



# Wet Gas Meter Solutions



## Flow

Coriolis, Ultrasonic Clamp-On, Vortex, Electromagnetic, DP Flowmeters



## Temperature

Explosion-Proof Temperature Transmitter



## Pressure

Pressure Transmitter



## Level

Guided Wave Radar, Explosion Proof Ultrasonic, Radar, Submersible, Pressure Based Level Transmitters



## Validation

Flow Computer, Flo-Mass



## Solution

Wet Gas Meter

## TECHNOLOGY SOLUTIONS

Tek-Trol a “Technology-Driven” company consistently providing robust advanced measurement, control & automation solutions. Tek-Trol offer strong process instrument and measurement expertise together with control products and solutions for: Volumetric Flow, Mass Flow, Temperature, Pressure and Liquid Level Applications, together with other specialist applications in many highly technical industry areas.

We provide all our customers a complete range of products and solutions for markets covering: Dairy, Water, Wastewater, Boiler control & instrumentation, District Heating and Cooling, Nuclear, Thermal, and Hydroelectric Power Plants, Oil and Gas, Paper, Sugar and many more.

*Tek-Trol is proud to be recognized for our multidiscipline flow measurement industry knowledge, innovative solutions, reliable products, and global presence!*

# WET GAS METER SOLUTIONS

Wet-gas measurement applications have increased in recent years, particularly in allocation metering, production monitoring, and in recent years the rapid move towards “wet gas fiscal”, for newly developed, marginal, and even large gas fields.

The Tek-Trol Wet Gas (WGM) range of flow meters and systems are uniquely positioned to provide operators with optimum solutions for wet-gas flow measurement produced to help the operator manage operations more efficiently. Wet Gas Measurement is more complicated than single phase gas flow measurement it presents the user with adverse flow regimes. Tek Trol has the proven expertise to help lift this burden from our customers.



Wet Gas Flows can encompass a wide range of flowing conditions.

Each customer requiring unique wet gas metering capabilities.

No single wet gas meter design is seen as being optimum for all wet gas flowing conditions and customer requirements.

Wet gas measurement today is very important in various applications such as:

- Gas and Gas condensate flow custody transfer.
- Allocation measurement where individual well production monitoring is needed for overall production control and efficiency.
- Identification of process water breakthrough for chemical inhibitor injection control and flow assurance / management.

Wet gas flows are also defined as natural gas dominant flow regimes that contain a relatively small amount of liquid entrainment flowing simultaneously within a pipeline along with other components.

Tek-Trol has the necessary portfolio of scientifically proven wet gas measurement products, including:

- DP (Differential Pressure) primary meters with wet gas correction factors implemented into a flow computer. *(From a known liquid sample this system offers corrected gas flowrates).*
- DP meters with installed downstream pressure taps using the Pressure Loss Ratio (PLR) to predict liquid loading plus wet-gas corrections. *(This system type meters both gas and liquid flowrates. - (low to moderate liquid loadings).*

A new meter type brand name “**CoVor™**” is now available!

This new patented meter design comprises of a Vortex and (DP) Cone meter hybrid within the same meter body.

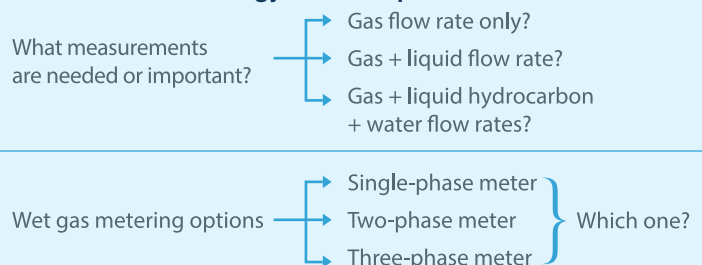
This unique measurement device can meter both gas and liquid flowrates simultaneously. *(For use with low to moderate liquid loadings, favorably used for steam assisted drainage (SAGD) in enhanced oil recovery and also wet gas!).*

All TEK-TROL wet gas flow metering products are available with the unique & patented Differential Pressure flow meter diagnostic system ‘**Prognosis**’©.

*(This highly recommended optional flow measurement enhancement monitors changes in liquid loading automatically and alerts the user to wet gas fluid /meter anomalies/issues in real time!).*

- ✓ Operator Friendly
- ✓ Low Maintenance
- ✓ Predict liquid loading value
- ✓ Uses Wet Gas Correction Algorithm
- ✓ Simple and Robust

**Knowing what measurements you want will help dictate the type of metering technology that is required.**





# WET GAS METER SYSTEM

## Wet Gas Flow

A sub-set of Two-Phase Flow where the flow is gas dominant by volume. Note that wet gas flow can have gas flow with one or more liquid components, example such as water only, hydrocarbon liquid only, a mix of both water and hydrocarbon liquid flows, or a mix of water, hydrocarbon liquids and other liquids such as chemical inhibitors, MEG, and wax etc. ISO DTR TC30 11583-2014 Technical Report defines a wet gas flow meter as a device that measures the gas and liquid flow rates in a wet gas flow. The meter may or may not measure the hydrocarbon liquid and water flow rates of the wet gas flow's liquid phase. Measurement of the pressure loss ratio is deemed sufficient to produce corrections for wet gas over-reading by using algorithms. It is important to select metering devices per process application to ensure they are fit for purpose.

## How Wet is Wet in a Gas Stream!

Defining wetness falls into different categories Terms such as GVF (Gas Volume Fraction) LVF (Liquid Volume Fraction), Fr (Froude Number gas and liquid- ratio of inertial force to gravity force) and XLM (Lockhart and Martinelli Number). The square root of the ratio of the liquid inertia to gas inertia). These parameters can leave the customer a daunting task of how to manage new projects with associated wet gas flow measurement applications. TEK-TROL experts can assist/help with this task and offer a specialist viewpoint to assist the customer decide what is best!

## Lockhart & Martinelli (X<sub>LM</sub>)

The use of L&M numbers in modern wet gas flow measurement systems to define wetness is now commonplace and is mentioned in many wet gas technical reports It is used in many wet gas meter designs to enable this non-dimensional quantitative value to be used within a wet gas flow meter.

## Lockhart & Martinelli (X<sub>LM</sub>) Attributes

The use of L&M numbers in modern wet gas flow measurement systems to define wetness is now commonplace and is mentioned in many wet gas technical reports & international standards.

The values of L&M number vary from XLM = 0 not wet to XLM = 0.3max very wet indeed, above this value the flow tends to be multiphase and in a slug flow regime. Most wet gas meters operate in between these 2 values.

The following nomenclature shows the main equations related to X<sub>LM</sub>. Reference to GVF, Froude No, gas density ρ<sub>g</sub> & liquid density ρ<sub>l</sub> is shown below:

$$X_{LM} = \frac{Fr_l}{Fr_g} = \frac{m_l}{m_g} \sqrt{\frac{\rho_g}{\rho_l}} = \frac{Q_l}{Q_g} \sqrt{\frac{\rho_l}{\rho_g}} = \frac{1 - GVF}{GVF} \sqrt{\frac{\rho_l}{\rho_g}}$$

Where  $m_g$  and  $m_l$  are the gas and liquid mass flow rates. With one single liquid component, a wet gas has one liquid density.

With multiphase flow there are two (or more) liquid densities. In this case, the liquid density used to calculate the gas to liquid density ratio and the gas densiometric Froude number is the average liquid density.

## Liquid Loading and Prognosis®.

The term 'liquid - loading' a qualitative term to describe the relative liquid content of the wet gas flow and is used to help calculate wet gas flow rates.

The liquid loading can be predicted by any pair of differential pressure transmitters used with any Orifice meter, Cone meter or Venturi meter.

Uniquely the **Prognosis®** flow management diagnostic system continuously checks the accuracy of all DP transmitter readings. And informs the user if any measurement issues are occurring – all in Real Time!

## Prognosis® The Smart Diagnostics!

Real Time & precise DP diagnosis is key in managing differential pressure-based measurement systems (Wet or Dry Gas).

Generally, many other wet gas systems assume changes in pressure loss ratio (PLR- a key factor in wet gas calculations), as a change in normal liquid loading, however, other parameters or issues may be causing this change outside of normal operation (i.e., DP Drift, Saturated Transmitter, Orifice Plate edge erosion etc.).

The TEK-TROL system powered by **Prognosis®** validates the DP flow meters health/ operating condition first, then performs a wet gas calculation! If a meter performance issue is detected **Prognosis®** informs the user that there is problem that needs to be addressed immediately!

All proprietary **Prognosis®** powered wet gas meters and diagnostic correlations work for a wider range of DP meters using two transmitters plus the main DP transmitter giving extra redundancy, wider ranges, of wet gas flow and greater beta ratio ranges! Altogether this offers a far greater accuracy and reliability than has been available to the user / operator previously.

## Many System Types currently available:



Wet Gas DPro-Orifice System



Wet Gas DPro-Venturi System

[Contact Us for Further Details!](#)



# DP METER WET GAS RESPONSE!



## Gas Meters & Wet Gas Flows!

The process flow ing conditions and subsequent flow pattern dictate any D.P. meters response to wet gas flow.

These flow patterns depend on many factors, including the meter orientation, gas to liquid density ratio ( $DR$ ) (i.e., pressure), the gas velocity (i.e., gas densimetric Froude number  $Fr_g$ ), the relative liquid to gas flow (i.e., The Lockhart-Martinelli parameter,  $X_{LM}$ ) and the liquid properties, Water liquid ratio (WLR). (See Figure 1.0 typical flow patterns/regimes.)



## Wet Gas Response - Orifice Plate

Flow Conditions dictate flow patterns and overall influences on a DP Meter s Over reading ( OR%) i.e.

$OR\% = f(X_{LM}, WLR, DR, Fr_g)$  Were also,

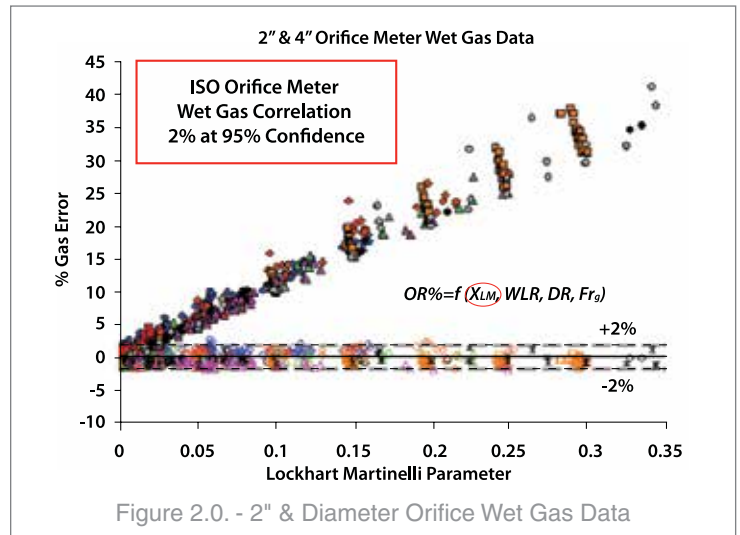
$$\text{Density Ratio}(DR) = \rho_g / \rho_l$$

$$\text{Froude No}(Fr_g) = \frac{m_g}{\sqrt{g^D}} \sqrt{\frac{1}{\rho_g(\rho_l - \rho_g)}}$$

The over reading ( can be plotted graphically showing over reading error in percent (vertical axis) and LM parameter ( $X_{LM}$ ) (horizontal axis).

An example of a 2 & 4 Diameter orifice plate wet gas test at CEESI. corrected to 2% is shown.

The calculations and correlation used to correct the over reading in the figure are based on the latest ISO/TC30 TR 11583 2014 Wet Gas Technical report (See Figure 2.0 next).

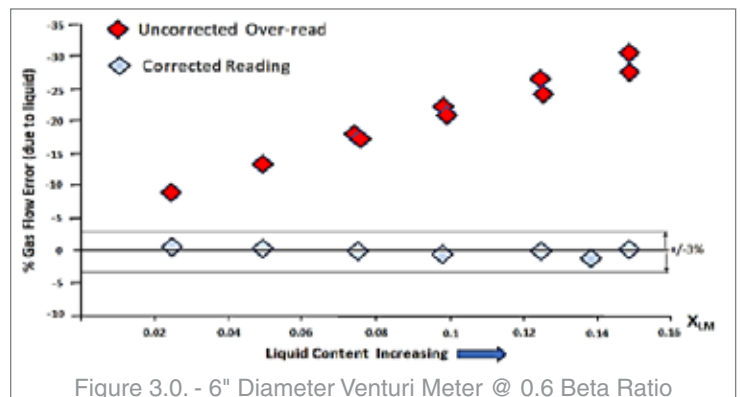


## Wet Gas Response - Venturi Meter

Upstream natural gas flow metering is challenging and difficult. The gas can be wet gas (i.e., mixes of gas, water, and oil) and tend to have water-related issues as: scale, salts, and hydrates. The Venturi meter is a favorite and popular meter in this upstream environment, due to its reliability, and inexpensive robust construction!

Venturi meters operated in wet gas flow are affected similarly to orifice plates, liquid entrainment affects the differential pressure reading in the positive. Its response to wet gas flow is likewise dependent on the gas to liquid density ratio (effectively a dimensionless representation of pressure for a set liquid components).

The OR% obeys similar rules as per Orifice plate systems and is always higher were liquid is present. (i.e., the apparent gas mass flow is usually higher than the actual gas mass flow rate of the total wet-gas flow - See Figure 3.0).



# WET GAS ORIFICE METER SYSTEM



## DPRO WET GAS SYSTEMS

### Wet Gas Orifice System

Orifice flow meters have a remarkably reproducible wet gas flow performance characteristic. This can be confirmed by reviewing the recent ISO/TC30 11583 technical report.

All TEK-TROL wet gas systems meet or exceed correlation data published in this document, particularly when using the **TEK-DPro Prognosis** enhanced flow diagnostics management system with wet gas capabilities.

### Wet Gas Operation Modes

When operating a TEK-TROL wet gas measurement system. The entrained liquid effect responses on the gas flow rate are obtained by using one of the following methods

- Type a. Basic keypad entry of the liquid type / composition from a sample.
- Type b. ISO/TC30 11583 based PLR automatic prediction of the XLM liquid loading.
- Type c. Enhanced ISO/TC30 11583 correlation using the unique **Prognosis** enhanced wet gas plus diagnostics management

system with extra transmitter down-stream to enable real time diagnostics of the meter operating condition. (using 3 DP transmitters).

### Wet Gas Orifice Meter

All TEK-DPro Wet Gas Orifice Meters / Fittings meet AGA 3, API MPMS 14.3 & ISO 5167-2 design specifications and geometry. The meters also have the following features available:

### Base Meter Specifications

Flange Sizes – 2-48" Diameter to sched 40 120 wall thickness. Flanges #150-#2500.

Dual and Single Chamber.

### Wet Gas Ranges and Specifications

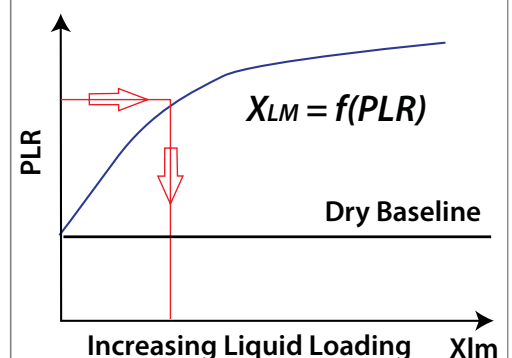
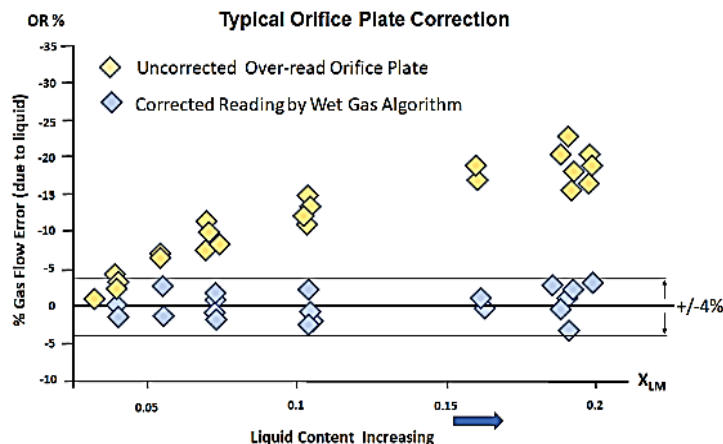
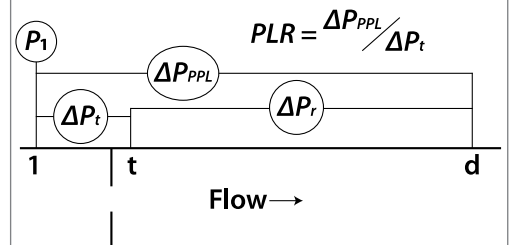
Liquid Loading:  $(X_{LM}) \leq 0.2$  ( $G_{VF} \geq 95\%$ )

Prediction Accuracy – up to +/- 3% with liquid loading indication.

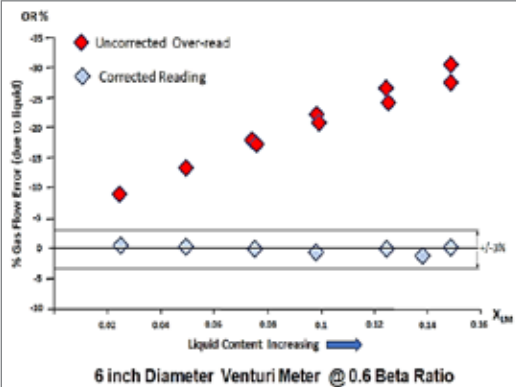
Prediction Pressures:  $\leq 150$  PSIG (10 Bar) -  $\leq 2500$  PSIG (83 Bar)

Liquid Loading Determination -Types b.& c. require no prior liquid loading or liquid flow rate knowledge!

TEK-TROL / Onboard enhanced correlation & diagnostics using TEK-DPro **Prognosis** enhanced diagnostics management system.



# WET GAS VENTURI METER SYSTEM



The "Venturi" differential pressure meter is a simple, sturdy, reliable, and inexpensive device that is popular for single phase and for wet gas flow metering applications.

All TEK DPro Wet Gas Venturi meters & systems use calculations per ISO TR11538 to determine wet gas flows and provide corrections.

The wet gas system monitors a relative amount of liquid loading in wet gas flow and alerts the operator through a visual indication. It also can predict the ratio between Permanent Pressure Loss to Traditional Differential Pressure using Pressure Loss Ratio (PLR).

TEK DPro enhanced wet gas system includes ISO/TC30 11583 correlations and the optional and unique Prognosis © enhanced wet gas and diagnostics management system with extra transmitter down stream to enable real time diagnostics of the meter condition during measurement operations (using 3 DP transmitters in all).

## AVAILABLE FEATURES

### Meter Sizes:

2"-48" all standard schedule connections.

### Meter Run Compliance

ISO 5167 pt4 / TR11583 Venturi Meter.  
Complete Meter Runs, Instrumentation and Flow Computer units supplied.

### Operating Ranges

as per ISO/TC30 11583

### Gas Flow Prediction Quality

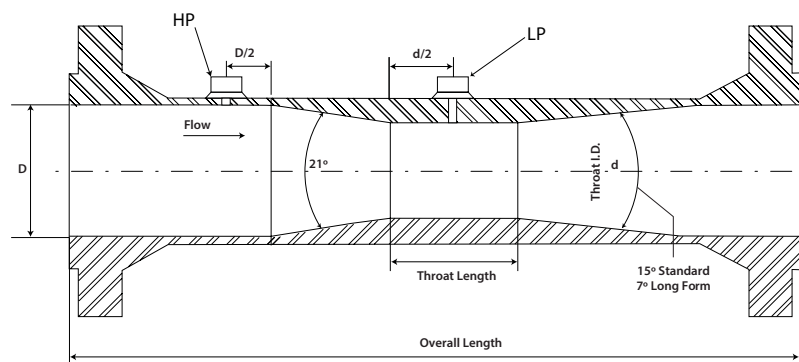
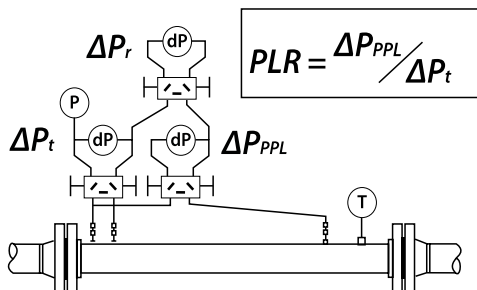
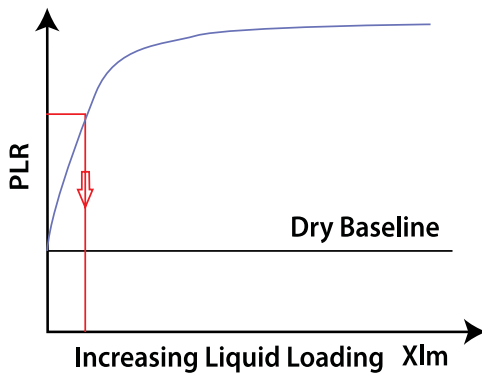
Up to 3% accuracy using liquid flow indicator

### Real Time Validation

Prognosis © optional validation system.

### Applications

Wet Gas streams: Using automatic liquid load prediction from on-board system within the ranges published in ISO TR11583. Also available by using keypad input (Note: liquid loading is then provided from separator or tracer dilution system outputs).



Were, HP = High Pressure Tap  
LP = Low Pressure Tap

D = Diameter  
d = Throat diameter





# COVOR WET GAS METER

**TEK-TROL's** Patented **CoVor**® Wet Gas Meter utilizes two proven different flow metering technologies in one-meter body. (A Differential Pressure Cone meter and Vortex meter).

This combination allows for the prediction of the fluid density, volumetric flow rate, and mass flow rate without any fluid density information being required from external sources.

The meter's ability to predict fluid density allows the meter to provide several valuable measurements with wet gas and steam applications.

The CoVor® Wet Gas Meter will also provide an accurate total mass flow measurement. It is also able to calculate the density of gas mixtures/compositions. Since natural gas is typically a composition of many different gases, each with their own density this gives the opportunity to compare the flowing fluid density with other calculated values from other devices situated on a gas pipeline.

With the additional two differential pressure transmitters, (three total) the TekValSys (powered by **Prognosis**®) advanced diagnostic management software can continually monitor and verify the meter's primary element fidelity, health and confirm its output uncertainty a large improvement over other metering systems without diagnostic capability.!

## Measurement Options

Measures fluid density, volumetric flow rate and mass flow rate along with density of changing gas mixtures. Liquid Loading Range XLM.  $\leq 0.12$  (GVF  $\geq 95\%$ ).

Pressure  $\geq 150$  psi ( $\geq 10$  Bar).  
Minimum Inlet Gas Velocity 'Vg'  $\geq 15$  ft/s ( $\geq 5$  m/s).

## Advanced Diagnostic Capability

Continuously monitor and verify the flow meter health and reduce output uncertainty using Advanced diagnostic software.

## Cost-Effectiveness

Multiple readings from a single installed device reduces initial cost, installation cost and cost-of ownership over the lifetime of the instrument.

## Base Calculations

ISO 5167 Pt 5 Cone Meters. ASME MFC-6M Vortex.

## Reliability

No moving parts

## Transmitter

Multi-variable options available for both temperature and pressure measurement.

## Remote Electronics Option

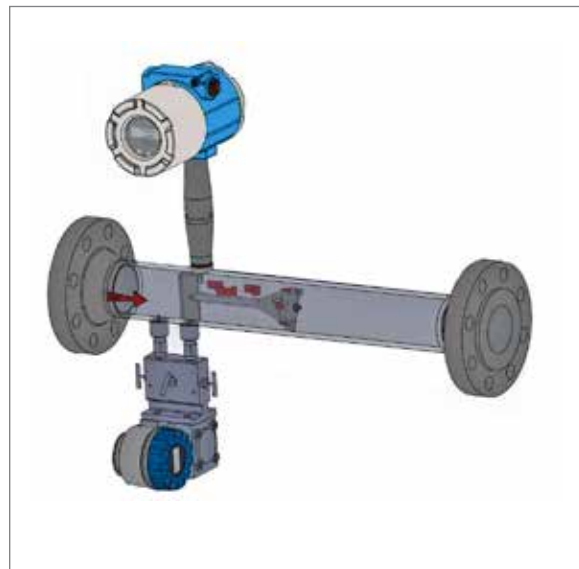
Use in harsh environments or locations with limited access.

## Mass Flow Equations

Real gas, Ideal gas, AGA 8, API MPMS 2540.

## HART Protocol

Modbus, BACnet, Power over Ethernet (PoE) communications available.



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