Armstrong
EXPERIENCE MATTERS

GRC 2024

October 27–30 | Waikoloa, HI

Reliable DP Flow Measurement in Geothermal Steam Environments – Including Non-Condensible Gases

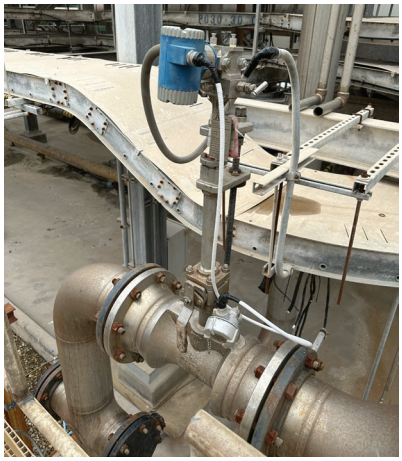
ABSTRACT

Metering steam and process fluids in geothermal environments is not the same as metering conventional steam and process fluids in the industrial world. Many challenges must be overcome to get reliable, long term accurate flow measurement of geothermal process fluids. Challenges such as corrosion, mineral deposits, NC gases, varying steam quality, large range of flows, low flowing pressures, space limiting piping configurations all make accurate, long-term measuring of flows difficult. The additional demands of constant maintenance and regulatory compliances make effective metering even more problematic.

Various techniques and metering designs using DP flow measurement have been developed over the years and many of these challenges can be surmounted. Solutions developed through years of experience have been used to lower maintenance costs and improve flow measurement reliability. Real world results are discussed using examples and challenges from many geothermal fields worldwide. Specific examples include, DP meter designs, material selections, NC gas metering, corrosion inhibiting coatings, meter types and measurement locations as well as custody transfer and power plant performance verification metering to name a few.

CASE STUDIES

Contact Energy – Tehuka 3 Geothermal Power Plant in Taupō New Zealand A custody transfer application between the Geothermal asset owner and power plant designer/supplier Ormat. "The 51.4mW plant is incorporating a novel design which will enable the carbon emissions from the project to be reinjected into the reservoir in the future". High precision, 24" Class 300#, custody transfer Classical Venturis were built, tested and calibrated to measure the steam flow to confirm power station delivered performance to PTC-46 requirements. Total uncertainty requirements had to meet a maximum ± 0.5% and meet ISO 5167, NACE MR0175, ASME B31.3 and PTC-46 requirements.



The Accelabar requires zero straight run. Seen here directly after elbow on NC Gas.

Cal Energy Hudson Ranch – Geothermal Power Plant in the Imperial Valley California Numerous Accelabars are used to successfully meter Non-Condensible (NC) gas emissions which must be reported to the local Air Quality Management Districts. These are typically 6" to 12" pipe sizes, depending on the power plant size, with low pressure and low flow rates which are prefect applications for the Accelabar technology. Many Accelabars were in NC service for over 8 years before being removed for cleaning of mineral deposits on the outlet side of the meter. Despite the heavy mineral deposits, accuracy and metering performance were not sacrificed as the metering section of the Accelabar and the Verabar sensing element remained clean and free from deposits. After cleaning the Accelabars they were reinstalled and are performing like new.

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PGPC (Aboitiz Power) and EDC in the Leyte-Luzon Geothermal Fields in the Philippines Many insert-retract sensors like the V400D models were used for metering Steam Field Supply lines, Water lines and V200 style Verabars for metering lower pressure Brine lines. Unlike other metering technologies Insert Retract Verabar sensors allow removal of sensors under pressure for the maintenance, inspection or replacement while never shutting down the process. Verabar sensors replaced high permanent pressure loss orifice plates on large steam service pipelines and increased total plant outputs by 1%-2%. V400 insert retract meters were also used on 16" water lines where water flow was being metered to combine with the Brine being reinjected to help dilute mineral contents to prevent clogging of the reinjection well permeability.

Cal Energy Vulcan – Geothermal Power Plant near the Salton Sea California Because of the critical nature of keeping some pipelines in the power plant always flowing, specially designed V400-20 partial insert Verabars made of Hastelloy C-276 were manufactured and Hot tapped onto 30" saturated steam lines that were heavily treated with chlorides. Partial insert Verabars were chosen, as the metering location had ample straight run and the higher flow rates were not conducive to spanning the entire pipeline. Gun drilled Hastelloy bar was machined for the sensor and was heat treated to increase the resistance to corrosion and stress corrosion cracking. The Verabars have proven to be very resistant to the mineral laden saturated steam and significantly increased the reliability and reduced the maintenance over a competitors 316SS Averaging Pitots that were replaced.

Veris V400D Hot Tap Model

Veris V400S Hot Tap Model

CONCLUSION

Many other successful Geothermal applications have been realized using special designed Accelabars with insert retract mechanisms to allow for routine inspection/maintenance operations. The Accelabar with no requirements for upstream and downstream piping straight run has been used in the most difficult piping conditions, saving precious piping real estate and money as well as providing accurate metering of difficult Geothermal fluids.

Other successful Geothermal applications around the world include using proprietary silicon-based coatings for improving corrosion resistance of high nickel alloys as well as increasing the lubricity and hydrophobicity of the metal surfaces. Coatings have extended the service life of Verabar sensors in many applications and the coating costs are usually quickly recovered in lowered maintenance costs. In conclusion, Veris' ability to design special flowmeters for difficult applications is the reason we are the leader of DP Flow Measurement in the Geothermal Industry.