenue assurance. Conventional flow metering technologies—such as turbine meters, Coriolis meters, and ultrasonic flow meters—are widely deployed across upstream and midstream facilities. However, their performance is often degraded under real-field operating conditions characterized by multiphase flow, fluctuating temperature, pressure variations, and changing fluid composition. (Silva, A. P. da, & Oliveira, E. C. de. (2024) &Wokoma, E. M. (2024).

These limitations result in measurement bias, cumulative volume errors, and frequent recalibration requirements. Net Oil compensation has emerged as a corrective approach capable of addressing these challenges by dynamically adjusting measured flow values based on real-time fluid properties. This study focuses on the development of a customized Net Oil compensation module integrated into a DCS environment to improve metering accuracy and overall system efficiency. (Amangeldy, B., Tasmurzayev, N., Shinassylov, S., Mukhanbet, A., &Nurakhov, Y. (2024), Khisty, V. H. (2024), &Yadav, S. (2025).

II. LITERATURE REVIEW

2.1 Traditional Metering Challenges

Several studies have highlighted the limitations of conventional metering systems under multiphase flow conditions. Entrained gas, water cut variation, and fluctuating fluid density introduce systematic errors that significantly impact measurement accuracy. These effects are particularly pronounced at low flow rates and during transient operating conditions. (Wokoma, E. M. (2024).

2.2 Existing Compensation Techniques

Traditional oil metering systems are largely dependent on manual calibration, lack integrated customized Netoil compensation Module for multiphase flow, and are prone to measurement errors and data latency (Wokoma, E. M. (2024), Rashid, R. Z. J. A., Mustafa, M., Ismail, I., et al. (2025). Such limitations adversely affect hydrocarbon accounting accuracy, leading to discrepancies in revenue sharing, regulatory compliance, and operational decision-making.

2.3 Research Gap

Despite advances in metering technology, there is limited research on the seamless integration of real-time Net Oil compensation algorithms within DCS platforms. Most existing solutions operate as standalone systems, resulting in delayed corrections and reduced operational flexibility. Also, there is

Inadequate Focus on Data Quality, Sensor Health, and Reliability. This gap underscores the need for an adaptive, control-system-based Net Oil compensation framework.

III. METHODOLOGY

A hybrid research design was adopted combining:
i. Analytical modeling, based on internationally recognized standards (API MPMS and ISO 5167),
ii. Computational system development, using SCADA/DCS logic and function blocks,
iii. Empirical evaluation, through operational data analysis and system testing using Kelton Metering Software.

This mixed-method approach enables both theoretical rigor and practical applicability, ensuring that the developed compensation model performs reliably under real industrial conditions.
The proposed Net Oil compensation framework was developed using a structured methodology.

3.1. Nature and Sources of Data

Data used in this study were obtained from both primary and secondary sources:
i. Primary data consisted of real-time operational data acquired from field instruments, including flow rate, temperature, and pressure measurements obtained through the SCADA/DCS system.
ii. Secondary data included design documents, process flow diagrams (PFDs), piping and instrumentation diagrams (P&IDs), manufacturer datasheets, industry standards (API MPMS 11.1, ISO), and historical production records.

3.2 Compensation Algorithm Development.

A customized Net Oil compensation algorithm was developed to dynamically adjust gross flow measurements in real time. The algorithm accounts for variations in temperature, pressure, density, and phase fractions, and was implemented directly within the DCS control logic to enable fast and reliable corrections.

Compensation modules are hardware/software units that apply correction factors to raw metering data. They rely on equations of state (EOS), empirical correlations, and calibration curves to adjust measured values.

Common approaches include:
i. API tables (e.g., API MPMS Chapter 11) for volume correction factors.
ii. Advanced signal processing techniques, including noise filtering and signal smoothing algorithms, were applied to raw meter signals to improve data integrity and measurement stability prior to compensation.

Data analysis involved both quantitative and comparative analytical techniques. Gross and net oil flow values were computed using temperature and pressure compensation equations. Performance metrics such as measurement accuracy, response time, and system reliability were evaluated. Comparative analysis was conducted between compensated and uncompensated measurements to assess improvement in metering accuracy achieved through the implemented SCADA/DCS-based solution.

Algorithm development involves the following sequences:
iii. Step 1: Extract real-time flow, temperature, and pressure data from DCS.
iv. Step 2: Apply API MPMS 11.1 Chapter 12 equations to calculate VCF.
v. Step 3: Implement customized function block in DCS control logic.
vi. Step 4: Output compensated for Netoil flow alongside uncompensated flow for comparison.
vii. Step 5: Archive both datasets for validation and performance analysis.

Table 3.1: Flowchart Legend.

Symbol	*Description*	*Data source*
T	Line Temperature	Field Transmitter
P	Line Pressure	Field Transmitter
$\rho t,p$	Density at line temp and pressure	Field Transmitter
$\rho 60$	Estimated density at 60degC	Picked from the sequence of integers 700, 705, 710…990, 995, 1000)

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Symbol	*Description*	*Data source*
ρT,P	Density at base condition	Calculated by calculation module
K0,K1,K2,	Constants based API commodities	Input parameters constant.
α_{60}	Thermal expansivity factor at based temperature	Program output
C_{TL}&C_{PL}	Correction effects of Temperature and Pressure	Calculated variables based on API equation.
F_p	Compressibility Factor	Calculated variables based on API equation.
$CTPL$	Correction Factor	Program output
$V_{(t,P)}$	known (Volume at line temperature and pressure obtained directly from meters),	Program output

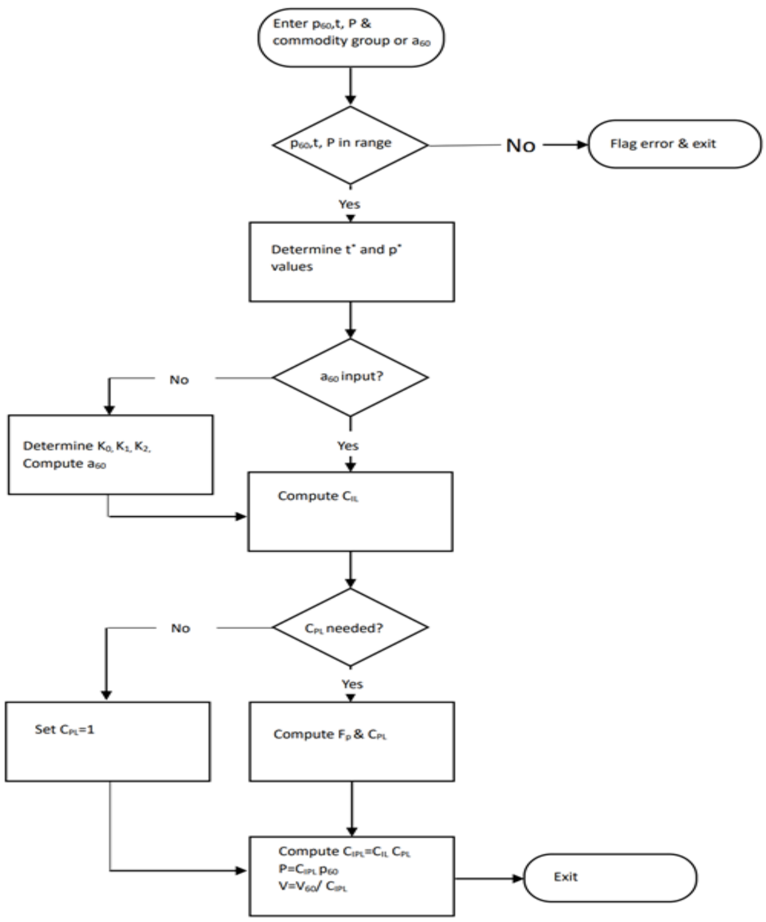

Figure 3.1: Flow Chart for procedure correcting Volume and Density Factor

Applied Compensation Calculation/Algorithms.
The Flow compensation is computed in the Emerson DeltaV DCS customized CALC_blocks and Mathematical Integrator function block. The CALC_blocks in DeltaV DCS are customizable function blocks that allow for the execution of mathematical equations for process control applications.

Flow compensation calculations typically involve:

i. Defining the input variables (e.g., flow rate, temperature, pressure).
ii. Establishing the desired output (e.g., compensated flow rate).
iii. Implementing control logic to handle dynamically changing conditions.

Table 3.1: Abbreviations& Symbols.

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Sn	Abbreviation	Description
1	VCF	Volume correction Factor
2	Fp	Compressibility coefficient of the liquid
3	α_{60}=Cd	Thermal expansivity factor of the crude oil
4	CPL	Effect of pressure correction on liquid
5	ρt,p	The density of the mixture, with no corrections applied.
6	DCS	Distributed Control System
7	Pe	Base pressure (0barg/ 0psig)
8	GSV	Gross Compensated Flowrates.
9	NSV	Netoil Compensated Flowrates.
10	CTPL	Temperature and Pressure correction effect
11	A, B, C&D	Known API Commodity Crude oil constant
12	NFR	Netoil Flow Rate
13	TEF	Totalized Export oil flow
14	TGF	Totalized Gross Flow Rate from each flow meter
15	BSW	Watercut Base and salt reading from Agar meter.
16	$\Delta t = (G)$	change in the temperature at base condition.
17	δT = K	(Base temperature correction factor) = 0.01374979547
18	R	Assigned Variables used in Compensation Algorithm's
19	G	Assigned Variables used in Compensation Algorithm's

Governing Mathematically Equations for the general compensation model.

Compensated gross standard volume flow: The crude oil compensation volume flow is calculated by multiplying the gross volume flow rate coming directly from the flow meters with the volume correction factor as shown below. (API MPMS (2004) with Addendum 2, 2019). Manual of Petroleum Measurement Standards, Chapter 11.1: Temperature and Pressure Volume Correction Factors. American Petroleum Institute.)

$$GSV\ (n) = Gross\ FlowRate(n) * CTPL \quad (3.1)$$

Where GSV is the compensated gross standard volume flow at operating condition calculated at flowing conditions, and CTPL is the volume correction factor based on API MPMS 11.1 with Addendum 2, 2019).

Net oil flow rate (NFR): This is the actual net oil flow rate in the gross flow. Unit is in barrels per day (bbl/d).

This is mathematically represented as shown in equation (3.2).

$$NFR\ (n) = Gross\ FlowRate(n) - Water\ Flow\ Rate \quad (3.2)$$

$$TGF_p(n) = \sum_0^t GSV\ (n) \quad (3.3)$$

Where $\sum_0^t GSV\ (n)$is the totalized compensated Gross flow from each flow meter calculation block.

Total Export Gross Oil(TEG_{oil}): This is the sum of the totalized gross flow of all flow meters. Unit is in barrels (bbl). This is mathematically represented as shown in equation (3.4).

$$TEG_{oil} = \sum_1^n TGF_{oil}(n) \quad (3.4)$$

$$TNF_{oil}(n) = \sum_0^t NFR\ (n) \quad (3.5)$$

Where$NFR\ (n)$is the number of volumes of net oil that has passed through the flow meter.

$$TEN_{oil} = \sum_1^n TNF_{oil}\ (n) \quad (3.6)$$

Where $\sum_1^n TNF_{oil}$ (n)sum of the totalized net oil of all flow meters

Weighted Average Watercut: This is the average watercut of total production. This is calculated by means of the following formula.

$$Weighted\ Avg\ WaterCut(\%) = \frac{(TEG(oil) - TEN(oil))}{TEG(oil)} * 100 \quad (3.7)$$

3.5 Reset Philosophy.

The accumulated values for the gross and net flow rates shall be reset at 0600 hours every day. All current accumulated values are saved and referred to as Yesterday Readings.

3.4 Design Naming Conventions.

The control strategies are designed based on the naming convention in use on the DCS. Table 3.3 lists the names of the control modules used for the design implementation.

Table 3.3: Control Module Design Naming Conventions.

Control Module Name	*Description*
METERING_SKID	Name of the DCS Area for Flow Compensation related modules
GBRG1_NETOIL	Name of the DCS Process Cell for Flow Compensation related modules
API_MPMS 11.1	Name of the Customized Design Library function block for Netoil Compensation.
U55_NET_EXPTCOMP	Name of Gross oil calculation from Flow meters.
U55_NET_EXPTOTAL	Export Total Control Module for flow meters
U55_NETOIL_COMP	Compensation Calculation Control Module for Flow meters
U55_NETOIL_TOTAL	Name of Totalized Algorithms for Compensated flow
U55_100-WC-001	Watercut-BSW Agar Meter raw reading FROM Field
FS-100PI-150	Station discharge pressure Control Module for flow compensation
U55-TT-001	Station Temperature Control module
FS-101UI-150	Observed Gross Volume flow rate for FM meter 1 Control Module
FS-101UI-151	Observed Density flow for FM meter 2 Control Module

The following equations form the fundamental basis of the proposed Netoil compensation model, developed in accordance with API MPMS Chapter 11.1 standards. Mathematical formulation incorporates temperature and pressure correction principles applicable to crude oil and petroleum products. The definitions and descriptions of the variables and parameters used in these equations are provided in Table 3.1 and Table 3.2, respectively.

$$C_{TPL} = (C_{TL} \ \ C_{PL}) \quad (3.8)$$

$$= exp\{-\alpha_T \Delta t[1 + 0.8\alpha_T(\Delta t + \delta_T)]\} \quad (3.9)$$

$$\alpha_{60} = \frac{K_O + K_1 p^* + K_2 p^{*2}}{p^{*2}} = \frac{K_O}{p^{*2}} + \frac{K_1}{p^*} + K_2 \quad (3.10)$$

$$C_{PL} = \frac{1}{1 - F_{P\,(P-P_e)}} \quad (3.11)$$

$$F_P = exp\left\{A + Bt + \frac{C+Dt}{\rho^{*2}}\right\} \quad (3.12)$$

Flow Compensation Concept Equation:

$$V_{(T,P)} * CTPL \quad (3.13)$$

Where, $V_{(t,P)}$ is known (Volume at line temperature and pressure obtained directly from meters),
CTPL (Correction for Temperature and Pressure on Liquid)

$$CTPL = CTL * CPL \quad (3.14)$$

CTL is Correction for effect of Temperature on Liquid,
CPL is the Correction for effect of pressure on Liquid.
Calculation of Temperature Correction Factor on the Liquid (CTL).
Temperature correction refers to the conversion of data collected at the observed process temperature to the equivalent values at reference temperature. The NOC application automatically applies temperature correction to NOC data, using the temperature data from the RTD built into the sensor.
The detail of the calculation for the effect of temperature on the Crude oil is described in the formula using an API MPMS 11.1.6.1 Customary units for calculation as shown below.
The definitions and descriptions of the variables and parameters used in these equations are provided in Table 3.1 and Table 3.2, respectively.
The logic dynamically converts the incoming line temperature from Degree Celsius to Degree Fahrenheit using customary units as shown in Equation (3.16.)

$$T = (1.8 * t) + 32 \quad (3.16)$$

Where,
$\Delta t = G = t - T$
change in the temperature at base condition.
t= input line temperature from field in Degree Celsius converted to Fahrenheit, varies over time so is an input variable for the calculation.
T= base temperature = 60°F.
αT= Cd =Thermal Expansion coefficient factor at base temperature
δT = K (Base temperature correction factor) = 0.01374979547. (Reference API MPMS 11.1 appendix). Assigning the known variables R equation (3.17) into Equation (3.15) and substituting with equation state on thermal expansivity factor equations reduces the equation to (3.18)

$$R = 1 + (0.8 * Cd) * (G + K) \quad (3.17)$$

$$C_{TL} = exp\ \{(-(Cd) * G * (R)]\} \quad (3.18)$$

Calculation for Thermal Expansion Coefficient $\alpha_{60} = cd$).
The thermal expansion coefficient of the crude at base temperature and observed densities of flow are calculated from the formula below.
The definitions and descriptions of the variables and parameters used in these equations are provided in Table 3.1 and Table 3.2, respectively.

$$\alpha_{60} = \frac{K_0 + K_1 p^* + K_2 p^{*2}}{p^{*2}} = \frac{K_0}{p^{*2}} + \frac{K_1}{p^*} + K_2 \quad (3.19)$$

Note $Rd^2 = p^{*2}$, $\alpha_{60} = cd$, K_0 =341.0957 and $K_1 = K_2 = 0$ which are modelled down to.

$$C_d = \alpha_{60} = \frac{341.0957}{p^{*2}} \quad (3.20)$$

Where, αT is the thermal expansion coefficient at base temperature, ρ* is the calculated observed density from individual flow meters, and K_0, K_1, K_2 are constant based on commodity group as shown below Table (3.5) as per API MPMS 11.1, Addendum 1 to API MPMS 11.1-2014 standard.

Calculation of Pressure Correction Factor on the Liquid (CPL).
The effect of pressure on the crude oil at standard condition can be calculated as shown below:
The definitions and descriptions of the variables and parameters used in these equations are provided in Table 3.1 and Table 3.2, respectively.

$$C_{PL} = \frac{1}{1 - F_{P\,(P-P_e)}} \quad (3.21)$$

$$\text{If } B_m = 1 - F_{P\,(P-P_e)} \quad (3.22)$$

Equation (3.21) reduced by substituting the variables with Equation (3.22), then

$$C_{PL} = \frac{1}{B_m} \quad (3.23)$$

Where P and Pe (14.696) are the alternate pressure and base pressure (0barg/14.696Psig) of the crude oil respectively.
Fp is the compressibility coefficient of the crude oil, and CPL is the pressure correction factor on the crude oil, crude oil.

Calculation of compressibility Coefficient of the Crude oil.

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The compressibility coefficient of the crude oil at standard temperature and pressure is gotten from the equation below. The definitions and descriptions of the variables and parameters used in these equations are provided in Table 3.1 and Table 3.2, respectively.

$$F_P = exp\left\{A + Bt + \frac{C+Dt}{\rho^{*2}}\right\} \quad (3.24)$$

Assigning variables to model the equation (3.24) compressibility factor as used in the customized algorithm.

Let $ZB = \left\{\frac{C+Dt}{\rho^{*2}}\right\} = \left\{\frac{C+Dt}{Rd^{*2}}\right\}$ (3.25)

Note: $\rho^{*2} = Rd$ flowing density at line condition from field input.

Equation (3.24) reduced to by substituting the variables at Equation (3.25)

$$F_P = exp\left\{A + Bt + ZB\right\} \quad (3.26)$$

Where Fp is the compressibility coefficient of crude, ZB assumed variable and A, B, C, D are the constants stated below. API MPMS 11.1 2004.section at standard condition respectively. There was one set of coefficients for the Fp compressibility factor based on density in kg/m3 at 60°F as shown in table (3.6) below.

The constants specified on Table 3.6 are used by the model to calculate for the compressibility factor Fp in the module. The customized module is designed to calculate real-time compensation based on Equation (3.26).

Table 3.2: Coefficients constants for Compressibility Factor

Fp Constants	Value
A	-1.9947
B	0.00013
C	793920
D	2326

Calculation of observed Density.

The calculated observed density at flowing condition of temperature and pressure is calculated as shown below.

The definitions and descriptions of the variables and parameters used in these equations are provided in Table 3.1 and Table 3.2, respectively.

$$P^* = \rho_{60}\left\{1 + \frac{\exp[A(1+0.8A)]-1}{1+A\,(1+1.6A)B}\right\} \quad (3.27)$$

Where ρ* is the observed calculated density at flowing condition, and $\boldsymbol{\rho}$ is the flowing density from individual flow meters at standard temperature and pressure, and A, B, K_o , K_1, K_2 and K_o=$K_1 = 0$ are constants as per Addendum 1 to API MPMS 11.1-2014 standard.

Where the assigned variables used to model the equations (3.27) are defined as follows.

$$M = \exp[A(1 + 0.8A)] - 1 \quad (3.28)$$

$$N = 1 + A\,(1 + 1.6A)B \quad (3.29)$$

Substituting the variables (M &N) into Equation (3.27) reduced the model to Equation (3.30)

Where M & N are assumed to be variable.

$$P^* = \rho_{60}\left\{1 + \frac{M}{N}\right\} = \rho_{60}\left(\frac{N+M}{N}\right) (3.30)$$

(3.30)

$$A = \frac{\delta_{60}}{2}\left[\left(\frac{K_o}{\rho_{60}} + K_1\right)\frac{1}{\rho_{60}} + K_2\right] \quad (3.31)$$

$$B = \frac{2K_o + K_1\rho_{60}}{K_o + (K_1 + K_2\rho_{60})\rho_{60}} \quad (3.32)$$

Logic dynamic Substituting $K_o = 341.0957$, $K_1 = K_2 = 0$ and $\delta_{60} = 0.01374979547$,then Equation (3.31) modeled to a general equation (3.33) and (3.34).

$$A = \frac{2.34499}{p^{*2}} \quad (3.33$$

$$B = \frac{2K_o}{K_o} = 2 \quad (3.34)$$

$$R = 1 + 0.8 * cd * (G + K) \quad (3.35)$$

$$Vm = -\{(Cd * (G * K)\} \quad (3.36)$$

Referencing to Equation (3.13)

$$V_{(T,P)} = V_{(t,P)} * CTPL$$

Where, $V_{(t,P)}$ is known (Volume at line temperature and pressure obtained directly from meters).

3.4 Simulation and Validation

The developed compensation model was validated using computational Kelton Metering Software and pilot-scale experimental data from API MPMS 11.1. Performance comparisons were conducted between

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compensated and uncompensated measurements to assess accuracy and reliability.

The analysis indicated that the difference between the compensated Gross Volume reported by the DCS and that calculated by the Kelton software is less than 1%. Field application deployment was also performed on the existing Agbada 2 Flowstation facility DCS hardware located at Niger Delta Area of Rivers State and the results outlined on Figure 4.3.

IV. RESULTS AND DISCUSSION

Preliminary testing for the temperature and pressure compensation calculations was conducted utilizing various test scenarios derived from the API MPMS 11.1 documentation. The results obtained demonstrated a strong correlation with those presented in table (4.1) & (4.2) respectively.

Table 4.1: Result Validation using Metering Kelton Software

Sr	Input Temp (°F)	Input Pressure (Psi)	Input Density(kg/m3)	Input Volume Rate(bbl/d)	Kelton Software Flow Validation (bbl)
1	75	250	600	11000	10888.32
2	78.8	450	786.98	12000	11904.6
3	80	530	793.521	13000	12897.85
4	82	700	810.56	14000	13893.46
5	85.44	800	868.21	15000	14882.43
6	92.22	901	960.3	16000	15863.93
7	180.2	1100	1012.3	17000	16428.68
8	250	1350	1100.34	18000	17197.26
9	280	1450	1141.01	19000	18090.10
10	302	1500	1163.5	20000	18988.94

Table 4.2: Results from parameters using Emerson DeltaV Standalone DCS

Sr	Input Temp (°F)	Input Pressure (Psi)	Input Density(kg/m3)	Input Volume Rate(bbl/d)	DCS Compensated Flow (bbl)
1	75	250	600	11000	10979.2
2	78.8	450	786.98	12000	11963.2
3	80	530	793.521	13000	12958.8
4	82	700	810.56	14000	13957
5	85.44	800	868.21	15000	14941.6
6	92.22	901	960.3	16000	15914.2
7	180.2	1100	1012.3	17000	16439.8
8	250	1350	1100.34	18000	17164.8
9	280	1450	1141.01	19000	18040.1
10	302	1500	1163.5	20000	18922.8

Table 4.3: Result Validation at Real-Time from Field deployment.

	Compensated	Uncompensated	Compensated	Uncompensated

Desc	Previous Day Totals Gross (bbl.)	Previous Day Totals Net Oil (bbl.)	Previous Day Totals Gross (bbl.)	Previous Day Totals Net Oil (bbl.)	Current Day Totals Gross (bbl.)	Current Day Totals Net Oil (bbl.)	Current Day Totals Gross (bbl.)	Current Day Totals Net Oil (bbl.)
Export Train 1	19244.50	24046.70	19514.30	24383.90	842.13	1052.31	853.85	1066.36
Export Train 2	28259.50	35310.90	28491.00	35599.30	1522.55	1902.26	1534.21	1916.88
Export Header	49439.0	61779.80	48005.30	59983.10	2459.95	3073.83	2388.05	2983.24

Net Oil Comparison Summary

Export Meter	Compensated Net Oil (bbl.)	Uncompensated Net Oil (bbl.)
Export Train 1	1052.31	1066.36
Export Train 2	1902.26	1916.88
Export Header	3073.83	2983.24

Figure 4.1: Netoil Production Comparison Summary Current Day Netoil

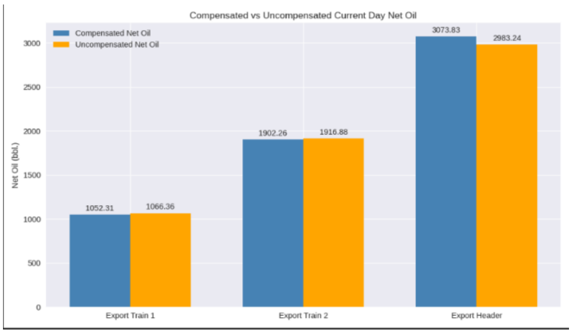

Figure 4.2: Compensated VS Uncompensated Current Day Netoil

Key Observation on Figure (4.1) and (4.2).

i. Export Header has the highest net oil volumes overall, with compensated net oil slightly exceeding uncompensated.
ii. Export Train 2 shows a small difference, with uncompensated net oil slightly higher than compensated.
iii. Export Train 1 follows the same pattern as Train 2, with a modest increase in uncompensated net oil.

Results Analysis.

Compensation adjustments typically account for measurement corrections, system losses, or calibration factors.

i. The fact that Export Header's compensated value is higher than its uncompensated ones suggest a reconciliation or correction that added volume.

ii. For the trains, the compensated values are slightly lower, possibly due to adjustments for losses or inaccuracies.

These variations suggest that compensation adjustments—likely for measurement corrections or system losses—can either increase or decrease reported volumes depending on the meter.

Key analysis of Result:

The compensated gross flow values generated by the Distributed Control System (DCS) were validated against results obtained from the Kelton flow calculation validation software using identical temperature, pressure, density, and volume flow rate inputs. The objective of this comparison was to assess the accuracy and reliability of the implemented Netoil compensation algorithm within the DCS environment.

As shown in the results table, the compensated gross flow values calculated by the DCS closely match those generated by the Kelton validation software across all test cases. The observed deviations between the two calculation platforms are consistently less than 1%, which is well within acceptable industry limits for flow measurement and custody transfer applications as prescribed by API MPMS standards.

The minor differences observed can be attributed to factors such as numerical rounding, internal computational precision, and slight variations in implementation of correction algorithms between the DCS and the Kelton software. Despite these minor variations, the trend consistency and close numerical agreement confirm that the DCS-based compensation logic accurately applies temperature and pressure corrections in line with recognized industry standards as illustrated on Figures (4.3) and (4.4) respectively.
Furthermore, the results demonstrate that the DCS compensation model maintains accuracy across a wide operating range, including varying

temperatures, pressures, fluid densities, and flow rates. This indicates that the customized Netoil compensation module is robust and capable of reliable performance under different process conditions typically encountered in upstream oil metering operations.

V. DISCUSSION

The results demonstrate that integrating Net Oil compensation within a DCS environment provides significant advantages over traditional standalone compensation methods. Real-time fluid characterization and adaptive correction enable continuous accuracy improvement, even under fluctuating process conditions. Furthermore, the DCS-based implementation facilitates seamless integration with existing control, monitoring, and data historian systems, enhancing operational visibility and decision-making.

From a fiscal perspective, improved metering accuracy directly contributes to better custody transfer reconciliation and reduced financial discrepancies. The proposed solution also aligns with digital oilfield initiatives by enabling scalable and data-driven metering optimization.

VI. CONCLUSION

This study presents a customized Net Oil compensation module implemented within a DCS control system to enhance metering efficiency in oil and gas applications. The developed approach effectively addresses the limitations of conventional metering systems by dynamically correcting measurement errors caused by fluid property variations and multiphase flow conditions. Validation results confirm significant improvements in accuracy, reliability, and operational efficiency. Future work will focus on large-scale field deployment and integration with digital oilfield and advanced analytics platforms to further extend the benefits of Net Oil compensation.

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