Discussion on Water Dew Point and Hydrocarbon Dew Point of Natural Gas

Xiaomei Zou *, Fengxia Huang, Liming Zhang, Tumeng Gele

Test Research Institute of Tarim Oilfield Branch, PetroChina Company Limited, Korla 841000, Xinjiang, China

*Corresponding author e-mail: 201821000623@stu.swpu.edu.cn

Abstract. During natural gas processing and gathering and transportation, water dew point and hydrocarbon dew point as two of control parameters in natural gas because of safety, economy and efficiency etc. In the field chilled mirror manual visual method always be taken to measure water and hydrocarbon dew point due to online instrument test under a differential condition from the pipeline. For hydrocarbon dew point, there’re some assays have implied that heavier components in natural gas have an important effect on hydrocarbon dew point, at the same time hydrocarbon dew point gained under the pressure between 2MPa~4MPa is equal to the max condensation temperature which has a practical meaning. On the other hand, the retrograde condensation cannot be ignored; for water dew point, application of molecular sieve would make dew point measurement easier, while application of dehydrating agents such as methanol; glycols and glycerol could cause interference, instruments &operators differences are exist, but the changing process is consistent when chilled down temperature. In this case, Attention should be given to a white fog which might appear on the center of the surface of the chilled mirror one or more times while temperature dropping down. At last some suggestions are given from two aspects of processing and measurement of water and hydrocarbon dew point.

Keywords: natural gas, water dew point, hydrocarbon dew point.

1. Introduction

In natural gas processing, gathering and transportation, water dew point and hydrocarbon dew point are one of the quite important control and demand indicators for the reason of safety, economy and transmission efficiency, etc.

The compulsory national standard GB17820-2012 "Natural Gas" sets: under the pressure of the intersection, the water dew point should be 5℃ lower than the lowest ambient temperature under the transportation conditions; There should be no liquid hydrocarbon in natural gas under the pressure and temperature conditions of the natural gas intersection.

The hydrocarbon dew point of natural gas is inseparable from its component. Hydrocarbon is mixture of hydrocarbons with different carbon numbers. Therefore, the contents of heavy hydrocarbon under the current pressure of natural gas have a certain impact on the hydrocarbon
dew point. Water as a single substance, under a certain pressure, the water vapor content is high, the water dew point is high, and otherwise the water dew point is low.

2. Test Methods of Dew Point
There are many kinds of methods for testing water dew point, including weighing method, hygrometer method, electrolysis method, infrared method, chilled mirror method, etc., online test is often installed at the production site as a reference, and manual visual measurement method is also used for measurement.

At present, there are four methods for testing hydrocarbon dew point: 1. Manual and visual measurement method based on chilled mirror technology. 2. Automatic test method based on chilled mirror technology. 3. Phase equation is used to calculate the hydrocarbon dew point based on the component obtained by chromatography. 4 International Standard ISO6570 determines the contents of potential liquid hydrocarbon (weighing method). The automatic method is generally used for on-line continuous testing; the calculation method and the weighing method have certain condition constraints at present, so the manual visual measurement method is generally used for measurement on site.

The chilled mirror dew point meter is the most accurate, reliable, and basic measurement method, which is widely used for standard transmission and requires experienced personnel to operate and maintain it.

The appendix A of GB/T27895-2011 "Determination Chilled Mirror Visual Measurement Method of Natural Gas Hydrocarbon Dew Point" has stated the interference and identification of water hydrocarbon dew point.

3. About Water Dew Point

3.1. Influence of hydrocarbon dew point
In general, the water dew point of natural gas is lower than hydrocarbon dew point, and the greater the difference between the two, the easier to distinguish. It is difficult to distinguish when the water dew point is close to the hydrocarbon dew point. It is rare that the water dew point is higher than the hydrocarbon dew point, at this time, it will interfere with the observation of the hydrocarbon dew point.

3.2. Alcohol interference
The method of methanol correction is given in the appendix of GB/T 17283 and is well applied in practice. However, there is no reference for the dew point correction of natural gas that uses other alcohol for dehydration treatment. This may cause the judgment result of water dew point to be higher than the true dew point value. Although equipped with alcohol filter, due to the large chilled span and time-consuming chilled balance, once the filter fails, it will affect the observation of the water dew point.

3.3. Other influence
The operation of the instrument will also have a certain influence on the observation results. Operate as strictly as possible to reduce or avoid operating errors.

The following were testing the different phenomena in the chilled process of the water dew point at the same measuring point for several days. Since the process parameters were adjusted every day, the result of the dew point is different every day, but the change process of the mirror surface was the same when the temperature lowered.
It can be seen from the process that white fog appear on the mirror surface one or more times in the chilled process, and it will not disappear easily if the temperature continues to fall quickly, and it will gradually disappear if chilled is slow, it shows that it is not the water dew point. This point should be paid special attention to in actual operation.
4. About Hydrocarbon Dew Point

It was found that two instruments with the same model have no obvious difference for water dew point in practice, but the hydrocarbon dew point has different sensitivity. Two cold mirror dew point meters with the same model are connected to the same gas source with tee simultaneously, one has no change and the other has visible uniform liquid drop.

4.1. The influence of heavy component on hydrocarbon dew point

As the temperature lowers, the appearance of liquid condensate is a continuous process in natural gas; first of all, heavy carbon components are separated out, when the temperature drops to a certain critical value, the separated amount of liquid will increase significantly.

Wu Haihao and others' "Influence of Heavy Component on the Phase Characteristics of Natural Gas" shows that the higher the carbon content of the heavy component, the greater the influence on the critical condensation pressure (p max) and critical condensation temperature (T max). The C6+ contains small amounts of gas sample C, its p max and Tmax are higher instead, the reason is that the high carbon number component (such as C9, C10) in the gas sample accounts for a large proportion.

Luo Qin et al. extended the natural gas component to C14 in "Analysis of Detection Technology in Natural Gas Hydrocarbon Dew Point". It shows that the calculated hydrocarbon dew point is very different, and the difference between the calculated results of C6 and C14 reaches 60 °C.

4.2. Critical condensate temperature

Dutch Peter van Wesenbeeck pointed out in the paper "A Traceable Calibration Procedure for Hydrocarbon Dew Point Chilled Mirror Instruments": the maximum condensate temperature occurred in typical processed high-quality pipeline natural gas between 20bar and 40bar, namely 2MPa-4MPa. PVT data and full component data were used, PVTsim software was used to conduct the solid phase deposit simulation of the feed gas in a high-pressure condensate gas field, the simulation results were obtained: the critical condensate temperature of the feed gas was -7.05°C, the pressure corresponding to this temperature is 3MPa or so. As shown in Fig.1.

![Fig. 2 Simulation of solid phase deposit](image)
It can be seen from the above that the hydrocarbon dew point measured in the 2MPa to 4MPa pressure range is the maximum condensate temperature, which also has the most practical significance.

4.3. Retrograde condensation phenomenon of natural gas
Some condensate gas or wet gas may still have retrograde condensation phenomenon in a certain temperature and pressure range (especially under high pressure) even after some hydrocarbon condensate is removed from the treatment plant (station), their hydrocarbon dew point first increases as the pressure decreases within a certain range of the gas pipeline, and then begins to drop after reaching the critical condensate temperature. Therefore, when they enter the buried gas pipeline, on the one hand, the temperature quickly drops to the same as the ambient temperature, and on the other hand, the pressure gradually drops below the dew point pressure, enters the retrograde condensation range of the phase envelope zone, so condensate oil will continue to separate out until they passes through retrograde condensation range. Natural gas has retrograde condensation phenomenon in a certain range. Even the separated dry gas still has retrograde condensation phenomenon, and its hydrocarbon dew point rises as the pressure drops, and this retrograde condensation phenomenon occurs within the pressure range of the gas pipeline, liquid hydrocarbon will be separated out in the pipeline, and the hydrocarbon dew point requirements of commercial gas cannot be met.

A high-pressure condensate gas field successfully solved the wax blockage problem by injecting condensate oil into natural gas, but its daily injection volume can only recover 10%, it can be seen that 90% enters the gas phase, due to the introduction of heavy components, the hydrocarbon dew point of natural gas sharply rises, it is close to the pipeline temperature. Therefore, condensate will inevitably separate out on the way from the long-distance pipeline to the intersection, no matter in safety, economy and transmission efficiency, it is a loss. Winter is more serious than summer.

5. Discussion and suggestions

5.1. Suggestions of the process:

5.1.1. According to the phase diagram of the processed natural gas, the natural gas is raised to above the condensate temperature and under the external transmission pressure for transportation, so that the processed natural gas has no retrograde condensation phenomenon within the pressure range of the whole gas transmission pipeline, which ensure the safe, stable and economical operation of gas pipelines.

5.1.2. Before the natural gas is transported, facilities are added to further remove and recover heavy component before entering the pipeline, or first collect liquid at the intersection and then enter the handover, moreover, regularly collect liquid pigging pipe.

5.2. From dew point monitoring:

5.2.1. Due to the difficulty in taking full-component samples, using calculation methods or phase diagrams obtain hydrocarbon dew point is costly and lacks timeliness from full component, therefore, it is recommended to measured hydrocarbon dew point as the maximum condensation temperature under 3MPa fixed pressure, which is more practical.

5.2.2. There are interference and other uncertainties during the water dew point test. When it cannot be confirmed, we can try to use a pressure reducing valve to reduce the pressure to a lower pressure for testing, and then confirm by water content conversion. The premise of this confirmation method is that the air source is stable; otherwise the water dew point cannot be determined.
References:

[1] GB17820-2012 "Natural Gas"

[2] GB/T 17283-2014 "Determination of Water Dew Point of Natural Gas-Cooled Surface Condensation Hygrometers".

[3] GB/T27895-2011 "Natural Gas Determination of Hydrocarbon Dew Point-Cooled Mirror Method".

[4] Long Huaizu, Guo Feng. Research on Control of Hydrocarbon Dew Point in Gas Transmission Pipeline[J]. Petroleum Planning & Engineering, 2004, (5): 1-12.

[5] Peter van Wesenbeeck. A Traceable Calibration Procedure for Hydrocarbon Dew Point Chilled Mirror Instruments[J]. Chemical Engineering of Oil & Gas, 2012, (03): 253~263.

[6] Wu Haihao, Sun Binbin, Sun Yu, Gong Jing. Influence of Heavy Hydrocarbons on Phase Behavior of Natural Gas[J]. Natural Gas Industry 2008, (11): 99-102.

[7] Luo Qin, Zeng Wenping, Wang Xiaoqin. Detection Technology of Natural Gas Hydrocarbon Dew Point[J]. Chemical Engineering of Oil and Gas, 2008, (S1): 53-58.

[8] Chen Gengliang. A Review on the Hydrocarbon Dewpoint of Pipeline Natural Gas[J]. Natural Gas Industry 2009, (4): 125~128.